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FRAMEWORK APPROACH AS A STRATEGY FOR RESEARCH AND DESIGN OF COMPLEX SPATIAL INFORMATION SYSTEMS (USING THE EXAMPLE OF NGDI)

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Abstract

The so-called Framework approach to the research and design of complex spatial information systems (SpIS) is considered. An example of such SpIS is the National Geospatial Data Infrastructure (NGDI) of Ukraine in the sense documented as of the end of 2024 in the Law of Ukraine "About NGDI" and in the Terms of Reference for the National NGDI geoportal. Due to the ambiguity of the term, it is advisable to consider the approach from three viewpoints (interpretations). In this paper, attention paid to one of these three viewpoints - the approach as a strategy. This strategy, as well as the Framework approach itself, called constructive, because they based on the so-called Conceptual Framework and Solutions Framework (SoFr) of the SpIS. According to the authors, the proposed strategy will solve the most important problem of the NGDI today - the actual lack of a ***strategy****. In addition, the Framework approach will help in solving the three biggest problems of the NGDI today: product, process, and expertise (quality control).*

In the domains of NGDI and NSII (National Spatial Information Infrastructure) and in their contexts, the most important are three viewpoints (interpretations) on the Framework approach as a: 1) specific constructive strategy for using geographic information systems and technologies (GIS&T) to manage the territory of Ukraine; 2)

generalization of the methodology for dealing with SpIS such as NGDI and NSII; 3) γ-method, which is denoted by γSoFr, where γ means general, and which "works" at the level (stratum) of IGIM (Integrated Geospatial Information Framework) for Ukraine. The limitations of the article allow us to dwell in more detail only on the consideration of the first interpretation. The second and third interpretations are only formulated for general understanding and with the expectation of sufficiency for next planning of the NGDI project.

One of the concretizations of the Framework approach is the so-called "AtlasSF Framework approach". It is a generalization of the AtlasSF (Atlas Solutions Framework) method and tool, which previously used to create (classic) Atlas systems (AtS). The AtlasSF Framework approach is a hierarchy of three homogeneous Solutions Framework (SoFr) methods. They called General (γ), Conceptual (β) and Application (α) SoFr, respectively, and combined into a hierarchical system (model) - Conceptual Framework of the subject X, where X, in addition to AtS, can take the values of NGDI or NSII.

The Framework approach is proposed to use for the solutions of main and actual now NGDI project problems as follows. The first problem – called ***product*** *– is solved by harmonizing the model of the existing NSII of Ukraine with the INSPIRE model. To make this solution constructive it is recommended the notion of Atlas GIS (AGIS, AGIS-CH) and the currently known implementations of its parts, proven in solving Cultural Heritage problems.*

The second problem – called ***process*** *– is solved by using the AtlasSF Framework approach. The specifics are the application of the γ-, β-, and α- SoFr methods of this approach. The not yet created γSoFr method should be a meta-method of βSoFr, working at the level (stratum) to which the IGIF projection for Ukraine belongs. The IGIF projection includes the National Spatial Data Infrastructure (NSDI) and its subset NGDI, βSoFr is an update of the GeoSolutions Framework, and αSoFr is the current revision of AtlasSF1.0+.*

*The third problem – **quality assurance** of key solutions – is solved by using the V-model of development, in which validation and verification of solutions must immediately conforms the requirements and architecture. In addition, the frameworks used are architectural patterns that should be "typical" solutions. Otherwise, the pattern (framework) cannot be a "typical solution to a typical problem".*

Keywords: *Atlas Geoinformation System (AGIS), AtlasSF Framework approach, NGDI, NSDI, NSpAI, NSII, IGIF, INSPIRE.*

Actuality and research purpose

Actual problems

In 2020, the Law of Ukraine on NGDI was accepted and the creation of the corresponding National GeoPortal began. Previously, we pointed out some problems of both the Law and the initial stages of creating the GeoPortal. This work examines the most important, integral problem: **The absence or unsuitability of the current NGDI strategy (if it exists)**. This problem is divided into two: 1) it is unknown what is being created, and 2) it is unclear how this unknown can be created. The problem of the unknown of what is being created is reduced to the problem of the "product", and the problem of incomprehensibility is reduced to the problem of the "process of creating a product".

What was said in the previous paragraph can be considered from different viewpoints and detailed accordingly. For example, it is possible to talk about the strategy of the NGDI product and the strategy of the process of its creation. However, we would like the reader of this section to understand that the most important problem is the lack of a strategy, which will definitely end in the failure of everything, starting from the NGDI idea and ending with its implementation. At the same time, it is necessary to understand that almost any failure is prone to participants in the "failure process" and will present the failure in different ways, but not as a failure. These opportunities increase incredibly in the absence of a correct and constructive strategy.

Thus, the main **goal of the research** is to propose such a constructive (realizable) strategy of the NGDI (creation) as part of the NSII (National Spatial Information Infrastructure). It is called “constructive” because it offers not just a “strategic plan”, but also a so-called “framework” approach to its implementation. Instead of a review of works on the above and below mentioned separate, although the main problems at the moment, we will refer only to the article [1], where three main and urgent problems of the NGDI creation project are formulated. Let us repeat only their (slightly updated) abbreviations:

1. **Product.** The Law of Ukraine on NGDI stipulates a product model of NGDI/NSDI (National Spatial Data Infrastructure), which does not correspond to the realities of Ukraine.

2. **Process.** The first stages of development of the National GeoPortal of the NGDI [2] (beginning of design) indicate that the developers chose a **waterfall** development process. The waterfall process is not suitable for the NGDI project.

3. **Management** (expertise). Without quality assurance of the product and process (as now), no advisory body (like Working Group) **will help**. The lack of quality assurance will make the project a failure.

According to the authors, the cited article “about practice…” should help solve the following problems: 1. Product and 2. Process. However, one should not forget about the “poor transferability” of practice. For example, it is known that in everyday life, a “coach” is usually needed to “transfer” practice. And this is not always possible. We hereby draw attention to the problem of using the terms used in the title of the cited article, and with it the notion of “practice”. In fact, “practice” is a multi-valued notion, which is specifing by adjectives such as “practice of methodics”, “practice of methodology” and even “practice of strategy”.

This article proposes a constructive strategy for creating complex spatial information systems (SpIS) similar to NGDI and NSII. A variant of the strategy is considered, which can be leaded to a Framework approach to the study and design of complex SpIS. In the proposed approach, the framework is understood as in computer science, where it is defined as an “architectural pattern”. Architecture refers to complex spatial information systems (SpIS). Examples of complex SpIS are NGDI and NSII.

The use of the Framework approach will allow solving the above-mentioned Problem 3. Management (quality assurance). This statement takes into account one of the definitions of a pattern as a typical solution to a typical problem. The pattern must be accepted by all (most) project participants, in particular, those who make decisions. This is how “typicality” is achieved.

Important notes

We would like to make the following comments to the solutions described below:

1. The investigated spatial phenomenon of reality is represented using the notion of “system”. The resulting system is called the System Under Study (SUS), or the Spatial System Under Study (SpSUS), or simply the Spatial System (SpaSys). Most known English term in professional literature is “System Under Study” (SUS). Sometimes is used “System Of Interest” (SOI) term – System, which investigated.

2. Among SpaSys or SUS, are distinguished the domains of NGDI, NSDI, NSpAI, NSII spatial phenomena, denoted NGDI/…NSII. Among other domain definitions (see below), it is advisable to use the following definition from ISO/IEC 24744:2014:

"3.1 information-based domain is an area (region) of activity for which information is the most valuable asset.

Примітка 1 до запису: це означає, що створення, маніпулювання та поширення інформації є найважливішою діяльністю у базованому на інформації домені. Типовими базованими на інформації доменами є інженерія програмного забезпечення та систем, реінжиніринг бізнес-процесів та управління знаннями. »

3. Another frequently used restriction is the allocation of a “Large Territory” (LT) in the study. To indicate whether an artifact belongs to the context of a LT, such

records as, for example, SpaSys-LT are used. LT denotes a structured territory in some way, which may be the territory of a country or some other "large" region. Examples of regions are the oblast of Ukraine or the Danube region. In the first case, the structuring is the administrative-territorial division of the country's territory into separately managed "oblasts". In the second case, the structure of the Danube region is formed by the association of countries whose rivers are related to the Danube: 1) flow through the territory of the country of the Danube region, 2) flow into the Danube, as in the case of Ukraine, where the Tisza River is such.

4. We are interested in the information models of the systems under study, which are also systems, but informational, denoted by IS. Among IS, the class of Spatial Information Systems (SpIS) is distinguished. Among SpIS, in turn, there are IS that called "classic" and have been repeatedly implemented, in particular by us. Our experience includes operating the so-called "classic" SpIS: EA, AtIS, CIS and GIS. In recent years, we have had to introduce two new classes of SpIS: Systems Electronic Atlases (SEA) and Atlas GeoInformation Systems (AGIS). To "unify" the SpIS domains and their models, the concept of context is used. **Context** is any information that can be used to characterize the state (situation) of an entity. An entity is a person, place or object that is considered relevant for (related to) the interaction between the user and the program, including the user and the programs themselves. More formal than context is the concept of modeling spaces, the components of which model or metamodel real-world phenomena.

5. Strategy is most often defined in dictionaries as a long-term plan for achieving something or achieving a goal, or the ability to make such plans.

Literature review, research materials and methods (identification of the main components of the Framework Approach)

"A pattern is, in short, both a thing that happens in the world and a rule that tells how to make that thing and when to make it. It is both a process and a thing; it is both a description of an actual thing and a description of the process that will produce that thing" [3]. We often use this definition, in addition to the definition from indormatics: “pattern is a typical solution of a typical problem”. An overview of patterns definitions given in the monograph [4].

In addition, the cited monograph describes two architectural patterns, which in computer science called “frameworks”: Conceptual Framework and Framework Solutions. The term “architectural” refers to the architecture of spatial information systems (SpIS) such as Electronic Atlases, Atlas Information Systems, Cartographic Information Systems and Geographic Information Systems. According to the above definition by Alexander [3], Conceptual Framework and Solution Framework contain a description not only of products (SpIS), but also of the processes of their creation. That is, Frameworks are both a product and a process (method). Frameworks characterized by a product-process dualism, which especially clearly manifested in Framework Solutions. In them, dualisms even form a construction called the main triad.

Recent information on Conceptual Frameworks is contained in the articles [5], [6], and on Frameworks Solutions – in the monograph [4]. Of particular interest are the long-known GeoSolutions Framework GeoSF and Atlas Solutions Framework AtlasSF, which also described in the monograph [4]. After the monograph, information on these frameworks updated in the direction of generalization. Today we have several publications that are worth paying attention to. In addition to those already cited, these are in chronological order:

1. The fundamental property of GeoSF and AtlasSF is their conformance to the model of Framework Solutions (FrSo) of the subject X. It fixed at the beginning of the century. Let us immediately note that in the monograph [4] the so-called β- and α-FrSo were considered as examples. An example of βFrSo was the GeoSolutions Framework GeoSF, and αFrSo was AtlasSF. GeoSF proposed at the beginning of the century as a method and way of building the National Spatial Data Infrastructure (NSDI), and the first version of AtlasSF - AtlasSF1.0 - as a means (technology) of building a number of Electronic Atlases, in particular, the Electronic Version of the National Atlas of Ukraine (ELNAU). The monograph explains the concept of

“editions” of AtlasSF1.0. There were three of them and they were designated AtlasSF1.0(n), where n=1, 2, 3. All of them belong to the first generation of Web 1.0. Until the "post-Web 1.0" generation - AtlasSF1.0+ - the "public" designation of revisions was not used, although the "internal", "project" revision number still exists. For example, we are currently working with revision 0.60 of AtlasSF1.0+.

2. The “method” of the so-called “model” cartography. This is described in the article [7]. The roots of model cartography are found in Tobler’s analytical cartography and in Berliant’s model-cognitive cartography. The modern development of model cartography is the monograph [8].

3. “Approach”, as stated in the abstracts [9]. The abstracts called “AtlasSF Atlas Solutions Framework as an approach, method and means of creating Atlas and GeoInformation Systems”. The title of the abstracts also identifies the “subject X” already mentioned above, which can be quite arbitrary.

Due to the volume issues, we will not consider the concepts of NGDI, NSDI, NSpAI (National Spatial Activities Infrastructure), NSII, INSPIRE, IGIF, although there have been many publications about them over the years of their existence. Instead, we recommend the article [10], which contains an initial overview of the issue and is fundamental in defining the current model of the NSDI of Ukraine. It explains the concept of NSpAI. We recommend also “to refresh” the definitions of the concepts of METHODOLOGY, METHOD, METHODOLOGY, TECHNOLOGY, MEANS according to the article [11], since they are also essential in this work.

Next, we need a general understanding of the concept of Model-Driven Engineering (MDE), a subset of which is called Model-Based System Engineering (MBSE). For this, we can use the monograph [9], which provides the following relations: MDA⊂MDE⊂MDD⊂MDE⊂MBE, where MDA is Model-Driven Architecture, MDD is Model-Driven Development, MDE is Model-Driven Engineering. Then, the following relations between the concepts of MBE and Relational Cartography were provided: MDA≈OS, MDD≈AS, MDE≈CS, MBE≈GS, where ≈ means "almost" coincide, OS – Operational Stratum, AS – Application Stratum, CS – Conceptual Stratum, GS – General Stratum. At the same time, in the monograph [9] it was emphasized many times that the higher strata are decisive for the lower ones.

Written in the previous paragraph requires multi-page explanations, for which there is not enough space here. Instead of a detailed consideration of MBE, we will cite sources where it is possible to obtain additional information. We will only point out the very useful monograph for understanding MBE [12] and the monograph [13], reprinted several times. The relations MDA⊂MDD⊂MDE⊂MBE is present in other sources in one way or another. The concepts of "modeling" and "models" as objects of modeling/research used in the article require clarification/explanation. There is extensive literature devoted to these concepts, including the references already given.

In our works, we often use the term and concept of Information System (IS, here SpIS) in a broader sence (ISb, here SpISb). "Usual" IS are called IS in the narrow sense (ISn or SpISn), which, like ISb (SpISb), are defined in [14]. The concept of ISb (SpISb) has proven to be very useful and powerful. In particular, the concept of "extension methodics" is used further, which is applied to certain ISn/SpISn. Conceptual Frameworks and Frameworks Solutions also use the concept of "extension", as they define the structure of an extended SpIS and thereby indicate the components that need to be extended. Extension is the basis of our methodology, part of which (methodics) is called Atlas Extension (AtEx). Atlas extension is performed "bottom-up" - from the Electronic Atlas (EA) to the Geographic Information System (GIS) or even to the Geographic Information Platform (GIP). "Extension" is nothing more than supplementing the knowledge of the current stratum with the knowledge of the neighboring stratum, while respecting the accumulated (known) knowledge about the relation between the strata. In addition to AtEx, we also identified GeoInformation Extension (GIE), as well as "mixed" extensions. The GIE methodology is called a "top-down" extension, from GIP/GIS to EA. In both cases of extension - "bottom-up" or "top-down" - framework methods are used to solve known problems, and the solution of new problems is carried out according to some development model. In this case, we talk about “mixed” or “combined” extensions.

If we compare the MBSE methodology and our variants of the “extension” methodology based on extension methodics (for example, AtEx), we must admit that our results cannot yet be called a “Pattern-Based Methodology for Handling SpIS” or some other methodology with a similar name. At the same time, we already have practical experience in applying the practice of creating a hierarchical (complex) SpIS, so we can quite clearly describe the process of creating this hierarchical SpIS, which definitely exists. And if there is both a process and a practice, then there must be a methodology. We believe that it only needs to be further defined and described. This is enough to use the term “approach” with justification and call it (like the strategy) constructive.

At the moment, our approach can also be called the “Framework approach of extension (of Atlas and Geographic Information Systems)”. It is based on framework methods from two groups, each homogeneous with respect to the subject: 1) Conceptual Frameworks X, 2) Frameworks Solutions XY. Although the approach itself cannot be called a set of homogeneous methods, since in the first case the subject is X, and in the second – XY. In general, solutions obtained by applying one of the two or both frameworks (and an arbitrary number of times) are called frameworks. The concept of X has been explained several times before. The concept of XY is divided into two concepts with variable values. Y shows the dependence on the value of the stratum, therefore the SoFr XY can be formulated as follows: (Conceptual (β) │Application (α) │Operational (ω)) Framework Solutions of the stratum Y= β, α, ω, of the Subject X.

Since the beginning of the century, we have used instances of both Frameworks in many projects for the creation or development of subject X. In fact, generalizations began immediately, which can be combined into two directions, homogeneous according to some criterion: 1) subject, or 2) process.

Around the middle of the last decade, we believed that:

1. The first version of the GeoSolutions Framework (GeoSF1.0), implemented in the standard version of GeoSF0, has ‘worked out’. We came to this conclusion due to the obsolescence of the ISGeo Triplenet Software Suite (TriNet) portal software, on which GeoSF0 was implemented.

2. In practice, we used the GeoSF specialization – the first version of the Atlas Solutions Framework (AtlasSF1.0). This means, in particular, that we narrowed the subject area of GeoSF to Electronic Atlases (EA) and Atlas Information Systems (AtIS) – together, AtIS. That is, we moved away from the subject of NSDI. In fact, it turned out that everything was so and at the same time wrong. Namely:

1) GeoSF consists of a GeoSF method and means. Means are implementations of the method. GeoSF specialization in AtlasSF is not a simple specialization (instantiation), but part of a more complex conform relation. AtlasSF is a mean of the AtlasSF method, which is different from the GeoSF method. GeoSF0 means are deprecated, but GeoSF method is not.

2) Based on the definition of the method, we arrived at the concept of an approach, which we called the “Framework of (spatial) solutions” (SoFr). We omit the adjective ‘spatial’, since we are always dealing with a generalization of geosystems – spatial systems. If this is the case, then all the Framework Solutions identified and/or developed by us – ProSF, GeoSF (GeoSF1.0), AtlasSF1.0 and AtlasSF1.0+ – are methods from the set of homogeneous methods of the SoFr approach.

3) Each SoFr method ‘works between’ two adjacent strata. Therefore, we have started to introduce ‘strata’ refinements into the names of the methods: for example, ‘application’ or ‘conceptual’.

4) Previously, we believed that there was a small inconsistency - the 'natural' hierarchy of method-implementation of the method (means) is violated. To deal with this, the concept of application and/or conceptual methods was introduced. And these are already three, and for the Web 1.0+ formation - even all four strata.

In addition, we fall under the 'mixture' of elements belonging to several strata at once, if several formations need to be considered in one system. This is difficult to explain and describe.

5) Another problem has been created by the development of modern technologies, when it is supposedly possible to 'get' an element through (by skipping) a stratum - for example, a base map from a Conceptual Stratum.

Difference between Approach and Methodology

First, let's understand the concepts of "approach" and "methodology". The reason for using them together here is the "epistemological neighborhood" or, in other words, the "neighborhood of knowledge" about these artifacts, which is explained further in **Fig. 2.** It is taken into account that the relations between the corresponding components of neighboring "epistemological" hierarchical levels/strata is no less important than the components themselves. An informal representation of our understanding of the hierarchy of the concepts of "approach" and "methodology" used in the context of the article in open sources is as follows:

Approach and methodology are closely related terms (concepts?) that are often used in research, problem solving, project management, and other fields. Although related, they have different meanings:

Approach: 1) An approach refers to an overall perspective or way of addressing a problem, task, or situation; 2) It is a broad plan or strategy that sets the general direction for how something will be done; 3) An approach is more high-level and conceptual, focusing on the main principles or ideas that will guide the work; 4) It is often described in terms of the philosophy or theoretical framework that underlies a particular effort.

Methodology: 1) Methodology, on the other hand, refers to the specific procedures, methods, and tools used to carry out a particular task or research project; 2) It is a systematic and structured way of collecting data, analyzing information, or solving a problem; 3) Methodology is more detailed and practical comparing to an approach, outlining the step-by-step process that will be followed to achieve the objectives outlined in the approach; 4) It includes the methods, techniques, and tools that will be used to collect and analyze data, test hypotheses, or reach conclusions.

In summary, an approach sets the overall direction and provides a guiding philosophy, while a methodology outlines the specific steps and methods that will be used to implement the approach and achieve the desired results. An approach is more about the "what" and "why," while a methodology is more about the "how."

In the article [10], the framework approach was understood as a set of (non)homogeneous "framework" methods. This meant that the methods could be both homogeneous and heterogeneous, but still "framework". The Dictionary of Business Terms (and Wikipedia) was used there, where the approach was defined as "a set of homogeneous methods". The concept of "homogeneous totality" was not defined. Instead, we followed the definition of homogeneity through "statistical totality" (with obvious edits): 1) *Homogeneous totality*: accessed 2024-Jul-22, https://rus-business-terms.slovaronline.com/18163- Homogeneous totality - a statistical totality, which is characterized by the belonging of its constituent elements to the same type of phenomenon and the similarity between the elements according to the features essential for this research.

Or 2) *Totality, homogeneous*: The same as in 1) + The statistical totality can be homogeneous for some features, and heterogeneous for others.

Additional information about the concept of "approach" together with the concept of "methodology" here and there is given not simply. Even though our results have not yet been formalized as a methodology for SpIS handling (including a methodology for creation). At the same time, this information is enough to confirm that it is suitable for more than a totality of homogeneous and even heterogeneous methods.

When the phrase "Framework approach to research and design of (folding) SpIS" gets used, then they are toil in respect:

1. Two classes (groups) of frameworks: 1) Conceptual Frameworks (CoFr); 2) Frameworks Solutions (SoFr). Frameworks here are the so-called architectural

patterns that are used in information technology to operate information systems or their components, which correspond to the concept of subsystems.

2. Well-known, “classic” examples of SpIS are Electronic Atlases (EA), Atlas Information Systems (AtIS), Cartographic Information Systems (CIS) and GeoInformation Systems (GIS). Each class has its own, recognized by a certain group of researchers and therefore “classic”, definition. Spatial information systems (SpIS) are left for designation, in addition to “classic” and “non-classic” SpIS. Examples of “non-classic” SpIS are the so-called Systemic EA (SEA) and Atlas GeoInformation Systems (AGIS), the definition of which is still recognized by a small group of researchers.

3. The concept of “complex SpISs” is reserved for such “classes” of SpIS as NGDI, NSDI, NSpIA, NSII, INSPIRE, and IGIF. Instances of these classes are truly complex SpISs. All of these classes, or their understandable instances, require clarification, however, according to our understanding: NGDI $\subset$ NSDI $\subset$ NSpIA $\subset$ NSII $\subset$ INSPIRE $\subset$ IGIF. Each inclusion $\subset$ cannot be called “homogeneous”, but the main thing here is to recognize their existence.

The research domain and its understanding as a system

In computer science, the term "domain" refers to a part of reality that is modeled by a computer system or application. In particular:

1) In software engineering, a **domain** is the intended subject area of a computer program. Formally, it represents the intended subject matter of a particular software project, whether narrowly or broadly defined. For example, for a particular software project whose goal is to create a program for a particular hospital, that hospital would be the domain. Or, the project could be expanded to encompass all hospitals as the domain. In computer programming design, a domain is defined by outlining a set of common requirements, terminology, and functionality for any program designed to solve a problem in the field of computer programming, known as domain-based engineering. The word “domain” is also taken to be synonymous with *application domain* [15]. A **domain** usually refers to the subject matter of an application. In other

words, in application development, a domain is the area of knowledge and activity around which the logic of the application revolves.

2) **Domain**: A sphere of knowledge, influence, or activity. The subject area to which a user applies a program is the software domain [16].

The term “domain” in this article refers to the uniting of the subject areas of the NGDI, NSDI, NSpAI, NSII systems, which is denoted by NGDI/…/NSII. The INSPIRE and IGIF domains are also related to the research domain of the article, but we can count on their management only within Ukraine, so the list of domains is shortened. At the beginning, only the inclusion relations NGDI⊂NSDI⊂NSpAI⊂NSII and, probably, NSII⊂INSPIRE⊂IGIF are fixed between the components of the domain. Then they are specified. These relations are different, their belonging to the inclusions ⊂ is achieved by specializations that can be useful from the viewpoint of additional knowledge both about the components themselves and about the relations between them. For explanation, let's consider the obvious ones: NGDI⊂NSDI, NSII⊂INSPIRE.

The relation between NGDI⊂NSDI may seem like a terminological problem: Geospatial or Spatial data? We have already explained the differences in terms in earlier works: the term “spatial” is more general than “geospatial”. However, more important are the differences in the understanding of modeling systems: NGDI or NSDI. The NSDI of Ukraine is inextricably linked to Spatial Infrastructure Activities (SpIA) in Ukraine. In fact, the study of SpIA related to NSDI is more important, and not vice versa. Only NSDI and SpIA or their important parts, between which the dualism relation is true, are of practical interest. An example of such dualism can be formulated as follows: it is impossible to operate with NSDI without SpIA, and modern SpIA is impossible without (digital) NSDI. This dualism is a type of “process↔product” dualism, where the process is SpIA, and the product is NSDI [10].

The relation between NSII and INSPIRE seems obvious, since NSII is the Spatial Information Infrastructure (SII) of Ukraine, and INSPIRE is the European

Union (EU) SII. Without specifying the inclusion relation, this is almost an obvious fact, since Ukraine (in particular, as a territory) wants (plans) to become a member of the EU. The problem here is the insufficient formalization of both NSII and INSPIRE, without which we do not risk saying specifically what we are talking about. For example, in Ukraine there is an informal opinion that INSPIRE is a set of specifications of component (fundamental) data. At the same time, the Law of Ukraine "On NGDI" does not oblige to comply with these specifications, and the absence of the INSPIRE-specific order of processing fundamental data (first, second, third queues) makes the implementation of this Law unrealistic. At least due to the constant limitation of resources and the lack of priorities (ordering), it is possible to spend all of them in a specific period of time on things that are not essential at the moment.

An additional explanation of our understanding of the research domain comes from the so-called Model-Based Engineering (MBE), which is often considered as Model-Based Systems Engineering (MBSE), Model-Driven Engineering (MDE), Model-Driven Development (MDD), or even Model-Driven Architecture (MDA). All these terms and concepts are explained in the monograph [4]. There, the scheme MBE $\supset$ MDE $\supset$ MDD $\supset$ MDA is proposed. Despite the large number of monographs on this topic, we will use in a sense the "primary" articles [18] and [19].

According to [19], the idea of Model-Driven Engineering (MDE) originated from software engineering (SWE)… MDE evolved when the paradigm (of programming) changed from object-oriented, where everything is an object, to model-oriented, where everything is a model. The object-oriented paradigm is about classes and objects, and the main relation are instantiation (an object is an instance of a class) and inheritance (a class inherits from another class). MDE is about models, but it also concerns the relation between the model and the system under study (which can be a software artifact or a real-world domain), metamodels, and model transformations. Similar to the object-oriented paradigm, MDE can be characterized by two main relations, namely representation (a model represents a software artifact or a real-world domain) and confirmation (a model confirms to a metamodel). In general, MDE is a branch of systems engineering in which the process relies heavily on the use of models and modeling. Modeling is viewed as the disciplined and rational production of models.

Fig. 1 shows the Metamodel of the Favre Megamodel (excerpt) as a UML class diagram. The diagram defines the most abstract discourse (domain) concept in the MDE, the System. The (incomplete) classification of systems, shown in **Fig. 1a**, distinguishes between physical systems (PhysicalSystem), digital systems (DigitalSystem), and abstract systems (AbstractSystem). A PhysicalSystem represents things from reality, such as a "travel agency". An AbstractSystem is an abstraction in the human mind that can be processed by the human brain, such as concepts and their relations from the biological domain. Finally, a DigitalSystem is a digital representation that can be processed by computers, such as an XML document with a representation of biological classes and their properties in OWL format.

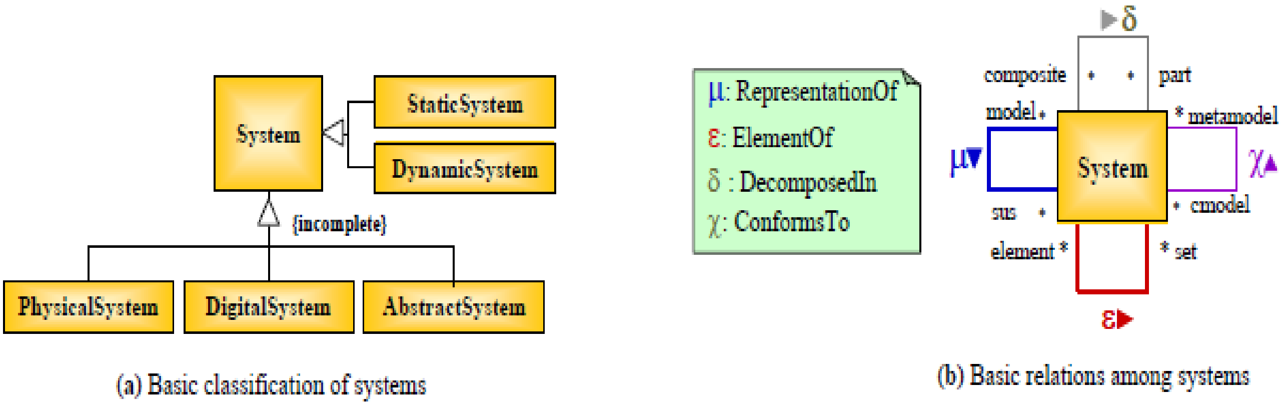

Fig. 1. Megamodel: classification of systems according to [18]; a) Basic classification of systems according to [30; Fig. 1]

In our work, we have been using the concepts of Abstract, Digital and Physical Systems (AbstractSystem, DigitalSystem, PhysicalSystem) from [18], [19] for quite some time as a specialization that we need. Namely, in the part of reality or actuality that interests us, a system is usually given, which we call the "system under study" (SUS) or "spatial system under study" (SpaSUS) or simply "spatial system" (SpaSys). In the field of computer science, a SpaSys is often denoted as SUS (System

Under Study). We are interested in a special class of SUS or SpaSys information models, which is called Spatial Information Systems (SpIS). Among SpIS, we research, design and create instances of the EA, AtIS, CIS and GIS classes.

In recent years, we have had to introduce into consideration two more classes of SpIS, which are called Systemic EA (SEA) and Atlas GIS (AGIS). The reasons for the emergence of these classes of SpIS are different, although their instances may have much in common. The concept of SEA is used to denote the "probable" results of the evolution of "classic" atlas systems (AtS). The classic AtS is called the union of (classic) EA and AtIS: AtS = EA∪AtIS. The AGIS class arose as a result of the development of the concept of a modern registration system of immovable cultural heritage (CH) [20]. According to this concept, in simple terms, the modern register of immovable CH cannot be simply a Register, but should be an Atlas GIS (AGIS) of Cultural Heritage - AGIS-CH. At the same time, AGIS-CH should be a hierarchically organized multi-strata system, in which the systems of each stratum (components) should model the corresponding part of reality/actuality.

In this article, the Framework approach is inseparable from the domain and its model X to which it is applied. Assigning values to the variable X is allowing to specialize the Framework approach. One such (published) specialization is the AtlasSF Framework approach [9], which we use to handle AtS. Using the results of [21; Fig. 3], **Fig. 2** is obtained, which is called the scheme of usage of Atlas Geoinformation Systems and Models (AGIS and AGIM). At the same time, the usage of AGIS and AGIM is a minor limitation, since the latter can be used to represent almost all currently known SpIS.

The names of **Fig. 2** may vary depending on the context. Here it is given by the AGIS and AGIM systems used to model the reality represented by SUS. We have used the notation "SUS of LargeTer" – SUS of the Large Territory (LT). The SUS, in turn, are represented by the so-called Spatial Systems (Spa-systems) and/or Geo-systems. They belong to the so-called Abstract (virtual) world, Abstract-physical world and/or Physical world. AGIS includes all classic AtS, as well as non-classic

AtS needed in practice today. Geo-systems from **Fig. 2** conform to Physical Systems (PhysicalSystem) from **Fig. 1a**, and Spa-systems from **Fig. 2** are shown in two parts: the first of the two is from the Abstract (virtual) world, the second of the two is from the Abstract-physical world. The part of the Spa-system from the Abstract (virtual) world in **Fig. 1a** corresponds to the AbstractSystem in **Fig. 2**, and the Part of the Spa-system from the Abstract-physical world in 2a conforms to the DigitalSystem in **Fig. 3**.

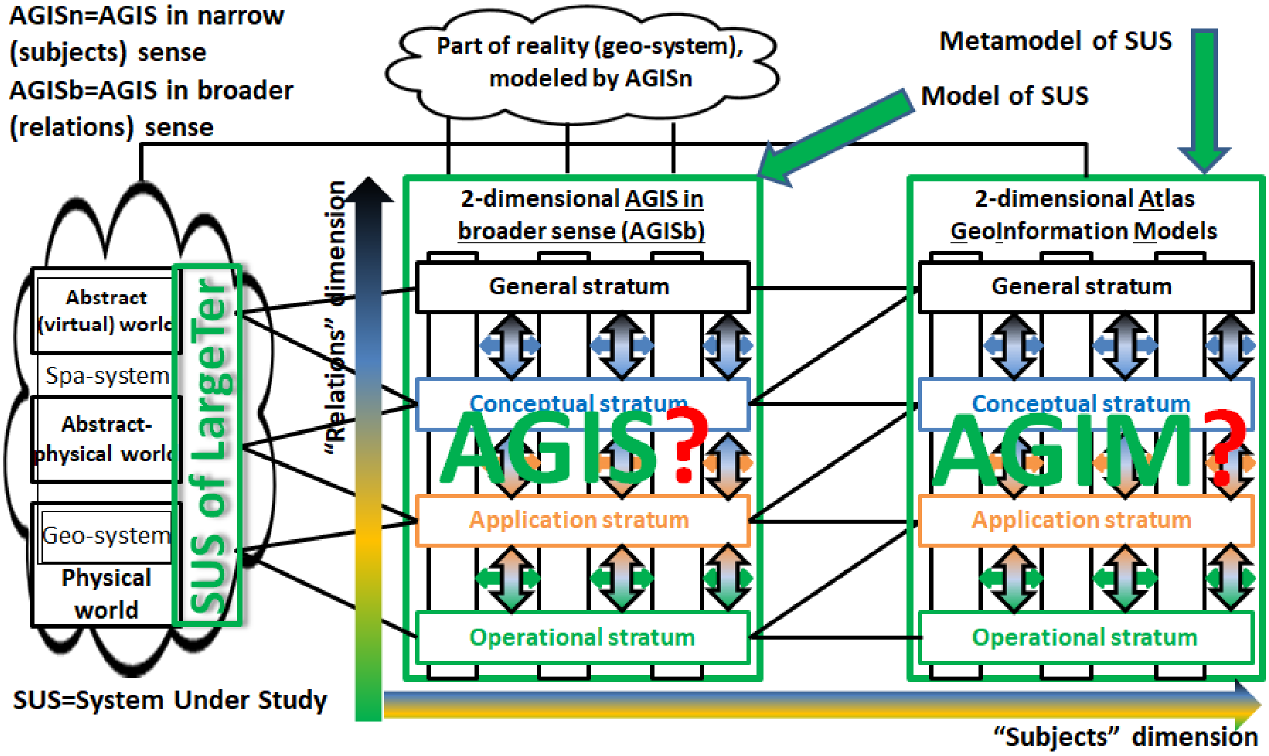

Fig. 2. Scheme of usage of AGIS and AGIM

Of course, Geo-systems are also Spa-systems, but we show them separately in order to be able to distinguish physical geography and its achievements. For example, in **Fig. 2**, the relations of the Operational and Application Strata of model (AGIS) are meant primarily with the Geo-systems of the Physical World. An example of such a "geo-system" is relief. At the end of the section, we give their definition from [21]: A *Geographic (spatial) system (Geo-system (Spa-system))* is defined as an ordered pair (A, R), where A is a set of things, among which there are geographical (spatial), and

R is a set of relations between the elements of the set A, which form a unity or organic whole.

Interpretations of the Framework Approach (in domain and context)

In the domain and context of NGDI/…/NSII, the term “approach” is understood in three senses: 1) as a strategy for using GIS&T in the management of (large) territories (LT) of Ukraine; 2) as a generalization of the methodology for expanding SpIS, which include NGDI and NSII; 3) as a certain general (γ-) method for studying complex spatial phenomena and designing their information models (SpIS) using Conceptual Frameworks of “subject X” and Frameworks Solutions of “subjects XY”, where X can take the values of both NGDI, NSII, and other rather arbitrary AtS. Another change in subject X depends on changes in values of Y, which denote belonging to a stratum. That is, XY are used to denote different values of subject X, which may depend on the values of stratum Y.

To present our understanding of the “approach” helps **Fig. 2**, which is often called the “research scheme”, dependent on the Subject of research (domain) of SUS. To describe it, it is enough to explain the meaning of the relations between entities shown by the three-dimensional arrows: 1) “Relations” dimension, 2) “Subjects” dimension, 3) Model of SUS, 4) Metamodel of SUS. The description of the relations follows the description of the entities.

Relation 2) “Subjects” dimension is the easiest to explain, so let’s start with it. This arrow indicates the study of subjects, which is carried out by transforming the representations of subjects at each stratum. At the lowest stratum, subjects are entities of the Physical World and, in particular, the Geo-system. The transformation of subject representations is carried out “left-to-right” - according to the Datalogic-Infologic-Usage process. The simplest example is the transformation of electronic map artifacts from the Operational Stratum. At the beginning of the transformation, we have input data for building a map, which are usually obtained from the “SUS of LargeTer” and, more specifically, from the Geo-system of the Physical World. As in

[21], we recommend starting with the transformational cartography to be used in this work from the monograph [22].

Relation 3) Model of SUS shows the modeling relations of "SUS of LargeTer" - AGIS (6 relations shown by "usual" arrows and a volumetric green arrow "Model of SUS"). They take into account the relations 1) "Relations" dimension, which are not the most obvious. Unlike the rather obvious relation 2) "Subjects" dimension, it states that there are two types of relations between the elements of the strata. The first type is called "epistemological" relations, indicated by "bottom-up" arrows. The second is called "reductive" relations, indicated by "top-down" arrows. "SUS of LargeTer" should be modeled by a hierarchical SpIS, the class of which in this case is indicated by AGIS. The question mark next to AGIS means that there may be options primarily from the set of "two-dimensional" AGIS in the broader sense (AGISb). Further generalization is allowing even to state the possibility of using other two-dimensional models.

Relation 4) in **Fig. 3** is the relation between the "SUS Metamodel" and "SUS of LargeTer" or, in other words, between AGIM and SUS LT. In this case, AGIM should be a model of SUS LT and be modeled by AGIM. That is, AGIM should be a metamodel of SUS LT. When using AGIM, the studied system (SUS LT), the modeling system (AGIS) and its models (AGIM) are understood as hierarchical, multi-strata and necessarily interconnected by a modeling relation. Each stratum of AGIM/AGIM can be processed separately, even by a separate group of researchers, but so that the per-strata results can be (iteratively) integrated into the final hierarchical system. In addition to the green research subjects "SUS of LargeTer", AGIS and AGIM, **Fig. 3** also shows other elements. Most of them are present in the [21; Fig. 3] and described in the cited article.

When creating modern complex Atlas and GeoInformation Systems (AtS, GIS, AGIS, AGIM, etc.), it is necessary to use many different information constructs: approaches, methodologies, methods, techniques, technologies and tools. An example of such a system is the Atlas GeoInformation System (AGIS) of cultural heritage

(AGIS-CH). The conception of AGIS-CH and its model AGIM-CH is described in the monograph [20]. It is decisive for the initial understanding of AGIS and AGIM. Further, we use our vision of the majority of all the mentioned information constructs and their basic relations sufficient for the article. SUS LT, AGIS and AGIM are used, where necessary, as examples.

Hambrick and Fredrickson's strategic diamond

This subsection significantly uses of the article [23] and its implications, some of which are referenced in [24]. Given the topic of this article, we highlight three important theses.

First, even title of the article [23] - Are you sure you have a strategy? - makes us not take the term "strategy" lightly, but rather think about its real meaning. It must be said that the term is very popular and most often does not correspond to the concept and subject to which it is applied. Hambrick and Fredrickson give the following examples of strategy formulations, taken from actual documents and announcements of several companies: 1) "Our strategy is to be a low-cost supplier"; 2) "We adhere to a global strategy"; 3) "The company's strategy is to integrate a number of regional acquisitions"; 4) "Our strategy is to provide unsurpassed customer service"; 5) "Our strategic goal is always to be first"; 6) "Our strategy is to move from defense to industrial applications."

What do these grand statements have in common? Only that **none of them is a strategy**. They are strategic threads, simply elements of strategies. But they are no more a strategy than Dell Computer's strategy, which can be summarized as direct sales to customers, or Hannibal's strategy of using elephants to cross the Alps. And their use reflects an increasingly common syndrome - the pervasive fragmentation of strategy.

Second, the authors [23] essentially propose a model of the so-called “strategy rhomb” for the “managerial” description of strategy. It (the model) is already present in an excerpt from the Executive Overview: “…Strategy has become a common term used to denote what someone wants. Managers now talk about their “service strategy," their "branding strategy," their "acquisition strategy," or whatever other strategy they have in mind at a given moment. But strategists — whether they are CEOs of well-known firms, division presidents, or entrepreneurs — must have a strategy, an integrated, comprehensive concept of how the business will achieve its goals. If a business is to have a single, unified strategy, then it must have parts. What are these parts? We present a framework for strategy development, arguing that strategy consists of five parts, answering five questions — arenas: where will we be active? products: what will we deliver? differentiators: how will we win in the market? staging: what will be our speed and sequence of moves? economic logic: how will we get the return? The article develops and illustrates these areas of choice, emphasizing how important it is that they form a single whole.

One of the options for a graphic representation of the strategic diamond is shown in **Fig. 3**. Starting from the top corner of the diamond and moving clockwise, we have the following key elements: arenas, products, differentiators, staging, and, in the middle, economic logic. To obtain an effective strategy, it is important to consider each of the five elements of the given strategic diamond model, since they are all interconnected and reinforce each other. More detailed explanations:

1. Arenas: What do we plan to achieve? What is the nature of our products, services, sales channels, and market segments? What geographic areas do we plan to expand into? What technologies will we use?

2. Products (Vehicles): What will we deliver? Will we create strategic alliances? Development? Licensing?

3. Differentiators: What sets us apart from our competitors? Is it image, price, product reliability, and how quickly we get our product to market? How do we win the market?

4. Staging: How will we promote our product or position it? How fast will we move? In what order will we move forward?

5. Economic logic: How will we recover costs (earn profits)? Will this be achieved by reducing costs to capture value? Providing premium services at a premium price?

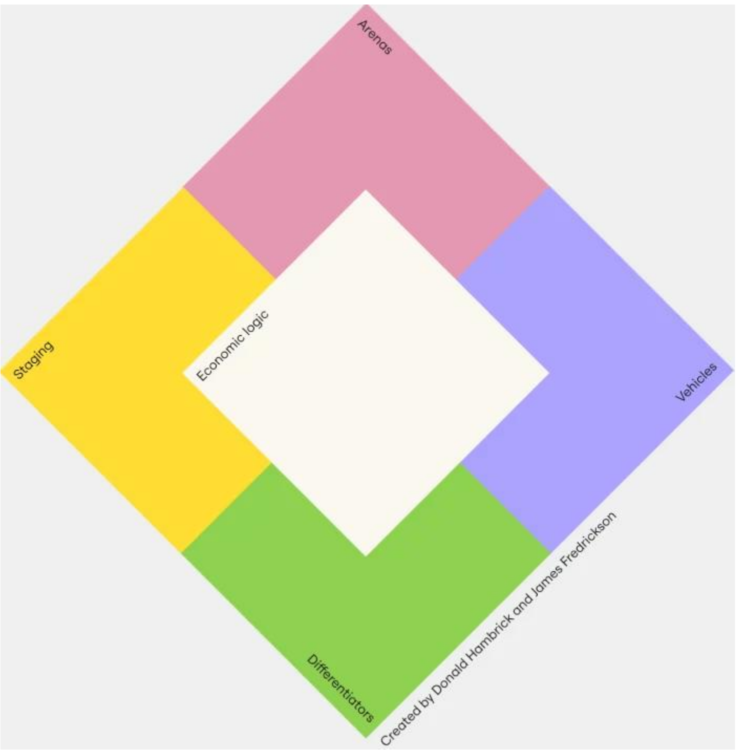

Fig. 3. Strategic diamond model

Third. It is needed to pay attention to the already existing software implementations of the strategic diamond model. So, it is easy to get your own strategic diamond using the ***Miro*** visual collaboration platform, which is an ideal canvas for creating and sharing an integrated strategy model. The company offers to use **the strategic diamond template.**

Although the five elements make up the strategic diamond, a good strategy is more than just choices on five fronts. It is an integrated, mutually reinforcing set of options that form a coherent whole.

The example below illustrates how Tesla's strategic approach, viewed through the diamond framework, played a key role in its success:

Arenas Tesla's Main arena is the electric vehicle market. The company specializes in the design, manufacture, and sale of electric vehicles. Tesla's arena also

extends to energy storage solutions, solar panels, and the development of autonomous driving technologies. In the big picture, its arena revolves around renewable energy infrastructure.
Tesla's **products** include a line of electric vehicles, including sedans (Model S, Model 3), SUVs (Model X, Model Y), and the upcoming Cybertruck. These vehicles feature advanced technology, high-performance capabilities, and long-range electric batteries that set them apart from traditional internal combustion engine vehicles and other electric vehicles.
Differentiators Tesla's key differentiators are its technological innovation, brand image, and focus on sustainability. The company has established itself as a pioneer in electric vehicle technology with advanced battery systems, energy efficiency, and autonomous driving features. Tesla's brand image is associated with luxury, innovation, and environmental awareness, which attracts consumers looking for environmentally friendly transportation options.
Staging Tesla initially focused on producing high-end electric vehicles to attract early buyers and demonstrate viability. As it gained recognition and improved manufacturing capabilities, it expanded its offerings to include more affordable models aimed at a global consumer base. Tesla has also accelerated its development of autonomous driving technology, gradually introducing advanced features via over-the-air software updates.
Tesla's **economic logic** is centered around achieving economies of scale, reducing costs, and creating a sustainable business model. The company plans to increase production volumes to lower costs and make electric vehicles more affordable for the mass market. It also seeks vertical integration, producing key components in-house to reduce costs and capture value throughout the supply chain.

Interpretation of the approach as a strategy in the domain and context of NGDI/…NSII

The interpretation of the approach as a strategy follows from the results of the article [11], called "Towards strategy of geoinformation systems and technologies using for territory management”. Both there and here the clarification “large territory” (LT) is used, one of the meanings of which is the territory of Ukraine. The cited article presented Figures 2 and 4, from which **Fig. 5** follows. We caution that we are not talking about direct conclusions, since in the cited article the subject of the study was limited to the GIS&T domain, although the NGDI…/NSII domain obviously belongs to it. Since no direct evidence is provided for this, we note with this caveat that Fig. 5: 1) graphically clarifies the theses “Framework approaches in territory management strategy” and the corresponding report1[1], 2) shows that the (framework) approach is a hierarchical concept dependent on the methodology; 3) “epistemologically” harmonizes the above-mentioned information constructions. In the context of the article, we can formulate the strategy as **“Using the Framework Approach for the Research and Design of Complex SpIS such as NGDI, NSDI, NSpAI and NSII”.** Our “AtlasSF Framework Approach” [9] is a specialization of the Framework Approach.

At the “Infrastructure Echelon (NSDI)” we added the Environment to the Methodology (see **Fig. 4** on the right). In this case, the Environment corresponds to the definition from [25], and by Methodology we can understand as: 1) the Methodology of Models Based Systems Engineering (MBSE, [25]) or 2) the methodology we create, which would correspond to our approach and would take the meaning of one of the extension methodics: Atlas Extension (AtEx), GeoInformation Extension (GIE), or Combined Extension. We showed the processes of methodologies as an alternative to the Methodics – Processes from [25]. Epistemologically below are Method/Practice/Technology. Technology is shown higher than the components Means/Tools, because it is higher (better) organized.

[1] V International Scientific and Practical Conference "Formation of Sustainable Land Use: Problems and Prospects", Kyiv, Dec 19, 2024. Report "Towars strategy of geographic information systems and technologies using for territory management". In fact, the report "Harmonization Practices (SII) of Ukraine with INSPIRE taking into account the lessons of the DRDSI (Danube Reference Data and Services Infrastructure) pilots" was held

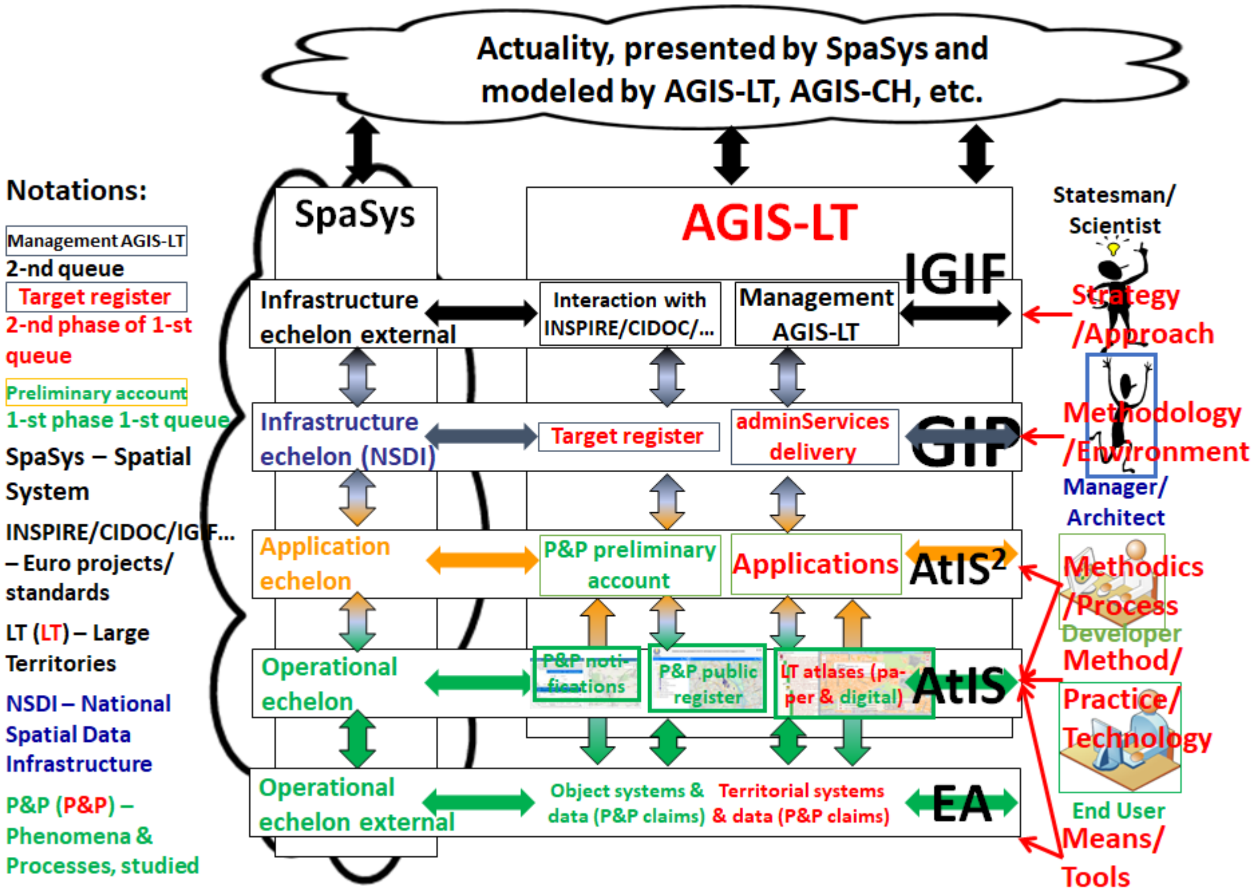

Fig. 4. Corrected figure [11; Fig. 2, 4]

The term "Practice" denotes a concept that in the "epistemological" hierarchy (hierarchy of knowledge) is on the same level as the concepts "Method" and "Technology", as shown in **Fig. 4**. To interpret the concepts, a special class of the so-called Atlas GeoInformation Systems (AGIS) of Large Territories (LT, AGIS LT) is used as an example, where LT can be a country or a "managed" region. AGIS is a hierarchical integrated system of spatial information systems (SpIS), where at the lower level of the hierarchy there are usually Electronic Atlases (EA), and SpIS of higher levels are certain generalizations of EA, including Atlas Information Systems (AtIS), GIS, or GeoInformation Platforms (GIP). The term "certain" here means that the generalization is carried out using such well-known in computer science relations as "classification" or "conformity." For less formalized relations, the term "metasystemicity" is used.

The red arrow and the entry "Strategy/Approach" indicate the "External Infrastructure Echelon". In this echelon, three artifacts from AGIS-LT are shown: 1) the rectangle “Interaction with INSPIRE/CIDOC/…”, 2) the rectangle “AGIS-LT management”, and 3) a two-sided volumetric arrow with the IGIF caption. The meaning of the rectangle “Interaction with INSPIRE/CIDOC/…” is described in several our works. Of these, only the results of the article on the harmonization with INSPIRE of the so-called Spatial Information Infrastructure (SII) of Ukraine [17] were used.

To explain the current meaning of the rectangle “AGIS-LT management” in this article, we will use the relation of one or more artifacts of the “something” group with IGIF. The term “something” is used here to denote artifacts corresponding to IGIF. To provide an interpretation of the term “something”, we will consider the available information about IGIF. The first such useful information is obtained from the presentation [26], where is **Fig. 5**. There, IGIF (Integrated Geospatial Information Framework) and its components are shown on the left, and (N)SDI ((National) Spatial Data Infrastructure) and its components are shown on the right.

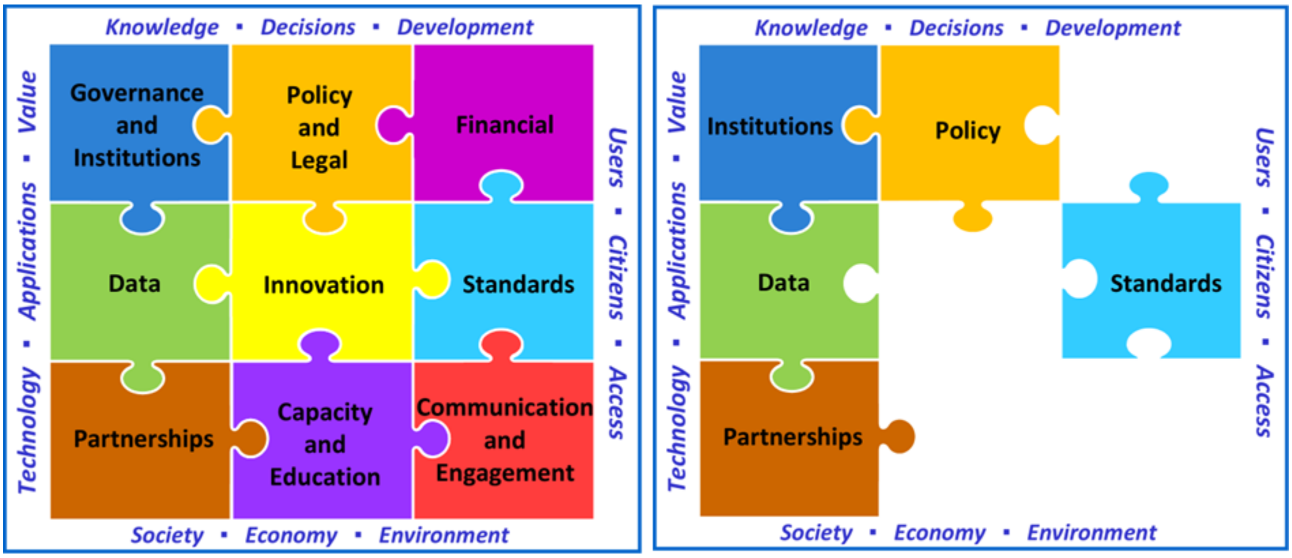

Fig. 5. The relation between IGIF and NSDI according to [26]

Let's remind that **Model-Based Engineering** (MBE) is defined as: “An **approach** to engineering that uses models as an integral part of the technical basis (baseline), which includes requirements, analysis, design, implementation and verification of capabilities, system and/or product throughout its life cycle (acquisition)” [25]. We note that all the most advanced models of the product/system life cycle necessarily include the phases of research, development and support. MBE states that at each of these phases there should be corresponding models of the SUS.

The MBSE (Model-Based Systems Engineering) **Methodology** is defined through a **process**, **method** and **tool (technology)** [25] as follows:

- **Process** – A logical sequence of tasks that are performed to achieve a specific goal. A process defines "WHAT" must be done without specification/concretization "HOW" each task must be performed.

- **Method** – Consists of techniques/ways/means of accomplishing a task, the "HOW" of each task. The terms "method", "technique/way/means", "practice" and "procedure" can be used interchangeably in this context.

- **Tool** – A instrument used in a particular method that can improve the effectiveness of a task. Thus, methods help bridge the gap between process and tools. The purpose of a tool should be to facilitate the execution of the "HOW".

- **Methodology –** Defined as a set/collection of related processes, methods, and tools.

There are relations between the components of the definition, which are also important elements of the methodology. **Fig. 6** and **Fig. 7** help to understand them.

There are close, supportive relations between the components of PMTE (Process, Methods, Tools, Environment) according to the PMTE paradigm, shown vertically in the middle of **Fig. 6**. These components of PMTE must be consistent with each other and must be well integrated and balanced to achieve the greatest benefit from good systems engineering practices. The process is performed using methods appropriate for each step of the process. In other words, a specific process must be supported by specific methods. In turn, each method may be supported by one or more tools. A tool must be supported in a specific environment.

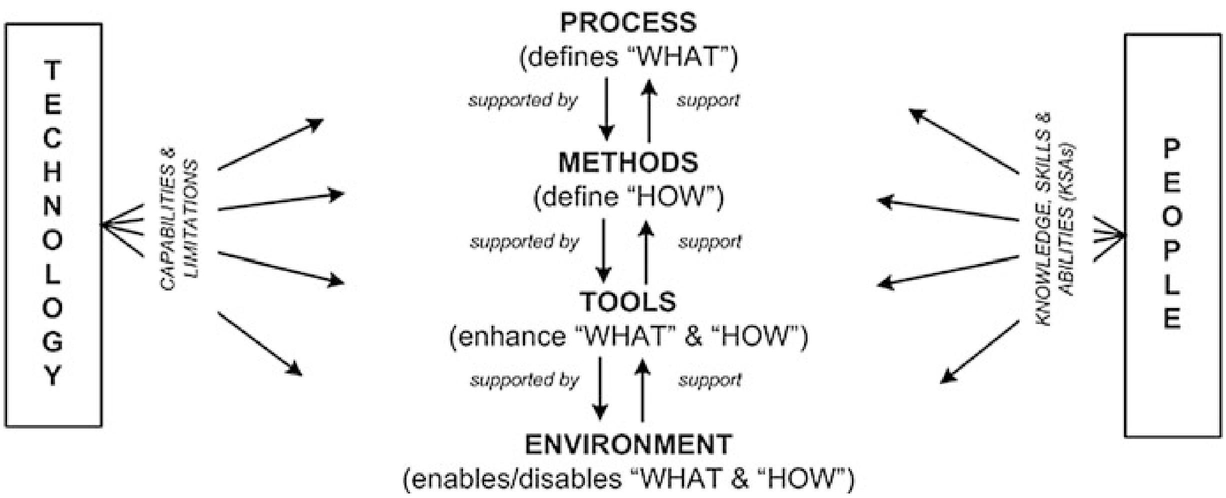

Fig. 6. PMTE elements and the impact of technology and people [25; Figure 3-10]

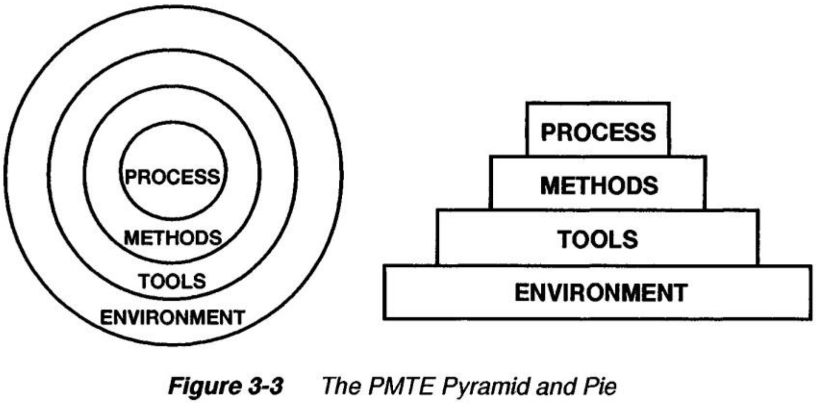

Fig. 7. The PMTE pyramid and its pie chart [25; Figure 3-3]

Let us recall some useful definitions from [25].

A *process* is a logical sequence of tasks that are performed to achieve a specific goal. A process defines "WHAT" must be done without specifying "HOW" each task must be performed. The process structure provides multiple levels of aggregation to allow analysis and definition at different levels of detail to support different decision-making needs. The overall process structure contains phases that are composed of tasks, and tasks are composed of multiple steps. Other decompositions and levels of aggregation are possible.

A *method* consists of the techniques for performing a task, the "HOW" of each task. (Although a method is usually considered a process, for the purposes of this definition we will consider processes and methods to be separate and distinct.) Methods usually involve a degree of discipline and order. However, methods can be performed in an undisciplined manner, even though good methods generally improve the structure and efficiency of the task.

Systems engineering (SE) methods deal with ideas. These ideas relate to functions, requirements, architecture, and verification, among others. Methods have the following *attributes*: (a) Thinking patterns/processes (b) Knowledge base (c) Rules and heuristics (d) Structure and order (e) Notation. All SE methods consist of one or more of the following *basic methods*: (a) Observation (b) Analysis (c) Synthesis (d) Conceptualization (e) Characterization (f) Optimization (g) Documentation (h) Communication. There are two main categories of SE methods: Management and Engineering, each of which is divided into subcategories.

Means (instrument, tool, way) is a *tool* that, when applied to a specific method, can increase the effectiveness of a task. Of course, improper application of a means (tool) is unlikely to increase effectiveness. Most tools in the context of systems engineering are computer and/or software. The purpose of the tool should be to facilitate the execution of the "HOW".

The *environment* consists of the surroundings, external objects, conditions or factors that influence the actions of an object, an individual or a group. These conditions can be social, cultural, personal, physical, organizational or functional. The purpose of the project environment should be to integrate and support the use of the tools and methods used in the project.

There seems to be nothing new in the above definition of the MBSE methodology, since any methodology is always defined as a set/collection of “connected” methods. The presence of tools “connected” to the methods is always (implicitly) implied. Therefore, it is important to start from the “core” of the left part of **Fig. 7** – appropriate “connected” processes. This is very fundamental for us, because in practice we have long used the dualism “product-process” in the context of system patterns and/or corresponding system methods. Let us recall that we started with the definition “a set of homogeneous methods is called an **approach**”. Then we introduced the concept of heterogeneity and indicated that a methodology is a kind of specialization of an approach. However, here we will not pay attention to the conditions under which an approach becomes a methodology. We pay attention not to the differences, but to the similarities of the approach and methodology.

Conformities between the strategic diamond and the Solutions framework

Recall that the Framework Solutions model was defined by the petrad of the Presentations, Products, Processes, Services, and Basics packages [4], and the strategic diamond was defined by the Arena, Products (transport), Differences, Staging, and Economic Logic elements [23]. Let us consider two groups of conformities between packages and elements of two constructs: direct and indirect. The Products package and the Products element and the Processes package and the Staging element are in direct conformity. Here we used the obvious fact that Staging is an element of the corresponding process: development, creation, support, etc. All other constructs are in “indirect” relations.

First, let's consider the Differentiators element. To build a correspondence to it in the SoFr, it is possible to use the “accentuation” function. It was applied in the article [7], where accentuation was used to highlight the desired cartography paradigm. It should be noted that the Differentiators element in the strategic diamond does not seem obvious to us, since, for example, “advantage over a competitor” is a rather controversial issue that does not always make sense and sometimes cannot be achieved. However, if we adhere to the strategic diamond model, then there must be something in this corner. Our proposal is “accentuation”.

The Economic Logic element in the SoFr model can be formed in the Basics package, because it is fundamental in business. In addition to the obvious needs of a specific business, there are also the needs of a group of businesses. An example is the use or non-use of NGDI/NSDI. In this case, the Economic Logic will have to be “derived” from the rather dubious advantages of using the National Infrastructure. Especially considering that in NGDI the advantage is given to state organizations. For private organizations, there are only problems that outweigh the advantages. However, at the beginning of the millennium, we proposed to build NSDI using a bottom-up approach, “embedding” NSDI elements into the architecture of geo-enterprises. For this, even the GeoSF0 tool was proposed for inclusion in the geo-enterprise portal. This was supposed to be beneficial for geo-enterprises and they could use the portal for business development, since the solution was open.

Finally, the Arena element corresponds to the SoFr domains, about which we can currently only say that there are γ-, β-, α- domains that correspond to γSoFr, βSoFr, αSoFr, which requires a separate article. In addition to the integral Arena element, we will separately note that both in the strategic diamond and in SoFr there are relations (interrelations) between elements and packages. In SoFr, relations between packages and/or package elements are determined by such mechanisms as “dualism” and “triad”. Thus, the dualisms products-processes, bases(products)-products and bases(processes)-processes are very often used. The listed dualisms form the main SoFr triad Products-Processes-Bases. At the same time, γSoFr is the basis of the γ-method.

What has been said in this subsection is enough not to consider the statement about the conformity of the strategy outlined in the strategic diamond model and the strategy outlined in the Framework Solutions model, and therefore about its conformity with the Framework approach, as unfounded.

Conclusions

One of the three currently available interpretations of the Framework Approach is briefly described – as a strategy for researching and designing complex SpIS such as the NGDI and its generalizations, which include the NSII. This solves the problem of the lack of a strategy in the implementation of the NGDI Law.

The Framework approach is also proposed to be used to solve the so-called product, process, and expertise problems relevant today (as of the end of 2024) in the NGDI project, which is currently being implemented in Ukraine.

In general, it is shown that constructiveness in strategy can be achieved in three ways using: 1) the strategic diamond model, 2) the γ-method of the Framework Approach, and 3) model-based (systems) engineering (MBE or MBSE).

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КАРКАСНИЙ ПІДХІД ЯК СТРАТЕГІЯ ДОСЛІДЖЕННЯ І ПРОЕКТУВАННЯ СКЛАДНИХ ПРОСТОРОВИХ ІНФОРМАЦІЙНИХ СИСТЕМ (НА ПРИКЛАДІ НІГД)

Розглядається названий Каркасним підхід до дослідження і проектування складних просторових інформаційних систем (ПрІС). Прикладом такої ПрІС є Національна Інфраструктура Геопросторових Даних (НІГД) України у розумінні, задокументованому на кінець 2024 р. у Законі України і у Технічному завданні на геопортал. Через багатозначність терміну підхід доцільно розглядати з трьох точок зору (інтерпретацій). У даній роботі увага приділена одній з трьох таких точок зору – підхід як стратегія. Дана стратегія, як і сам Каркасний підхід, називаються конструктивними, тому що базуються на так званих Концептуальному Каркасі і Каркасі Рішень (КаРі) ПрІС. На думку авторів запропонована стратегія дозволить вирішити найголовнішу на сьогодні

проблему НІГД – фактичну відсутність **стратегії**. Крім того, каркасний підхід допоможе у вирішенні трьох найбільших на сьогодні проблем НІГД: продукта, процеса і експертизи (контролю якості).

У доменах НІГД і НІПІ (Національної Інфраструктури Просторової Інформації) і у їх контекстах найважливішими є три точки зору (інтерпретації) на Каркасний підхід: 1) як конкретної конструктивної стратегії використання геоінформаційних систем і технологій (ГІСіТ) для управління територією України; 2) як узагальнення методології поводження з ПрІС такими як НІГД і НІПІ; 3) як γ-метод, основою якого є γКаРі, де γ значить загальний, і який «працює» на рівні (страті) IGIM (Integrated Geospatial Information Framework) для України. Обмеження статті дозволяють детальніше зупинитися тільки на розгляді першої інтерпретації. Друга і третя інтерпретації лише формулюються для загального розуміння і з очікуванням достатності для усвідомленого планування проекта НІГД.

Однією з конкретизацій Каркасного підходу є так званий «Каркасний підхід AtlasSF». Він є узагальненням методу і засобу AtlasSF (Atlas Solutions Framework), які раніше використовувалися для створення (класичних) Атласних систем (АтС). Каркасний підхід AtlasSF є ієрархією трьох однорідних методів Каркасів Рішень (КаРі). Вони називаються відповідно Загальним (γ), Концептуальним (β) і Аплікаційним (α) КаРі і об'єднуються в ієрархічну систему (модель) Концептуальним каркасом предмета X, де X, крім АтС, може приймати значення НІГД чи НІПІ.

Каркасний підхід пропонується використати для вирішення головних і актуальних нині проблем проекту НІГД наступним чином. Перша проблема – називається **продуктовою** – вирішується гармонізацією моделі існуючої у реальності НІПІ України з моделлю INSPIRE. Щоб зробити це рішення конструктивним рекомендується перевірене на вирішенні задач Культурної Спадщини поняття Атласної ГІС (АГІС, АГІС-КС) і відомих на сьогодні реалізацій її частин.

Друга проблема – називається **процесною** – вирішується застосуванням Каркасного підходу AtlasSF. Конкретика полягає у застосуванні методів γ-, β-, і α- КаРі цього підходу. Ще поки що не створений метод γКаРі має бути мета-методом βКаРі, що працює на рівні (страті), до якого (якої) відноситься проекція IGIF на Україну. Проекція IGIF включає Національну Інфраструктуру Просторових Даних (НІПД) і її підмножину НІГД, βКаРі є оновленням Каркасу ГеоРішень GeoSF (GeoSolutions Framework), і αКаРі є поточною редакцією AtlasSF1.0+.

Третя проблема – **гарантії якості** ключових рішень – вирішується застосуванням V-моделі розробки, у якій валідація і верифікація рішень має одразу узгоджуватися з вимогами і архітектурою. Крім того, використовувані каркаси є архітектурними патернами, які повинні бути «типовими» рішеннями. Інакше патерн (каркас) не може бути «типовим рішенням типової проблеми».

Ключові слова: Атласна ГеоІнформаційна Система (АГІС), Каркасний підхід AtlasSF, НІГД, НІПД, НІПрД, НІПІ, IGIF, INSPIRE.