# AN APPROACH TO ONTOLOGY-BASED MODELLING OF STATE DEVELOPMENT FUNDS

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This paper proposes an approach to building an ontological model in the domain of the state development funds. Authors describe the process of creating ontology of the Guarantee Fund of Autonomous province of Vojvodina (OMGFAPV). Created ontology defines the structural position of the fund in the domain of public administration and administrative procedures of the Guarantee Fund of Autonomous province of Vojvodina (APV) in the process of issuing the guarantees. In this paper, the authors also present a method for state guarantee funds conceptual model creation as a basis for creating OMGFAPV.

*Keywords: e-government, information system, ontology, services*

### Ontološki pristup modeliranju državnih razvojnih fondova

Izvorni znanstveni rad

U ovom radu je predloženo pristup izgradnji ontološki modela u domeni državnih razvojnih fondova. Autori opisuju proces stvaranja ontologije Garantnog fonda  Autonomne pokrajine Vojvodine (OMGFAPV). Kreirana  ontologija definira strukturni položaj Fonda u području javne uprave i opisuje upravne postupke u Garantnom fondu Autonomne pokrajine Vojvodine (APV) u procesu izdavanja garancija. U ovom radu, autori predstavljaju i metodu za kreiranje konceptualnog modela državnih garantnih fondova kao temelja za stvaranje OMGFAPV.

*Ključne riječi: e-vlada, informacijski sustavi, ontologije, servisi*

## 1    Introduction

The state guarantee funds are a form of organization of the state administration with the task of indirectly facilitating the financing of small (micro) and medium-sized enterprises. Its activities raise the level of investment and stimulate economic development. Guarantee funds are established by state entities, national or regional governments, in cooperation with state agencies and development institutions. The following development funds are established in AP Vojvodina: Vojvodina Development Fund, Agricultural Development Fund, Capital Investment Fund and the Guarantee Fund of APV. The focus of research in this paper is on the creation of an ontological model of the Guarantee fund of APV. Knowledge of business processes, documents and participants in business processes and decision-making workflow within the given administrative domain is a collection of: expertise, knowledge based on experience, and individual knowledge and skills of the administrative staff. The task of the conceptualization is turning informal knowledge into ontology with the help of professionals in the field of the modelled ontology. Another aspect of this work is the application of ontologies created for the development of the information system of the observed domain. Specific qualities of the use of ontologies in the development of information systems are as follows. Information systems, by definition, consist of three different types of components: application programs, information resources and user interface. By analysing the interaction of ontology and information systems two aspects (dimensions) of the interaction can be distinguished [1]:

*Time dimension*: refers to the use of ontologies in the phase of exploitation or the stage of development of information systems. *Structural dimension*: refers to the way that ontologies affect information system components.

Main advantages of the model is a representation of knowledge about the domain which, in the use of traditional techniques for developing information systems, are firmly integrated into the user interface code by a separate component of formal ontology and a standardized user interface [4, 8].

The paper is organized as follows: the second section provides an overview of the related work. The third section presents conceptual model of the state guarantee founds. The fourth section presents an ontological model of the Guarantee Fund of APV. The fifth section shows the detailed administrative task's semantic representation. In the final, sixth section, concluding remarks and directions for further research are given.

## 2    Related work

This section will present research results related to the problem investigated in this paper.

Ontologies have been successfully integrated in several works. For example, in [7] the ontology supported the monitoring and requirements of development of the user interface, and in [8] ontologies are used as input models for an automatic code generator to create user interfaces. In a study of applying ontologies in the development of e-Government [9] the authors presented a method of modelling ontologies in the domain of e-Government. According to the authors [9] each public service of e-Government is semantically modelled and contains references that point to the required input data. Predefined values of input data or preconditions can be expressed with semantic rules. In this way it allows automatic creation of (web) forms and interactive validation of input data [13]. According to the authors [5, 6], the development of new applications and projects begins with modelling the ontology. The modelled ontology is a description of the domain that is used as the basis for creating new applications or services. In this

context, the created ontology is comparable to the platform independent model (PIM) and as such is used in MDA (Model Driven Architecture) [12]. When modelling the ontology, the authors used two types of classes and subclasses, by introducing the following assumptions:
1) Each class that contains a subclass is seen as an abstract class
2) Each class that does not contain a subclass is considered a realistic class (the basis for the creation of form)
3) Electronic services accept only the instances of realistic classes as input data.

The authors of [10, 11] also dealt with these problems. The basic idea is to transform the created ontology with the help of the transformation tools in the DLL script and thus preserve all relations, constraints, and information about the domain. DLL script is used to generate a relational database. Author of [14] proposes a feasible implementation of a multi-agent environment which makes use of ontologies and ontology mapping to achieve semantic interoperability. In a study of applying ontologies in the development of e-Government the authors presented a method of modelling ontologies in the domain of e-Government [15].

The presented rules and ways of modelling ontologies, according to the authors [7], allow the unambiguous identification of e-Government services. The authors in [2], propose a model of the system in which the procedures performed by each administrative unit in the decision-making process and the creation of administrative documents are described. The main component of the proposed system is ontology of the public administration. An ontology modelled in this way allows hierarchical control of the administrative units, control of administrative acts anticipated by legislation, communication between administrative units involved in the creation of administrative documents and calling of the procedures that trigger electronic services. In [3] the authors propose the creation of an ontology, which represents different aspects of service including administrative documents and legislation. This ontological model is focused on describing the electronic services of public administration.

The ontological model created in this paper relies on the results of [2] and [3].

## 3 Conceptual model of the state guarantee funds

By analysing the presented models of state guarantee funds described in [16], we recognize the fundamental differences in the functioning of state guarantee funds as follows: type of agreements of issue guarantees between the Guarantee Fund and commercial bank, type of client, place of the client application for the issuance of guarantees or the manner and place of the client's solvency analysis (risk assessment) and the method of issuing guarantees.

Described models of state guarantee funds represent a starting point for creation of a conceptual model of state guarantee funds (CMSGF). The conceptual model of state guarantee funds will be presented with the upper ontology. The upper ontology will be limited to concepts that are abstract and general enough to cover the higher level in a wide range of areas. In the upper ontology, concepts that are specific to a particular domain have not been included. This ontology will be created with Protégé editor.

The analysis of the model described in [16] identified a common domain concept of state guarantee funds: Participant, document and procedure.

### 3.1 The Participant concept

The concept of participant defines the types of participants and their interrelations within the domain of the observed state guarantee funds. We identified the following participants:
- State (local, regional) public administration
- Financial institutions
- Customers (clients)
- Fund.

Fig. 1 presents the participants in the processes within the domain of the state guarantee funds. Presented participants are common to all models of state guarantee funds.
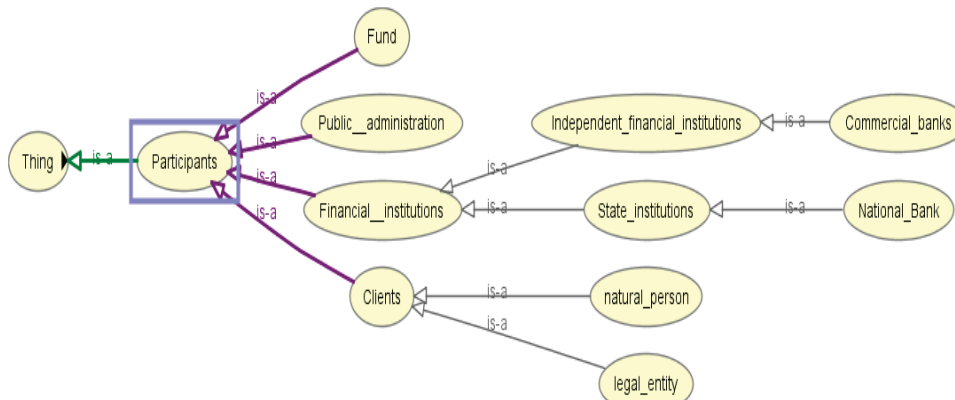


**Figure 1** Participants concept

### 3.2 The Document concept

The concept document was created based on an analysis of all the documents that have been identified

within the general model of state guarantee fund. We identified three groups of documents:
1) General acts
2) Planning acts
3) Administrative acts.

### 3.2.1 General_act concept

This group of documents placed state guarantee fund in the legislative framework. These documents define the mission of the fund, the ownership of capital, methods and procedures for issuing the guarantee.

### 3.2.2 Planning_act concept

Documents belonging to this group are created each year. This group includes documents which define relations with commercial banks as well as the types of planned activities planned.

### 3.2.3 Administrative_act concept

Administrative documents are the product of administrative tasks within the operating procedures of state guarantee funds. General model of state guarantee funds identifies documents that appear as a result of the execution of administrative tasks during the business process of issuing the guarantee. These documents are specific to each model of the state guarantee fund. Fig. 2 shows the taxonomy of the Document concept.
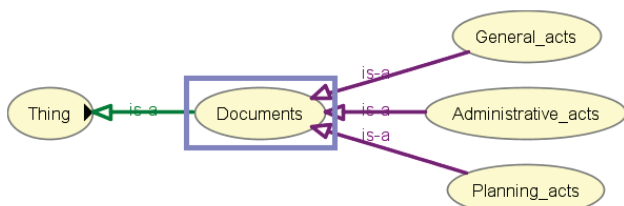


**Figure 2** The Documents concept

Identified documents in the general model of state Guarantee Fund are separated into three categories. Their taxonomy is shown on Fig. 2. These documents are the result of administrative activities - procedures that produce the identified documents. Analogously defining the taxonomy of types of documents we create the taxonomy of procedures.

### 3.3 The Procedure concept

The Procedure concept represents taxonomy of administrative procedures in the fund. Procedures are categorized into three categories: Procedure for issuing guarantees, planning procedures and general procedures.
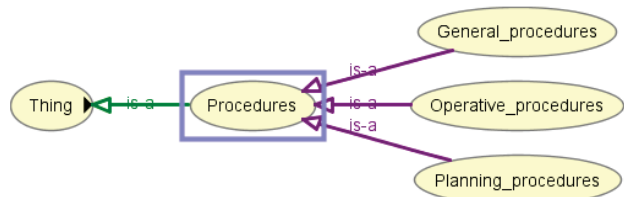


**Figure 3** The Procedures concept

As shown on the Fig. 3, the taxonomy of the Procedure concept identifies the following classes: Operating procedures, planning procedures and general procedures.

### 3.3.1 Operative_procedure concept

We analyse only procedures for issuing guarantees. Procedures for issuing guarantees are specific to each state guarantee fund.

### 3.3.2 General_procedure concept

Regulatory procedure related to organization of funds within the state administration and positioning fund in the legal frameworks is classified as a general procedures. These procedures are specific to each State Guarantee Fund.

### 3.3.3 Planning_procedure concept

This concept describes the procedures that should support the creation of planned annual activities of Fund. These procedures define the planned financial resources and activities that will be carried out in a calendar year. These procedures are specific to each state guarantee fund.

Ontological descriptions of the administrative activities are generally applicable to all government development funds. Below is a detailed description of the ontological model of the Guarantee Fund of APV (OMGFAPV), which defines the administrative procedures and tasks.

## 4 Ontological model of the GFAPV

As a basis for the creation an OMGFAPV we use the conceptual model of state guarantee funds as defined in the previous section. Ontological model of the Guarantee Fund of APV is an extension of a CMSGF. Also we compare CMSGF and public administration ontology presented in [2] and identifies three aspects of ontology as follows:
1) Concept Participant as defined in CMSGF corresponding to the structural aspect of public administration from [2] which describes the administrative units and their hierarchical relationships.
2) The concept Document defined in CMSGF corresponding to the textual aspect of ontology [2]. Textual aspect of ontology in [2] describes the documents that appear to be the product of administrative units described in the structural aspect of the ontology. Textual aspect is presented with four main classes, namely:
  1. Administrative documents - all documents generated by administrative units.
  2. The client documents - all documents that clients fill and create as an ongoing communication with administrative units.
  3. Legal texts - laws and bylaws relevant to the issue of guarantees.

4. Judicial decisions - decisions relating to administrative procedures in the process of issuing the guarantee.

The second part of the ontology given in [2] represents a procedural aspect of the ontology.

3) Procedural aspects of public administration ontology given in [2] is presented as an extension (specialization) OWL-S. Basic concepts of procedural aspects are: the complete procedure, and procedures and tasks. Complete procedures are composed of one or more procedures while the procedures are composed of one or more tasks. A procedure calls each integrated part or full step procedure comprising of at least one informative task and one executive task. The tasks are atomic activities which can not be further broken down and carried out by an administrative unit. Each task is executed within a single procedure. Each task has input the data you need to fill the administrative officer or the system as a result of execution of the task is an administrative act.

Features of the procedures that were introduced by this concept are:
- Hierarchical controls to anticipated legislation
- Communication between administrative units that participate in the creation of administrative documents

- Sequential procedures - procedures that are activated by services.

The complete procedure in the observed domain is the procedure of issuing guarantees. This aspect corresponds to the concept of the procedure defined in CMSGF.

4) The service aspect is represented by OWL-S. The interaction of administrative procedures with services is shown in the form of processes. Service model is presented as a process model. Procedures and complete procedures are presented as a composite process, while tasks are represented as free processes. This aspect represents a specialization CMSGF. We identify basic administrative activities: Registration of participants of the competition, Analysis of the submitted documentation, assessing the risk of funds placement, the decision on funds placement, and Type of placement.

## 4.1 The Participants concept

By this concept, all participants in procedures are represented. The concept is shown in Fig. 4.

Three subclasses of the Participants class are defined in this way: Financial_institutions, Public_administration, Clients.
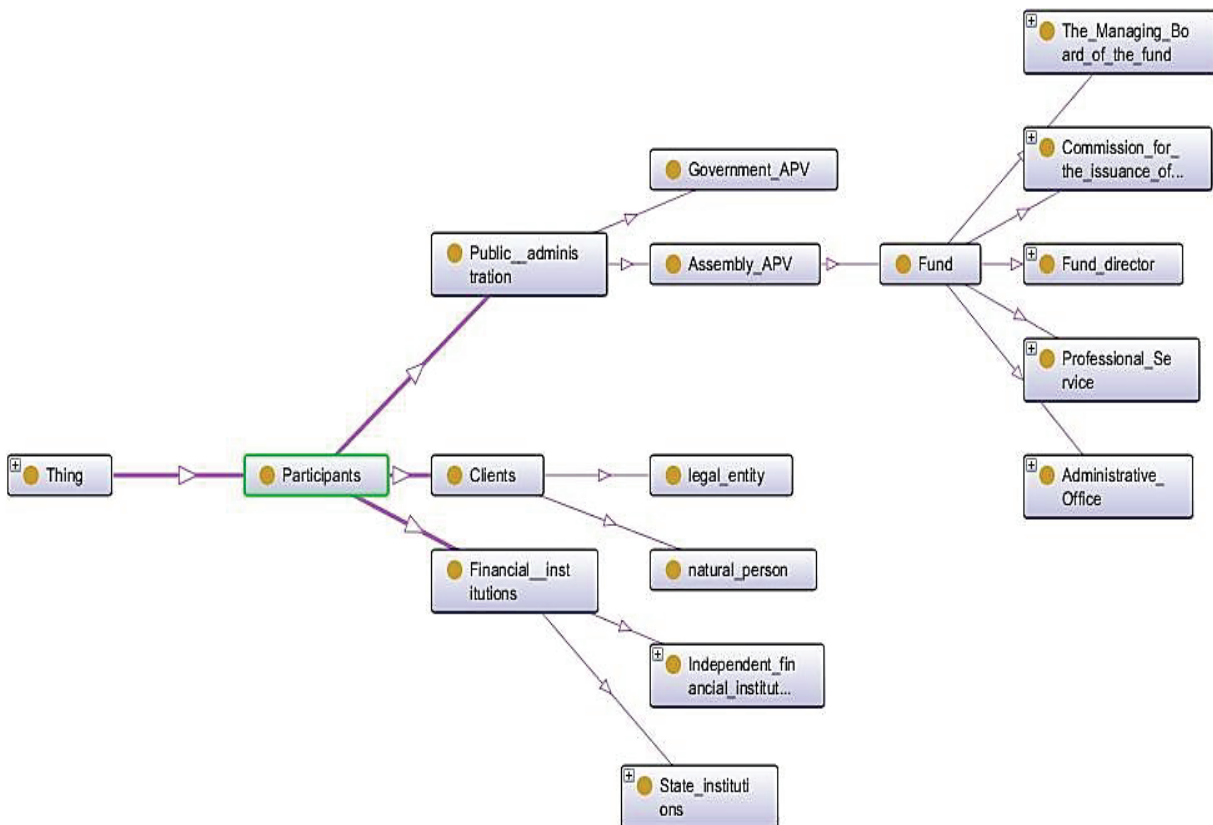


**Figure 4** Participants-ontological concept

### 4.1.1 The Financial_institutions concept

This ontological concept describes financial institutions that cooperate with the Guarantee Fund as well as external participants in carrying out work procedures of the fund.

Two groups of financial institutions were identified: State institutions (The National Bank) and the Independent financial institutions (Commercial banks, Credit Bureau Association of Serbian Banks).

The properties of these concepts are *SubClassof* and *haveService*. The property *SubClass'of* describes the

structural position of the concept, while the property *haveService* indicates the existence of external services that are invoked during the execution of procedures.

### 4.1.2 The Public_administration concept

The classes described by the concept Public_administration represent the organizational structure of state administration in AP Vojvodina and the place and role of the Guarantee Fund of APV in this organizational structure.

### 4.1.3 The Fund concept

The classes identified in the taxonomy of the Fund are, as follows: Managing Board, Fund director,

Professional Service, Administrative Office and Commission for the issuance of guarantees.

### 4.1.4 The Clients concept

The classes described by the concept Clients represent participants who are allowed to apply to Fund open competition. The classes identified in the taxonomy are: Legal entity and Natural person.

### 4.2 The Documents concept

The concept Documents is created by analysing all of the documents identified in the Guarantee Fund of APV. Fig. 5 shows the Documents concept.

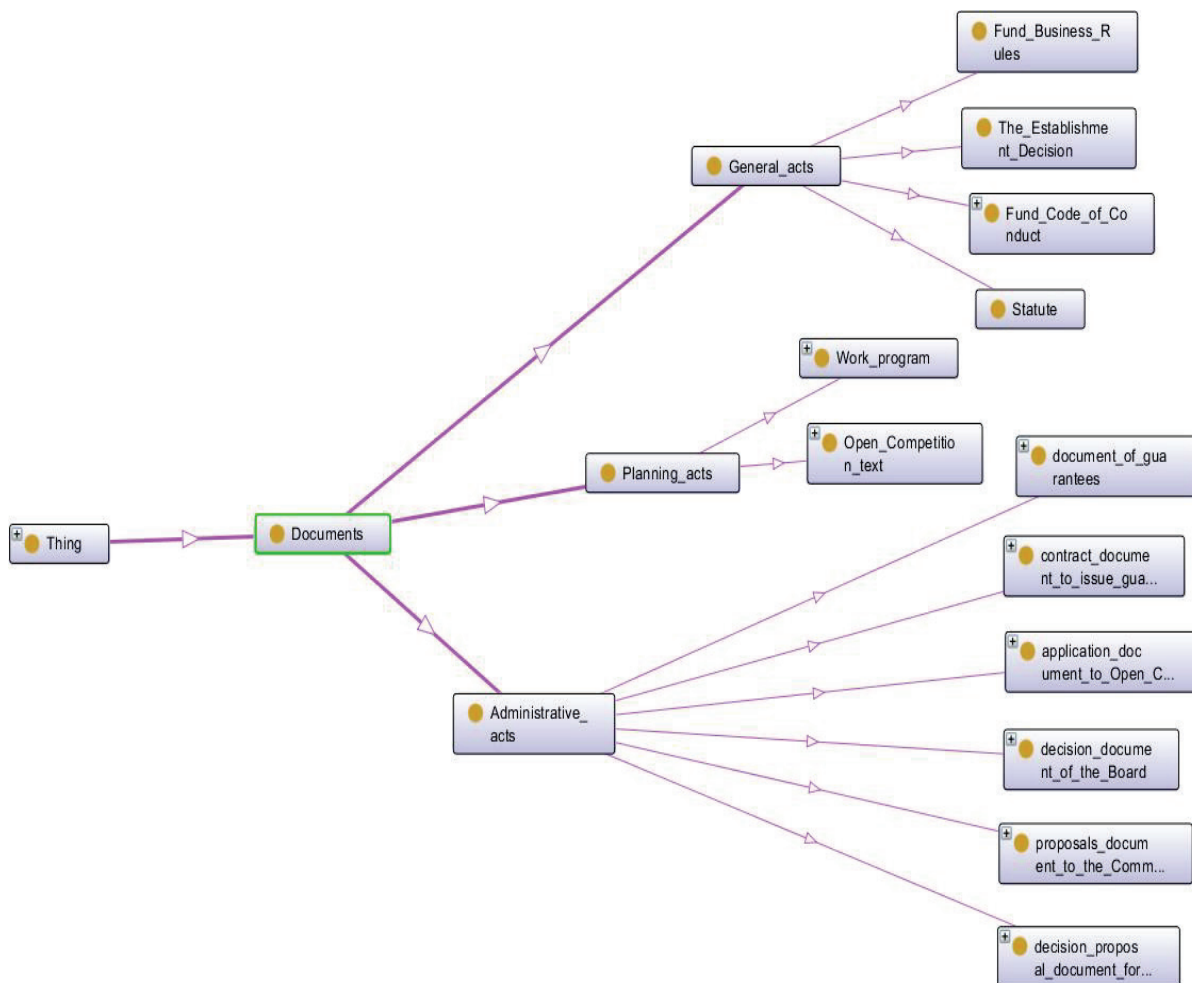Three groups of documents were identified: Administrative acts, Planning acts, and General acts.



**Figure 5** The Documents ontological concept

### 4.2.1 The Administrative_act concept

As defined above, administrative documents are the product of administrative tasks within business procedures. Semantic descriptions of documents that have been identified as a result of the execution of administrative tasks are given below. If we look at the documents as a product of administrative tasks in the case of the Guarantee Fund of APV, the following documents that appear as a result of the execution of administrative

tasks in the business process of issuing a guarantee can be identified:

- The application document to Open Competition
- The proposals document to the Commission for the issuance of guarantees
- The decision proposal document for the Board
- The decision document of the Board
- The contract document to issue guarantees
- The document of guarantees.

*Administrative_act* concept is a subclass of the Documents concept. In addition, it is associated with the property *Producedby* that describes it in terms of administrative procedure which produces the document of *Administrative_act* type, and the property *FillBy* which determines the entity from the Participants taxonomy who fills out a pre-defined form of the document of *Administrative_act* type.

### 4.2.2 The Planning_act concept

Documents belonging to this group are created each year. This group includes the following documents: Work program, and Open Competition text. Apart from their property *SubClass of* which defines hierarchical relations among documents, they are associated with properties that describe them in terms of creation and approval

- *Createdby* – defines the entity from the Participants taxonomy that created the document
- *Acceptedby* – defines the entity from the Participants taxonomy that approved the document.

### 4.2.3 The General_acts concept

The documents that determine the legal framework of the fund belong to this group. In the case of the Guarantee

Fund of APV, these are the following documents: The Establishment Decision, The Statute, The Fund Business Rules, and The Fund Code of Conduct. Apart from their property *SubClass of* which defines hierarchical relations among documents, they are associated with properties that describe them in terms of creation and approval:

- *Createdby* - defines the entity from the Participants taxonomy that created the document
- *Acceptedby* - defines the entity from the Participants taxonomy that approved the document.

### 4.3  Procedures concept

The Procedures concept represents taxonomy of the administrative procedures of the fund. This taxonomy is created based on operational procedures for issuing guarantees and procedures relating to the creation of planning acts of the fund. In addition, the taxonomy contains procedures related to utilization of the documents that define legal and regulative framework of funds within the state administration. The taxonomy is shown on Fig. 6.

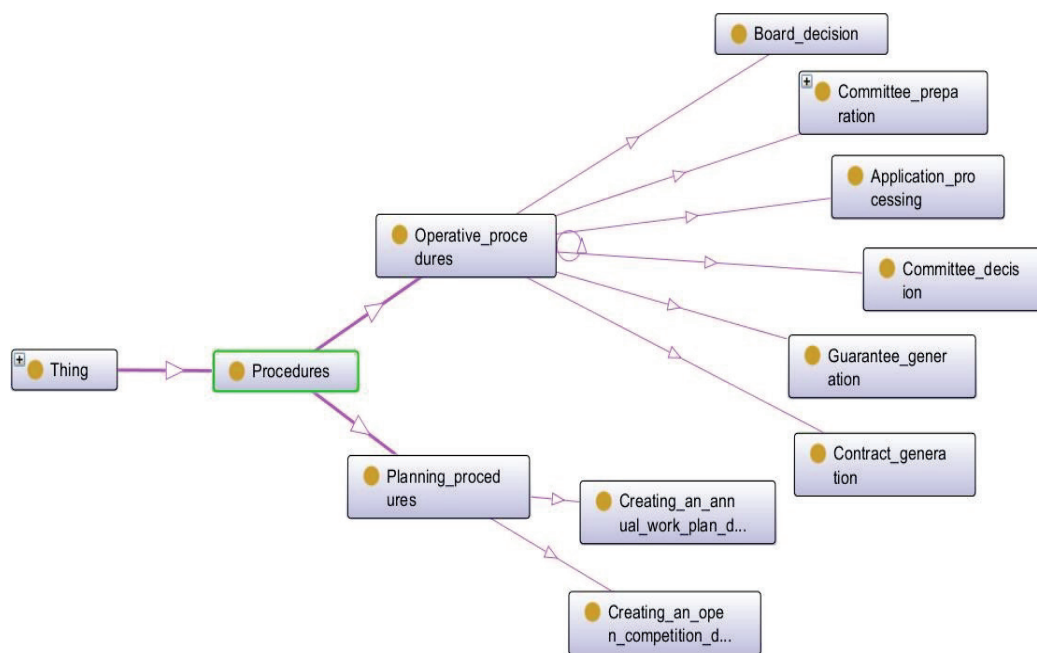The taxonomy of the Procedures concept consists of following classes: Planning_procedures, Operative_procedures.



**Figure 6** The Procedures concept

### 4.3.1 Planning_procedures concept

This concept describes the procedures aimed at planning annual activities of the Fund. The outputs of these procedures are various documents that contain activities to be performed in a calendar year and related financial resources. The following procedures have been identified: Creating an annual work plan document, and Creating an open competition document. The properties of classes describe these procedures:

- *SubClass of* – identifies the structural position of the concept within the **Procedures** taxonomy.

- *HaveOutputDoc* - identifies the document that results from performing general administrative procedures.
- *PerformedBy* - identifies the perpetrators of the procedure.
- *GeneralActsReferenced* – identifies all General_Act concepts, which are legal/regulative basis for the created planning document.

### 4.3.2 Operative_procedures concept

Basis for creating the Operative_procedures ontological concept are: Task, Procedure, and Full

Procedure as defined in [2]. Each task is executed within a Procedure. Each task has input data that an administrative worker or system should fill out and the result of the execution of the task is an administrative act. The Procedure contains only one task with the corresponding input and output data, which is filled out by an administrative worker or system. Full_Procedure is composed of one or more procedures, while Operative_procedure is composed of one or more tasks. In the case

of the Guarantee Fund of APV, the Full_Procedure is the procedure of issuing the guarantee.

Analyzing Operative_procedures concept the following classes are identified: Application_Processing, Committee_Preparation, Committee_Decision, Board_Decision, Contract_Generation, and Guarantee_Generation.

Fig. 7 depicts Application_Processing class, and properties and relations of the Operative_procedures concept.
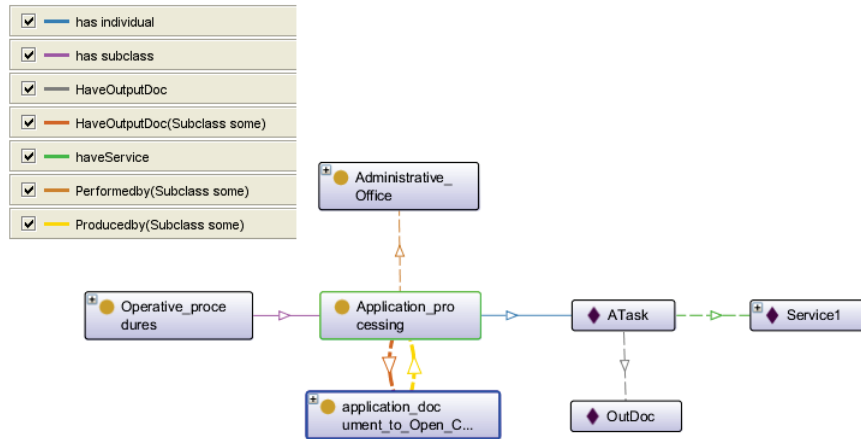


**Figure 7** The Application_Processing class

Services that call the specified Operative_procedures during their execution are presented by their profiles. Communication between these procedures and the service can be defined as an atomic process since the action of the service can be performed in a single interaction with the service.

### 4.4 The Services concept

Classes of internal and external services that are invoked for executing the work procedures of issuing guarantees are described in this taxonomy. The following classes are defined: InternalServices and ExternalServices. Internal Services are the services that are provided by the Fund, while External services are those that are provided by third parties like banks, other administrative bodies, etc. Both have same properties *SubClass of* and *availableOn*. The property *SubClass* identifies the structural position of the concept within the Services taxonomy, while the property *availableOn* – indicates service provider URI. Members of the class InternalServices (Service_A_P, Service_C_P, etc.) are presented by the *PresentedBy* property. This property points to the service profile that presents the service and the operational procedure that uses this electronic service.

### 5 The description of the administrative task

As described in our model above, an Operative_procedure is composed of one or more tasks. We call these tasks Administrative tasks. A semantic representation of an administrative task can be described as follows:
- The Task belongs to a class of Procedures
- The Task has input data- DataProperties

- The output document is the result of the execution of Task.

The Task has a unique document template. Each class and subclass of the ontology within the concept of the Operative_procedures has input data. Properties dataProperties describe input data of each Operative_procedures class.

The annotation of the ontology with elements of user interface or database elements is based on the rule that administrative tasks have input data. As shown in Fig. 2, input data is a series of variables that are filled with the resulting document template of the administrative task. The names of the input data are represented with dataProperties of the observed task. The descriptions of input data are defined in dataProperties – isDefinedBy property in the following form, Fig. 8.
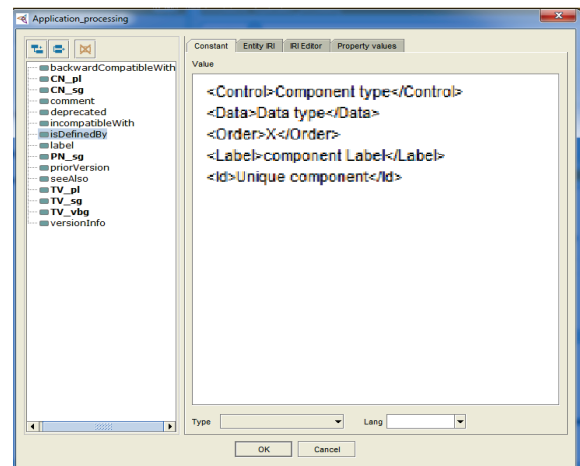


**Figure 8** isDefinedBy property

# 6   Conclusion

This paper presents the research related to the modalities of the functioning of state guarantee funds and research in the field of modelling information systems using the ontological approach. Based on the research, we created a conceptual model of state guarantee funds, which served as the basis for the development of the ontological model of the Guarantee Fund APV. The presented model describes the semantic content that was used for further development of the information system or part of the information system of the Guarantee Fund APV. In the proposed ontological model we specifically described and analysed ontological concepts which are defined by the administrative procedures and tasks.

Creating and using ontologies of knowledge of administrative processes and modelling systems that would speed up and automate the work of state administration, creates prerequisites for technical and organizational interoperability of different government agencies. Perspective and further research should focus on the development of standards for describing and creating ontological knowledge of administrative processes within the domain of the state development fund. In this way, we would ensure, among other things, the basis for fast and efficient creation of an ontological model for information systems of state administration standardized in the aspects of interaction, visualization, maintenance and generation.

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