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ONTOLOGICAL MODEL FOR DATA PROCESSING ORGANIZATION IN INFORMATION AND COMMUNICATION NETWORKS

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Abstract. The functioning of modern information and communication networks is impossible without data processing. With the emergence of new network services, the amount of information that needs to be processed increases, while the requirements to the data processing quality become more and more stringent. Therefore, the problem of designing and maintaining a scalable data processing system with a flexible quality of service management is becoming more and more important for a network operator. Such data processing systems have a complex internal structure with many interrelated parameters, which makes them difficult to analyze, manage, and expand. This study proposes to use an ontological model to store, represent, and manipulate the information in the operator's data processing system. The ontological model allows to structure and systematize the data of an information processing system, and transparently reflects the relationships between the parameters of the system to simplify its analysis and scaling. The proposed ontology of a data processing system consists of three related subsystems. The paper describes the proposed ontological model and additionally analyzes the sources of information that needs to be processed in the information and communication network.

Keywords: information and communication network, data processing system, ontology, model, network operator, analysis, scaling, class, relations.

INTRODUCTION

Until the last decade, the term "communication network" primarily meant a set of technical means of communications and facilities designed for routing, switching, transmission, and/or reception of signals between the terminal equipment [1]. However, in modern communication networks, the operation of technical means of communications is not possible without software. Moreover, a big part of hardware functionality is being replaced by software due to the convergence of information and communications technologies. Communication network becomes a cyber-physical system, where the physical and software network components are deeply intertwined. Therefore, the term "information and communications network" is used instead today to emphasize the fact that the set of information and communications systems act as a whole within the information processing. Having an extremely complex internal structure, such a cyber-physical network can not be easily controlled by the man without using the approaches to intellectual data analysis.

In information and communications network data processing plays an essential role. To ensure efficient data processing, telecom operators must manage their data processing system wisely taking into account multiple criteria. Therefore, the relevant problem for the telecom operator is to represent his data processing system in a way to simplify its analysis, maintenance and operation, and to add sup-

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port for the system's scalability. To reach these objectives, the system should be represented in a formalized way, so that the parameters of the system are explicitly exposed, the internal dependencies within the structure are easy to analyze and the new component may be easily added to support the system's scalability.

There exist multiple approaches to complex systems' formalization. In particular, the system may be represented with the help of the relational model [2], object-oriented model [2, 3], network-based model [4], ontological model [5, 6]. The relational model focuses on organizing data in two-dimensional tables. The advantage of the relational data model lies in the simplicity and convenience of physical implementation on a computer. The main disadvantages of the relational model include the lack of standard means of identifying individual records and the complexity of describing hierarchical and network relationships. The object-oriented data representation model operates with concepts such as class and object. Classes define a data structure and represent a set of attributes (text string, integer, image, etc.). Instances of a class (objects) have a certain structure and can contain other objects, forming an arbitrary hierarchical structure. As a rule, systems based on an object-oriented data model are functional, flexible, but at the same time, more complex. Being hierarchical, these systems have a limitation: the use case, when a child class has more than one parent class is not supported here. To tackle this problem, the network-based model exists. In this model, the classes and relationships are represented in a form of a graph, which makes this model much more flexible. Ontology is an attempt at a comprehensive and detailed formalization of a certain area of knowledge using a conceptual scheme. By the ontological model, data can be represented as a set of different types of information objects and links between them. The main advantage of the ontological model is its comprehensiveness. In contrast to the object-oriented and network-based model, not only the classes and objects are in focus here, but also the complex semantic relations between them. It helps to describe the system more exhaustively and explicitly. Because of these advantages, we have chosen an ontological model to help the operator to simplify the management and analysis of his data processing system.

In this paper, the usage areas of data processing within the activity of the information and communication network operator are analyzed. In order to simplify the data processing organization, an ontology of the operator's data processing system is proposed. It formalizes the data processing system and exposes its parameters, allowing the operator to analyze and manage the data processing infrastructure with less effort. The paper is structured as follows: in Section 2 we provide an overview of the related work. Section 3 is dedicated to the analysis of the main data sources in the operator's network to reveal the importance of data processing in modern information and communication networks. Section 4 describes the proposed ontological model which aims at simplifying the analysis, management, and scaling of the data processing system. Section 5 provides an example of simplified data processing system analysis. The results of the paper are summarized in the Conclusion.

RELATED WORKS

There exist a number of approaches to formalizing a communication network with the help of an ontological model. The authors of [7] proposed a general ontological model that describes a semantic of the domains relevant for the Next Generation Networks (NGN). Their main idea was to introduce a central point ontology (core ontology) that defines the main concepts of the mobile domain. Except for the core ontology, the authors generally described a number of sub-ontologies that need to be further refined and extended to further domains. Among them is a communication resources sub-ontology. In this paper we are focused on the data processing system as a communication resource of the network and thus we aim at refining this part of the ontological model proposed in [7]. However, from our point of view the authors did not pay enough attention to the quality of service assessment in the communication network, although this aspect itself contains a large number of concepts and relations that should be considered and formalized.

In [8] an approach to ontology modelling for telecommunications service domain was proposed. Within their telecommunications service domain ontology (TSDO), the authors distinguish the Terminal Capability Ontology, Network Ontology, Service Role Ontology, Service Category Ontology, Charging Ontology and Service Quality Ontology. From our point of view, the main advantage of the proposed concept is taking into account the quality of service parameters as a separate full-fledged ontology. Meanwhile, the authors paid attention to formalizing the communication resource domain as well. In our work we would like to elaborate on this concept and describe the network resources in a relation with its quality parameters in particular. Since the service quality is influenced not only by the network resources but also by the various workloads which have to be processed in the network, in contrast to [8] we would like to pay separate attention to the semantic interoperability of all three domains: network resources, service quality, and workload.

According to the 5G whitepaper [9], in new networks along with traditional Quality of Service parameters such as the packet error rate, transmission latency, and data rate, the new parameters such as network energy efficiency are becoming more and more important. Energy efficiency of data processing in general is a highly relevant topic. According to [10] the amount of power consumed by the data processing facilities around the world comprises near 2% of all electrical power produced worldwide. In order to deal with this problem a number of hardware and software energy efficient approaches to data processing were proposed. Among them are the virtual machines consolidation [11], energy efficient scheduling [12, 13], resource scaling [14]. These approaches have already become standard for the distributed data processing facilities, however, they did not get enough attention in the communication network domain. Of course, energy efficient approaches are used there, but from our point of view, they must be included in the general formalized data processing architecture. In this paper, we try to approach this problem with the proposed ontological model of the data processing system in communications.

DATA PROCESSING RESOURCES IN INFORMATION AND COMMUNICATION NETWORKS

According to the authors of [15], information and communication network resources are divided into information, data processing and storage resources, software. Information resources are information and knowledge transmitted through the information and communication network. Data processing and storage resources are the performance of processors and the amount of memory of computers running on the network, as well as the time during which they are used. Software resources include network operating systems, server software, workstation software, application software, traffic analyzers, network controls, and more. Communication resources are resources that are involved in the transportation and redistribution of information flows in a network. It means that the data processing and storage resources have already become an essential part of modern communication networks.

Alongside with the access and core network, data centers (representing the data processing and storage resources) are becoming the key components of the infrastructure of the communication network operator [16]. Let us briefly overview these key components of the network. Access network is connected to the end (terminal) nodes — equipment installed by users of the network. For example, in the case of building an operator network to provide Internet access services, the end nodes may be subscribers' computers or subscriber routers. The main purpose of the access network is to concentrate the information flows coming through numerous communication channels from user equipment. The core network combines individual access networks, performing the functions of traffic transit between them through high-speed channels. Data centers and service management centers are network resources on the basis of which customer service is provided. Such centers can store information of two types:

– user information, i.e., information that is of direct interest to end users of the network (information resources);

– service information that helps provide services to users.

Examples of the first-type information resources are web-portals, which contain a variety of reference and news information, information from e-shops, etc. Resources of the second type are various systems of authentication and authorization allowing the operator to check the rights of users for receiving the services; billing systems, which help to manage charges for services in commercial networks; databases of user credentials that store usernames and passwords, as well as lists of services to which each user is subscribed, etc. The second type of resources should also include a centralized network management system.

A prominent example of an information and communication network in which information and communication technologies work as a single indivisible whole is the 5G network. Let us briefly consider the basic principles of this network design in order to reveal the additional purposes of data processing in 5G networks. To do this, let us analyze the white paper provided by the European organization 5G PPP (public-private partnership in the field of 5G infrastructure — a joint initiative between the European Commission and the European ICT industry (ICT manufacturers, communications operators, service providers, SMEs and research institutions). According to the documentation [9], the key paradigm of the 5th generation mobile network is its programmability. Programmability ensures flexible network adaptation at various levels, including infrastructure, network functions, services, and applications. In particular programmability in the data plane, transport network (core network) and access network are distinguished. In 5G programmability is primarily inspired by two technologies: SDN (Software Defined Network) and NFV (Network Function Virtualization) technologies.

SDN is an approach to network design, implementation, and management that separates network management (control plane) and traffic management process (data plane). This separation greatly simplifies network administration and management, as the control plane processes only information related to the logical topology of the network. The data plane instead organizes network traffic according to the configuration set in the control plane. Unlike conventional IP networks, whose functions are decentralized, SDN follows a centralized approach [17].

The main idea of NFV technology is to replace specialized network equipment (e.g., L2 switches, routers, NAT devices (Network Address Translation), firewalls, etc.) with software — virtualized network functions — consolidated on general-purpose hardware (commodity servers) [18].

Thus, to enable these technologies communication operators must maintain the data processing infrastructure as well.

Another purpose of maintaining the data processing infrastructure for the telecom operator is a Big Data analysis. Such an analysis helps operators to improve the technical and economic parameters of the network, enable the personalization of telecom services, and ensure more efficient allocation of funds. Data processing infrastructure is used in particular for the analysis of the subscribers' activity, traffic changes, long-term network characteristics, etc. The operators report the positive impact of the Big Data analysis included in their operational workflow [19, 20].

Summarizing this analysis, we would like to highlight 3 main areas of use of data processing by a telecom operator:

1) ensuring the functioning of SDN and NFV technologies;

2) implementation of such necessary network functions as authorization and authentication of users, billing service, etc.;

3) analysis of Big Data in the field of communications.

Thus, the effective design, construction and operation of data processing infrastructure is an important problem for operators of modern communications networks (including 5G networks).

ONTOLOGICAL MODEL OF A DATA PROCESSING SYSTEM IN INFORMATION AND COMMUNICATION NETWORKS

Computational ontologies are the means to formally model the structure of a system, i.e., the relevant entities and relations that emerge from its observation, and which are useful to our purposes [5]. Ontologies (or ontological models) help to formalize the structure of a system in order to simplify its management, improve its design, automatize system's operation, etc. In this paper we introduce the ontological model for the data processing system of the telecom operator to simplify its management. This simplification is a consequence of considering the system as a formalized structure with explicitly exposed parameters.

Being a structured representation of the information in some subject area, every ontology is based on the raw data, stored in some kind of informational database (Fig. 1). Examples of such raw data are the subscribers' records in a billing system, statistics of the daily workload in a data processing system, nominal parameters of the data processing equipment, etc. The ontological model transforms this raw data into knowledge. Modeling the data processing system as an ontology, we may distinguish 3 separate structural parts of the system. These parts correspond to the 3 subcomponents of the ontological model respectively:

1) the ontology of the processing system components (servers, processing software, etc.);

2) the ontology of the workloads (the input workload sources and parameters, etc.);

3) the ontology of the system quality assessment criteria (performance, energy efficiency, etc).

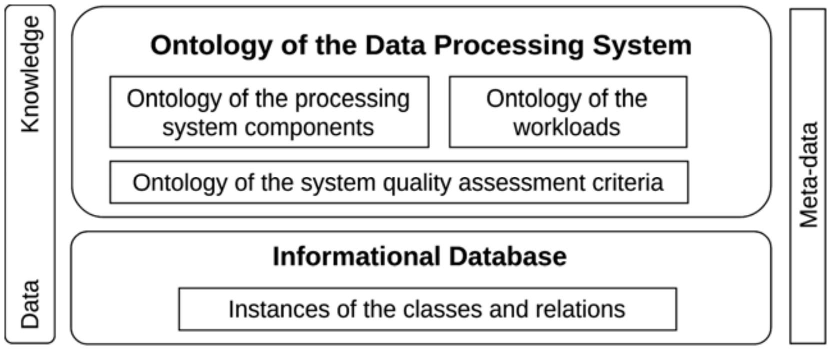

Fig. 1. General structure of the proposed ontological model of the data processing system

Dividing general ontology of Data Processing System in to such correlated components allows to describe in detailed way each subprocess that is performed be network operator while analyzing and managing data processing infrastructure with less effort.

Let us explain these subsystems. Data processing equipment and software represent the *ontology of processing system components*. The ontology of these components reflects the physical structure of a system itself. The *ontology of the workloads* encompasses the input workload and parameters of the available data processing equipment. The input workload comes from the aforementioned sources (we consider either Big Data tasks, subscribers' data or NFV processing tasks to be the sources here). Computational job is a unit of workload. Each job is characterized by its requirements which depend on the type of the workload source. The processing system consists of server clusters, consisting of N physical nodes (servers) respectively. Each server has an amount of computational resources (processing cores, RAM, etc.) and operates with specialized data processing software, aimed to manage the resources of the processing system, schedule the computational jobs, etc.

The output parameters are those criteria that are evaluated for the system. For the efficient data processing, telecom operator needs to design his data processing systems in a way to:

– fulfill the *Quality of service requirements* depending on the workload type (e.g., the allowed probability of a job loss for the internal Big Data processing tasks may be higher than the probability of loss for the billing service task, since it presumes direct cooperation with the subscriber);

– ensure sufficient *performance* of the data processing system (with "performance" here we mean the amount of processed data per time unit. I.e., the bigger performance of the data processing system is, the higher processing throughput is achieved);

– increase the *energy efficiency* of the data processing system. Since it greatly affects the operator's OPEX (Operating expense), so it is important to consider this criterion not only during system design (to purchase more energy efficient equipment), but also during operation.

These parameters are described by the *ontology of the system quality assessment criteria*.

Formally, the ontology may be specified as a set [6]:

$$O = \{C, A, R, T, F, D\} ,$$

where

1) C is the set of classes that describes the notions of a subject domain;
2) A is the set of attributes that describes the features of notions and relations;
3) R is the set of relations specified for classes:

$$R = \{R_{AS}, R_{IA}, R_n, R_{CD}\},$$

where R_{AS} is the associative relation:

$$R_{AS}(O) = \{C_i(O) \times C_j(O), M(R_{AS}) = \{str\},$$

where M is a type of relation meaning,

R_{IA} is the relation “is–are”, also known as a “part–whole” relation:

$$R_{IA}(O) = C_k(O) \subset C_m(O) ,$$

R_n is the relation of inheritance:

$$R_n(O) = a_i, r_i \vee A_{C_m}(O) \to a_i, r_i \vee A_{C_k}(O) ,$$

R_{CD} is the relation “class–data”:

$$R_{CD}(O) = C_j(O) \subseteq D_i(O) ;$$

4) T is the set of standard types of attribute values;
5) F is the set of limits for values of attribute notions and relations;
6) D is the set of instances for a particular class.

The proposed ontology of the telecom operator’s data processing system is represented in Fig. 2. The formal description of the ontology may be found below.

Proposed ontology is formally described as follows:

Set of ontology classes: $C = \{C_1, C_2, ..., C_{25}\}$

C_1 — Operator’s data processing system. This class describes the concept of an operator’s data processing system as a physical entity.

C_2 — Source of the workload. This class includes concepts related to the input workload for the data processing system. As discussed in Section 1, possible sources (at least those considered in this paper) are.

C_3 — Operator’s Big Data.

C_4 — Subscribers’ data (e.g., credentials, data about the usage of services, billing information, etc.).

C_5 — NFV processing task. Within the NFV concept, the tasks usually performed by the specialized hardware (e.g., traffic routing, NAT, etc.) are performed on the commodity servers. Within this ontology we call these tasks generally “NFV processing tasks”, however this entity may be refined with respect to the concrete virtualized functions in the considered network.

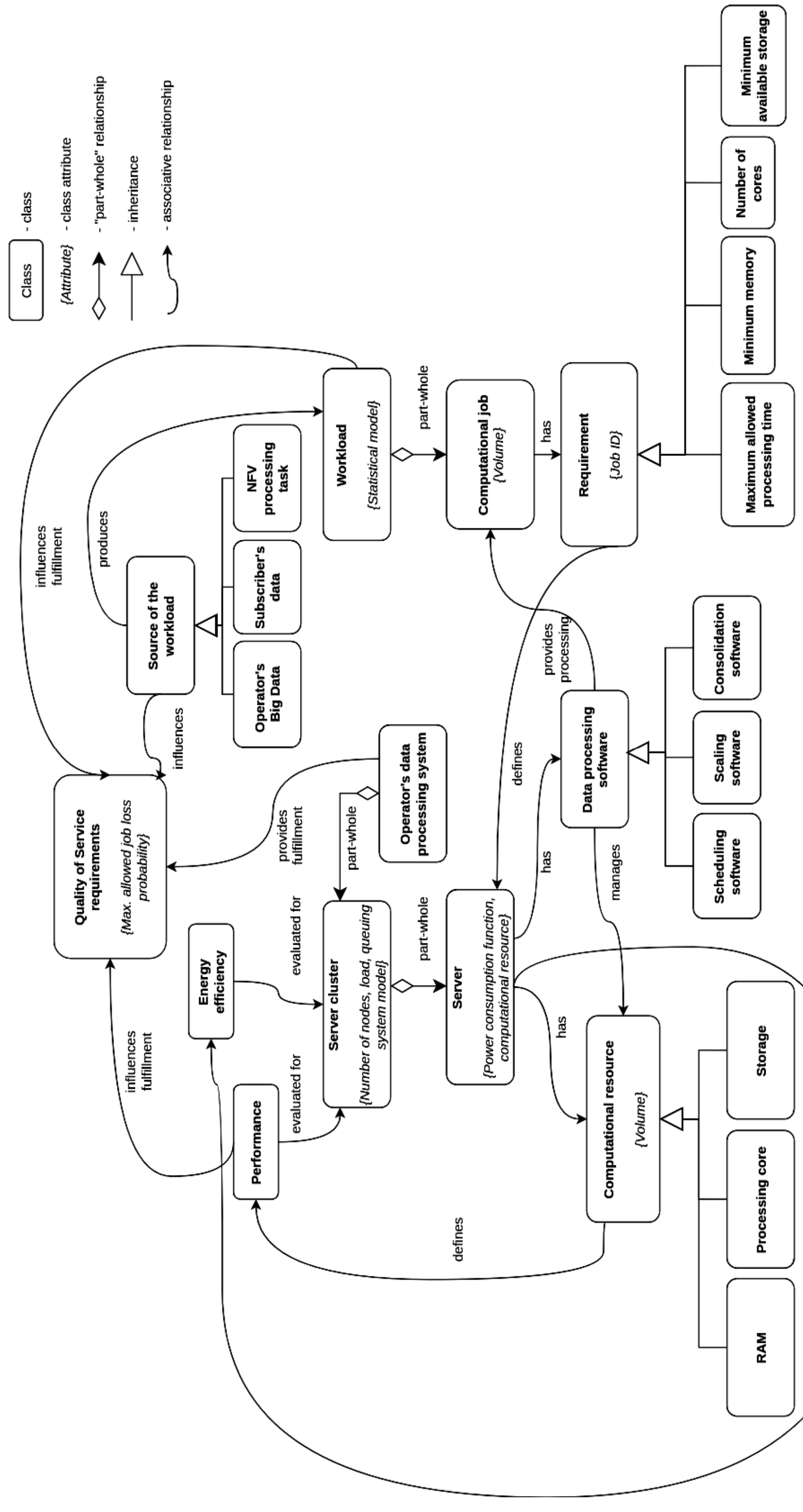

Fig. 2. The proposed ontology of the network operator's data processing system

These classes are connected with their parent class C_2 with the help of the relation of inheritance.

C_6 — Server cluster. A class describes physical objects that are part of a data processing system. The attributes of the server cluster are the number of its nodes, load and cluster model as a queuing system: $C_6 = (A_6, D_6)$.

C_7 — Server. This class describes the physical objects that are part of the server cluster. The attributes of the server are its power consumption function and computational resources: $C_7 = (A_7, D_7)$.

C_8 — Computational resource. This class includes concepts that describe the physical computing resources of the server. The attribute of the computing resource is its volume: $C_8 = (A_8, D_8)$ Inherited types of the computational resources are:

C_9 — RAM (Random Access Memory). This class reflects the concept of the physical resource of the server's RAM. The class has an inherited "volume" attribute that displays the amount of available server RAM: $C_9 = (A_9, D_9)$.

C_{10} — Processing core. The class describes the concept of the server's physical processor resource. It has an inherited "volume" attribute that displays the number of server processing cores: $C_{10} = (A_{10}, D_{10})$.

C_{11} — Data storage. This class displays the concept of a physical resource - a data storage device (hard disk, SSD, etc.). The class has an inherited attribute "volume", which reflects the available amount of server storage: $C_{11} = (A_{11}, D_{11})$.

These classes are connected with their parent class C_8 with the help of the relation of inheritance R_{n_8}.

C_{12} — Workload. This class is responsible for describing the abstract concept of input workload of a data processing system. The workload is generated by the sources of the workload (C_2). It is characterized by the attribute "statistical model", which corresponds to the concept of the statistical curve of the input load: $C_{12} = (A_{12}, D_{12})$.

C_{13}— Computational job. This class describes the concept of a computational job as a unit of input workload in the system. The class has a "volume" attribute that expresses the amount of computations required to process the job (for example, in the number of elementary operations): $C_{13} = (A_{13}, D_{13})$.

C_{14} — Requirement. This class describes the requirements of computational jobs for the physical resources of the system. The requirement has a job ID as an attribute to bind a specific requirement to the job that owns it: $C_{14} = (A_{14}, D_{14})$. The inherited requirements are:

C_{15} — Maximum allowed processing time. This is the time after which the job is removed from the processing, even if the processing was not completed successfully. The class inherits the "job ID" attribute to bind a specific job requirement to its job: $C_{15} = (A_{15}, D_{15})$.

C_{16} — Minimum memory (capacity). The class describes one of the requirements of a computational job, which reflects the minimum amount of RAM of a server, at which a job can still be processed on this server. The class inherits the "job ID" attribute to bind a specific requirement to the job that owns it: $C_{16} = (A_{16}, D_{16})$.

C_{17} — Number of cores. The class describes one of the computational job's requirements, which reflects the minimum number of free server processor cores that will be allocated for processing this job. The class inherits the "job ID" attribute to bind a specific job requirement to its job: $C_{17} = (A_{17}, D_{17})$.

C_{18} — Minimum available storage. The class describes one of the computational requirements that reflects the minimum amount of free server storage to be used during processing. The class inherits the "job ID" attribute to bind a specific job requirement to the corresponding job: $C_{17} = (A_{17}, D_{17})$.

These classes are connected with their parent class C_{14} with the help of the relation of inheritance $R_{n_{14}}$.

C_{19} — Quality of Service (QoS) requirements. The class describes the requirements to the data processing that correspond to a specific type of service (data being processed). In our interpretation the class has an attribute "maximum allowed job loss probability", which limits the probability of losing the job when processing by the system: $C_{18} = (A_{18}, D_{18})$. In general, any other attributes agreed within the QoS requirements may be shown here.

C_{20} — Energy efficiency. Describes the concept of energy efficiency of a processing system in general and each physical server in particular as the amount of electrical power consumed to perform a unit of work.

C_{21} — Performance. Describes the concept of performance of a computer system in general and each physical server in particular as the amount of work performed per unit time.

C_{22} — Data processing software. Displays the concept of software used in a distributed computing system to distribute and process the workload, as well as control the state of the system as a whole. In our interpretation it encompasses the following types of software:

C_{23} — Scheduling software. This class represents the software that is used to distribute the computational jobs between the available hardware (servers). This process is also known as jobs' scheduling.

C_{24}— Scaling software. This type of software is responsible for managing the quantity of available hardware in the system. It is in particular important for energy efficiency: fewer resources may be kept available in case of the underload of the system to save some power.

C_{25} — Consolidation software. This software manages the consolidation process of the virtual machines.

If other types of software are used by the operator, they may be added as the separate classes of the ontology as well.

These classes are connected with their parent class C_{22} with the help of the relation of inheritance $R_{n_{22}}$.

Associative relations: $R_{AS} = \{C_i X C_j\}$

"*produces*" — displays the relationship between the "Source of the workload" class and the "Workload" and shows the process of producing the workload by various sources;

"*influences*" — reproduces the relation between the "Source of the workload" and "QoS requirements" and expresses, that different types of workload sources have different QoS requirements;

"*influences fulfilment*" — connects the classes "Workload" and "QoS requirements" and shows that the amount of workload influences the fulfillment of the QoS requirements (e.g., it is more difficult to fulfill the requirements in busy hours);

"*provides fulfillment*" — this relationship describes the relationship between the "Operator's data processing system" and "QoS requirements". The system must operate in such a way as to ensure compliance with the QoS requirements;

"*defines*" — this relationship describes the relationship between the class "Computational resource" and "Performance". The essence of this relationship is to reflect the impact of the quantity and quality of server computing resources on its performance. This relation connects the classes "Requirements" and "Server" as well to show the fact that the jobs' requirements define the choice of the hardware, on which the job may be processed;

"*has*" — a connection that shows the logical affiliation of one class to another. The classes "Server" — "Computing resource", "Server" — "Data processing software", "Computational job" — "Requirement" have this relation;

"*provides processing*" — this relation connects the classes "Data processing software" and "Computational job" showing, that the data processing software operates with the jobs in order to let them be processed;

"*manages*" — the relation shows, that the "Computational resources" are managed (scaled, distributed, etc.) with the help of the "Data processing software";

"*evaluated for*" — shows the relationship between the parameters of the data processing system (Energy Efficiency and Performance) and the Operator's data processing system itself.

"Part-whole" relations: $R_{IA}(O) = C_k(O) \subset C_m(O)$

"Part-whole" relations are defined between the classes "Operator's data processing system" and "Server cluster", "Server cluster" and "Server", "Workload" and "Computational job" to show that one entity is a part of another one.

The described ontology formalizes the data processing system and simplifies the analysis and management of such a system. The parameters of the system are explicitly exposed and the operator is able to see the relations between them.

AN EXAMPLE OF A SIMPLIFIED DATA PROCESSING ORGANIZATION WITH THE HELP OF THE ONTOLOGICAL MODEL

Let us consider an example of simplified data processing organization with the help of ontology. In the related research [21], we consider the problem of energy efficient data processing which is a very important topic nowadays. The problem is to ensure a minimal power consumption of a data processing system without losing the processing performance and ensuring the fulfilment of the QoS requirements. This is a complicated task which requires having an overview on a system as a whole, and taking into account multiple influencing parameters. Due to the task's specificity, it is infeasible to analyze the separate parts of the system, since they cooperate solving the processing tasks and act together as a single distributed data processing system.

The proposed ontology explicitly shows the complex semantical dependencies between the input workload parameters of the system and assessment criteria. The operator sees that the fulfilment of the QoS requirements is directly influenced by the system performance and indirectly influenced by the computational resources of the system. Thus, in order to fulfil the QoS requirements he should increase the volume of the computational resources. However, he also sees that the resources are managed by the data processing software and so, instead of changing the resources (which may be costly) the operator may focus on the software tuning in order to improve the resource management.

Considering the energy efficiency criterion, the operator sees that it is defined for each separate processing node (server) in the system. And the decision regarding the server to be chosen is taken based on the requirements of the input jobs. Therefore, a design decision based on this analysis would be to pay attention to the jobs' requirements analysis to ensure a more thoughtful choice of the processing server.

Based on a conducted analysis, a comprehensive energy efficient approach to workload processing was proposed in [21]. This approach takes into account individual power consumption characteristics of computing nodes, deals with dynamic workload deviations, and ensures meeting requirements to the service quality combining energy efficient scheduling and horizontal scaling. The results of the approach are largely due to the ontological model, which helped to identify and link together all the complex semantic dependencies of the system. All the details regarding the approach and its evaluation may be found in [21]. The main point that we would emphasize here is that due to the used ontological model, the complex dependencies between the parameters and the assessment criteria of the system were easily embraced and the formalized system representation was used as an input for the automatic system optimization software. The ontological model is designed and refined once for the whole system and helps to analyze it in the future due to the visualization and formalization.

CONCLUSION

In this paper we analyzed how the data processing is involved in the range of activities of the modern information and communication network operator. We defined that the main directions of data processing in modern information and communication networks are related to the NFV and SDN applications, traditional subscribers' management functions (authorization and authentication of users, billing service, etc.) and Big Data processing. In order to simplify the organization of this data processing, an ontological model of the data processing system in communications was proposed. This model formalizes the data processing system exposing its parameters and visualizing the relations between them. It simplifies the analysis of the system for the network operator and enables partial or full automatization of the system analysis and management in future. An example of an energy efficient data processing problem was considered to show how an ontological model simplifies the analysis and optimization of a complex data processing system.

The proposed ontology assumes the possibility of expansion and addition. For example, processing security can be considered as another important criterion for the quality of data processing (especially for the modern network services such as connected vehicles). This parameter and corresponding additions to the ontology should be considered as a related future work.

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ОНТОЛОГІЧНА МОДЕЛЬ ДЛЯ ОРГАНІЗАЦІЇ ПРОЦЕСУ ОБРОБЛЕННЯ ДАНИХ В ІНФОРМАЦІЙНИХ ТА КОМУНІКАЦІЙНИХ МЕРЕЖАХ / Л.С. Глоба, Н.А. Гвоздецька, Р.Л. Новогрудська

Аннотація. Функціонування сучасних інформаційно-телекомунікаційних мереж неможливе без оброблення даних. З появою нових мережевих послуг кількість інформації, що потребує оброблення, зростає, при цьому ставляться дедалі жорсткіші вимоги до якості оброблення даних. Тому для оператора мережі дедалі більшої актуальності набуває проблема побудови та підтримання системи оброблення даних з можливістю гнучкого керування якістю послуг та масштабування. Такі системи оброблення даних мають комплексну внутрішню структуру з багатьма взаємопов’язаними параметрами, що ускладнює їх аналіз, керування та розширення. Запропоновано використовувати онтологічну модель для зберігання, подання та маніпулювання інформацією в системі оброблення даних оператора. Онтологічна модель дозволяє структурувати та систематизувати дані системи оброблення інформації і прозоро відображати взаємозв’язки між параметрами системи для спрощення її аналізу та масштабування. Запропонована онтологія системи оброблення даних складається з трьох зв’язаних підсистем. Наведено опис запропонованої онтологічної моделі та додатково проаналізовано джерела інформації, яка потребує оброблення, в інформаційно-телекомунікаційній мережі.

Ключові слова: інформаційно-телекомунікаційна мережа, система оброблення даних, онтологія, модель, оператор мережі, аналіз, масштабування, клас, відношення.

ОНТОЛОГИЧЕСКАЯ МОДЕЛЬ ДЛЯ ОРГАНИЗАЦИИ ПРОЦЕССА ОБРАБОТКИ ДАННЫХ В ИНФОРМАЦИОННЫХ И КОММУНИКАЦИОННЫХ СЕТЯХ / Л.С. Глоба, Н.А. Гвоздецкая, Р.Л. Новогрудская

Аннотация. Функционирование современных информационно-телекоммуникационных сетей невозможно без обработки данных. С появлением новых сетевых услуг количество информации, которая нуждается в обработке, возрастает, при этом выдвигаются все более жесткие требования к качеству обработки данных. Поэтому для оператора сети всё большую актуальность приобретает проблема построения и поддержки системы обработки данных с возможностью гибкого управления качеством услуг и масштабирования. Такие системы обработки данных имеют комплексную внутреннюю структуру со многими взаимосвязанными параметрами, что затрудняет их анализ, управление и расширение. Предложено использовать онтологическую модель для хранения, представления и манипулирования информацией в системе обработки данных оператора. Онтологическая модель позволяет структурировать и систематизировать данные системы обработки информации и прозрачно отражать взаимосвязи между параметрами системы для упрощения её анализа и масштабирования. Предложенная онтология системы обработки данных состоит из трех связанных подсистем. Приведено описание предложенной онтологической модели и дополнительно проанализированы источники информации, которая нуждается в обработке, в информационно-телекоммуникационной сети.

Ключевые слова: информационно-телекоммуникационная сеть, система обработки данных, онтология, модель, оператор сети, анализ, масштабирование, класс, отношения.