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General Architecture of Cloud

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Abstract

An important element of current systems' sustainability is to increase efficiency gains in every part of the system. Because of this, not only those systems are based on information and communication technology that exist only in cyberspace, but also those that have material manifestation. Cloud computing is one of the building blocks of information technology. Therefore the cloud computing has an impact on all industries. This is the reason why the result of cloud computing examination is important. The purpose of this paper is to synthesize the general architecture of cloud systems to standardize further studies of structure and technological aspects. This method is based on philosophical foundations and represents a new perspective in information technology.

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Keywords: cloud; general; architecture; structure; layer.

1. Introduction

The history of the application of cloud computing is rather short. This technology appeared in 2008. Solutions used in building clouds are documented separately in accordance with the manufacturer's platforms used. However, documentations for the entire cloud system are missing because the manufacturing companies of construction components create only some parts of the cloud and have no interest in the standardization. The manufacturing companies are profit-driven and they strive for a monopoly situation. Therefore it is not in their interest to compare their technology to other manufacturer's technology. Because of this the structure of clouds is only documented on

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the manufacturer's own platforms. The purpose of this paper is to synthesize the general architecture of information and communication technology cloud systems. Producing the general architecture makes the study and the comparison of clouds simpler and more unified. This also applies to the safety aspect. The general architecture is the basis so that the security survey of cloud systems may be performed on a unified platform. This unified platform facilitates the negotiation of a possible vulnerability assessment and the establishment of the criteria of the risk assessment.

The study should start by laying down the general principles of cloud architecture synthesis. Detection of the components required for operation is based on examination of solutions of component-manufacturers. For example: Cisco, Computer Associates, Dell, EMC, Fujitsu-Siemens, Hewlett-Packard, Hitachi, IBM, Microsoft, Oracle, VM-Ware. These companies do not produce all part of cloud, but their products' functionality overlaps. Because of this, synthesizing the complementary elements and generalizing the equivalent elements of the solutions are needed to create the general structure. To produce a universal structure the study is based on philosophical foundations. This method is a unique way in information technologies and it creates a new aspect system.

The bases of the study are the human thinking method (nature, abstraction, modeling, revision) and the philosophical abstract categories (thing, property, relation). These elements produce a matrix structure. According to the human thinking should address the vertical layers. These layers are analogous to information technology layers (natural resources, artificial resources, virtualization, operation, management). The horizontal aspect system should be analogous to the base elements of the philosophical abstract categories. The extension of the horizontal aspect system with primary and secondary system change (control, organic change) generates a dynamic system model.

2. Study of structure

The change in the demands of IT systems created the requirement system of the cloud. Technologies that meet the requirements determine cloud behavior. The international definition of the cloud is based on this behavior: "cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [1]. In order to examine the structure of the cloud one should study those components that define the behavior specified by the cloud definition. Additionally, it is useful to determine the indispensability of each component.

2.1. Vertical structure

Based on the definition of the cloud, its main features can be grouped around the following topics: availability, structure, capacity, flexibility and measurability [2]. The structure of traditional systems was the following: network, hardware, operating system, database layer and application layer. In this approach the operating system has shared the resources provided by the hardware. The model changed after the virtualization came out. Virtualization has appeared as a new layer between hardware and operating system [3,4,5]. This technology makes it possible to resize the hardware resources flexibly. The processing points get only those resources that they need [6]. In addition, this layer affects availability [4,6], capacity [7], and measurability [8]. Because of this the study should start by examining this layer.

When using virtualization, physical IT resources, such as data storage [9], processing capacity [10], and communication elements can be flexibly arranged into logical resource groups. Then these logical resources can be assigned to virtual processing points. In this way the physically used IT resources are separated from the logically necessary IT resources [3,11,12]. Furthermore the logical resource groups are the base of the measuring [8].

The operating system specified by the traditional model is above the virtual layer. In order to make a unified statement, the operating system, the database components, the application components and the data link components should be compressed into a single layer: the operation layer. The platform for this layer is the operating system and the layer's task is to implement business processes. The top management layer above this operation layer is complemented with cloud management components [7,13].

The hardware layer is below the virtual layer, which generates physical IT resources [9,10]. Additionally, the energy components that produce mechanical and building engineering resources for the hardware layer must be included in the model, because without that the cloud is inoperative. This bottom layer is the fundamental layer.

These layers are all essential when designing the cloud. Furthermore, it can be observed that each layer corresponds to the theoretical modeling level energy, material, abstraction, replica, continuity.

2.2. Horizontal structure

To consolidate the negotiation of the horizontal structure one should organize the components around the philosophical abstract categories. These categories are: thing, property, relation. The first is the thing, what works, what performs the service. According to IT paradigm it is the processing or transformation. The second is the property, what determines how the thing works. In IT paradigm it is data or storing. The third abstract category is the relation that expresses the external relationship. According to IT paradigm it is the communication or transmitting. This paradigmatic triple reflects a general static approach. Supplementing these abstract categories with primary and secondary system change forms a dynamic model. The three abstract categories form a unit and the elements describing the change give the movement of the system. That is why all elements are mandatory.

3. General architecture

The created matrix structure is shown in Figure 1 that is based on the above mentioned vertical and horizontal considerations and mandatory elements. Components of the matrix structure are mandatory. If any component is missing the system will not meet the cloud requirements. This is the reason why this infrastructure can be referred to as architecture.

The architecture of cloud can be broken down into five main layers due to the principle of interconnection. Each of the layers represents one level of human thinking: the manifestation of energy, the manifestation of material world, the modeling layer of the human mind, the replica of reality and the layer of continuity. Furthermore, all layer's task is to ensure the safety of the operational layer's working.

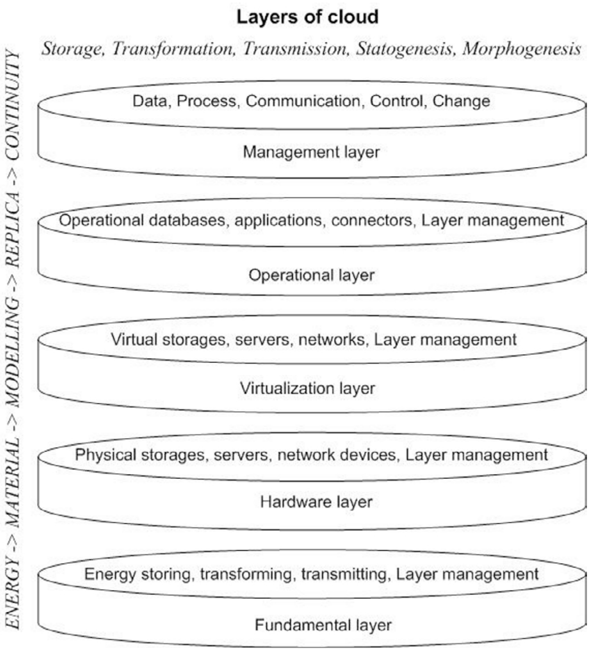

Fig. 1. General architecture of cloud.

The earlier mentioned manufacturers produce only parts of this structure: Cisco creates hardware and management layer components; Computer Associates is developing management layer components; Dell, EMC, Fujitsu-Siemens, Hitachi produce fundamental, hardware and management layer elements; Hewlett-Packard creates components to all layers; IBM produces elements to all layers, except the virtualization layer; Microsoft creates virtualization, operation and management layer components; VM-Ware produces virtualization and management elements; Oracle creates operational and management layer components. The manufacturers' implementations are different, but the operating principles are similar. This synthesis contains the logical model of the architecture in a universal manner.

The most important advantages of this architecture are the high availability and the flexibility. But its complexity also carries the disadvantages. The high availability ensures the system's working, but the complex system contains more components and this means greater technological risk and possibility of failure on each part [14]. Because of this, the creating and maintaining this technology is very expensive. This is the reason why the basic storing, processing and communication services are provided in larger service packages. The cloud technology is only one of the IT building blocks today. There are more and more applications and solutions that employ more different clouds' services. Unfortunately, presentation of cloud application options would go too far beyond the boundaries of this study.

Considering the layer of energy as the bottom layer, the following can be determined for each layer.

3.1. Fundamental layer

The fundamental layer is the lowest layer of cloud architecture. It corresponds to the layer of natural energy management. It serves the hardware layer above it. In this layer the natural resources are transformed to mechanical resources by mechanical and building engineering solutions. Elements of the layer:

- Energy storages: the most important are the flexibility of the soil, the flexible constructions of the building, the flexible elements of suspended ceilings and raised floors, coolants, batteries.
- Energy converters: for example noise protection, vibration protection, earthquake protection architectural layers, mechanical heat dissipators and heat exchangers, aggregators.
- Energy Intermediaries: primary communal services such as water, waste water, gas, electricity, communication service components and their management components and pipeline networks, horizontal parts of the building.
- Layer management tools: all components that are designed to maintain the right conditions for this layer. For example air conditioning, dehumidification, pest control, groundwater and cooling water intrusion prevention, flood protection, earthquake protection, noise protection, vibration protection, traditional safety technology features from mechanical protection to fire protection and live defense.

3.2. Hardware layer

The hardware layer uses the services of the underlying fundamental layer and serves the virtualization layer above it. This layer is the logical equivalent of physical manifestation. In this layer the mechanical resources are transformed to physical IT resources by IT hardware devices. Elements of the layer:

- Physical data storages [9]: local and network storages, storage area networks, converged system components.
- Physical servers [10]: traditional and group-servers, server-blocks, converged system components.
- Physical networks and network devices [10]: passive and active network devices, integrated multifunctional devices, modular devices, converged system components.
- Layer management tools [9,10]: administration and monitoring components, operation and support tools.

3.3. Virtualization layer

The virtualization layer uses the services of the underlying hardware layer and serves the operation layer above it. This layer corresponds to modeling in human thinking. This layer covers physical IT resources and creates flexible virtual IT resource pools. It also makes it possible to create virtual services for measuring. Elements [3,4,5,15]:

- Virtual data storages that are created from the organization of physical data storages, virtual storage spaces that serve virtual processing points.
- Virtual resource centers that are created from the organization of physical servers, virtual processing points that are designed to deliver business services.
- Virtual networks and virtual network devices.
- Management tools for the virtualization platform: administration, monitoring, operation and support tools

3.4. Operational layer

The operation layer uses the services of the underlying virtualization layer, providing operational parameters for the management layer above it. This layer corresponds to the replication of reality in the human mind. Its platform is the operating system. Business processes are realized in this layer and all other layers are responsible for ensuring continuous and sustainable operation for this layer. The elements of the layer are the same as the components of the conventional network operating system approach:

- Database management [16,17]: database engines, engine management components, middleware systems.
- Processing applications: components of the business logic and the graphical logic, visualization components.
- Communication components: connectors, middleware systems [17], portal systems.
- Conventional layer management: network service applications, administration and monitoring components, operation and support tools.

3.5. Management layer

The management layer is the top layer of the cloud. All layers provide data for this layer indirectly, but it relies directly on the operational layer. This layer is the logical equivalent to ensuring continuity and sustainability. Elements of the layer:

- Data management tools: for example backup and archiving systems, storage hierarchy systems.
- Management system of processing points: for example configuration and inventory tools.
- Management system of network services.
- Management of management: for example decision support systems, control systems, validating systems, service management, change management.

4. Conclusions

This study is based on manufacturers' technological documentations and the documentations of implementations. It is also based on technological research of manufacturers. The progress of generalization and the creation of synthesis are individual in this topic and based on philosophical foundations. For this reason, the development of vendor-independent architecture is unique. In addition, the matrix structure used for modeling is individual. Assembly of the overall architecture of cloud in this manner is unique. It can be determined about the vertical layers of the matrix structure generated by the examination: each layer communicates with its adjacent layers; a given layer uses the layer underneath and serves the layer above. The fundamental layer is the layer of the energy management. The hardware layer is the layer of the physical manifestation. The virtualization layer is the layer of the human modeling. The operational layer is the functional layer of the business model. The management layer is the manifestation of the continuity of the system. All layer's task is to ensure the safety of the operational layer. The horizontal articulation of the matrix structure should be developed by storage, transmission, transformation, statogenesis and morphogenesis topics. Components of the matrix structure are mandatory. If any component is missing the system will not meet the cloud requirements. This is the reason why this infrastructure can be referred to as architecture.

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