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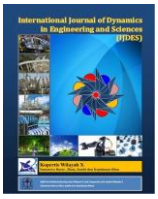

CLOUD-BASED INFORMATION TECHNOLOGY ARCHITECTURE MODELING COMPUTING

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Abstract

Cloud computing technology is a technology where most of the processing and computing is located on the internet network thus enabling users to access the services they need from anywhere and at any time. According to data from the Directorate General of Higher Education (DIKTI), currently in Indonesia there are more than 3,000 good universities private and public. In general, all these universities have the same business processes and needs information Systems. But in reality every university builds the architecture and system requirements the information individually. This raises several problems, namely system redundancy information, there is no standardization of data structures, there is no data consolidation between one information system and another others and the inconsistency of information system development. Some of these problems form the basis of thought to design an information technology architecture model using the concept of cloud computing.Based on the results of an analysis of the condition of universities in Indonesia and using the framework that has been selected, a cloud computing-based information technology architecture model is generated that is in accordance with the conditions and requirements needs of universities in Indonesia. The information technology architecture consists of business architecture, business architecture, data, application architecture and technology architecture. Research is expected to contribute to universities in Indonesia, especially as a reference in designing information technology architecture.

Keywords: Information Technology Architecture, Cloud Computing

1. Introduction

Information technology architecture in an organization is a blueprint that explains how elements of information technology and information management work together as a single unit. Thus, the application of the right information technology architecture will greatly assist the achievement of organizational goals, including educational organizations. Higher education as one of the educational institutions in Indonesia also requires the role of information technology in carrying out its business processes. Information technology architecture planning is also an important thing to do so that the technology strategy is aligned with the university's business strategy. However, currently there are not many frameworks or models of information technology architecture that are appropriate to be applied in higher education institutions in Indonesia. Most of the existing information technology architecture models are only limited in scope to certain educational institutions.

The emergence of cloud computing technology provides added value for the design of information technology architecture for customers

organizations, including educational institutions. Carl Hewitt in [1] stated that cloud computing technology

is a technology where most of the processing and computing is located on the internet network so that it allows users to access the services they need from anywhere. Because it has easy access, many companies are starting to try to apply the concept of cloud computing, including in Indonesia such as PT Astra Graphia Information Technology, PT Infinys System Indonesia and PT Indo Pacific (GreenView) [2].

Based on data from the Directorate General of Higher Education (DIKTI), currently in Indonesia there are 3,150 public and private universities and 15,830 study programs. This fact shows that the scope of research in universities in Indonesia is quite broad. The number and distribution of higher education institutions is also a potential and a challenge for the government to provide a fair and equitable education for the people of Indonesia.

Although each of these universities has the autonomy to carry out its business processes, the government as a policy maker has standardized the implementation of education through Law no. 20 of 2003 concerning the National Education System. In the law, it is stated in article 20 paragraph (2) that universities are obliged to carry out education, research, and community service. So, in general, all universities in Indonesia have similar business processes. The similarity of business process characteristics will be used as the basis for designing architectural models for universities in Indonesia.

Based on the above background, this research will design a model of information technology architecture that is in accordance with the conditions and needs of universities in Indonesia. This study will discuss (1) how the cloud computing technology-based information technology architecture model is suitable for higher education institutions in Indonesia, (2) what are the components of cloud computing-based information technology architecture for universities in Indonesia and (3) what are the services provided by cloud computing providers in the model of higher education information technology architecture.

The research methodology used as a reference uses the TOGAF Architecture Development Method . methodology

According to [4], corporate architecture is a strategic information that defines the company's mission, as well as what information and technology are needed to achieve that mission. Enterprise architecture consists of basic architecture, goal architecture and structured planning to achieve goals. The basic architecture of an enterprise is an existing architectural condition, for example, the enterprise network architecture. Destination architecture is the architecture of the company to be achieved or to be built (to-be). To achieve the goal architecture, we need a plan and structured steps so that it will gradually be achieved.

Information technology architecture is the basic organization of software-intensive systems. A system is software intensive because the most prominent part of an information technology architecture is its application, which is the part that allows users to do their business work. There are quite a lot of information technology architecture design frameworks available today. But basically they have the same goal, namely to facilitate the design of information technology architecture in a company. An example of an architectural framework Information technology that is widely used is the Zachman Enterprise Architecture Framework [5], [6] Group Architecture Framework (TOGAF) [3].

TOGAF is the industry standard for architectural development methods and resource bases that can be freely used by any organization wishing to develop an enterprise architecture for use in its own enterprise. TOGAF has been continuously developed and evolved since the mid 90's by representatives from several leading information technology vendor and user organizations, working together in The Open Group's Architecture Forum.

TOGAF provides various methods and tools to assist companies in preparing, developing, deploying and maintaining their enterprise architecture. TOGAF is created and continuously refined based on best practices from various companies and organizations. TOGAF supports four types of enterprise architecture, namely business architecture, data architecture, application architecture and technology architecture.

The business architecture is the architecture that defines the business strategy, main and supporting business processes of the organization and their management. Data architecture defines the data structure and resources owned by the company, both physically and logically. One example of data architecture in educational institutions, for example, is the structure of data storage for lecturers and students.

While the application architecture defines the blueprint of the development of applications and information systems within the company, including its relation to the company's business processes. One form of enterprise application architecture can be seen in the IT planning document (IT Plan). TOGAF also supports technology architectures that describe software, hardware and network requirements to support business processes and other architectures.

TOGAF as an information technology architecture framework has phases that make up the information technology architecture development cycle. This cycle is known as the Architecture Development Method (ADM). ADM consists of one preparatory phase, 8 (eight) main phases and a process that manages and manages all phases in ADM.

2. METHOD

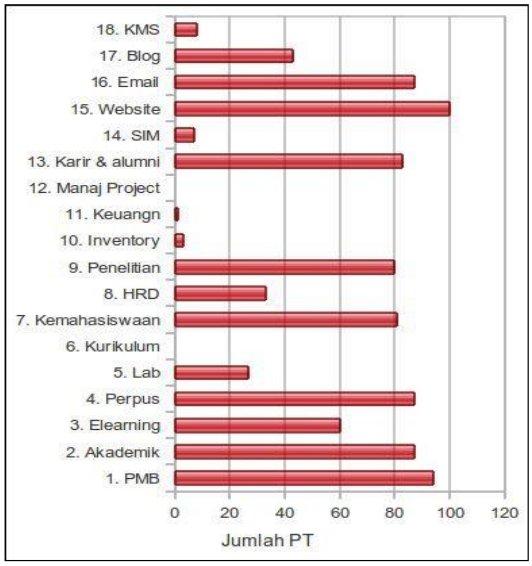

Figure 1. Results of a Survey of Higher Education Information Systems in Indonesia

Based on the results of a survey conducted on 100 (one hundred) universities in Indonesia (figure 2), it can be concluded that there are 9 (nine) information system applications implemented by most universities in Indonesia.

Indonesia. The nine applications are mapped into the McFarlan Strategic Grid [12] as shown in figure 3.

Based on the results of the mapping of information system applications in universities presented in the picture above, there are several applications that fall into the Support category, namely Student Information Systems, Personnel Information Systems, Goods Inventory Information Systems, Finance Information Systems, Websites, Emails and Blogs. These applications are quite necessary in college but do not really affect the main business processes in college

STRATEGIC	HIGH POTENTIAL
SI Manajemen Project SI SI Executive Knowledge Management System	
SI Penerimaan Mhs Baru SI Akademik LMS (Elearning) SI Perpustakaan SI Laboratorium SI Kurikulum SI Penelitian & PPM SI Alumni dan Karir SI Laporan Akademik (EPSBED)	SI Kemahasiswaan SI Kepegawaian SI Inventory Barang SI Keuangan Website Email Blog
KEY OPERATION	**SUPPORT**

Figure 2. Mapping College Applications with McFarlan Strategic Grid

While in the Key Operational category, there are 9 (nine) information system applications, namely New Student Admission Information Systems, Academic Information Systems, LMS (Elearning), Library Information Systems, Laboratory Information Systems, Curriculum Information Systems, Research & PPM Information Systems, Information Systems Alumni and Career Information, SI Academic Report (EPSBED). The nine applications above are core (main) applications that should be available at every university in Indonesia. If one or more of these applications are not available, the university's business processes will be disrupted or encounter obstacles. Therefore, these nine applications will be used as services in the cloud for all universities.

Meanwhile, there are three information systems that are included in the Strategic category, namely Executive Information Systems, Project Management Information Systems and Knowledge Management Systems.

The application of the information system will increase the competitiveness (competitive advantages) for universities. Meanwhile, in the high potential application group, there is no information system. Currently, universities generally do not have an information system that is high potential. In relation to the world of education, especially universities, high potential applications are applications that can be the basis for the government or universities in taking.

3. RESULT

Cloud computing-based application architecture in universities describes how the position of applications as services that will be placed in the cloud, as well as how each application relates both between applications in the cloud and with other applications outside the cloud. In Figure 4 below, the position of the application in the cloud is described and its relationship to the application in the university. Between the college and the cloud is connected by an INHERENT network.

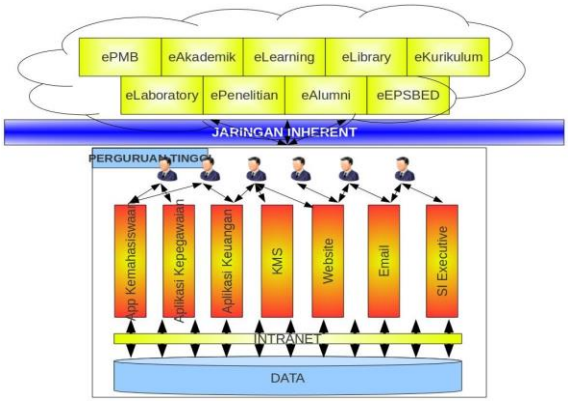

Figure 3. Cloud-based Application Architecture

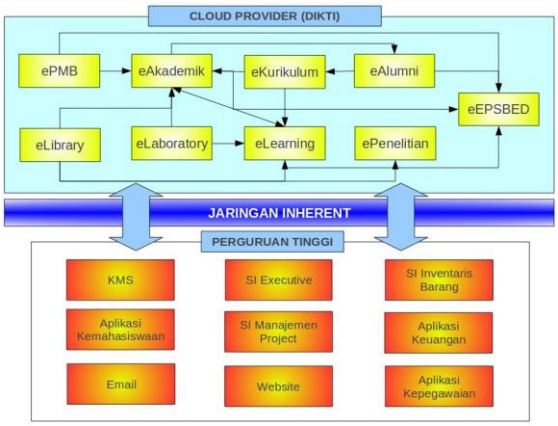

Figure 4. Cloud-based Application Architecture

If viewed in more detail, then there is a relationship between each application in the cloud. For example, the new student admission system will be related to the academic information system, especially in terms of data consolidation of students who have passed the selection of new student admissions. Besides being influenced by the new student admission system, the academic information system is also influenced by the learning system (eLearning), laboratory system (eLaboratory), library system (eLibrary) and also curriculum system (eKurikulum). In addition to the relationship between applications in the cloud, there is a reciprocal relationship between cloud providers and universities. This reciprocal relationship is manifested in the interaction process of using the system and updating university data in the cloud. The relationship between cloud providers and universities can use the higher education network, namely INHERENT.

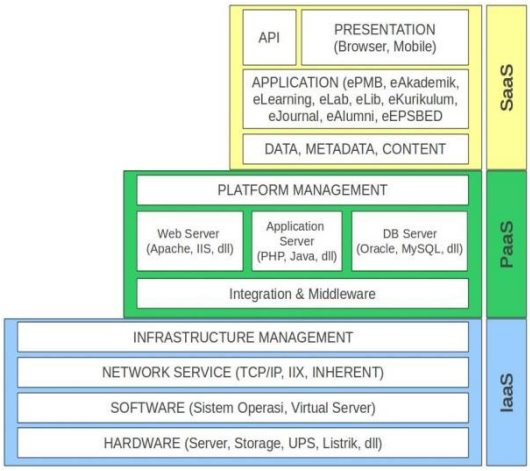

Figure 5. Cloud Computing Technology Architecture and Development Model

In the Infrastructure as Service section, there are several technology components, namely hardware, software, network services and infrastructure management. Hardware components involve physical components such as servers, storage media, UPS and other supporting components such as power sources. In the software component, especially regarding the operating system and its supporting applications, as well as virtual server applications that allow the provision of different server specifications for each user according to their respective needs. The Network Service component manages data communication services over the network. For universities, they can use the TCP/IP protocol which is widely used and use the INHERENT network that is already available. The last

component is infrastructure management which is in charge of managing the use of infrastructure, including information on infrastructure usage

The second part is platform as service. This section consists of several components, including Integration & Middleware which serves as a communication liaison between one component and another. For example, between PHP or Java as a programming language, it is connected with ODBC (Open Database Connectivity) in order to be able to connect with various types of databases. The other component concerns the platform required for the application to run properly. Considering the condition of universities in Indonesia, it is proposed to use a web-based platform so that it can be accessed easily. To build web-based applications, three basic components are needed, namely web servers such as Apache and IIS, server-based application servers such as PHP and Java, and databases such as MySQL and Oracle.

Software as a Service is the topmost part of the cloud computing application development model. In this section there are components of the data structure and metadata required by the application. For higher education institutions, as explained in the application analysis, there are nine applications that become services in Software as Service. Each of these applications is associated with the Presentation component which manages the appearance of the application in various media, such as browsers and mobile phones. In addition, there is an API (application program interface) that is needed to connect the application with other applications that may be developed by universities.

Apart from being based on the development model, the technology architecture can also be seen from the cloud provider side. Cloud Provider as a party that provides cloud-based services is the most important party in the proposed information technology architecture for universities. The resulting information technology architecture model, especially for cloud providers, is made using the Market-oriented Cloud Architecture model proposed by Rajkumar Buyya, Yeo and Venugopal [10] . The model is divided into 4 (four) main layers, namely the physical machine or device layer, the virtual machines (VMs) layer, the SLA Resource Allocator layer and the last layer is the user or user layer.

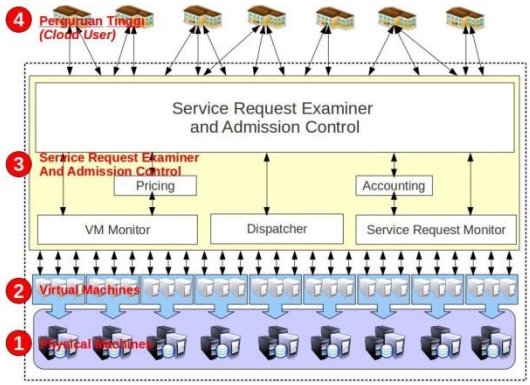

Figure 6. Cloud-based College IT Architecture

At layer 1 there is a physical infrastructure which is the most basic part of the resulting information technology architecture. Physical infrastructure in the form of application servers needed, both servers for data processing, databases, web servers and other types of servers required by each application. As explained in the previous section, there are nine applications proposed to be placed in the cloud. Server toughness in a cloud-based architecture greatly affects the quality of the resulting service. Moreover, to serve all universities in Indonesia, which number more than 3000. To increase the toughness of the server, grid technology can be used where each computing process can be executed (executed) by several servers at once. With this process division, the process speed will be better than without grid technology.

At layer 2 there are Virtual Machines (Virtual Servers). The concept of virtual marchine or virtualization will increase the availability of IT services and will save the amount of physical infrastructure required. With virtualization technology, it is also possible for each client or service user to virtually have full power over their own server, even though they have to physically share resources with other clients. Meanwhile, Layer 3 is an SLA Resource Allocator that is part of the cloud architecture in charge of managing service availability for each user. This section is the part that connects applications, information systems or services provided by cloud providers with cloud consumers, namely universities. This section is also responsible for receiving service requests from universities, analyzing the feasibility of these requests and responding to requests.

At Layer 4 there are users or service users, namely all universities registered with the Directorate General of Higher Education (DIKTI). Users or users can apply for a service required by the college. On the other hand,

users can also request termination of a service if it is no longer needed. Service settings by users can be done through a portal or application provided by the cloud provider.

4. Conclusion

Based on the results of the discussion and research that has been done, it can be briefly concluded that:

• With a large number of universities in Indonesia, the most suitable information technology architecture to be implemented is a service-oriented architecture and uses virtualization and grid computing technology.

• Universities in Indonesia have 9 (nine) main information systems that should be placed in the cloud, so that it will save development and implementation costs. The nine information systems are (1) new student admissions information system, (2) academic information system, (3) e-learning system, (4) library information system, (5) laboratory information system, (6) curriculum information system, (7) research & community service information system, (8) alumni and career information system, and (9) academic reporting information system (EPSBED).

• By using a cloud architecture modeling framework based on user needs, an information technology architecture model for universities in Indonesia is produced which consists of business architecture, data architecture, application architecture and technology architecture.

By using the concept of cloud computing, the resulting information technology architecture will solve the problem of information system redundancy, lack of data consolidation and standardization and inconsistency in information system development. For universities, the resulting architectural model will be beneficial, namely saving application development costs. In addition, with a third party building applications, universities can focus more on their main business processes, namely providing education and teaching, research and community service.

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