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ANALYSIS OF CLOUD COMPUTING INFRASTRUCTURE SYSTEM WITH NIST STANDARD CLOUD COMPUTING STANDARDS ROADMAP

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ABSTRACT

Cloud computing is a computing model that provides easy access to computing resources in the form of services. Cloud computing describes an operational and economic model for the provision of it infrastructure and related services. This thesis aims to test the on premise infrastructure at pt. In this study, the aspects tested include, on-demand-self-service, broad network access, resource pooling, rapid elasticity, measured service, virtualization, browser as a platform, free and open source software, web 2.0 support, and utility computing. . The research method used here is a direct test method on the existing infrastructure at PT. XYZ.

Keywords: *NIST, Cloud Computing, Standardization*

INTRODUCTION

Information Technology in this day and age has been adopted by various aspects of the field of life, conditions like this occur because Information technology can cooperate with many fields of knowledge. For both private and government companies, information technology has brought about fundamental changes that have become a major *backbone* for many sectors. *Cloud computing* is a mechanism, where a set of information *technology resources* that are interconnected and almost unlimited, both infrastructure and applications are owned and managed entirely by third parties so as to allow *customers* to use these *resources* on-demand through a network both private and public cloud computing is also interpreted as a client-server model, where resources Such as servers, storage, networks and software can be viewed as services that can be accessed by users remotely and at any time. Users of cloud computing services can access files in real time over the internet without the need to install a local computer. The National Institute of Standards and Technology (NIST) argues that cloud computing is an information technology model that provides a sense of comfort, accessible anywhere along with computing resources and is also quickly released with minimal effort by

management (Riana, 2020). *Cloud computing* according to the National Institute of *Standards and Technology* (NIST) is a computational model that provides ease to access computing resources in the form of services. *Cloud computing* describes operational and economic models for the provision of IT infrastructure and related services. Common characteristics that must be owned by a *cloud* system are *pay-per-use, elastic capacity, self service interface,* and virtualization resources. The *cloud* service model according to NIST is divided into *Software As A Service* (SAAS), *Platform As A Service* (PAAS), and *Infrastructure As A Service* (IAAS) To build a system that the cloud requires several conditions, in accordance with the standards contained in the Special Publication of the National Institute of Standards and Technology (NIST) issued a system that can be said to be a system that cloud computing has that is five conditions. characteristic. Cloud systems must have five characteristics of On-demand self-service, Broad network access, Resource pooling, Rapid elasticity, and Measured service (Ngurah & Arsa, 2019). In the current era of technological development *Cloud Computing* is a technology that has many advantages. Because this computing model allows users to use *resources* such as *networks,*

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servers, storage, applications and services in *cloud* systems. On the other hand, it can also be *shared* as well as used together. In addition, *cloud computing* also has the advantage of increasing the flexibility and capability of computer processes without the need to spend large funds to create new infrastructure. It will also minimize the cost of training new experts as well as in terms of licensing new software (PW & Ujianto, 2020). However, behind these conveniences there are several threats that must be considered for users and *cloud* service providers. Some of those threats are data leaks, credential theft, API hacking, system vulnerability exploits, account hijacking, permanent data loss, misuse of cloud services, and DOS attacks. Therefore, there needs to be security standards applied to *cloud computing* providers.

PROPOSED INNOVATION

Cloud computing according to the National Institute of Standards and Technology (NIST) is a computational model that provides ease to access computing resources in the form of services. *Cloud computing* describes operational and economic models for the provision of IT infrastructure and related services. Common characteristics that must be owned by a *cloud* system are *pay-per-use, elastic capacity, self service interface*, and virtualization resources. The *cloud* service model according to NIST is divided into *Software As A Service (SAAS)*, *Platform As A Service (PAAS)*, and *Infrastructure As A Service (IAAS)*. To build a system that the cloud requires several conditions, in accordance with the standards contained in the Special Publication of the National Institute of Standards and Technology (NIST) issued a system that can be said to be a system that cloud computing has that is five conditions characteristic. Cloud systems must have five characteristics of On-demand self-service, Broad network access, Resource pooling, Rapid elasticity, and Measured service (Ngurah & Arsa, 2019). In the current era of technological development *Cloud*

Computing is a technology that has many advantages. Because this computing model allows users to use *resources* such as *networks, servers, storage, applications* and services in *cloud* systems. On the other hand, it can also be *shared* as well as used together. In addition, *cloud computing* also has the advantage of increasing the flexibility and capability of computer processes without the need to spend large funds to create new infrastructure. It will also minimize the cost of training new experts as well as in terms of licensing new software (PW & Ujianto, 2020). However, behind these conveniences there are several threats that must be considered for users and *cloud* service providers. Some of those threats are data leaks, credential theft, API hacking, system vulnerability exploits, account hijacking, permanent data loss, misuse of cloud services, and DOS attacks. Therefore, there needs to be security standards applied to *cloud computing* providers (PW & Ujianto, 2020). This research discusses "Analysis of *Cloud Computing* Infrastructure Systems According to Standardization of NIST *Cloud Computing Standards Roadmap*". The authors will also provide recommendations regarding the most appropriate standards to apply to the cloud computing architecture. With this research is expected to reduce / minimize threats from any perspective in terms of the application of cloud computing technology.

METHODS

The following stages carried out by the author for this design are formed in a systematic framework in the form of research flow. This flow will be useful to explain the stages that are done from before the design to testing at the end of the design. Here is the research flow shown in Figure 1 .

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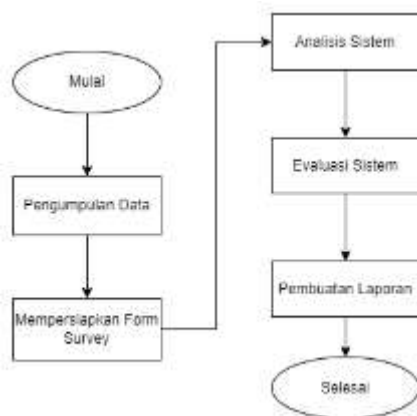


Figure 1 Research Flow

Source: Ngrurah & Arsa, (2019)

Here is an explanation of the stages of the research flow shown in Figure 1, as follows:

1. Data Collection Stage, at this stage the author collects data in terms of *standardization of cloud computing* in accordance with the standardization mentioned by NIST. The author studied these standardizations that function in the creation of survey forms.
2. Preparing For The Survey Form, at this stage the author created a survey form related to the *standardization of cloud computing* mentioned by NIST. This survey form serves to be a reference for the author at the time of testing.
3. System Analysis Stage, at this stage the author observes *the cloud computing* system in *xyz* company. Mini site analysis serves to find out the specifications of *cloud computing* and also to find out the type of *cloud computing*.
4. System Evaluation Stage, at this stage the author will conduct testing in accordance with the survey form that has been made by the author in the previous stage in order to get the appropriate results.
5. Report Creation stage, this stage is the last stage where the author will make a report about the test that the author has done. This report will show the results obtained by the author after the author conducts system testing.

The hardware and software required in this testing process are as follows:

1. Laptop/PC

The specifications are AMD Ryzen 3 3200U 2.60 GHz Processor, 8 GB RAM, 256 GB SSD, 1 TB HDD, and AMD Radeon VEGA 3 Graphic Card.

2. Cloud Computing Infrastructure

TIENS	BRAND	TYPE	SPESIFIKASI
SERVER	QNAP	T3-EC880U	SSDs for caching, Scalable design, up to 816TB raw capacity, V
SERVER	QNAP	T3-EC880U	SSDs for caching, Scalable design, up to 816TB raw capacity, V
SERVER	HP	PROLIANT DL380G7	2X QUAD CORE XEON E5550 2.66GHZ / 2X HDD HP SAS 300GB
SERVER	HP	PROLIANT DL380GE	1X QUAD CORE XEON E5504 2.0GHZ / 2X HDD HP SAS 300GB
SERVER	HP	PROLIANT DL380GE	1X QUAD CORE XEON E5504 2.0GHZ / 2X HDD HP SAS 300GB
SERVER	HP	PROLIANT DL380GE	1X QUAD CORE XEON E5504 2.0GHZ / 8X HDD HP SAS 300GB
SERVER	HP	PROLIANT DL380G7	2X QUAD CORE XEON E5550 2.66GHZ / 4X HDD HP SAS 300GB
SERVER	BNV	NETVISTA	small desktop - P4 2.56 GHz - 256 MB - 40 GB

3. Google Chrome version 87.0.4280.66

The browser used to access the cloud computing portal.

To conduct *testing on cloud computing* the author of the author refers to the standardization set by. Here are the methods the author uses:

1. Data Collection

This stage is the stage of gathering information in *cloud computing*. At this stage the author collects data where later the author will test the cloud computing infrastructure in accordance with NIST standardization which will be tested at the testing stage. Some of the data that will be tested are, *on-demand-self-service, broad network access, resource pooling, rapid elasticity, measured service*.

2. Testing

At this stage the tester conducts cloud standardization testing on the cloud contained in PT. XYZ in accordance with the survey form that has been created. The test results are:

1. On Demand Self Service

On Demand Self Service as stated by NIST that users can configure the cloud independently such as upgrading the server, reprimanding capacity, adding security and others according to what the user wants without the need for intermediaries from the service provider. At PT. XYZ existing features can already be used by users but these features cannot be changed, added or reduced. All of those things are only regulated by the service provider or from the IT center where those who adjust to their user's needs which means the request for a raid must remain through the service provider or IT center.

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2. *Broad Network Access*

Broad Network Access is where the capabilities of the cloud are available over the the cloud using the various devices mentioned. Because the cloud is in the form of virtual or through a website so accessing it will be easier with various devices such as existing users in the company can access the cloud using existing computers and access using a personal laptop.

3. *Resorce Pooling*

As mentioned by NIST mentioned that resource pooling is a number of resources or cloud resources can serve many users whose locations vary, but the resources used are in one place. Cloud at PT. XYZ cannot be used if it is not within range of use for example if there is a bug that occurs in the software that the officer must be in the location to be able to access it and fix it just like the users who if already out of the company then the cloud cannot be used.

4. *Rapid Elasticity*

The standardization mentioned by NIST this one is the ability of cloud services can be used dynamically where users can quickly increase or decrease service capacity according to the needs of situations and conditions. The existing capacity in the cloud pt. XYZ cannot

network and can be accessed by various types of smartphones, tablets, computers and laptops wherever you are. Users of PT. XYZ can access be added or reduced by the user. The user can only use as provided by PT. XYZ. We can take an example at the time of use in the cloud PT. XYZ increases then it will often occur down and users have to wait a while to queue in order to enter alternately. Capacity addition can only be done by the IT center PT. XYZ.

5. *Measured Service*

Measured Service mentioned NIST where in *the cloud* system there are features to monitor the services used such as storage that has been used, the amount of CPU and memory used, the features used, *security* used and many more that serve to find out in transparency the cost we will. While at PT. XYZ users cannot monitor the amount of *storage usage*, features and others. That's because the use of *the cloud* is only used by private companies where users who use *the cloud* costs are borne by the company so this feature does not exist on users. The standardization mentioned above is the main standardization mentioned by NIST while the additional standardization mentioned by NIST. That standardization can be seen on Table 1.

Tabel 1 Testing

Standardization	Information
<i>On Demand self Service</i>	NIST said, Users can independently configure the cloud such as upgrading servers, reducing capacity, adding security and others according to what users want without the need for intermediaries from the service provider. In PT.XYZ existing features can be used by users but these features cannot be changed, added or reduced. All these things are only regulated by the service provider or IT center where they are tailored to the needs of their users which means user requests have to go through the service provider or IT center.
<i>Broad Network Access</i>	Broad Network Access or broad internet access is where the capabilities of the cloud are available via the internet network where it will make various types of devices (smartphones, computers, tablets, laptops and others) that can be connected to the internet network able to access the cloud wherever they are (Simmon, 2018). Because PT. XYZ has made a website for access, automatically users at PT. XYZ can access the cloud with smartphones, tablets, computers and laptops because they already use the website as the medium. Users can also access the cloud through a website that has been prepared by PT. XYZ wherever they are as long as they are connected to the internet network. This standardization can be said PT. XYZ has fulfilled it.

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<i>Resorce Pooling</i>	<p>As stated by NIST that resource pooling is a collection of computing resources provided by cloud service providers where these resources must be able to serve many customers (according to the number of users who use the service) and be dynamic depending on the number of customers (multi-tenant) and can serve according to customer request (Simmon 2018). Cloud computing resources at PT. XYZ are not dynamic because if PT. XYZ wants to upgrade cloud capabilities such as adding servers, adding memory, adding CPU and so on, it all has to be done manually. The service provider must purchase all of them then installed and configured so that they can be used to serve users. Existing resources will also continue to be active even though only a few people use the service. That's because there is no auto-scaling feature which functions to turn on or turn off automatically the number of servers needed according to the number of users using the service. Existing resources also cannot adjust to customer requests because customers can only use the resources that have been provided by PT.XYZ. Therefore, PT. XYZ does not meet this standard.</p>
<i>Rapid Elasticity</i>	<p>The standard mentioned by NIST on this one is that the capacity of cloud services can be used by users flexibly where users can quickly increase or decrease services according to the needs of situations and conditions (Simmon 2018). PT.XYZ cloud users cannot increase or decrease the service as they wish. Users can only use all of these services in accordance with what has been provided by the service provider. This causes inflexibility for users in terms of increasing or decreasing services because users cannot customize services according to their individual needs. If the user wants to increase the service or decrease the service, they must submit it to the service provider and it will not necessarily be executed by the service provider. This will make it difficult for users and make PT.XYZ's cloud inflexible for its users. This makes PT.XYZ not meet the rapid elasticity standard.</p>
<i>Measured Service</i>	<p>Measured Service mentioned by NIST where in the cloud system there is a feature where users can monitor the services used by users such as storage that has been used, the amount of CPU and memory used, services used, security used and many more that function to find out accurately. transparency of fees that users will pay (Simmon 2018). Meanwhile at PT.XYZ users cannot monitor the amount of storage usage, security, etc. This is because the cloud provided by PT.XYZ is only intended for internal users, which does not require this monitoring feature. All costs are borne by the company. Here users only use the services provided by PT. XYZ in the form of a website that can be accessed at any time without knowing how much the company has to bear. Users only pay student bills, which are payments intended for student lectures only. PT.XYZ also uses the VMware vSphere system, this system can function for monitoring but this is intended for service providers where they can monitor their servers but have no impact on users. Therefore, this standardization is not fulfilled by PT. XYZ.</p>
<i>Virtualization</i>	<p>Virtualization is a technology that allows a physical machine to become a shared resource that can be shared and used by several services at once. These services can be configured independently without affecting the configuration of other services even though they are on the same physical machine and each service can have its own operating system (Harijanto and Ariyanto 2015). The existing cloud at PT. XYZ has embedded a form of virtualization in their cloud system. They use VMware VSphere as their form of virtualization where they use this to handle the operating system on each of their servers so that they can see the number of accesses to their servers, used storage, manage and configure</p>

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	the services on their servers and to separate each service configuration so that every service configuration that exists on each server does not affect each other. While on the user side, users can also access the services provided by PT. XYZ's cloud through the website where it is already virtual. So PT.XYZ has met this standard because it has virtualized their cloud.
<i>Browser As Platform</i>	As the name suggests, the browser must be a medium in a cloud which becomes a place to access the cloud where the cloud must be in the form of a website (Tasaki et al., 2013). the service at PT.XYZ is already in the form of a website, so it will automatically use a browser to access the website, the browser will automatically become the platform. So this standardization has been fulfilled by PT. XYZ.
<i>Free and Open Source Software</i>	Cloud software can be freely used, studied, copied, modified as needed, redistributed, and the source code is open, allowing users to participate in development (Putra & Utami, 2021). The configuration of the services provided by PT.XYZ cannot be freely studied, copied and changed by its users. The configuration shown is only the basic configuration and cannot be changed, that's because the software system, coding and configuration are not freely opened. That's why PT. XYZ does not meet this standard.
<i>Support Web 2.0</i>	As the name suggests the cloud must be able to run on web 2.0 which is where web 2.0 is the second generation of the WWW or the World Wide Web. Web 2.0 is more dynamic and easier to access without the need to understand programming to access it unlike the first generation web which was difficult to access and had to understand programming (Media et al., 2014). PT.XYZ cloud already supports web 2.0 which can be easily accessed via the link provided by PT.XYZ. The characteristics of web 2.0 are HTTP/HTTPS and on the e-learning web link uib already uses HTTPS which makes users don't need to set up or have to understand programming to be able to access the PT.XYZ cloud. Therefore, this standard has been fulfilled by PT. XYZ.
<i>Utility Computing</i>	This is where the service provider provides according to the user's request and charges according to the usage that the user uses (Fahmi et al. 2016). PT.XYZ cloud does not have this feature because the use of cloud in the company is only used internally.

The *security used* to protect attacks that occur in the private *cloud* PT. XYZ that is:

1. *NGAF Sangfor Firewall*
NGAF Sangfor Firewall is the world's first AI or artificial intelligence enabled and integrated NGFW (Next Generation Firewall) + WAF (Web Application Firewall) with comprehensive protection from all threats powered by innovations such as Neural-X and Engine Zero. This NGAF Sangfor Firewall protects against malware such as ransomware, trojans and also handles the network from virus threats and unknown access. NGAF also secures network paths so that no unknown IP addresses enter and spread malware, viruses or attacks such as DDOS and others (Muzakka et al. 2019).
2. *AES Authentication (Advanced Encryption Standard)*
AES (Advanced Encryption Standard) authentication is an encryption system that is used to encrypt the login data of every registered user who has login access according to their respective accounts so that data leaks and data are not exchanged. At PT. XYZ uses AES (Advanced Encryption Standard) authentication to manage registered users who can log in according to their respective user logins so that data leakage does not occur in each user account (Musliyana, Arif, and Munadi 2016). Standardization testing of cloud computing in accordance with NIST

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standardization conducted by researchers has obtained results that can be seen in Table 2.

Tabel 2 Hasil

Standardization	Status
<i>On Demand self Service</i>	Appropriate
<i>Broad Network Access</i>	Appropriate
<i>Resorce Pooling</i>	Not appropriate
<i>Rapid Elasticity</i>	Not appropriate
<i>Measured Service</i>	Not appropriate
<i>Virtualization</i>	Appropriate
<i>Browser As Platform</i>	Appropriate
<i>Free and Open Source Software</i>	Not appropriate
<i>Web Support 2.0</i>	Appropriate
<i>Utility Computing</i>	Not appropriatee

The result that the author got in this test is the cloud that is on PT. XYZ cannot be said to be a cloud computing because the 5 main standards of cloud computing mentioned by NIST are only 1 that are met and most supporting standards are also not met. Therefore, the author concluded that the cloud is in PT. XYZ cannot be said to be a cloud but is just a server on premises.

LIMITATIONS

This section must describe the limitations of the project. Numbered lists or bullet points may be used to list limitations. The results of this study may not be perfect because the data obtained still has many shortcomings and the author's knowledge about cloud computing is still basic.

FUTURE WORK

The section must describe proposed future work. Future work aimed at overcoming some of the limitations may be useful. The author hopes this journal can be a reference for the next researcher and provide a good impact and science on the standardization of cloud computing. The author also hopes to increase enthusiasts in cloud computing technology where the author believes this technology will develop very rapidly in the next few decades.

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