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Research on Characteristics and Technologies of Cloud Computing

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Abstract: Cloud computing technology has promoted the innovation of software development concepts, which also represents one of the advanced development trends of software development technology. Software engineers have advanced the traditional software development system to the next level. Cloud computing technology gives users access to files, software, and servers. Cloud computing providers store and process data in a location that's separate from users. With the increase in internet users, more and more challenges arise in software development. Software development no longer faces a single demand for design. Software needs to be able to support the personalized content of a large number of users. In recent years, traditional software development is not meeting the requirements of users. This is where cloud computing can offer a solution at a low cost. Cloud computing technology combines with network access to build a corresponding data resource library, which has a very low management cost. It can enable massive data to be released quickly so that any user without professional knowledge can use cloud computing to process data more conveniently and quickly. At the same time, cloud computing technology also needs to be able to meet security challenges. In large-scale cluster deployment and access strategies, network security, data security, and other issues in software development technology also bring many new challenges. Studying advanced software development technologies in the cloud computing era from the perspective of software maintainers has brought new changes, new features, new capabilities, and new models in this field. We emphasize that the private clouds can be well adapted to the company's unique data requirements, using the company's existing hardware resources to build the cloud, which greatly reduces the company's overhead. One common feature is the possibility to use technology from everywhere. It is proven that cloud computing services enable users to access application services from any location using a variety of endpoints, often without control or knowledge of the exact division of these resource pools. However, it is possible to know in which administrative region or data center these resource pools are located. Through the research on advanced software development technology of cloud computing, this paper analyzes how cloud computing solves the problems of large-scale software architecture and cluster stability. The paper gives the corresponding strategy and scheme and expounds on the practical prospect of cloud computing technology in future software development and design.

Keywords: Cloud Computing, Distributed, Virtualization, Large-Scale Computing Power, Disaster Recovery, Backup, Data Security, Network Security

1. Introduction

Since the 21st century, the rapid development of the Internet has led to the emergence of cloud computing technology. Cloud computing, as a new computing model, can be used in combination with storage architecture and distributed computing. To achieve the effective processing of large-scale data, data processing becomes more convenient and faster. It can provide resources mainly with distribution, and virtualization by using the Internet as the basis for expansion. Distributed cloud systems promise to bring about a new era of cloud computing. These systems distribute public cloud services to several locations outside a provider's

data centers, but the provider still controls them. Cloud providers take care of cloud service architecture, governance, operations, updates, and delivery. Since data centers can be anywhere, latency and data sovereignty challenges are reduced. Distributed cloud services offer the benefit of a public cloud service with those of a private cloud. A Cloud computing platform is a physical entity with computing capacity, data capacity, storage capacity, and network communication capacity, with high capacity, data throughput, reliability, security, speed, and high-quality architecture system and computing model [1]. With its powerful computing capabilities, it can effectively meet the computing needs of different users, and users can easily and quickly use cloud computing to store and calculate large-scale data by simply using their computers or cell phones. Cloud computing is also a new way of operating network services.

2. Classification of Cloud Technology Characteristics

There are three main classifications of cloud technology principal characteristics including public cloud, private cloud, and hybrid cloud.

2.1. Public Cloud

A public cloud is provided by third party providers for users. The public cloud is generally available over the Internet and is the cheapest technology. Public clouds have the following characteristics including data security, convenience, data sharing, and infinite possibilities.

2.1.1. Data Security

Cloud computing provides the most reliable and secure data storage centers, and users no longer have to worry about data loss, virus invasion, and other problems.

On the other side of the "cloud", there is the most professional team in the world to help you manage your information and the most advanced data centers in the world to help you save your data [2].

Contrary to the documents saved on a personal computer, when documents are saved on a web service like Google Docs, and photos are uploaded to a web album like Google Picasa Web, no one has to worry about data loss or damage.

2.1.2. Convenience

Cloud computing requires usually only a computer on the user side and is the most convenient and cost-effective to use. In addition, there is no need to constantly upgrade your computer hardware to use a certain operating system or to use the latest version of certain software. As long as people have a computer with Internet access with a favorite browser, they can enjoy the unlimited fun brought by cloud computing.

2.1.3. Data Sharing

Cloud computing makes sharing data and applications between different devices easy. All electronic devices need only be connected to the Internet to access and use the same data at the same time.

Considering the variety and complexity of data synchronization methods across different devices, it takes untold time and effort to keep and maintain an up-to-date copy of contact information across many different devices. One of the most common scenarios is a personal computer or laptop with hundreds of email addresses stored in it. To send emails when traveling, contact information had to be synchronized regularly between the PC and the laptop. Another example is a cell phone with hundreds of contact numbers stored in it, then when you buy a new phone, you have a choice to synchronize phone numbers between the old phone and the new one.

Moreover, cloud computing provides unlimited space and computing power for storing, computing, and managing data, as well as completing various applications. For instance, when we are going on a road trip, as long as the phone is connected to the network, people can see the satellite map of their area and real-time traffic conditions. They can quickly check their preset driving route and ask friends on the network to recommend the best nearby scenic spots and restaurants.

The development of the public cloud brings some difficulties, the current use of mail development technology in computer software, the advantages of resources among the major enterprises have their characteristics, but the sharing is not strong, the technology is relatively closed, and even some he technology is monopolized within the industry [3]. As a computing model that best embodies the spirit of the Internet, cloud computing will surely show its powerful vitality shortly and will change people's work and lives in many aspects.

2.2. Private Cloud

A key feature of private clouds is the ability to retain a company's equipment when joining the cloud since delivering data to a third-party operator means giving up control of that data. While theft of data or unavailability of services in public cloud services is now almost extinct, processing data on your own devices is different from someone else processing. Private clouds can be well adapted to the company's unique data requirements, using the company's existing hardware resources to build the cloud, which will also greatly reduce the company's overhead [5].

Private clouds are built for the sole use of one customer and thus provide the most control over data, security, and quality of service. The company deploying a private cloud owns the infrastructure and can control the way applications are deployed on this infrastructure. Private clouds can be deployed within the firewall of an enterprise data center or they can be deployed in a secure colocation site. The core attributes of a private cloud are proprietary resources. Private clouds have the characteristics as follows:

2.2.1. Data Security

Every public cloud provider the services that are very secure in all aspects, especially the management of data. However, for enterprises, especially large ones, business-related data is their lifeline and cannot be threatened in any form, so in the short term, large enterprises will not put their

business-critical applications to run on public clouds. The private cloud is very advantageous in this regard because it is generally constructed behind a firewall [4].

2.2.2. Higher Quality of Service

The application of cloud computing components in software development gives full play to the analysis and design capabilities of the software and has a great impact on software reuse by setting up specific services and providing various interfaces for users to facilitate the effective application of software [6]. Because private clouds are generally behind a firewall, therefore, its quality of service will be very stable and will not be affected by the stability or otherwise of the network. For example, the core of business management can be protected by private cloud technology for large enterprises.

2.3. Hybrid Cloud

Hybrid clouds combine public and private clouds. In contemporary applications, it becomes the main model and development direction of cloud computing. To emphasize the examples, the private cloud is mainly for enterprise users for security reasons, however, this model is not fitted to this purpose. The reason is that enterprises prefer to store their data in private clouds, but at the same time, they want to have access to the computing resources of public clouds. In this case, hybrid clouds are increasingly adopted, which mix and match public and private clouds to obtain the best results, and this personalized solution achieve both cost savings and security [7].

Hybrid clouds have the following features based on the characteristics of public and private clouds (Figure 1).

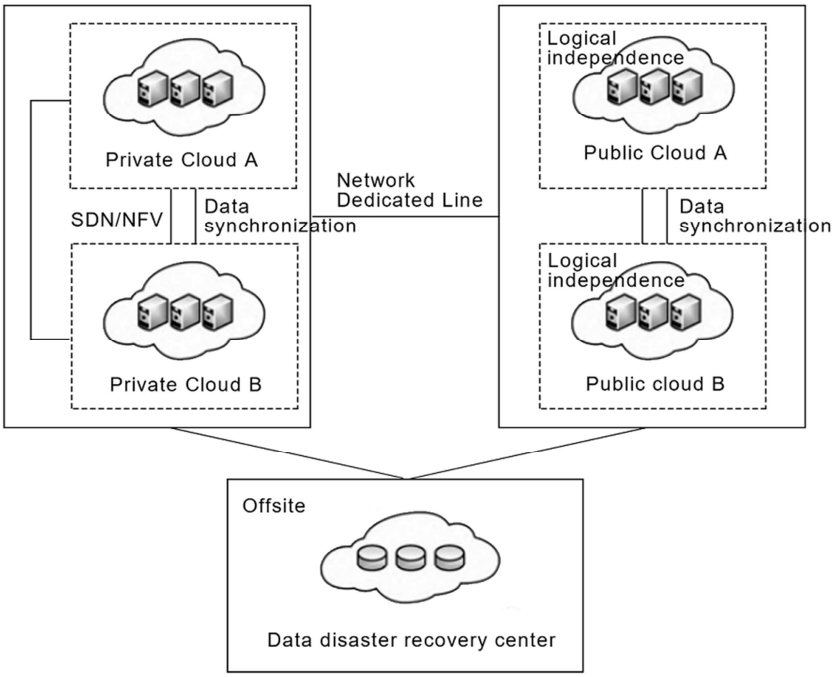

Figure 1. *Hybrid Cloud Disaster Tolerant Backup Architecture.*

2.3.1. More Perfect

In fact, the hybrid cloud perfectly solves the problem, the reason is that the security of the private cloud keeps the important internal data in the local data center, and the computing resources of the public cloud complete the work more efficiently and quickly. Therefore, it is more perfect than either a private cloud or a public cloud.

2.3.2. Scalable

Hybrid clouds break through the hardware limitations of private clouds. The scalable of the hybrid cloud is the feature of public and private clouds. The computing resources of public clouds are beyond the reach of private clouds. By leveraging the scalability of public clouds, higher computing power is readily available. By moving unclassified functions to the public cloud area, enterprises can reduce the strain on their internal private cloud. The pressure and demand on the internal private cloud can be reduced [8].

2.3.3. More Savings

A hybrid cloud can be effective in reducing costs. It can use both public and private clouds, and enterprises can put their applications and data on the most suitable platform to get the best combination of benefits.

3. Service Models of Cloud Computing

Cloud computing service is described as the movement of traditional computing, network, and storage resources into elastic and scalable services by providing software for virtualization, fault tolerance, and parallel processing.

Cloud computing services enable users to access application services from any location using a variety of endpoints, often without control or knowledge of the exact division of these resource pools. However, it is possible to

know in which administrative region or data center these resource pools are located.

3.1. Super-Scale

The scale of the enterprise is gradually becoming larger, the number of customers is gradually increasing, and with the increase of customers, the number of accesses expands dramatically.

"Google cloud computing has more than 1 million servers. Amazon, IBM, Microsoft, Yahoo, etc. have hundreds of thousands of servers [9]. Enterprise private cloud generally has hundreds of thousands of servers "cloud" can give users unprecedented computing power. This service achieves flexibility and broad application support. Hence, users request services from the "cloud" resources rather than from a fixed, tangible entity.

3.2. Virtualization

Cloud computing uses virtualization technology to make it possible to unify the provisioning and centralized operation and maintenance of physical resources across systems.

Virtualization refers to the virtualization of a computer into multiple logical computers. Multiple logical computers can run simultaneously on a single computer with different operating systems. The applications run in separate spaces without affecting each other, thus it can increase significantly the efficiency of the computer.

Virtualization uses software technology to redefine the division of IT resources, which can achieve dynamic allocation of IT resources, flexible scheduling and cross-domain sharing, and improve IT resource utilization so that IT resources can truly become the social infrastructure to serve the flexible and changing application needs in various industries [9].

The objects of virtualization can be PCs, servers, storage, networks, operating systems, applications, etc. at the hardware level [10]. Virtualization is a key step in reaching the cloud, it can make users far from the physical hardware and software to use IT resources remotely.

3.3. High Reliability

The "cloud" uses multiple copies of data fault tolerance, computing node isomorphic interchangeable, and other measures to ensure high reliability of services, the use of cloud computing than the use of local computer reliability.

3.4. Cost Effectiveness

Distributed systems now have a low price and performance ratio than centralized systems. In scenarios such as massive data processing, cloud computing replaces the centralized processing method of minicomputers plus disk arrays with the distributed processing method of computer clusters, which can effectively reduce construction costs.

3.5. High Scalability

The scale of the "cloud" can be dynamically scaled to meet the needs of application and user scale growth [11]. Cloud computing provides elastic and scalable resources that can be dynamically deployed, dynamically scheduled, and dynamically recycled to meet the resource requirements of business development and usual operational peaks in an efficient manner.

3.6. High Utilization of Devices

Cloud computing through virtualization technology can improve equipment utilization, integrate existing application deployments, and reduce the number of devices [11].

Cloud computing servers through virtualization technology can complete the document server, mail server, photo processing server, and other tasks. The combination of cloud computing and virtualization improves equipment utilization and saves the number of devices.

3.7. Universality

Cloud computing does not target specific applications but can be built with the support of the cloud to create a variety of applications. The cloud can support different applications at the same time.

3.8. On-Demand Services

When there is a cloud computing application, consumers can automatically get self-service computing resource capabilities, such as server time, network storage, etc., without interacting with service providers. Because of the easy service, users only need to have basic IT knowledge and can use the service after business training without professional IT training. To imagine, the cloud is a huge pool of resources. Cloud computing can be billed like water, electricity, and gas, with users buying on demand.

3.9. Extremely Inexpensive

Due to the special fault-tolerance measures of the 'cloud', extremely inexpensive nodes can be used to form the cloud, and the automated, centralized management of the 'cloud' frees a large number of enterprises from the increasingly high costs of data center management [7, 9]. The versatility of the cloud allows for a significant increase in resource utilization compared to traditional systems, so users can fully use the low cost technology.

3.10. Application Distributivity

Most applications in the cloud are extremely distributed, for instance, industrial enterprise applications, management, and the field are not in the same place.

Cloud computing uses distributed storage to store data, but also to ensure high availability and scalability. Data reliability is ensured through the use of redundant storage, whereby copies of the same data are kept on multiple nodes. In addition, to ensure that a large number of users use cloud computing services in parallel and to meet the needs of a large number of users, cloud computing storage technology must have high throughput and high transfer rates [12].

The cloud center area can monitor the usage and performance of distributed computers in the virtualized environment through a separate interface. With a single command, the service operates at all the machines quickly, without an individual command.

3.11. Environmental Protection

This is an environmentally safe technology because cloud computing greatly improves the utilization of hardware that through virtualization, utility computing, and other technologies, and it can balance the computing load of different physical servers. Reducing the number of devices through cloud computing will greatly reduce electricity consumption. Reducing the size of devices and turning off idle resources will promote green energy efficiency in data centers.

Cloud computing contributes to human progress, rather than simply enhancing technology.

4. Principle Technologies of Cloud Computing

The cloud computing model embodies the spirit of the Internet which is freedom, equality, and sharing. Cloud computing runs are done under a strict security management mechanism. There are several dominant software technologies including narrow artificial intelligence, mixed reality, and distributed cloud based on principle technologies with strong vitality characteristics of cloud computing technology.

4.1. Virtualization Technology

Virtualization technology plays an important role in cloud computing as a whole. At present, virtualization technology has become a de facto standard with Citrix Xen, VMware.

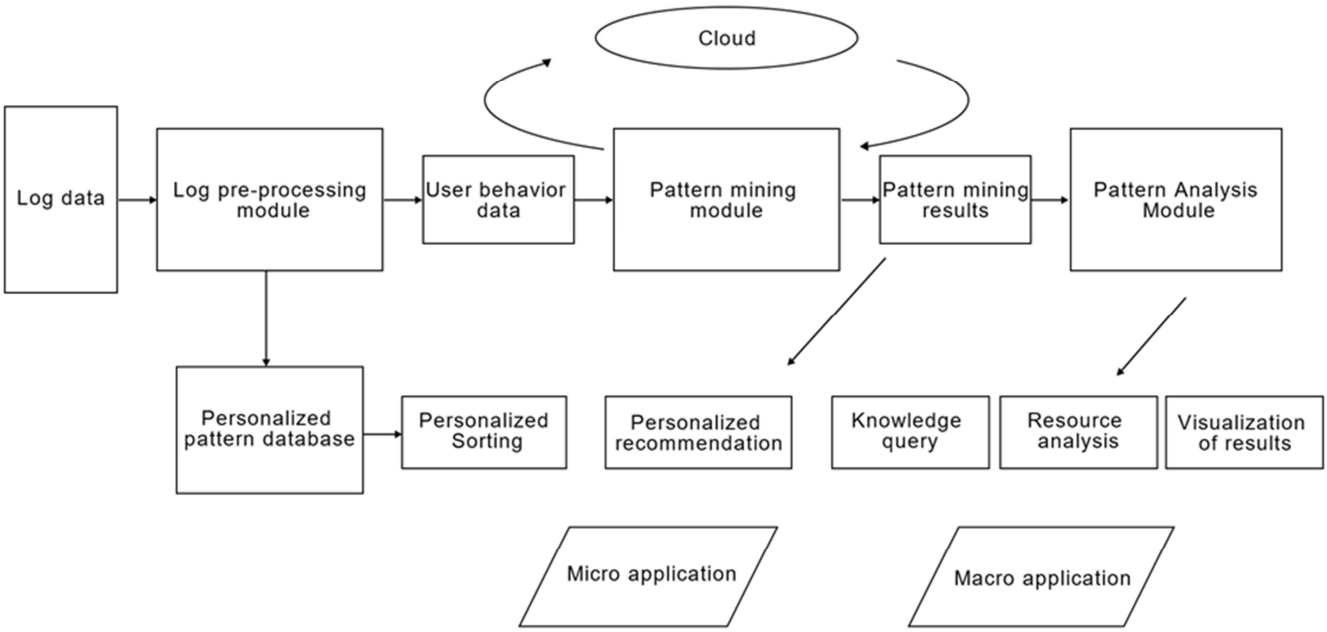

Figure 2. *Data Storage Usage Flow in Real-World Scenarios.*

ESXServer, and Microsoft Hype-V [13]. Virtualization technology is the basis for the operation of computing components and differs from the original computing model. The technology primarily operates on a virtual basis rather than a real hardware basis in cloud computing. The technology often enables a better understanding of user requirements, faster integration of resource information, high efficiency, and also improved resource utilization.

In addition, virtualization technology runs on a virtual basis, therefore, the shortcomings of real hardware are irrelevant to operational efficiency, greatly improving the reliability and self-healing of the operating system.

4.2. Data Storage Technology

Cloud computing distributes computing tasks across multiple modules, which are calculated and processed separately before being integrated, providing efficiency and meeting people's needs for data storage [15]. In the future, there is still much room for improvement in data storage technology. Figure 2 shows the main directions of development are to store data on a very large scale, to ensure data security, and to improve IO efficiency [15].

Cloud computing has improved data storage with the use of distributed storage [13]. Hence, we can emphasize that distributed storage is a more flexible storage method, mainly redundant storage, storing multiple copies of the same data, with security and reliability features.

4.3. Data Management Technology

The data management technology is dominated by Google's BigTable technology and Hadoop's HBase [14]. However, due to the different development concepts and forms of data management of the Bigtable and Hadoop, the traditional SQL database interface has difficulties in porting.

Therefore, the data storage technology of cloud computing integrates and stores information resources. An efficient and fast service experience is the scientific management of stored information. The aim is to enable users to quickly find the information they want to know in a large database [14]. In an analysis of data management technology research, the main thing is to provide RDBMS and SQL interfaces for cloud management to ensure that the data management aspects are more complete and can better serve the user.

4.4. Programming Technology

Programming is a common way to write simple programs that can be manipulated to better meet the needs of the day [14, 15]. The programming model in cloud computing does not need to be so complex that it is detrimental to the parallel execution of background tasks (Figure 3). The figure shows the cloud computing massive data analysis model that is the key feature of the programming models in cloud computing. It is important to ensure that complex data computing tasks can be completed efficiently. This will give the user a good experience. In the current state of development, Map/Reduce, a programming tool developed by Google is the main programming tool in cloud computing, which is very good at the parallel processing of data sets. It is also very good at scheduling complex parallel tasks.

4.5. Cloud Security Technology

Cloud computing is a computing model based on the development of Internet technology. Internet security, and issues such as vulnerabilities, viruses, and information leakage are also inevitable in cloud computing [15]. After a series of analyses and research, cloud security has developed to the third generation. It has entered the trusted cloud stage. It can automatically carry out security detection defense, reduce risk, and improve the security and efficiency of cloud computing. There is still a long way to go before cloud computing becomes widespread and applicable. Social acceptance, people's habits, technical capabilities, and even social management systems should all be changed accordingly in order to make cloud computing truly popular. But in any case, Internet-based applications will gradually penetrate into everyone's life and will have a profound impact on our services and lives. To cope with this change, it is also important for us to discuss the future development model of our business and determine the direction of our efforts.

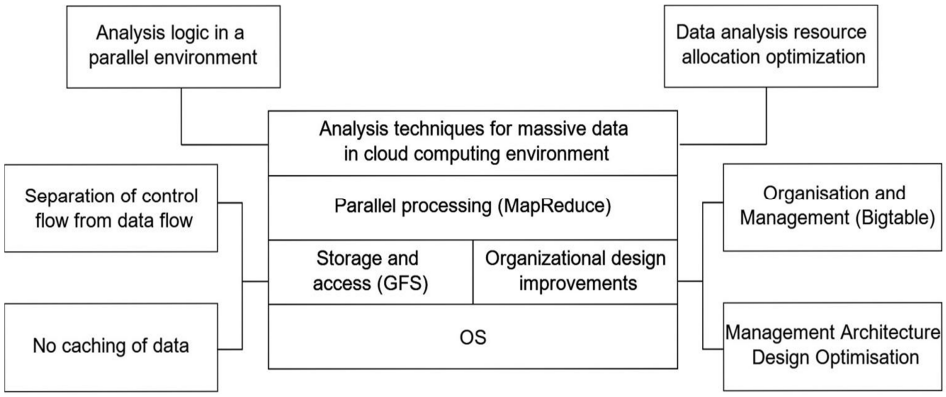

Figure 3. *Cloud Computing Massive Data Analysis Model.*

5. Cloud Computing Platform and Software Development

Cloud computing platforms enable the creation and management of large, complex IT infrastructures in an integrated, and scalable way. Cloud computing platforms can be divided into three categories such as storage cloud platforms, computing cloud platforms, and integrated cloud platforms. Examples of the design of cloud platforms include the Azure platform, which Microsoft is committed to building (Figure 4).

5.1. Impact of Cloud Computing Perspective on Software Development

Software technology, with significant changes in architecture.

(1) The software developed must be compatible with the cloud and can be organically integrated with the virtualization-centered cloud platform. Adapt to the dynamic changes in computing power and storage capacity [16].

(2) To be able to meet the use of a large number of users. This includes data storage structures and processing power.

(3) To be Internet-enabled and Internet-based to provide software applications.

(4) Higher security requirements. It can resist attacks. And can protect private information.

(5) It can work in various environments such as mobile terminals, mobile phones, and network computers.

The environment in which software is developed, with changes in working patterns [16].

Although traditional software engineering theory will not undergo fundamental changes, cloud-based development tools, development environments, and development platforms will facilitate agile development, collaboration

within project teams, and off-site development. The cloud platform can be used within a software development project team to enable online development, knowledge accumulation, and software reuse through the cloud [17].

Richer and more diverse final expressions of software products on a cloud platform, the software can be a service, web service, or an application that can be downloaded online, such as an application from the Apple Online Store.

Changes in software technology and architecture require that the focus of software testing should also be adjusted accordingly [17].

In addition to traditional software quality, software testing should also focus on the new quality requirements put forward by the cloud computing environment. Such as software dynamic adaptability, the ability to support a large number of users, security, multi-platform compatibility, etc. In the cloud computing environment, the software development tools, environment, and working modes have changed, which also requires the tools, environment, and working modes of software testing to change accordingly.

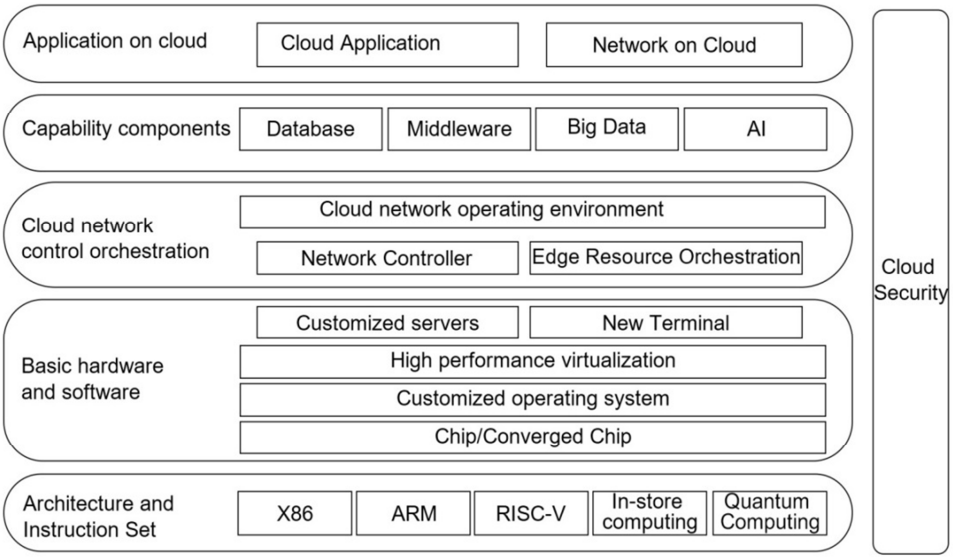

Figure 4. *Cloud Software Development Architecture landscape.*

Software testing tools should also work on top of the cloud platform, and the use of testing tools can also be carried out through the cloud platform. This is no longer the traditional approach. The software testing environment can also be ported to the cloud, and the testing environment can be built through the cloud. Software testing should also be able to achieve collaboration, knowledge sharing, and test reuse through the cloud. Changes in the presentation of software products. Software testing is required for different forms of products, such as testing of web services, internet applications, and software in mobile smart terminals.

5.2. Implications for the Design of Software Development Test Platforms from a Cloud Computing Perspective

The traditional software development model faces many challenges and dilemmas. For this reason, it is necessary to introduce a cloud-based software development and testing platform, with advanced cloud computing as the technical support, integrating cloud computing with project management tools to better break through the challenge of resource allocation on demand and ensure the high-quality delivery and use of the software. Specifically, it is manifested in the following aspects.

5.2.1. Reducing Software Development Costs

The traditional software development model has encountered unprecedented bottleneck problems, unable to achieve uniform resource allocation and coordination, there is a serious waste of resources. To this end, the introduction of a cloud-based software development and testing platform can achieve the creation, use, and management of resources on demand, truly optimizing the allocation and coordination of resources, greatly reducing the cost of software development and highlighting the concept and purpose of green R&D [17].

5.2.2. Improving Team Development Efficiency

The traditional software development model mostly uses monolithic software. There is a lack of teamwork and collaboration among software. This makes it face greater teamwork and cooperation problems. Subject to the limitations of their own capabilities. The solution to this problem is to design and implement a software development and testing platform from the perspective of cloud computing.

5.2.3. Enhancing the Quality of Software Development

To break through the quality flaws and shortcomings of traditional software development, integrate lifecycle management processes based on a cloud computing environment and introduce agile software development ideas to put it under a standardized and controlled state to quickly identify problems, diagnose them and solve them.

5.3. Research on the Design and Implementation of a Software Development Test Platform from a Cloud Computing Perspective

Agile development Scrum style can be used in the design of software development and testing platform, automatically build cloud computing infrastructure platform and unified collaboration platform, apply lifecycle management process, realize cross-platform software development and testing, and make it with data security.

5.3.1. System Architecture

The software development and testing platform from a cloud computing perspective are based on a unified deployment and development design with a multi-layer framework structure, supported by virtualization technology. With embedded development process templates, the software development cycle can be shortened and development costs reduced.

5.3.2. Network Infrastructure

The network infrastructure of the cloud-based software development test platform should be supported by a corresponding hardware environment, with a larger capacity in the data expansion center, the construction of high-availability servers, and the realization of sharing and virtualization of storage letters.

5.3.3. System Module Design

The cloud-based software development and testing platform system consists of the following modules. Infrastructure layer. It is the use of mature virtualization technology, such as Microsoft's Windows Server or Hyper-V technology, unified deployment, configuration, and integration of resources, to achieve the design of the hardware environment and operating platform system environment, so that the solid physical facilities into certain logical resources, can effectively achieve mobile management and shared use of them, a better solution to the problem of variability between hardware [18].

In particular, CPUs, memory, hard disks, switches, gateways, firewalls, etc., can be moved and exchanged at will under virtualized technology and environments, and network data can be managed and connected efficiently through distributed storage technology. Application platform layer. With the application of mature virtualization technology, this module can install, configure, move, deploy and manage different virtualization resources and build independent domain environments to achieve effective migration and monitoring management of virtual environments [19].

At the same time, it is based on the principles and concepts of service-oriented architecture, creating a loosely coupled service architecture model that enables better connection and invocation between the upper and lower layers. This module focuses on the collection and presentation of KPI metrics related to software development. It is the real user-facing level and window [20]. For example, resource in request, approval, virtual machine use, daily maintenance, system assurance, etc. It enables users to easily and comfortably access the corresponding services.

6. Conclusion

The paper focuses on a contemporary fundamental overview of cloud computing, its characteristics, models, and technologies. We have identified a trend toward virtualization in the software development process. The trend of new software development models describes virtual distributed storage and data management system, therefore, the higher requirements for cloud computing requires the platforms due to the complexity and security of a large amount of software development. Another remarkable thing of the software is the situation that has changed to distributed cloud applications. We emphasize the change makes the software development process more reliability, scalability. Cloud computing is all about helping users build fault tolerant, reliable, useful sharing systems. As a result of the research, we can say the cloud computing will be one of the outstanding computer software usages in future. At the same time, these features bring business value by helping companies and people to be able to make predictable major changes in software usages.

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