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Future internet architecture and cloud ecosystem: A survey

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Future Internet Architecture and Cloud Ecosystem: A Survey

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Abstract. The Internet has gradually become a social infrastructure, the existing TCP/IP architecture faces many challenges. So future Internet architecture become hot research. This paper introduces two ways of idea about the future research of Internet structure system, probes into the future Internet architecture and the environment of cloud ecosystem. Finally, we focuses the related research, and discuss basic principles and problems of OpenStack.

Key words: Future Internet; Architecture; Cloud Ecosystem; OpenStack.

INTRODUCTION

With the continuous development of society and information technology, the Internet has become a collection of information collection, transmission, storage and processing in one of the important infrastructure of information society. At the beginning, the design of the Internet is mainly used for solving large-scale machines and other resources of the time division multiplexing problem. Although the calculation of the continuous progress of technology, communication technology and the application of the model and calculation mode after single mode, client/server mode, mode of development to the current cloud computing model, but as the foundation of the most important technology in the Internet, the TCP/IP architecture has remained basically unchanged[1].

The current Internet is based on the TCP/IP architecture, which assume users and terminals is credible and intelligent, network itself only need provide best effort packet forwarding service. This idea is consistent with the initial host interconnect and resource sharing as the main goal of the Internet Design requirements. With the increasingly rich of application and calculation model and the enhancement of social dependence on the Internet, Internet access and network function occurred huge change, the TCP/IP architecture has been unable to meet the needs of sustainable development of the Internet, in spreading [2], dynamic [3] and safety [4] control present not able to solve the problem [5].

This paper analyzes the fundamental problems faced by the IP/TCP architecture, introduces the main ideas of the research on the future Internet structure, and some of the major future Internet architecture. The third section focuses on the future network architecture, basic characteristics and research progress of the test bed. The fourth section summarizes the future of the Internet cloud ecological environment. In the end, the research focuses on OpenStack, which is the research hotspot in the future Internet architecture, is simply introduced.

RESEARCH IDEAS AND PRESENT SITUATION OF FUTURE INTERNET STRUCTURE SYSTEM

At present, the domestic and international research on the future of the Internet structure, there are two main ideas: evolution or incremental and change. Evolution route changes and additions through the patch on the Internet

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TCP/IP, its core is still the TCP/IP architecture. It has not solve the problem faced by the TCP/IP architecture fundamentally. It can not or can not well adapt to the tremendous changes of Internet access and data exchange. In recent years, the military began to change route of the future Internet architecture, namely "from zero start", it will not be bound by the existing Internet architecture, study the new architecture, the idea of change has become the consensus of the future Internet architecture design. Nevertheless, in order to promote the deployment and implementation of the new Internet architecture, in the design process also need to consider the interoperability with the existing Internet, to support the development of the existing Internet to the new Internet deployment.

Some work has been done on two different research ideas[6-7].For example:(1) Incremental evolution: the national 973 project "a new generation of Internet architecture theory research; "Based research on measurable, controllable and manageable IP network"; "Based research on integration of trusted network and Pervasive Services"; "service oriented to the future Internet architecture and mechanism of"; the National 863 project" a new generation of Internet technology comprehensive experimental environment.(2)The new revolutionary: the National Natural Science Foundation (NSF) of the FIND and GENI program; the European Union in the FIRE framework of the FP7 program; Japan's AKARI project.

In view of the existing problems such as scalability, dynamic and security of the existing TCP/IP architecture, the main research progress of the existing FIA is: Scalable architecture, the specific program for the CCN/NDN[8-9];Dynamic oriented architecture, the specific programs are Clean-slate, Mobility First [10]; Service oriented architecture, such as SOFIA[11].

SERVICE ORIENTED FUTURE INTERNET ARCHITECTURE

Information transmission is only one of the basic functions of the Internet, service is the fundamental embodiment of the value of the internet. Internet hosting service showing explosive growth, the future Internet essence is a kind of has a very large scale, virtualization, high reliability, general, high expansion of service system, support the user in any position, use any terminal to easily access a variety of service. The future network architecture must adapt to these service models and service requirements. In the design concept of service driven, the future Internet architecture system is bound to become a research hotspot.

SOFIA is a kind of service oriented Internet architecture. The Internet is no longer just as a transport channel. But rather as a service pool. SOFIA as a services logo to protocol stack of slender waist, through service migration can realize service localization, an effective solution to the problems caused by the surge in Internet traffic. Through the separation identification and address the effective support ubiquitous mobile computing. The basic design ideas and technical features of the SOFIA architecture are as follows:(1)The basic idea of SOFIA is routing with service ID as the core, and the Internet is designed as a service pool which integrates the functions of transmission, storage and computation;(2)In SOFIA architecture, the identification of service serve as the hourglass model waist(As shown in Fig.1),and driven routing and data transmission by service identification;(3)The service request is driven by the service mark, and the mapping of the address is realized according to the registered information saved in the network, thereby realizing the positioning of the service;(4)SOFIA Internet is a service pool for the transmission, storage and computation;(5)The SOFIA network provides network virtualization capabilities, use of combinatorial optimization of the basic theory of the formation of a virtual network to the physical network approximation of the optimal mapping;(6)The SOFIA architecture provides inherent security mechanism, the authentication mechanism to ensure that only the legal service provider and the service request can access the network and design a series of safety mechanisms to ensure that service registration, service migration, service query, access to services such as each link to be in safe and controllable state;(7)The SOFIA architecture is validated and evaluated on a test bed built by a programmable virtual router[12].

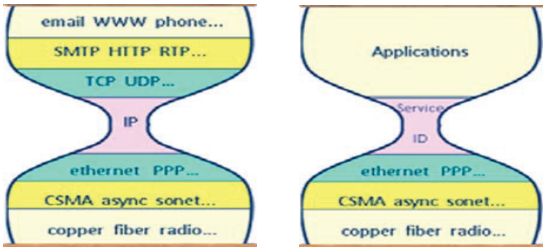

FIGURE 1.SOFIA replaces IP with a global unified service ID.

CLOUD ECOSYSTEM

Cloud Related Basic Terminology

Cloud Computing

A model for enabling service users to have ubiquitous, convenient and 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. Cloud computing enables cloud services. It is considered from a telecommunication perspective that users are not buying resources but cloud services that are enabled by cloud computing environments. The cloud computing model promotes availability and is composed of five essential characteristics, five cloud service categories and four deployment models.

Cloud Service

A service that is delivered and consumed on demand at any time, through any access network, using any connected devices using cloud computing technologies.

Cloud Ecosystem Actors

Cloud service user (CSU):A person or organization that consumes delivered cloud services. A CSU can include intermediate users that will deliver cloud services provided by a cloud service provider (CSP) to actual users of the cloud service, i.e. end users. End users can be persons, machines, or applications.

Cloud service provider (CSP):An organization that provides and maintains delivered cloud services.

Cloud service partner (CSN):A person or organization that provides support to the building of the service offer of a cloud service provider(e.g. service integration).

Cloud Computing Essential Characteristics

On-demand self-service: A cloud service user can unilaterally provision computing capabilities, such as server time, network storage and communication and collaboration services, as needed automatically without requiring human interaction with each service's cloud service provider.

Broad network access: Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g.,mobile phones, laptops, and PDAs).

Resource pooling: The cloud service provider's computing resources are pooled to serve multiple users using a multi-tenant model, with different physical and virtual resources that are dynamically assigned and reassigned according to user demand.

Rapid elasticity: Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out, and rapidly released to quickly scale in. To the cloud service user, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.

Measured service: Cloud systems automatically control and optimize resource use (e.g.,storage, processing and bandwidth) by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., the number of active user accounts).Resource usage can be monitored, controlled, and reported, providing transparency for both the cloud service provider and cloud service user of the utilized service.

Cloud Ecosystem Achitecture

In line with a general definition of a business ecosystem [b-HBR],a cloud computing business ecosystem(cloud ecosystem)is a business ecosystem of interacting organizations and individuals-the actors of the cloud ecosystem-providing and consuming cloud services.

Actors of Cloud Ecosystem

The following actors are identified in a cloud ecosystem(As shown in Fig.2):Cloud service users (CSU),Cloud service providers (CSP),Cloud service partners (CSN).

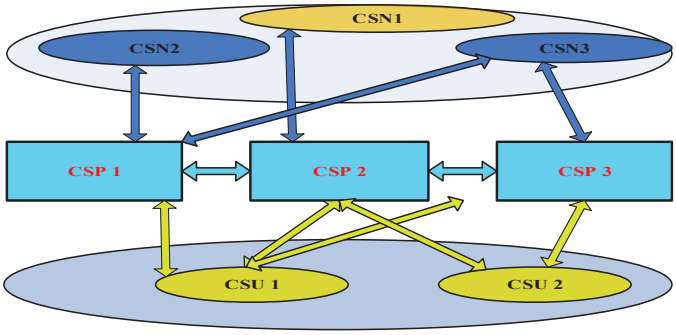

FIGURE 2.Illustrates the three actors involved in a cloud ecosystem.

Roles of Cloud Ecosystem

The following provides a non-exhaustive list of possible roles that can be played by each of the three cloud ecosystem actors(As shown in Fig.3).(1)Cloud service provider(CSP):Provider of SaaS and/or CaaS and/or PaaS and/or IaaS and/or NaaS, Inter-cloud(Inter-cloud peering, Inter-cloud service broker, Inter-cloud federation);(2)Cloud service user (CSU):Consumer, Enterprise (including enterprise administrator),Governmental/public institution;(3) Cloud service partner (CSN):Application developer, Content provider, Software provider, Hardware provider, Equipment provider, System integrator, Auditor.

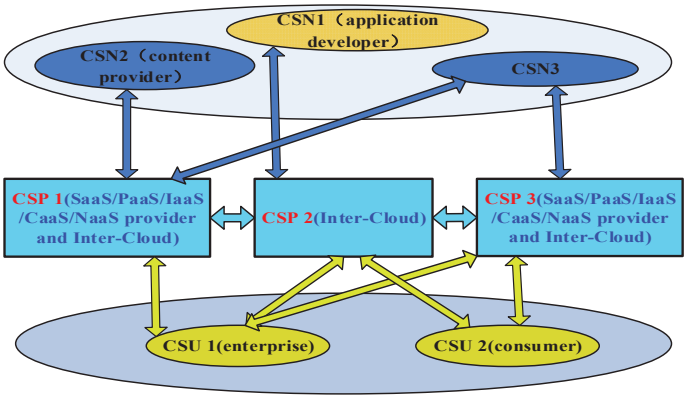

FIGURE 3.Depicts the actors with some of their possible roles in a cloud ecosystem.

Cloud Service Categories

Cloud software as a service (SaaS):A category of cloud services where the capability provided to the cloud service user is to use the cloud service provider's applications running on a cloud infrastructure.

Communications as a service (CaaS):A category of cloud services where the capability provided to the cloud service user is to use real-time communication and collaboration services.

Cloud platform as a service (PaaS):A category of cloud services where the capability provided to the cloud service user is to deploy user-created or acquired applications onto the cloud infrastructure using platform tools supported by the cloud service provider.

Cloud infrastructure as a service (IaaS):A category of cloud services where the capability provided by the cloud service provider to the cloud service user is to provision processing, storage, intra-cloud network connectivity services (e.g. VLAN, firewall, load balancer,and application acceleration),and other fundamental computing resources of the cloud infrastructure where the cloud service user is able to deploy and run arbitrary application.
Network as a service (NaaS):A category of cloud services where the capability provided to the cloud service user is to use transport connectivity services and/or inter-cloud network connectivity services.

Cloud Deployment Models

Private cloud[b-NIST DFN]:The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise.

Community cloud[b-NIST DFN]:The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g, mission, security requirements, policy, and compliance considerations).It may be managed by the organizations or a third party and may exist on premise or off premise.

Public cloud[b-NIST DFN]:The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.

Hybrid cloud: The cloud infrastructure is a composition of two or more clouds using different deployment models (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds).

It should be noted that the cloud-deployment models do not reflect where services, platforms, applications, or resources are actually hosted. For example, a private cloud can be hosted internally (on site) or externally (outsourced).

Profit Model of Cloud Services

More and more companies migrate applications to the third-party cloud platform, according to industry summary, there are freemium models, consumption models, tiered pricing models and permanent licensing model. Freemium model reduces the fees customers into the cloud services, consumption models targeted to buy a specific cloud service, tiered pricing models is very common in the enterprise, and permanent licensing model is a one-time purchase.

Cloud Security and Privacy

Although clouds allow customers to avoid start-up costs, reduce operating costs, and increase their agility by immediately acquiring services and infrastructural resources when needed, their unique architectural features also raise various security and privacy concerns [13].

In cloud computing paradigm, a cloud provider creates, deploys and manages the resources, application and services. Major types of security threats [14] in the context of cloud application are briefly described below: (1)Confidentiality-The principal of confidentiality specifies that only the sender and the intended recipient(s) should be able to access the contents of a message. Confidentiality gets compromised if an unauthorized person is able to access a message;(2)Authentication-Authentication mechanism helps to establish proof of identities. The authentication process ensures that the origin of an electronic message or document is correctly identified;(3)Integrity-When the data of a message are changed after the sender sends it, but before it reaches the intended recipient, we say that the integrity of a message is lost;(4)Non-repudiation-There may situations where a user sends a message, and later on refuses that he had sent that message;(5)Access control-The principle of access control determines who should be able to access what.

Opportunities for Market Players Through Cloud Computing

Cloud computing is changing the ICT ecosystem with emerging business roles and modification of the ICT industry value chain.

Small and medium enterprises consider the usage of cloud computing to improve flexibility and to reduce the cost of their IT systems. The hardware and software for the support of cloud services may be increased, since

operators need to possess extensive hardware and software resources for economies of scale. This may promote business growth for hardware and software providers. In general, cloud computing offers opportunities of business transformation for large ICT enterprises. Cloud computing also provides opportunities for other market players, e. g. application developers, application integrators, application providers, content providers. Cooperation with operators of cloud services enables the creation of a broader market and win-win situations between operators and these market players.

OPENSTACK INTRODUCTION

Cloud Solutions-OpenStack

OpenStack solution is recent and under active development. It has great potential due to its architecture and community and the support of its partners. All code is licensed under Apache 2 license. It's a platform developed by NASA dedicated to massive infrastructures. The main characteristics are Scalable, Compatible and Flexible, Open.

OpenStack Architecture

OpenStack architecture is built using three main components [15] (As shown in Fig.4):OpenStack Compute, Image and Object.

OpenStack Compute, also known as Nova, is a management platform that controls the infrastructure to control IaaS clouds. It is similar in scope to Amazon EC2 and Rackspace CloudServers. Nova Compute allows managing large networks of virtual machines and redundant and scalable architectures. It provides an administrative interface and an API needed for the orchestration of the Cloud. It includes instances management for servers, networks and access control. Compute requires no prerequisite hardware and is completely independent of the hypervisor.

Imaging Service (project Glance) provides storage services, recording and distributing the images to virtual machine disks. It also provides an API compatible with the REST architecture to perform queries for information on the images hosted on different storage systems.

Object Storage (Swift project) is used to create a storage space redundant and scalable for storing multiple petabytes of data. It's not really a file system but is especially designed for long term storage of large volumes. It uses a distributed architecture with multiple access points to avoid SPOF (Single Point of Failure).

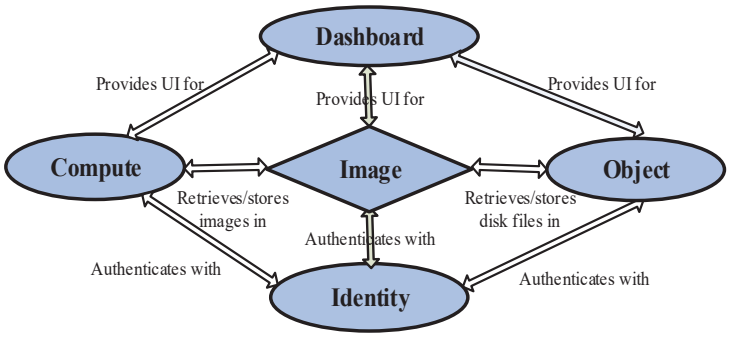

FIGURE 4.Depicts the actors with some of their possible roles in a cloud ecosystem.

Challenges of OpenStack

OpenStack development has been criticized by people: never stopped developing new features, but there has been a lot of problems in terms of stability ease of use, the community has not devoted part of the effort to study this problem, companies have to spend their own a lot of energy to solve their own stability operation and maintenance management.

OpenStack release fast, a release every six months, for many enterprises, the upgrade is a risk, but if you do not upgrade, it may be difficult to follow up again to go up. In general, in the interval of a version upgrade is also

acceptable, then a big gap is difficult to upgrade, if you do not upgrade, you need to follow many new features, have to develop their own maintenance, which is also a problem, is currently facing Jinshan Gong Clouds this issue, the burden is too large, has no way to upgrade. How to effectively solve the problem of OpenStack smooth upgrade should be a key consideration of the Community.

SUMMARY

Information transmission is only one of the basic functions of the Internet, service is the fundamental embodiment of the value of the internet. Internet hosting service showing explosive growth, the future Internet essence is a kind of a very large scale, virtualization, high reliability, general, high expansion of service system, support the user in any position, use any terminal to easily access a variety of service. The future network architecture must be adapted to the needs of these services and requirements. In the service driven design concept, the future of the Internet service oriented architecture system will usher in a rapid development. At the same time, the Internet cloud ecosystem will be more perfect.

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