ISSN 0002-306X. Proc. of the RA NAS and NPUA Ser. of tech. sc. 2016. V. LXIX, N 4.

UDC 62-50

AUTOMATION AND CONTROL SYSTEMS

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THE CLOUD SYSTEM DEPLOYMENT AND MANAGEMENT IN NATIONAL POLYTECHNIC UNIVERSITY OF ARMENIA

Having a strong cloud system that can both have high performance and be scalable to future needs is very important to any company. These two criteria are not the only ones that should be considered when deploying such a big project. Many different factors should also be considered such as redundancy, reliability, etc. Being one of the largest universities of Armenia and an institution meeting high computing demands, the cloud system has been deployed in National Polytechnic University of Armenia using the latest available technologies (CloudStack for management, Ceph for storage etc.) to meet all the necessary requirements of reliability and high performance.

Keywords: cloud, cloudstack, ceph, reliability, scalability, redundancy, management.

Introduction to cloud computing. The fact that cloud computing has been one of the fastest growing solutions for big companies is given. The reason behind this somewhat new technology's fast growth is not only how it manages to make a given file/storage available anywhere, but also reduces workload on servers by managing those resources [1].

Per the official NIST (National Institution of Standards and Technologies) definition, "cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [2]. As cloud computing developed, it started to be used for many different reasons: starting from an individual person to big corporations, from educational to scientific purposes.

Many types of cloud computing exist. First, we need to divide these types into two main groups:

- Based on location (cloud models);
- Based on services (cloud service models).

1. **Cloud computing based on its location.** There are four types of cloud computing based on location:

- Public;
- Private;

- Hybrid;
- Community cloud.

Public cloud. The idea behind public cloud is that it is provided by a public company to many customers. That is, the customer does not have physical access to it.

Private cloud. This type of cloud is deployed by a private organization/ customer. Although it is still available from the public network, it is not shared to any other party. Still, the private cloud's servers can be deployed by a public cloud company, with restricted permission only to the given organization/customer.

Hybrid cloud. Hybrid cloud is a combination of a private cloud platform with a public cloud provider. The idea behind this implementation is to put sensitive information on the private cloud, while placing all the other dependent data on to the public cloud. The communication between the two are handled via encrypted channel, thus making sure that all the flowing information is safe. Hybrid also helps to reduce the response time. If all the data were on public network handled by ISP, information flow obviously would be much slower, as it would need to travel longer distances back and forth.

It is often confused how these two clouds work together. One thing that should be clear is that private and public cloud systems are independent from each other in a hybrid cloud. They are interconnected by cloud software. This makes sure that the core purpose of hybrid cloud is intact, which is to separate sensitive data from dependent data, creating faster and more secure workload.

Community cloud. Community cloud's name explains its purpose. This is a cloud that is shared between several organizations/customers. For example, community cloud can be used by country's government for a general electronic document flow.

2. **Cloud computing based on its provided services.** There are three main types of cloud computing based on provided service:

- IaaS (Infrastructure as a service);
- SaaS (Software as a service);
- PaaS (Platform as a service).

IaaS. Infrastructure as a Service (IaaS) is a way of delivering Cloud Computing infrastructure – servers, storage, network and operating systems – as an on-demand service. Rather than purchasing servers, software, datacenter space or network equipment, clients instead buy those resources as a fully outsourced service on demand [3].

Software as a service is a software licensing and delivery model in which software is licensed on a subscription basis and is centrally hosted [4]. SaaS is typically accessed by users using a thin client via a web browser. SaaS has become a common delivery model for many business applications, including office and

messaging software, payroll processing software, DBMS software, management software, CAD software, development software, gamification-, virtualization, accounting, collaboration, customer relationship management (CRM), management information systems (MIS), enterprise resource planning (ERP), invoicing, human resource management (HRM), talent acquisition, content management (CM), antivirus software, and service desk management.

PaaS. Platform as a Service (PaaS) brings the benefits that SaaS bought for applications, but over to the software development world. PaaS can be defined as a computing platform that allows the creation of applications quickly and easily and without the complexity of buying and maintaining the software and infrastructure underneath it.

Given task: Building IAAS using NPUA resources. As already mentioned, cloud computing is used not only in big companies and corporations, but also in educational and scientific fields. Every educational organization can benefit from deploying a cloud based system to build bigger tasks and implement different technologies. National Polytechnic University of Armenia (NPUA) has a set of new resources (servers, network storages, laboratories with high end computers), which has been decided to be built into cloud based infrastructure as a service to be able to provide new solutions for many different educational and research challenges. Before deploying any cloud based service several factors should be considered first:

- Security;
- Scalability;
- Performance;
- Reliability;
- Management.

To have a cloud based infrastructure as a service in National Polytechnic University of Armenia, which considers all the above-mentioned factors, a set of servers has been deployed. First, to provide security and shield cloud - based network the from the university's local network, a set of VLAN has been created for management, storage, local network and public network. Also, some of this VLAN's are interconnected to provide high performance both for storage network and management. An example of cloud network is given below (Fig. 1).

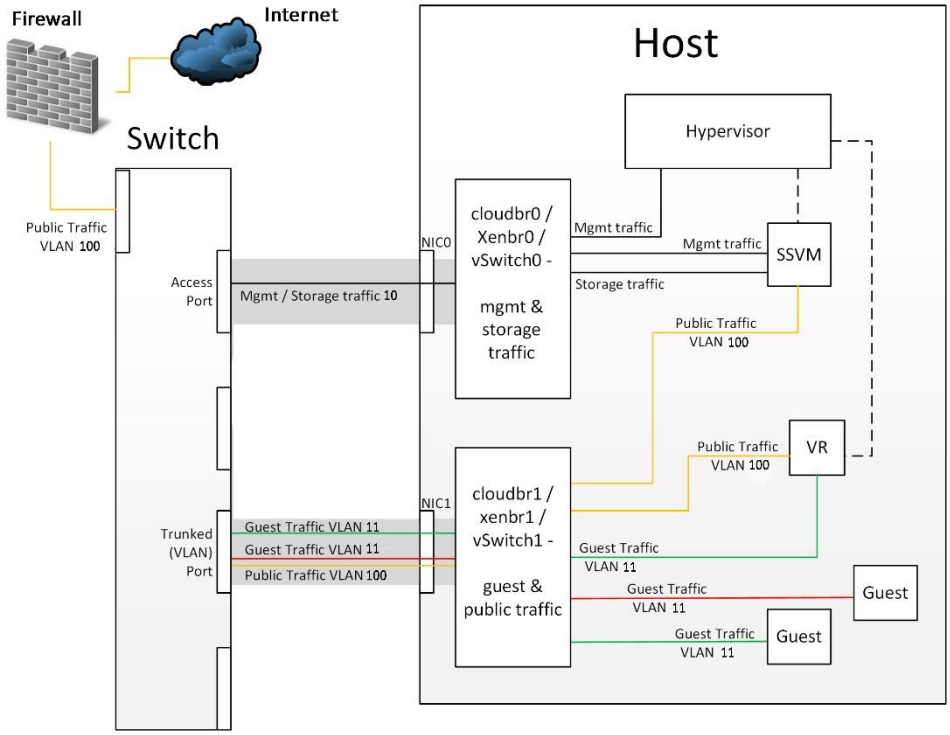

Fig. 1. Network configuration diagram

The main server, located in the server room manages all the systems in the cloud, which are network storages with their systems, hypervisors with their nodes. This centralized system management allows to optimize the workload on the servers and report any problems that may occur during implementation. Cloud infrastructure is in Data Center, and the clients of the cloud are in the 5th building with secure access to the cloud infrastructure.

Dealing with data is crucial for cloud computing. Storage not only should be reliable and safe, it also must be scalable, which means, it can be expanded on demand without infrastructure changes and service interruption. When storing big data, it is important to have a system that will deal with writing and reading in a fast and sophisticated manner, while being flexible with addition of storage. US based Inktank's Ceph gives their solution to data storage. The technology is open source and promises that storage can become endlessly expandable. Ceph at its base is an object-store system, which is called Rados (Fig. 2). As an object-store system Ceph stores data in the form of binary objects, which later can be split into smaller parts. The problem with basic storage devices, where data is stored in blocks, is that the entire disk first needs to be scanned to find the required information. This is where file-

systems help to resolve this issue. Ceph bypasses this by adding an additional layer, which manages blocks. This layer is called RADOS. The layer itself consists of two components: first of them is the Object Store Device (OSD), where each individual disk belongs to file-system's cluster. When the user needs to write, or read any data, the communication is held by this component. The other component is monitoring component, which handles OSDs. So, the principle is simple: it does not matter how many servers or hard disks are used to store the information. The only thing that the user will see is the interface the data is stored on, and it will always be the same intact one [5].

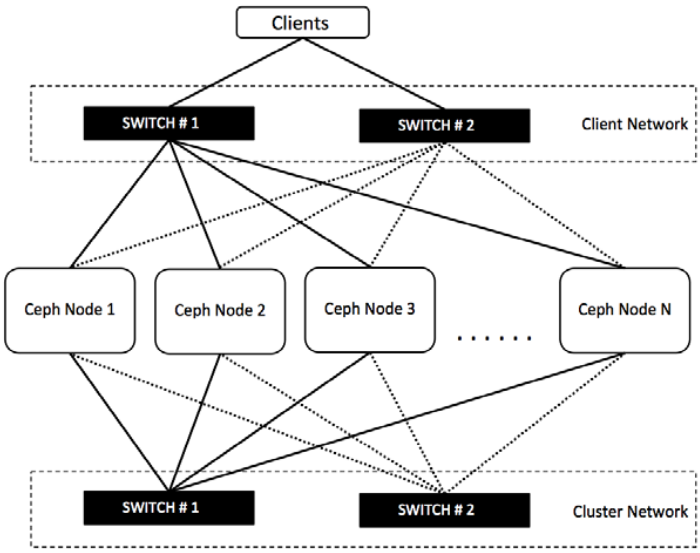

Fig. 2. Ceph object storage system

Besides having its centralized server, Ceph also needs to have its clients installed on the hypervisors for them to be able to write/read on the network storage. As already mentioned, the storage also has its own VLAN to eliminate security problems and most **o**f all to have steady high performance.

To manage cloud services, two types of technologies have been compared: CloudStack and OpenStack. Both CloudStack and OpenStack are open source software platforms for IaaS that offer cloud orchestration architectures used to make the management of cloud computing easier and more efficient [6]. OpenStack uses multiple components for managing different cloud services which requires additional resources. The CloudStack provides a single point of management and it is easier and faster to provision cloud infrastructure with CloudStack.

CloudStack. Initially developed by Cloud.com, CloudStack was purchased by Citrix then later released into the Apache Incubator program. It is now governed by the Apache Software Foundation and supported by Citrix. Since the Apache transition, other vendors have also joined the efforts by enhancing and adding core capabilities to the core software. The first stable version of CloudStack was released in 2013 [7].

1. ***Unique Features*:** The latest version of CloudStack includes commendable features such as storage independent compute and new security features that enable admins to create security zones across different regions. Its features enable a day-to-day use and resource availability.

2. ***Smooth Deployment*:** The installation of CloudStack is quite streamlined. In a normal setup, only one VM would run the CloudStack management server while another VM acts as the de facto cloud infrastructure. From a deployment and testing perspective, the whole platform can be deployed on one physical host, which has been used as an advantage for our deployment.

3. ***Scalability***: CloudStack has been designed for centralized management and massive scalability; enabling the effective management of numerous geographically distributed servers from a single portal.

4. ***Multi Hypervisor support***: The CloudStack software supports multiple hypervisors, which are the following [8]:

- Windows server 2012 R2 (with Hyper-V Role enabled);
- Hyper-V 2012 R2;
- CentOS 6.2 with KVM;
- Red Hat enterprise Linux 6.2 with KVM;
- XenServer 6.0.2 (with Hotfix);
- XenServer versions 5.0, 5.1 and 5.5.

5. ***Detailed Documentation***

6. ***Interactive Web UI*:** CloudStack has a polished and advanced web interface that makes it more user friendly.

Overall, the university's cloud computing system has the following look: Hypervisors, located in the laboratory, connect to the server (which is in server room) via switches, which themselves are connected to the server's switch via optic cable, thus providing a possibility for high bandwidth loads. They read/write information from the storage clusters, configured using Ceph, which provides security and reliability. Storage clusters themselves are configured via Admin node. All cloud services are managed via redundant centralized management server, which itself runs on CloudStack (Fig. 3).

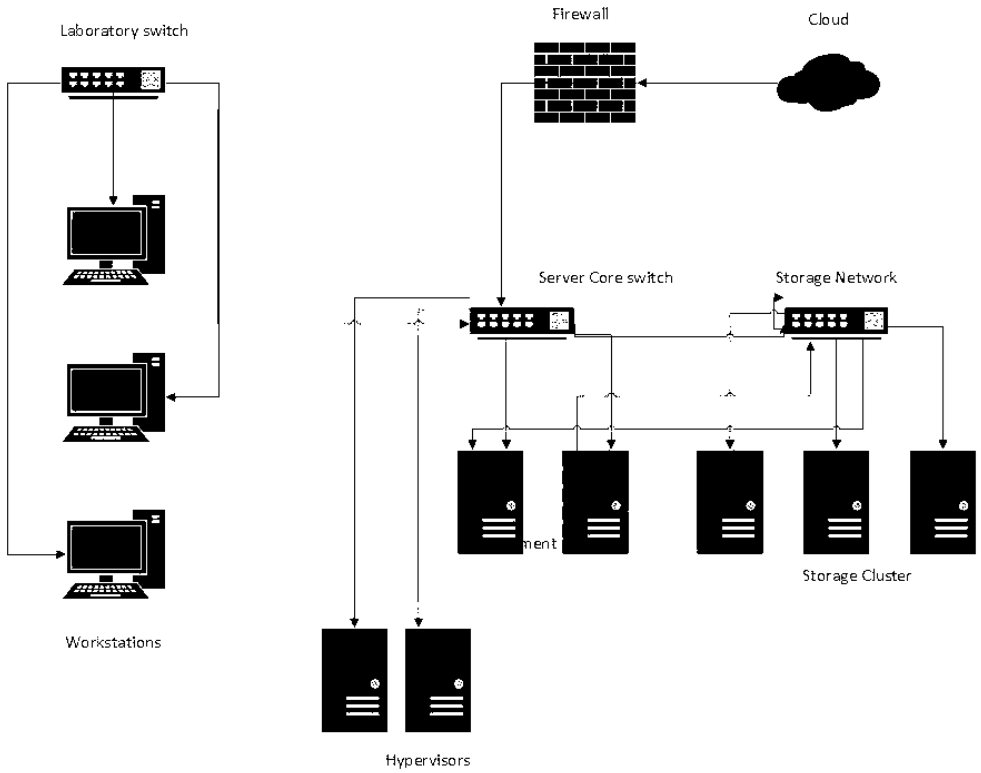

Fig. 3. NPUA cloud infrastructure

This architecture will provide a high performing and scalable system, to provide students and researchers with a place where they can deploy all their developments and run different tests and analytics for their projects.

Conclusion

- Cloud computing is the most popular solution at this moment, thus deploying one is crucial for academic and research projects;
- Cloud computing can provide many different approaches depending on the needs;
- Cloud storages managed with Ceph technology provides high read/write speeds and reliability;
- Cloud computing management is very important to be able to provide service continuity. This has been achieved using CloudStack.

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National Polytechnic University of Armenia. The material is received 03.07.2016.

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ԱՄՊԱՅԻՆ ՀԱՄԱԿԱՐԳԻ ՏԵՂԱԿԱՑՈՒՄՆ ՈՒ ԿԱՌԱՎԱՐՈՒՄԸ ՀԱՅԱՍՏԱՆԻ ԱԶԳԱՅԻՆ ՊՈԼԻՏԵԽՆԻԿԱԿԱՆ ՀԱՄԱԼՍԱՐԱՆՈՒՄ

Յուրաքանչյուր ընկերության համար կարևոր է ունենալ հզոր ամպային համակարգ՝ բարձր թողունակությամբ և ընդլայնման հնարավորությամբ: Բացի դրանցից, կարևորվում են այլ հատկանիշներ ևս, ինչպիսիք են, օրինակ, հուսալիությունը, անխափան աշխատանքը և այլն: Հաշվի առնելով, որ Հայաստանի ազգային պոլիտեխնիկական համալսարանը Հայաստանի ամենախոշոր բուհերց մեկը՝ համակարգչային մեծ ռեսուրսների կարիք ունի, համալսարանում ստեղծվել է ամպային համակարգ՝ կիրառելով նորագույն տեխնոլոգիաները (CloudStack ղեկավարման համար, Ceph տվյալների պահպանման համար և այլն), բավարարելու համար բոլոր անհրաժեշտ պահանջները, ինչպիսիք են հուսալիությունը և բարձր թողունակությունը:

Առանցքային բառեր. ամպ, cloudstack, ceph, հուսալիություն, ընդլայնում, անխափան աշխատանք, կառավարում:

Л.Г. КИРАКОСЯН, Х.А. НАЗАРЕТЯН

РАЗВЁРТЫВАНИЕ И УПРАВЛЕНИЕ ОБЛАЧНОЙ СИСТЕМОЙ В НАЦИОНАЛЬНОМ ПОЛИТЕХНИЧЕСКОМ УНИВЕРСИТЕТЕ АРМЕНИИ

Для любой компании важно иметь мощную облачную систему с высокой пропускной способностью и широкими возможностями. Кроме того, важное значение придается таким свойствам, как, например, надежность, безотказная работа и др. Учитывая, что Национальный политехнический университет Армении, являющийся одним из крупнейших вузов Армении, имеет большую потребность в вычислительных ресурсах, в университете была создана облачная система с применением новейших технологий (CloudStack для управления, Ceph для хранения и т.д.) с целью удовлетворения всех необходимых требований, таких как надежность и высокая пропускная способность.

Ключевые слова: облако, CloudStack, Ceph, надежность, масштабируемость, безотказная работа, управление.