

# Parallel Mobile Cloud Computing Platform Strategy

Prof. Dr. Dhuha Basheer Abdullah, Basma Basil Zubair

**Abstract**— The concept of cloud computing became famous in the last years due to the fast development in computing technology. The cloud computing means the capability of providing service of storing, processing, managing programs, and data over the network such as “Internet”. Mobile Cloud Computing is a new paradigm that appeared due to the increased usage of mobile devices. It provides cloud services for mobile devices, so it reduces resource and energy consuming that mobile device needs to store data or execute applications locally. Mobile cloud computing eliminates the problems that result from mobile device resource limitations. In this paper, a new platform was designed called Parallel Mobile Cloud Computing Platform (PMCCP). The platform is responsible for providing parallel cloud services for mobile and laptop devices. Microsoft cloud solution, i.e., System Center was utilized to build a private cloud. A prototype implementation for the environment was done by the design and analysis of two parallel services as web applications using ASP.NET and C#. These parallel web applications have been deployed on the private cloud. The parallel services were accomplished on cloud-based VM with two cores and on cloud-based VM with four cores. As well the results revealed that the platform is efficient and dependable.

**Index Terms**— Cloud Computing, Hyper-V, Microsoft Cloud Solution, Mobile Cloud Computing, Private Cloud, System Center, Virtual Machine Manager.

## 1 INTRODUCTION

Cloud computing began as a combination of other existing technologies and depends on their capabilities such as virtualization, grid computing and utility computing [1]. Cloud computing found a new idea to deal with computing architecture and delivery models. Everything in cloud offers as a “Service”. Cloud services help to enhance the business collaboration and operation [2]. Mobile devices became one of the most important things in human life. The aim of mobile computing is to provide simple way for end user to access the application that s/he needs it at anytime and anywhere but it still has some restrictions such as low connectivity, finite energy, etc.... therefor Mobile cloud comes to help users to access a useful program that couldn't work on mobile devices itself [3]. According to NIST [4] Mobile cloud computing defines as “an infrastructure where both the data storage and the data processing happen outside of the mobile device. Mobile cloud applications move the computing power and data storage away from mobile phones into the cloud, bringing applications and mobile computing to not just smartphone users but a much broader range of mobile subscribers”. Mobile cloud computing treats the constrains in mobile devices such as limitations in processing capabilities by execute heavy and complicated computations such as parallel tasks in more capable cloud instead of execute it on mobile devices this also decrease mobile energy consuming [5]. In this paper, a new platform has been developed to let a mobile device user execute a complex parallel application using only mobile device this is done by building private mobile cloud

computing and deploy parallel application as a service in this cloud and permits user to access the service that resides on private mobile cloud.

### 1.1 Contribution

Our research may contribute in the field of computing mobile devices in the following manner.

- 1- A proposed mobile cloud computing platform was designed. The proposed platform acts like a proxy between the cloud and the mobile devices.
- 2- As a backbone of the proposed platform, a private cloud for computer science department has been built using Microsoft cloud solution, i.e., System Center.
- 3- Implementing prototype environment for the platform and adopting two parallel applications that were designed and programmed as web services using ASP.Net and C# language. The results revealed that the platform was efficient and dependable.
- 4- Deploying the parallel services on the designed private cloud and permitting users access them. This results in the improvement of performance and energy efficiency.

### 1.2 Related Works

In [2015], S.Niranjani, R.Jehadeesan, S.Vanishree and P.Karthick [6] has set up a new prototype for private cloud and provided IaaS services for users. Hardware resources, configuration, and deployment of the fundamental components have been chosen. The researchers used OpenStack cloud platform on the open source operating system Linux. Also, graphical user interface was provided to users to help them access cloud resources. After building the cloud, the cloud performance was measured when user deploys scientific application.

In [2015], Sarita Shankar Pol and Shyamrao V Gumaste [7] discussed methods of setting and configuring private cloud

- Prof. Dr. Dhuha Basheer Abdullah is currently, the head of Computer Science Department, College of Computers and Mathematics, in University of Mosul, Iraq. E-mail: rtdm2005@yahoo.com
- Basma Basil Zubair is currently pursuing master's degree program in computer science in University of Mosul, Iraq. E-mail: bassma\_alzobeer@yahoo.com

using open source software like eucalyptus, open stack, Maas/Juju; these are freely available to build private cloud. Two implementations of private cloud "IaaS" and "PaaS" were provided by this software.

In [2015], Divya Shree R [8] has used Ubuntu to implement an OpenStack private cloud. The system contained three nodes: compute, controller, and storage. These nodes can be installed with Ubuntu server operating system. Compute node was installed using Nova packages. Whereas, controller node was installed using Glance, Keystone, and Horizon packages. Finally, storage node was installed using cinder packages. All these packages were available in OpenStack. All the three nodes were connected between them internally but the application needs to use the private cloud service connected to the cloud using external network. A new way to manage accessing the cloud was produced in this paper; it was decentralized instead of centralized one in other cloud systems. This can be done through "Decentralized Access Management Application". This application must be run on windows server virtual machine using Hyper-V.

In [2016], D. G. Grozev, M. P. Shopov, and N. R. Kakanakov [9] have used VMware technology to build and implement private cloud and they have implemented traffic optimization technology on cloud infrastructure. This implementation simplified the building and administrating all layers of energy management system using cloud.

In [2017], Navneet Singh and Dr. Vijay Dhir [10] have explained the way private cloud was built using open source cloud solution, i.e., Eucalyptus. They gave an overview on this solution and discussed the advantage and disadvantage of Eucalyptus. Then, they have described components of solution. Finally, they have listed steps to install and configure Eucalyptus.

### 1.3 Mobile Cloud Computing

Nowadays, Mobile devices become more important in human life. These devices are not bound to location or time. applications serve mobile user wherever and whenever needed regardless of the user's movement; this is called mobility. It is the most important characteristics of this computing. On the other hand, one can notice some problems such as low connectivity, energy consuming, etc.

In recent years, these problems were solved by moving to Mobile Cloud Computing. Aepona [11] defines Mobile Cloud Computing MCC as "a new paradigm for mobile applications whereby the data processing and storage are moved from the mobile device to powerful and centralized computing platforms located in clouds. These centralized applications are then accessed over the wireless connection based on a thin native client or web browser on the mobile devices". The mobile devices are connected to the mobile networks via base station. Mobile users' request, and information are transmitted to the central processors that are connected to the servers providing mobile network services. The request is delivered to a cloud through the Internet. A cloud controller processes the user request, then the services are provided to the user according to their need. These services are developed basing on the concepts of utility computing, virtualization, and

service-oriented architecture [12]. Mobile cloud computing makes easy to compute, process, and storage data on the cloud instead of Mobile devices which have limited computing power and small storage capacity [13].

There are several ways to implement mobile cloud computing. But none of them satisfies all the requirements of the mobile cloud. These include the following.

- **Offline Applications**

Offline application acts as a client that processes the presentation and business logic layer locally on mobile devices while data is download from servers. This type of applications also called "Native application". The most of common applications nowadays are Native applications [14].

- **Online Applications**

In online applications, the connection between mobile devices and the entire system must be always available. The main problem with mobile device application is the "portability" with other platforms. This problem is solved by using web technology. Web applications are a powerful alternative to offline applications [15].

## 2 PLATFORM STRATEGY

The designed platform (PMCCP) permits users to run their applications on a cloud-based virtual machine instead of running the same application on their own devices. This technology reduces the resources and energy consuming also helps the mobile devices users to run applications that need heavy computations using poor mobile devices with small memory size and low CPU capacity. Users only use their mobile devices or laptop and access the cloud and choose the service they need. The platform will then process users' requests and create a virtual machine for each user request and then on this VM the service will be executed. Finally, the result will be displayed on user's device screen. In this platform, server-client approach has been implemented. The private cloud acts as a server that run application on virtual machine, and user's mobile device or laptop acts as a client that requests a service from the cloud. The cloud administrator puts the parallel service that users need them on cloud and permits users to access them any time they need. All the services reside in the platform are parallel services, that means they need multi-cores VM to execute so, the cloud administrator prepares a VM template and specifies the number of cores in this VM. when user need to run the application, the platform creates a Virtual machine for this user depending on this template with cores specified by cloud administrator to run the selected application. The parallel services that published on the platform have been designed as a web services instead of traditional desktop application.

In PMCCP, all hosts and VMs have been joined to domain. So physical hosts (host 1 and host 2) and virtual machines (SQL, VMM, and VMs will be created by VMM during service deployment) have been joined to domain. Each user must have account on the domain to enable him access the platform and request service by only enter the domain URL in web browser. Also, the database of VMM will be saved on SQL

server that has been created before.

### 3 PLATFORM COMPONENTS

The constructed platform consists of two hosts that acts as main servers to build private cloud with three virtual machines on the first host and one virtual machine on the second host, also, a router has been added to platform to make a network connection between the two hosts. The cloud administration is done on the first host which contains virtual machine manager VM. Finally, user laptop or mobile used to access the services. The platform components illustrated in fig. (1).

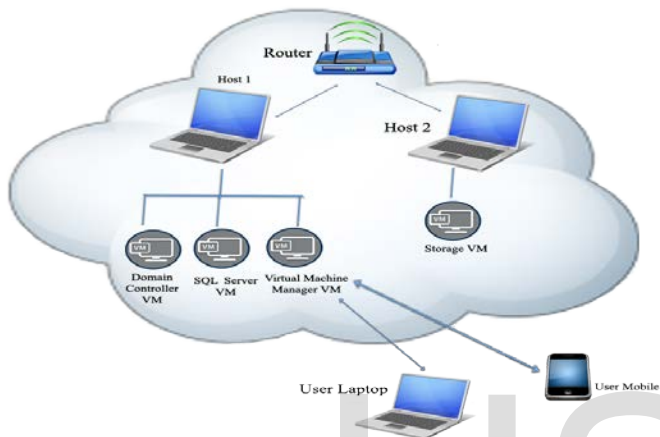


Fig. (4-1): Platform Components

### 4 PLATFORM ARCHITECTURE

In this work, a new platform was designed that called Parallel Mobile Cloud Computing Platform (PMCCP). There are several construction steps to build this platform. These steps illustrated in Fig. (2). As the first step, decision study to build private cloud or to work on public cloud has been made. Private cloud has been chosen to deploy services for users because its more secure for organization to build its own cloud than use public cloud serviced provided by third party. Another reason was organization does not need to pay fees every month for cloud provider to use public cloud services. Also, A solution has been selected to build the private cloud according to organization need. In this work, Microsoft private cloud (System Center) has been chosen to build the private cloud because its support .Net application and also it works with many virtualization platforms. After that, the components that used to build private cloud have been initiated such as initiating servers and increasing the capacity of Hard disk and memory. Then, the network between two hosts has been connected using a router. After that, a set of steps to build private cloud have been implemented such as creating VMs and perform each one of them to perform a certain task. A few Parallel services have been designed and analyzed. Finally, the parallel services have been deployed and published on the platform. After all these steps performed, the platform has been ready to access by users to request their services. All parts of the work and the practical

steps will explain in details in the following sections.

#### 4.1 Build Private Cloud

After network has been connected between two hosts, the steps to build private cloud have been implemented. Four virtual machines formed a private cloud parts. A virtual machine is a software computer that operates as a physical computer and based on architecture of physical computer. Each host can contain several virtual machines. Virtual machine is like physical computer runs an operating system and applications and has virtual devices and components such as processor, memory, etc.... The first virtual machine has been created acts as "Domain Controller". Domain Controller is a server that created to manage access to cloud resources such as servers, VMs and services. So, each user need to register in domain to enable her/him access the resource that she/he need it. When user log in the domain, the domain controller check user's permissions to ensure that she/he authorized to use cloud resources. All the roles and features needed to create and configure domain have been added to VM. The second one acts as "SQL Server" that needed it to store VMM database.

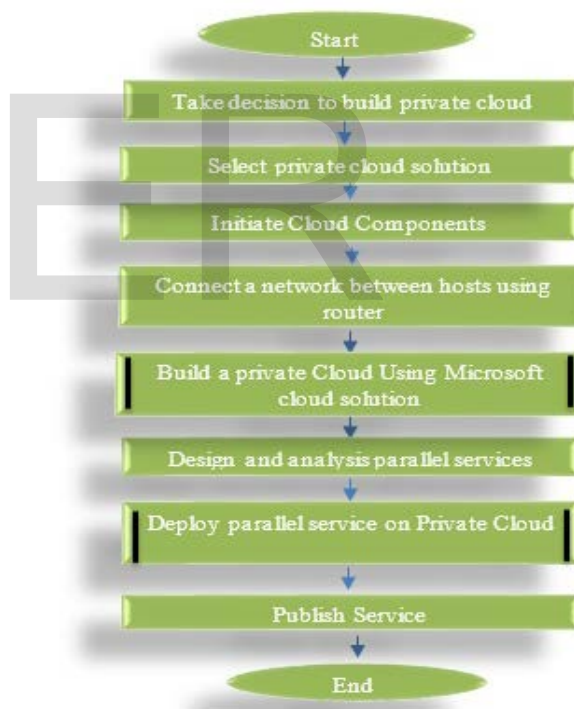


Fig. (2): General Platform Architecture

SQL server is a system developed by Microsoft. This system responsible to manage relational databases. it uses to store and retrieve data according to the request of an application that run on the same computer or on another computer in network. The third virtual machine acts as a main VM where "System Center Virtual Machine Manager" has been installed. SCVMM is one component of Microsoft system center package this software used to manage all the virtual machines created before also it used to create and manage the private cloud and



all cloud resources and services also it provides connection to public cloud to build hybrid cloud and move the virtual machine between private and public cloud. The Fourth virtual machine acts as storage server for the private cloud environment. The following steps summarized the building of private cloud.

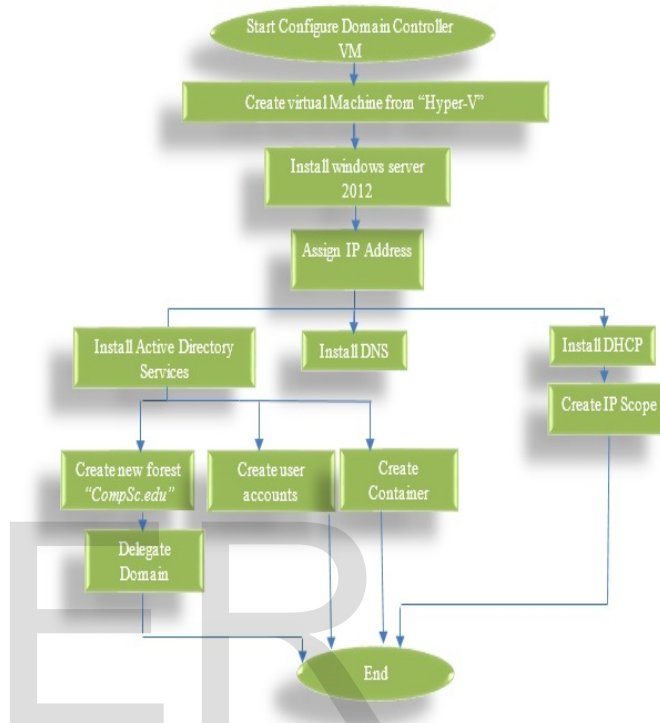
- Step 1:** Turn on virtual technology option on two hosts.
- Step 2:** Install windows server 2012 on two hosts.
- Step 3:** Install "Hyper-V" software on two hosts.
- Step 4:** Create three virtual machines on the first host and one virtual machine on the second one and install windows server 2012 on each one of them.
- Step 5:** Initiate the first virtual machine of host one as a Domain Controller and create domain.
- Step 6:** Join the second virtual machine of the first host with domain and then install SQL server.
- Step 7:** Join the third virtual machine of the first host with domain and install the System Center Virtual Machine Manager.
- Step 8:** Configure network, accounts, and VIP template in SCVMM.
- Step 9:** Join the virtual machine of the second host with domain and install StarWind software and SMI-S on this VM to create virtual SAN storage for private cloud.
- Step 10:** Add cloud storage to the SCVMM.
- Step 11:** From SCVMM create private cloud.

#### 4.2 Configure Domain Controller Virtual Machine

To build private cloud the first component has been configured is "Domain Controller". At the first step windows server 2012 has been installed on virtual machine. Then IP address has been assigned to this machine. After that, a set of roles need to add to the virtual machine to create domain controller. The first role is "Active Directory Service". This role responsible to create a Domain and also permits admin to manage and record information about all computers, resources and users included in this network. After that, a new forest has been created and named "CompSc.edu". A forest is a top level of active directory structure. Forest is a group of trees that contains global catalog, schema, structure and configurations of network. Then, the administrator account has been delegated as an administrator to this domain this enable administrator to add devices and users to domain. Then, after domain has been created the service account that responsible to manage VMM and user accounts that permit to them to access the cloud have been created. Also, a container to store a VMM Distributed key management has been created in active directory. Those distributed keys used by VMM to encrypt data on local computer. A second role is Dynamic Host Configuration Protocol (DHCP) that responsible to give a dynamic IP address for each virtual machine that created

using Hyper-V and joined to domain. Also, a Domain Name System (DNS) role has been added to maintain a directory of machines names and translate each name to its appropriate IP address. So, user can type the name of server in URL instead of Server's IP. A domain controller architecture is illustrated in fig. (3).

#### 4.3 Configure SQL Server Virtual Machine



The second important component of private cloud is a "SQL Server". This component was needed to store "Virtual Machine Manager" database and all the database of private cloud. To install SQL server the virtual machine has been created and windows server 2012 has been installed on this machine and IP address has been assigned. Then the virtual machine has been joined to domain. Then some pre-request configurations such as install .NET framework and open SQL server ports (4022 and 1433) in firewall have been opened.

**Fig. (3): Domain Controller VM Architecture**

A new rule in firewall has been created and the SQL server ports have been added to this rule. Then SQL server components (Data Base engine server, Management Tools-Basic) have been installed. Data base engine is the essential services in SQL that responsible of storing, processing and securing database. Also, Management Tools-Basic was used to configure and administrate all the components and databases in SQL server. Fig. (4) illustrate architecture of SQL VM.

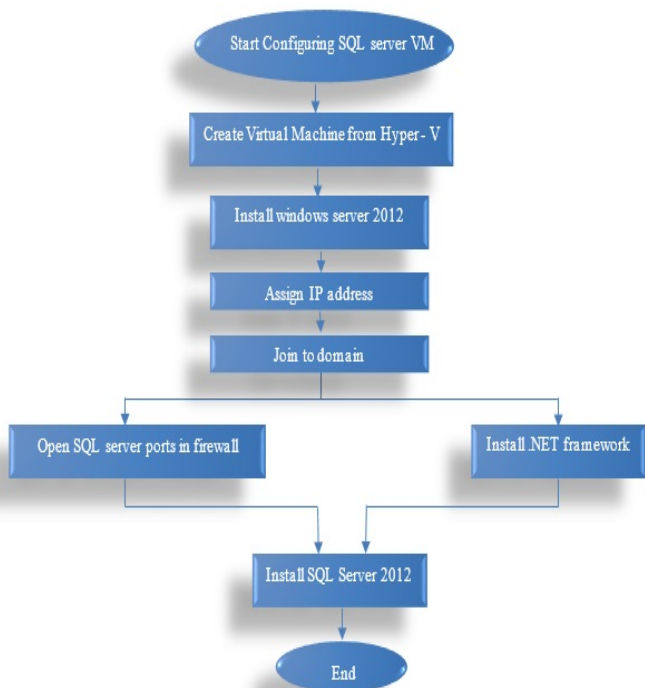
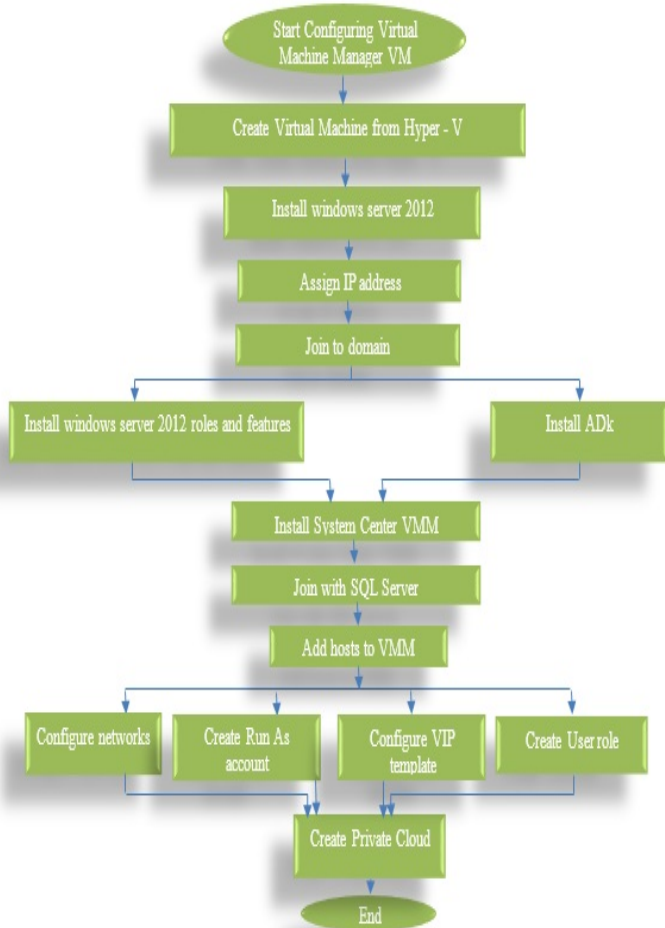


Fig. (4): SQL Server VM Architecture

#### 4.4 Configure System Center Virtual Machine Manager Virtual Machine

The most important part of private cloud is “Virtual Machine Manager”. As a first step, a virtual machine has been created and windows server 2012 has been installed also IP address has been assigned to this virtual machine. After that the virtual machine has been joined to domain. This component



also need to set some pre-request installations such as install Assessment and Deployment Kit (ADK) which is a set of tools that responsible to deploy operating system to appropriate computer or virtual hard disk. Also, some windows roles have been installed such as Internet Information Services (IIS). This role works as a web server which serves the requested web application that deploy on the cloud. Also, the security features of IIS have been installed such as Windows authentication, IP domain authentication, URL authentication, etc. also ASP.NET have been installed to provide the ability to deal with dynamic web pages and rich web applications that deployed on private cloud. All these pre-request installations have been installed to perform the environment to install “SCVMM”. After SCVMM has been installed, the SCVMM console has been opened and all settings such as add hosts and VMs, set private cloud logical network, create VIP template, Create Cloud, etc. have been configured. Fig. (5) shows virtual machine manager VM architecture.

Fig. (5): Virtual Machine Manager VM Architecture

#### 4.5 Design and analysis parallel Services

After private cloud has been built, services that needed to be published on the private cloud have been designed and Analyzed. A web services in this work means “web applications” that has been deployed on private cloud as “service” for users. In general, web application is a client-server application that reside on the remote server with a web interface that runs on client side using web browser. Parallel quick sort and parallel matrices multiplication have been designed and Analyzed then these parallel web applications added to private cloud.

##### A. Parallel Quick sort service

Parallel quick sort is a cloud service that works to sort number of elements and put each one in a certain location. It depends essentially on comparison between elements and change their index until all the elements put in right orders. To increase the efficiency and benefits of quick sort, parallel techniques used to enhance time consuming. Quick sort is one of divide and conquer algorithms. It means that the quick sort algorithm divides the original array to smallest arrays depend on selected value called “Pivot” the array division continue in recursive manner until reach a single element. Then the algorithm makes a comparison between the values and put each element in appropriate location in the array. Fig. (6) illustrates quick sort algorithm steps with an example. The Quick sort was implemented as a parallel application. Single instruction multiple data approach (SIMD) has been implemented. The following steps illustrate the procedure that has been implemented during this work to build parallel quick sort service.

**Step 1:** Two VM templates have been created in VMM. Two cores have been assigned to the first one, each core represent PE in SIMD topology. While four cores have been assigned to the second template.

**Step 2:** The web application for parallel has been created using ASP.NET and C#.

**Step 3:** Three Methods have been written to execute parallel quick sort

- Swap Method

- Partitioning method
- Parallel Quick Sort Method

**Step 4:** "Swap Method" has been used to switch between the places of two elements to put each one in its appropriate location.

**Step 5:** In "Partitioning Method", the original list has been divided to sub lists depend on pivot. The elements less than pivot put in sub list and elements greater than pivot put in separate sub list. Pivot position calculates using the equation:

$$\text{Pivot Position} = (\text{high} + \text{low}) / 2$$

This method has been called in recursive manner on the sub lists also.

Suppose "List" is the original list that need to sort.

Pivot: List [Pivot Position]

MList: List elements < pivot

GList: List elements > pivot

Each one of these sub lists has it separate elements which is in depended of elements of other sub lists. This mean that there is no data dependency among these sub lists. So, each sub list can be assigned to separate thread that can be processed by separate core. The cores process data in parallel.

❖ **VM template with only two cores**

At beginning the list divide depend on pivot to two sub lists

Core 1 process MList.

Core 2 Process GList.

Partitioning method works on MList and GList in parallel.

At second level Mlist divide depend on its pivot to MList1 and MList2. Also, Glist divide according to its pivot to GList1 and GList2.

Mlist1 and Glist1 operate in parallel, each one of them processed in separate cores then Mlist2 and Glist2 processed in separate cores in parallel.

❖ **VM template with four cores:**

At beginning the list divide depend on pivot to two sub lists

Core 1 process MList.

Core 2 Process GList.

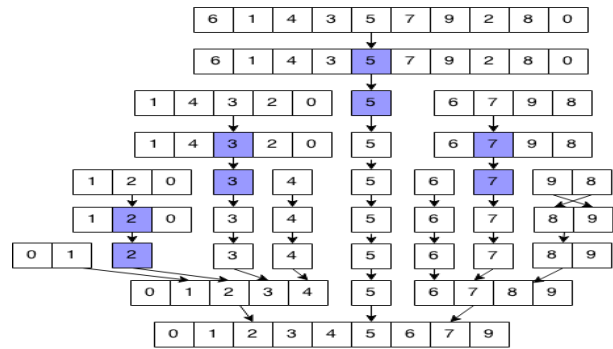
Partitioning method works on MList and GList in parallel.

At second level Mlist divide depend on its pivot to MList1 and MList2. Also, Glist divide according to its pivot to GList1 and GList2.

All sub lists (MList1, MList2, GList1 and GList2) operate in parallel, each one of them processed in separate core.

**Step 6:** The "Parallel Quick Sort" Method which work in recursive manner and in each iteration parallel quick sort method call the partitioning method.

**Step 7:** Finally, the web application has been published and the application package has been inserted in the application profile to deploy it on private cloud.



**Fig. (6): Example of Quick sort**

**B. Parallel Matrices Multiplication Service**

Parallel Matrices multiplication is a cloud service that implement a multiply between two matrices with huge number of elements using parallel technique on multi-core cloud-based virtual machine. The two matrices can be multiplied if and only if the number of elements in each row of the first matrix is equal to the number of elements in each column in the second matrix. In this work, multiply two matrices designed to parallelize the outer loop of multiplication method. The "SIMD" prototype has been implemented in this parallel application. So, the rows of the first matrix multiply with all columns of the second one in parallel. Parallel matrices multiplication has been also executed on two VMs. The first one consists two cores and the other one consists four cores. Fig. (7) illustrate matrices multiplication. The following steps illustrate the procedure that has been implemented during this work to build parallel matrices multiplication service:

**Step 1:** Two VM templates have been created in VMM. Two cores have been assigned to the first one, each core represent PE in SIMD topology. While four cores have been assigned to the second template.

**Step 2:** The web application for parallel has been created using ASP.NET and C#.

**Step 3:** The Method of Parallel Matrices Multiplication has been written to multiply the two matrices. In this method, the outer for has been parallelized. So, if there are two cores in VM then each two rows in the first matrix will multiply with all columns in the second matrix at the same time in parallel.

❖ **VM template with two cores:**

Suppose that there is two matrices Matrix 1 and Matrix 2.  
 And Result Matrix contains the result of Multiply Matrix 1 by Matrix 2.

Each two rows of Matrix 1 multiply with all columns of Matrix 2 in separate core. For Example:

Core 1: Row [0] in Matrix 1 \* all Columns of Matrix 2.

Core 2: Row [1] in Matrix 1 \* all Columns of Matrix 2.

❖ **VM template with four cores:**

Suppose that there is two matrices Matrix 1 and Matrix 2.

And Result Matrix contains the result of Multiply Matrix 1 by Matrix 2

Each four rows of Matrix 1 multiply with all columns of Matrix 2 in separate core. For Example:

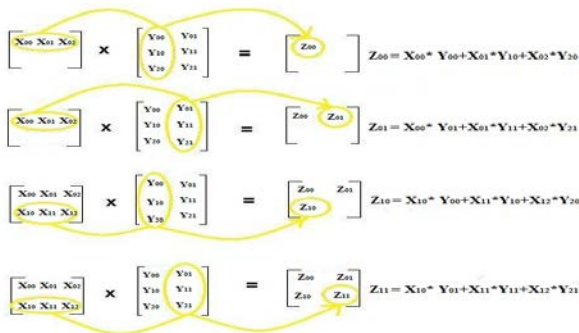
Core 1: Row [0] in Matrix 1 \* all Columns of Matrix 2

Core 2: Row [1] in Matrix 1 \* all Columns of Matrix 2

Core 3: Row [2] in Matrix 1 \* all Columns of Matrix 2

Core 4: Row [3] in Matrix 1 \* all Columns of Matrix 2

**Step 4:** Finally, the web application has been published and the application package has been inserted in the application profile to deploy it on private cloud.



**Fig. (7): Example of Matrices Multiplication**

**4.6 Deploy parallel Service on Cloud**

To deploy the parallel services that have been designed and analyzed before, then the cloud users can access this service and use it when they need. Some of steps have

been performed on the private cloud to enable service deployment. Firstly, a Sysprep hard disk has been created to attach it to the VM that will be created by VMM. System preparation (Sysprep) is a tool that enables to create a copy of installed windows with all programs and configurations with different security identifier and IP address to eliminate conflict on network. This customized image of windows can reuse through organization. After that a cloud capability profile has been set to indicate the capacity of the private cloud such as memory capacity, CPU capacity, numbers of VMs, etc... Table (1) shows capability profile properties with their values.

As the table shows, the virtualization platform that used in this cloud is Microsoft Hyper-V. Processor range means that there is no VM created on this cloud can request more than 8 processor. Also, memory range indicate the maximum memory size for VM.

**Table (1): Cloud Capability Profile Setting**

Property	Value
Fabric Computability	Hyper - V
Processor range	2-8
Memory range	8MB- 8GB
Hard disk Count	4
Disk Size range	100GB
Fixed Disk Mode	Allow
Dynamic Disk Mode	Disable

A hardware profile has been also set to indicate the components of each VM that will be created by VMM to deploy service. Table (2) shows properties of hardware profile with their values. This hardware profile will be used by VMM to create VM with only two processors. Another hardware profile has also been created with 4 processors.



The second hardware profile will be used by VMM to create a virtual machine with 4 processors.

**Table (2): Hardware Profile Setting**

Property	Value
Cloud Capability Profile	CS_CapabilityProfile
Processor	2
Memory	Dynamic Startup memory: 512 MB Maximum memory: 2GB
Video Adapter	Standard
Network Adapter	Connected to "Local Area Network" with Static IP V4 and static Mac address
CPU priority	1

Also, guest OS profile has been configured to indicate OS properties of the VM will be created by VMM. Table (3) illustrates the values that were given to guest OS profile. The roles and features specified in this profile will be installed on the virtual machine when VMM creates the virtual machine.

Then the application profile has been created for each one of services and parallel application packages has been attached to its appropriate application profile. After that, four VM templates have been created to enable VMM to create VM with the specifications indicated in each one of VM templates. Each one of VM templates takes different hardware profile and different application profile.

Finally, four copies of service template have also been designed. Two copies for Parallel quick sort one to execute application on two cores and second one to execute application on four cores. The other two copies of service template are for parallel matrices multiplication. The first

one to execute application on two cores and second one to execute application on four cores. After service template has been configured the service is ready to publish to users so any one of them can access this service and deploy it. To enable users to access service "App Controller" has been installed to provide web interface to cloud users. Fig. (8) illustrates service deployment steps.

After all the previous steps have been implemented the users can access Parallel Mobile Cloud Computing Platform (PMCCP) using her/his laptop or mobile device and then enter their credential and then he can choose one of the parallel service available on the private cloud.

**Table (3): Guest OS Profile Setting**

Property	Value
Operating System	64-bit edition of windows server 2012 standard
Identify information	PMCCM##
Time Zone	Baghdad (GMT+03)
Roles	- Application Server - Web Server IIS - IIS Hostable Web Cores - Management Tools - Common HTTP - Security - Performance
Features	.NET Framework
Domain	CompSC.edu

## 5 RESULT AND DISCUSSION

After private cloud has been built and parallel services has been published on cloud, a test for this cloud has been made to be sure that everything is working in a correct



manner. A self-service user from her/his personal laptop has accessed the service using a traditional web browser. The user followed the URL “vmm.compsc.edu” then she/he entered the credential to access her/his account of cloud.

While user access cloud and use one of the parallel services a performance for the virtual machines that execute the services on cloud has been measured also a performance on user device has been measured. CPU utilization of the virtual machines and user computer listed in table (4) and illustrated in Fig. (9).

Parallel Quick Sort	97%-100%	97%-100%
Parallel Matrices Multiplication	97%	88% - 98%
User Computer	35%	35%

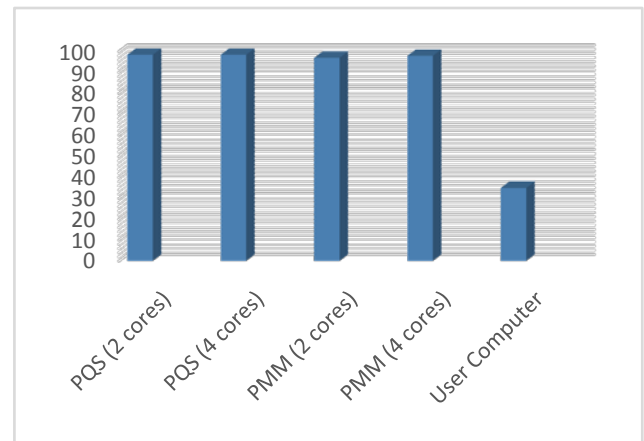


Fig. (9): CPU Utilization for PQS and PMM while executing in Cloud

Table (5) and Fig. (10) conclude all the memory usage for all VMs that execute the two parallel services.

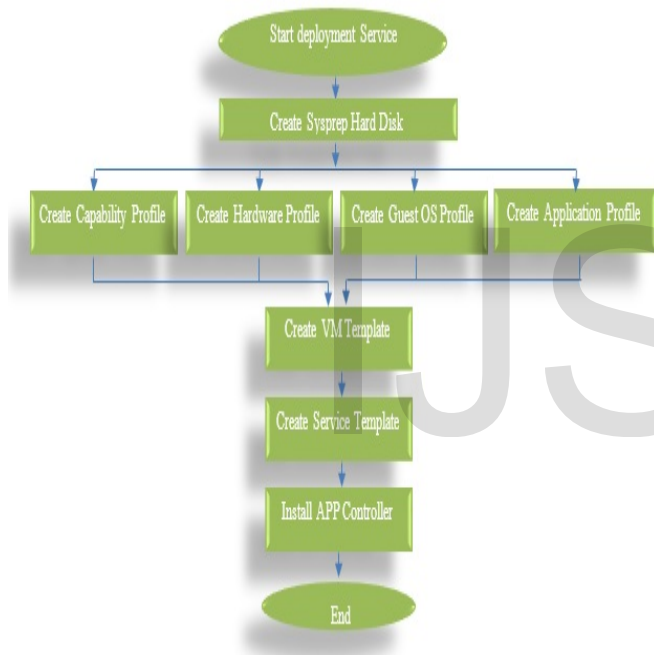


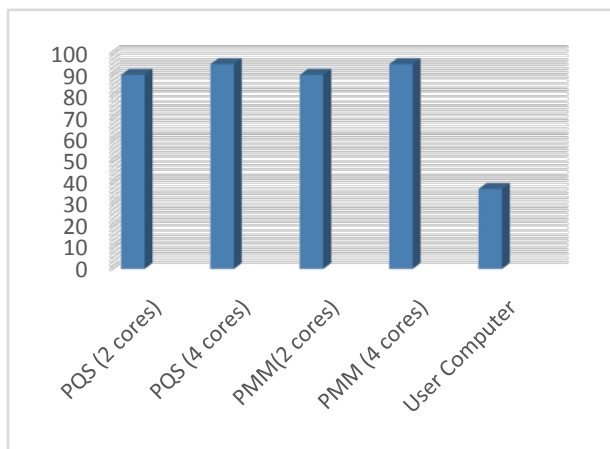
Fig. (8): Service Deployment

Table (4): CPU Utilization for PQS and PMM while executing in Cloud

	CPU utilization on two cores cloud-based VM	CPU utilization on four cores cloud-based VM
Parallel Quick Sort	97%-100%	97%-100%
Parallel Matrices Multiplication	97%	88% - 98%
User Computer	35%	35%

Table (5): Memory Usage for PQS and PMM while executing in Cloud

	Memory usage on two cores cloud-based VM	Memory usage on four cores cloud-based VM
Parallel Quick Sort	88%-90%	90%-97%
Parallel Matrices Multiplication	90%	90%-97%
User Computer	37%	37%



**Figure (10): Memory Usage for PQS and PMM while executing in Cloud**

Table (6) shows comparison between executing the parallel services on cloud-based VM with two cores and cloud-based VM with four cores. The table shows that executing services on VM with four cores take time less than executing parallel services in on VM with only two cores.

**Table (6): Elapsed time for PQS and PMM while executing in cloud**

	Elapsed time on two cores cloud-based VM	Elapsed time on four cores cloud-based VM
Parallel Quick Sort	81.7810 second	67.9986 second
Parallel Matrices Multiplication	172.734 second	143.462 second

Also, speedup has been calculated for the parallel services. serial copies of two services have been designed and programmed, also the execution time for two services has been measured and it was “119.943” for Serial Quick Sort and “199.382” for Serial Matrices Multiplication. The

speed calculated using the formula:  $Speedup = \frac{Execution\ Time\ in\ serial}{Execution\ Time\ in\ parallel}$ . The speedup values listed in table (7).

**Table (7): Speedup values for Parallel services**

	Speedup for two cores	Speedup for four cores
Parallel Quick Sort	1.4666	1.7639
Parallel Matrices Multiplication	1.1542	1.3897

The results that are presented above show that the proposed platform performance was satisfactory and it took less time by reducing resource consuming in the user’s devices.

it is worth noting that the user did not have to have high-performance resources to execute the required parallel services since their actual execution took place on the virtual machine. This machine was created and located on the cloud. The CPU utilization and memory usage of the user’s device were not affected by the execution of parallel services; the result was obtained and displayed on the user’s screen only.

A device with a network connection and cloud access were the only needs to use one of the deployed parallel services. The proposed platform helped to reduce the time to obtain the results by providing templates with different number of cores.

## 6 CONCLUSIONS

In this paper, a new platform for mobile cloud computing has been designed and implemented to provide parallel services for users on their mobile devices and laptops. A private cloud has been used as an environment for

deploying parallel services. a private cloud has been designed and implemented using Microsoft cloud solution (System Center). Hyper-V has been used as a virtualization platform to build private cloud. Using virtualization technology reduces the cost of building the platform because it eliminates the need to buy physical servers for each component by creating only virtual machines for all components. Also, using private cloud in this platform provides more security because no one has access to the underlying servers and components except the cloud administrator and no third-party organization has any control on the platform and reduces energy consuming and resources utilization on user devices. Parallel services have been designed, analyzed and deployed on cloud. Microsoft cloud solution enables to deploy .Net applications on the private cloud and provides these applications as a cloud services to cloud users. So, any web application written with C# language or any language of visual studio .Net can be deployed on Microsoft private cloud. When user accesses the service and uses it, the VMM starts to process user's request and creates virtual machine to execute the service. The VMM indicates the server where the new virtual machine will be created.

The execution of parallel services on private cloud reduces the resource consumption on user's device because the execution occurred on cloud-based VM not on the CPU of user device. The execution of parallel services on cloud-based virtual machine with four cores enhances the performance and reduces the execution time more than execution the same parallel services on two cores cloud-based VM.

## 7 REFERENCES

- [1]. Ferreira O. and Moreira F., 2012, Cloud Computing Implementation Level in Portuguese Companies, Elsevier, Conference on Enterprise Information Systems / HCIST 2012 – International, Conference on Health and Social Care Information Systems and Technologies, Procedia Technology, P.491-499.
- [2]. Hurwitz J., Bloor R. and Kaufman M., 2010, Cloud computing for dummies (HP special edition), Wiley Publishing.
- [3]. Fernando N., Loke S. W. and Rahayu W., 2013, Mobile cloud computing: A survey Future Generation Computer Systems, Elsevier, P. 84–

106.

- [4]. Prasad M. R., Gyani J., and Murti P. R. K., 2012, Mobile Cloud Computing: Implications and Challenges, Journal of Information Engineering and Applications, Vol 2, No.7, p.7-15.
- [5]. Warhekar S. P. and Gaikwad V. T., 2013, Mobile Cloud Computing: Approaches and Issues, international journal of emerging trends and technology in computer science (IJETTCS), Volume 2, Issue 2, P. 366-370.
- [6]. Niranjani S., Jehadeesan R., Vanishree S. and Karthick P., 2015, A Prototype for Private Cloud Implementation Using Open-Source Platform, International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE), Vol. 13, Issue 1, P. 311- 316.
- [7]. Sarita S. P. and Prof. Gumaste S. V., 2015, Private Cloud: By Means of Different Open Source Softwares, International Journal of Computer Science and Mobile Applications, Vol.3 Issue. 5, P. 15-20.
- [8]. Divya S. R., 2015, Decentralized Access Management with Anonymous Authentication of data stored on OpenStack and Hyper-V cloud, International Journal of Multidisciplinary Research and Development, Vol. 2, Issue 7, P. 148-151.
- [9]. Grozev D. G., Shopov M. P., and Kakanakov N. R., 2016, Practical Implementation of Private Cloud with Traffic Optimization, MIPRO, P. 298-303.
- [10]. Singh N. and Dr. Dhir V., 2017, Building Private Cloud Using Eucalyptus, International Journal of Advanced Research in Computer Science, Vol. 8, No. 4, P. 10-13.
- [11]. White Paper, 2010, Mobile Cloud Computing Solution Brief. AEPONA.
- [12]. Mathews S. M., Sundhari A. and Shanthi V. N., 2013, Cloud-Based Impact for Mobile and Pervasive Environments: A Survey, IOSR Journal of Computer Engineering, Vol. 15, Issue 4, P. 24-33.
- [13]. Nasrudeen Sha. M. and Karthik.U, Mobile cloud computing and security measures, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN: 2278-1684, p-ISSN: 2320-334X, P. 68-80.
- [14]. Bajad R.A. and Sinhal A., 2013, Cloud Computing on Smartphone, The International Institute for Science, Technology and Education (IISTE), Vol. 4, No. 10, P. 73-78.
- [15]. Kovachev D., Cao Y. and Klamma R., 2011, Mobile Cloud Computing: A Comparison of Application Models, Cornell University Library.

## 8 AUTHORS

**Prof. Dr. Dhuha Basheer Abdullah**, the head of Computer Sciences Department, College of Computers and Mathematics, University of Mosul. She received her PhD degree in computer sciences in 2004 in the specialty of

computer architecture and operating system. She supervised many Master degree students in operating system, computer architecture, dataflow machines, mobile computing, real time, distributed databases. She supervised three PhD students in FPGA field, distributed real time systems, and Linux clustering. Currently she supervises a PhD student in cloud computing. She also leads and teaches modules at BSc, MSc, and PhD levels in computer science. Also, she teaches many subjects for PhD and master students.

**Basma Basil Zubair**, a master student in Computer Sciences Department, College of Computers and Mathematics, University of Mosul. She interested in Cloud Computing, Computer Networks, Operating Systems subjects, Mobile Programming and Parallel Processing.

IJSER