

## VIRTUAL PRIVATE SERVER OR MICRO PCS: WHICH IS BETTER FOR THE LEARNING MANAGEMENT SYSTEM DECISION?

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### Abstract

Learning Management Systems (LMSs) are software systems for management of the electronic education of courses or training programs. With the LMS, education centres could easily manage educators and participants of the education programs over defined courses. However, LMSs require installation into 7/24 online virtual or real hardware servers to support non-stop educational requirements of the system users. Some of the education centres could install LMSs into their own servers with using their own resources. For the institutions which do not have sufficient funds, may choose to implement cloud based systems such as Virtual Private Server (VPS) based technological architectures. Most of the technology companies provide these server services with including, IP addressing, DNS routing starting with \$5 dollars per month bases. For the institutions that prefers their own servers rather than rented VPSs could have chance to achieve this goal with the help of new innovations in the mobile technologies. A credit card size Micro PCs which are built based on mobile device technologies can now easily used as servers for the Information Technology (IT) requirements of the organizations. Most of these Micro PCs support, Linux based operating systems which can be easily modified for the server machine purposes. In the LMS world, Moodle is one the well-known open source applications for answering educational requirements of the organizations. For these reasons, in this study, by taking Moodle as the LMS, VPS and Micro PCs concepts will be compared with well-known VPS providers services operational cost over simple Linux, Apache, MySQL and PHP (LAMP) server settings by looking at small (less than 100 concurrent users), medium (between 100 and 1000 concurrent users) and large number of users (more than 1000 concurrent users) conditions. The findings will be shared at the end of this study.

**Keywords:** Learning Management Systems, Virtual Private Servers, Micro PCs

### 1. INTRODUCTION

Changes in technology have direct effects on daily activities of students and lecturers. One of these technologies could be presented as the Content Management System (CMS) applications in the field of education. In the first days of CMS based architectures, lectures were simple course materials and publishing of these materials was satisfied the needs of the lecturers for sharing lecture contents. However with the developments in the Information and Communication Technologies (ICT), more interactive requirements have been started to appear, such as curriculum scheduling, role management of the users as course managers, lecturers and students, online exam implementation... To answer these requirements, as a specialized Content Management System (CMS), Learning Management System (LMS) started to build up. Moodle is one of the well-known open source LMS. Based on the predicted number of users, the hardware requirements are changing. If an institute have enough recourses, a simple server system could answer the requirements, however, most of the time this is not the case. Virtual Private Server (VPS) is a concept born with the cloud based systems to support great variety of virtual computerized hardware for the great variety of the software based information systems. As an alternative to these cloud based systems, based on the development in the field of mobile phone technologies, Micro PC market have been started to build up.

Especially with the support of the Linux, Apache, MySQL and PHP (LAMP) based open software architecture, micro PC's have a potential to be competitor against VPS based cloud systems.

In this study, LMS and Moodle, VPS and micro-PC concepts will be presented, after that, by focusing on LAMP architecture, the system costs will be discussed by focusing of three potential simultaneously number of users, less than 100, between 100 and 1000; and over 1000 users. This article will be ended with the conclusion and future study part.

## 2. HARDWARE AND SOFTWARE COMPONENTS

For installation of a LMS, hardware and software components should be specifically defined. This is an important step for satisfying functional requirements of the system. In this part, a general idea about the system component alternatives and selected ones will be presented.

### 2.1. Learning Management Systems and Moodle

Learning Management Systems could be defined as the software systems for management of the electronic-education of courses or training programs. According to Simonson and his colleagues (2006), compare with CMSs, the main differences in between LMS is CMS's main focused on the delivery of the courses. On the other hand, LMSs' focus is on an individual and tracks the learning needs and outcomes achievement. Even there a several different LMS systems are available in the current market, Moodle is one of the well-known and in-used LMS. Moodle has been used by the many institutions since its first version. (Moodle web page,2015). Moodle system can work over many of the Windows or Linux based system. However, to be able work, independent from its server, and application server such as, apache, tomcat..., a database server, such as MySQL, MsSQL and a programming language such as PHP, JSP, ASP etc., for scripting web functions and building the system environment and establish communication between the remaining components is required.

Most of the Linux based and Windows based cloud architecture can support LAMP and Windows, Apache, MySQL and PHP (WAMP) based settings. The main differences is the cost of the VPSs. Mainly, because of the license prices enforced by the Microsoft side, Linux based Moodle installations rather preferred by the system administrators. In this study, also for the Moodle setup, LAMP based installation is selected.

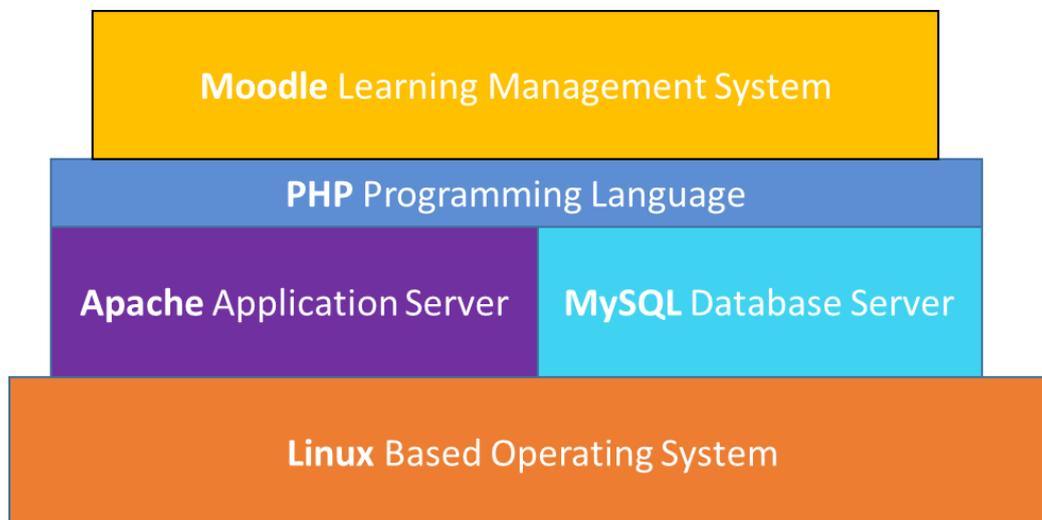


Fig. 1.The LAMP Server Components Positions and Moodle

### 2.2. Virtual Private Server

Even defining the software part requirements for Moodle is an important step, decision of the server is another challenge. LAMP and Moodle could be operational most of the system configuration, however the server definition is dependent on the number of users will use the system. Virtual Private Server is a virtualized machine that is generally sold or rent as a service by an Internet hosting companies. Today the structure of these virtual machines has been built over cloud system. Even there are well-known companies such as Amazon, Microsoft, Google etc. in the market, there are alternative companies especially focused on VPS based services. The price range changes based on the virtual hardware resources and Internet transfer limits that company offers. The virtual hardware components are, the number of CPUs and the size of the

disk and memory. In these VPSs, operating systems selection is depending on the customers systems requirements. Because of the licence prices, the Windows based VPS prices are higher than Linux based system. In this study, Digitalocean is selected (Digitalocean, 2015). Based on this firms LAMP related customer support this firm documentation is stays on the first page of the Internet searches, Also it's prices is reflecting the current market condition.

In the given operating system options, Ubuntu Server is selected as the base server operating system as a Linux base installation.

### 2.3. MiniPC

Currently, the best-known Mini PC series have been built under the name of Raspberry (Raspberrypi, 2015). Especially the model Pi 2 Model B, have been created a spectacular effect on the market with its \$35 price tag. With including additional components such as SD card for a memory module, power supply etc. the price could reach more than \$70. There are other alternative systems available in the market. Odroid C1 (Odroid C1+, 2015) is one of the MiniPC that is also in the price of \$35. Rather than Raspberry Pi 2 Model B, it has Ubuntu support. Even Raspberry Pi 2 Model B has Linux based operating system, the related documentation cannot be easily find especially on LAMP related installation. With help of Ubuntu, Odroid C1 is fully capable of execution of LAMP based system. For this reason, Odroid C1's current version C1+ is selected for VPS comparison.

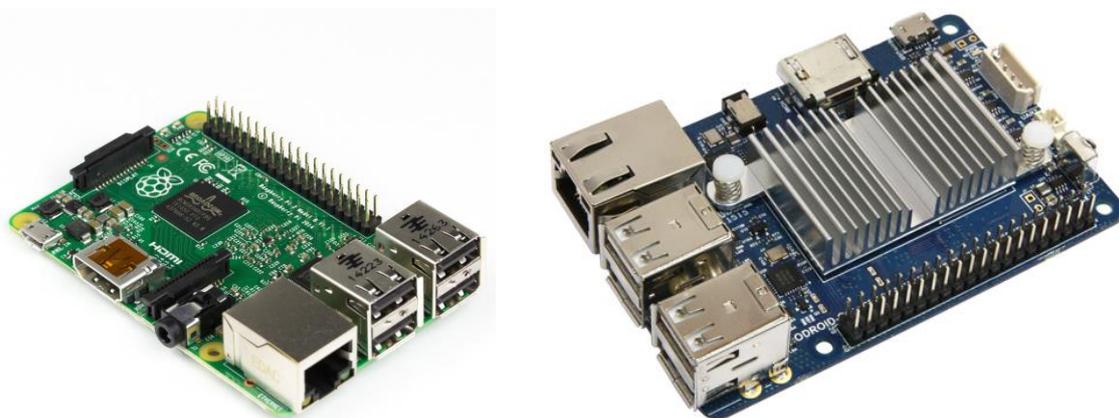


Fig. 2.The Raspberry Pi 2 Model B (Raspberrypi, 2015) (on the left), and the Odroid C1+ (on the right)

### 3. COST EFFECTIVE DECISION

The comparison between VPS and MiniPC was made based on the potential number of users. Three group of user is identified, less than 100 simultaneously users, between 100 and 1000 simultaneously and more than 1000 simultaneously users. For the MiniPC part, additional electricity and Internet connectivity costs are added. For this study, by taking \$1 as 3 ₺, the price conversion had been implemented. Based on the 3Mbps (Mega Bit per Second) Internet speed (both for download and upload) in an unlimited bandwidth connection, this the possible bandwidth available is 316 Tera-Byte/Month (1 Byte =8 bit). Based on the prices in Turkey, the average price for a land line connection is \$25 per month. The electricity calculation made base price for Mega Watt consumption of a households. For Odroid C1+ the consumption of a single device is calculated as \$ 0.00967/year. The domain name costs are not included in this study for VPS and MiniPC parts. The price of a single MiniPC with including the price of board, power supply and SD the price of the device was taken as \$58.5.

In this comparison, while the system properties of the VPS increases, hypothetically the number of Odroid C1+ also increased with assuming a well-established distributed computing structure. The intellectual knowledge of the system experts, that would be converted to the dollar based intellectual capital values, were not included into the content of this study. The other cost that may be required such as cooling the system, cabling of the machines, UPS also did not included into this study.

All the comparisons of the prices made based on yearly expected costs. In each table comparison is made by RAM size, number of CPUs, disk size, transfer rates between VPS and MiniPCs. Addition in to these attributes, for MiniPC, cost of machine, cost of electricity and cost of Internet included. As last attribute, the total cost was also included into total price comparison. Until reaching 316 Terra Byte rate, which is the maximum possible transfer rate in 3 Mbps, \$300 yearly Internet payment is taken as a stable value.

### 3.1. Less Than 100 Simultaneous Users

To compare less than 100 simultaneous users, two alternatives are given. In Table 1, \$10 VPS and 1 MiniPC, and in Table 2, \$20 VPS and 2 MiniPCs.

Table 1. \$10 VPS vs. 1 MiniPC

	VPS	MiniPC
Size of the RAM (in GB)	1	1
Number of CPUs	1	4
Disk (in GB)	30	16
Transfer Rate (Monthly in Terra Byte)	2	316
Cost Machine(\$)	--	58.50
Cost Electricity(\$)	--	0.00967
Cost Internet(\$)	--	300
Total Cost(\$)	120	358.50967

As shown in Table 1, using VPS could be logical in a total number of users possible 100 users case. A standard LAMP server can be easily run in this machine and simple text base content, 2 Terra Byte transfer is more than enough. On the other hand, single MiniPC is powerful in number of CPUs and transfer rate. However still it is not cost effective solution.

Table 2. \$20 VPS vs. 2 MiniPC

	VPS	MiniPC
Size of the RAM (in GB)	2	2
Number of CPUs	2	8
Disk (in GB)	40	32
Transfer Rate (Monthly in Terra Byte)	3	316
Cost Machine(\$)	--	117
Cost Electricity(\$)	--	0.01934
Cost Internet(\$)	--	300
Total Cost(\$)	240	417.01934

Table 2 shows another concept for \$20 VPS and 2 MiniPCs. Even with edition of 2 MiniPCs, for less than 100 user condition, \$20 VPS is more than enough. Additional 1 PC also increases the price and cost of electricity.

For less than 100 simultaneous users, VPS selection is a cost effective solution.

### 3.2. Between 100 and 1000 Simultaneous Users

Between 100 and 1000 simultaneous user rate, this could be defined as moderate user rate. As given in Table 3, the RAM size has been reached to 4 GB. On VPS side, number of CPU stays in 2 on VPS however this value is reached to the 16. As shown in Table 3, the total disk size is more than VPS alternative. However, the cost is still greater than VPS alternative for the MiniPC.

Table 3. \$40 VPS vs. 4 MiniPC

	VPS	MiniPC
Size of the RAM (in GB)	4	4
Number of CPUs	2	16
Disk (in GB)	60	64
Transfer Rate (Monthly in Terra Byte)	4	316
Cost Machine(\$)		234
Cost Electricity(\$)		0.03868
Cost Internet(\$)		300
Total Cost(\$)	480	534.03868

### 3.2. More Than 1000 Simultaneous Users

Table 4. \$80 VPS v.s. 8 MiniPC

	VPS	MiniPC
Size of the RAM (in GB)	8	8
Number of CPUs	4	32
Disk (in GB)	80	128
Transfer Rate (Monthly in Terra Byte)	5	316
Cost Machine(\$)		468
Cost Electricity(\$)		0.07736
Cost Internet(\$)		300
Total Cost(\$)	960	768.07736

Starting from more than 1000 Simultaneous users, conditions started to change to more distributed structure. As an alternative to the single machine structure, a separate Application Server, Database, structure in different VPS could be selected. However single VPS could not be good alternative. The \$80 monthly budget could be also used 8 single \$10 Machine, 4 single \$20 machine or 2 single \$40 machine. However, when it is compared with the total cost, starting from this point, 8 MiniPC application is a good alternative when comparing over cost.

As shown in Figure 3, until this point, using MiniPCs should be selected.

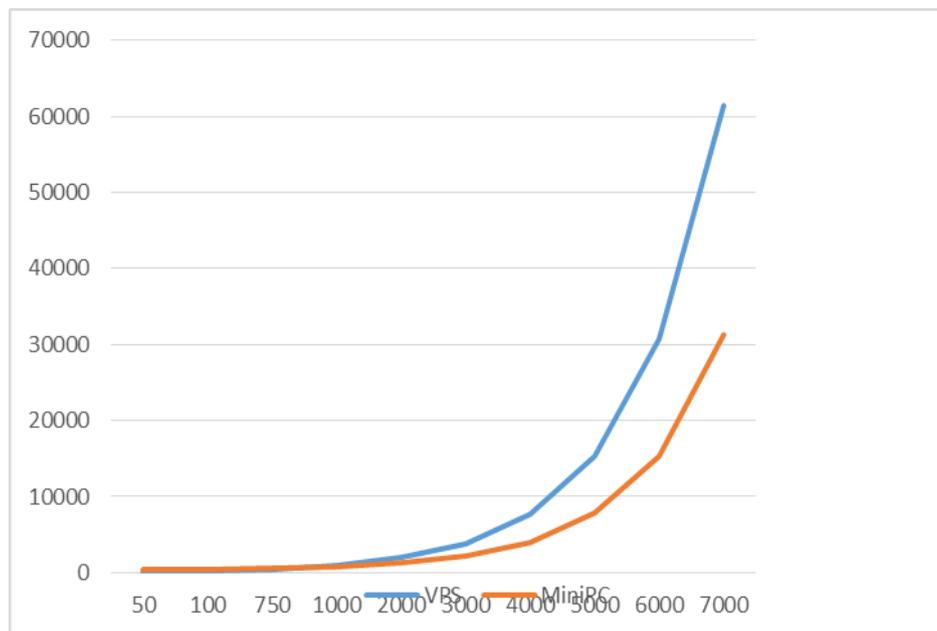


Fig. 3. The expected cost through 7000 simultaneously users

#### 4. CONCLUSION AND FUTURE STUDIES

As shown in Figure 3, especially for the systems with more than 1000 users under LAMP configuration, MiniPC implementation should be chosen by the LMS system administrators. However this is a fact that, LMS systems may not expect than 5000 simultaneous users. This should not be forgotten that VPS machines are not belong to institutes, it is only a rental service. On the other hand MiniPCs are belong to the system architects. For this reason, the utilization of the MiniPC is an important point that need be considered by the system architects. Also only an Internet connection that only belongs to the LMS system also another important aspect for the LMS installation.

Also in real life applications, MiniPCs also required to be tested. As a future study, a real life MiniPC based information systems architecture could be implemented for the real life uses.

#### 5. ACKNOWLEDGEMENT

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