

CLLOUD LABS: A cost efficient approach for conduction of lab practices in Educational Institute

Abhijit Powar¹, Vikrant Chatole², Rohit Dhiwan³, Chandan Prasad⁴

¹Professor & HOD, Department of CTIS & MACT, School of Information & Technology, Ajeenkya DY Patil University, Pune, India

²B.Tech Scholar, CTIS, School of Information & Technology, Ajeenkya DY Patil University, Pune, India.

³BCA Scholar, MACT, School of Information & Technology, Ajeenkya DY Patil University, Pune, India.

⁴Assistant Professor, Department of CTIS & MACT, School of Information & Technology, Ajeenkya DY Patil University, Pune, India.

ABSTRACT

The field of Information Technology and Computers is an ever evolving field, which is rising and developing at a mammoth scale every day. Keeping up with this chase between technologies is a lot difficult already. This chase demands the next generation of incoming and upcoming professionals to not only be aware but be well versed about these systems and technologies. The educational practical systems currently in implementation seem more of an obstacle than an asset in attaining and fulfilling this demands for both, the institution and the students. The paper discusses a completely new approach to tackle this problem with overwhelming advantages over the current practical lab setups, by implementing Cloud Remote Labs.

Keywords: Cloud Labs, Cost Efficient Labs, Virtual Labs, Remote Labs.

1. INTRODUCTION

Lab practices are an essential part of any course curriculum, which cannot be compromised on but even if it seem of such an essence, setting up a lab is actually quite a hassle full job to do. A Windows Server configuration or Mobile Application lab conduction requires high configured systems. Apart from that, Windows Server Configuration practical labs also require a Client System to test several services configured on the server. For Mobile Application development based on different platforms require different OSs to be installed on the systems which imply that for both the lab conductions, each student will require more than one system with high configurations to be installed and all of this with the fact that not every institute can afford this much of finance in labs itself. With the unavailability of these many systems with high configuration, it becomes difficult for the institute to conduct the practical lab sessions of several subjects.

Cloud Computing, a mounting innovation and concept in Information Technology seems the most potential remedy to this intricacy. By creating virtual labs with desired configurations on a remote cloud server on the go it distinctively solves the problem with utmost results in efficiency. The main aim of the paper is to traverse the use of cloud computing for conducting labs in a cost efficient manner. The paper comprises of Sections. Section I Introduction of the problem statement and suggesting a viable solution to it. Section II Explaining the system requirements of an institute to conducts labs. Section III is a brief explanation of the proposed system and architecture and Section IV is a map of advantages of Cloud Lab over the classical lab infra.

2. SYSTEM REQUIREMENTS

System Configuration for Labs

In the Lab, when every aspect is taken into consideration, it necessitates 3 systems at the least to fill in the requirements, 2 for server configuration lab and 1 for Mobile application development labs. Taking Server configuration labs in consideration, the first system, say PC1, requires an i5 or i7 processor at minimum, clocked at 3GHz and above, along a RAM of minimum 12 GB with 40% services installed at a clocking speed of 1666 MHz. The HDD requires being of 500GB. The system has to be running on Windows Server 2012 R2 Operating System. The switch requires to be 10/100/1000Mbps and a CAT6 LAN Connection.

The Second PC, PC2, necessitates to be of a Dual Core or i3 Processor at minimum alongside a RAM of 2 GB and an HDD of 100 GB and running on Windows 7/ Windows 10 Professional Operating System Software.

The Mobile Application Developments labs requires a system packed with an i5 or i7 processors clocked at 3GHz or above with a RAM of 12GB and a HDD of 500 GB.



Figure 1. Traditional Lab Layout

3. PROPOSED SYSTEM ARCHITECTURE

As mentioned above, the traditional infra layout requires, at the minimum, two machines per student for the server configuration labs. Out of which one being a high-end machine with higher configurations and the other being a low-end machine with lower configurations and also both need to be connected to the network. The problem stands in the availability of the resources, that is, the systems, it is quite difficult for the institutes to avail such a high number of systems with such high configuration throughout the lab for every student. Another hurdle that lasts is the hassle of reconfiguring each and every machine and the server after a practical is conducted, for the use of the next practical batch.

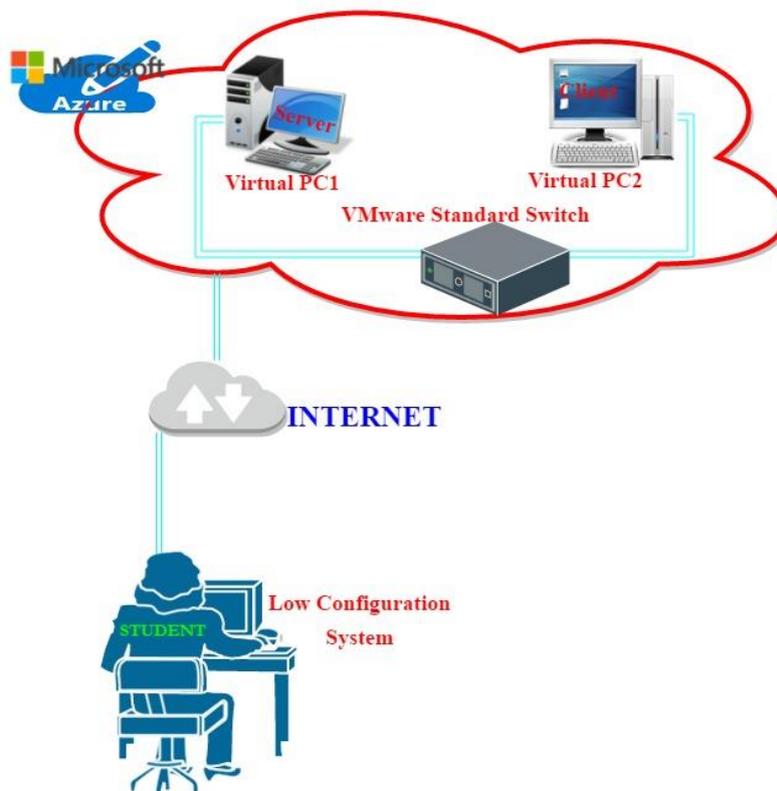


Figure 2(a). Proposed System Architecture

For Mobile Application Development labs- one system is sufficient but needs a substantial level of configurations i.e. it needs to be a high-end machine which, as mentioned, is already difficult to avail and apart from the app development labs the powerful hardware of these systems will be underutilized which, clearly reflects the efficiency level of the current lab infra. The traditional lab structure and method also fail to provide any kind of fault tolerance.

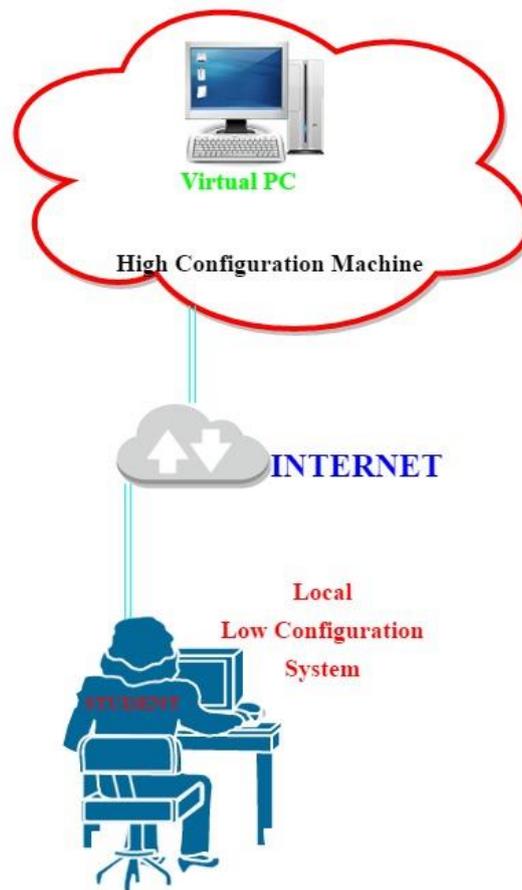


Figure 2(b). Proposed System Architecture

The Microsoft Azure Cloud is potentially the best solution out there to tackle down every hassle and difficulty produced in the traditional methods of lab practice. The cloud-based system provides an extensive range of tools and features to overcome EVERY problem involved and originated in the classical method of lab practical sessions by completely substituting the hardware and physical components with virtual features which are preferentially alterable along with being platform independent, all over the cloud and on the go. Upon registration, one can create a sub-administrator account for students to access with their respective credentials. The Student now has the freedom and power to create Virtual machines/PCs in the cloud system with the desired systems configurations, OS and application software services. As mentioned, the server configuration lab practicals require 2 machines, one with High-End configurations and the other with Low-End configurations and hence so the student can create them on the cloud system. Apart from that, as the both the Virtual Systems are created and are a part of Azure Cloud they're connected via a Virtual Network. Thus a single student can access both the systems at a single instant and can perform various server configuration lab practicals. More importantly and probably the best part is that all of these processes take place within the same usual configuration physical system and all the transition and modification to configurations are made at the respective Azure cloud system.

Similarly, Mobile Application Development practical sessions can also be conducted by creating a High-Configuration Virtual System and installing the required software directly on the virtual machine as it comes with a 100 Mbps internet connection the software can be downloaded directly on the virtual machine without losing any memory space on the personal physical system. This completely rectifies the need of a physical system with an appropriate configuration or the need to replace the physical components of a system to perform a certain task/practical. The Azure don't only amend the hassles of configuration variations but it also takes this experience to another level. As the Azure system is platform independent, Cloud based system, it can be accessed from any part of the world at any instant from any computer irrespective of the platform it is running on. From a student's perspective, it is a great freedom as he/she can perform the practical from anywhere and at any hour by ousting the obligation of sticking to a single machine or network in a specified time limit.

4. COST ESTIMATION ANALYSIS

The cost estimation analysis of traditional approach vs cloud based approach and the outcomes are below:

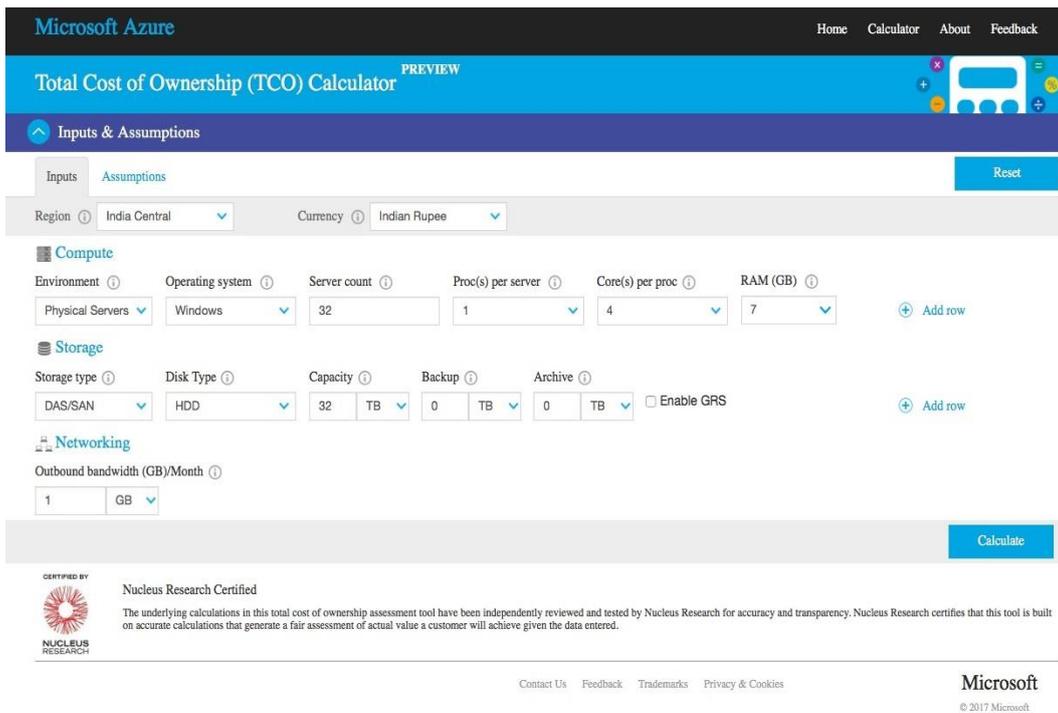


Figure 3(a). Cost Analysis

Storage costs		Azure storage costs	
Hardware infrastructure		Storage maintenance	
DAS/SAN-HDD		Page Blob storage - LRS	
Cost per GB	₹68	Usable storage volume (RAID 10 configuration) in GB	16,384.00
Storage (RAID 10 configuration) volume in GB	32,768	Storage cost per GB/Month	₹3,725.15
Total storage procurement cost over 3 year	₹2,219,377	Annual storage cost per usable volume	₹732,394
Storage maintenance		Number of storage transactions required per usable volume	160,000
Storage maintenance cost (10% of storage procurement cost) over 3 years	₹665,813	Annual storage transactions cost per 10,000	₹0.02438
		Total annual transactions cost	₹5
		Total LRS storage maintenance cost over 3 years	₹2,197,197
Total storage costs over 3 years	₹2,885,190	Total storage costs over 3 years	₹2,197,197
IT labor costs		IT labor costs	
Number of IT admin hour(s) needed per year	352.91	Number of IT admin hour(s) needed per year	182.25
Hourly rate for IT administrator	₹3,386	Hourly rate for IT administrator	₹3,386
Total IT labor costs over 3 years	₹3,585,385	Total IT labor costs over 3 years	₹1,851,613
Total on-premises costs over 3 years	₹40,849,524	Total Azure web direct costs	₹22,700,459

Figure 3(b). Cost Analysis

Estimated On-premises costs (3 Years)		Estimated Azure costs (3 Years)	
Compute costs		Azure compute costs	
Hardware costs		Azure virtual machine costs - Web direct	
Cost per 2 proc 2 core, 8 GB RAM physical server	₹419,858	Number of hours per month	744
Number of server(s) required	32	Virtual machine utilization	70 %
Total cost for physical server(s)	₹13,435,465	F4 Standard (4 core, 8 GB RAM) Windows	₹31.088/hr
Cost of maintaining physical server(s) - 20% of cost of physical server(s)	₹2,687,093	Number of virtual machine(s) needed	32
Total cost of maintaining server(s) over 3 years	₹8,061,279	Total virtual machine costs per month	₹518,101
Total hardware costs over 3 years	₹21,496,744	Total web direct virtual machine costs over 3 years	₹18,651,648
Software costs			
Cost of Windows Data center license per 2 Proc, 2 core, 8 GB physical machine	₹78,402.89		
Number of license(s) needed	32		
Total Windows licensing costs over 3 years	₹2,508,892		
Electricity costs			
Price of electricity per KWH	₹6.77		
Power rating of 2 proc 2 core, 8 GB RAM server	166 Watts		
Total electricity cost consumed by 32 server(s) - 2 proc, 2 core, 8 GB RAM servers per month	₹26,755.91		
Total electricity costs over 3 years	₹963,213		
Total on-premises compute costs	₹27,176,770	Total Azure compute costs	₹18,651,648

Figure 3(c). Cost Analysis

Data center costs		Azure data center costs	
Data center compute costs		Total Azure data center cost over 3 years	
Number of rack units per rack	42	₹0	
Rack units required per 2 proc 2 core, 8 GB RAM server	1		
Number of 2 proc 2 core, 8 GB RAM servers	32		
Total number of rack units required	32		
Total number of rack units required for all server(s)	32		
Number of racks required	0.76		
Data center construction cost per rack amortized over 20 years	₹965,965		
Total Data center compute costs over 3 years	₹2,207,921		
Data center storage costs			
Rack mounting/installation cost	₹137,996		
Total Data center storage costs over 3 years	₹413,988		
Total Data center costs over 3 years	₹2,621,909	Total Azure Data center costs over 3 years	₹0
Networking costs		Azure networking costs	
Total hardware + software costs over 3 years	₹24,005,636	Total outgoing bandwidth needed per month	1 GB
Network hardware and software costs assumed to be 25% of hardware and software costs over 3 years	₹6,001,409	Total outgoing bandwidth cost per month	₹0
Network maintenance cost assumed to be 20% of network hardware and software costs over 3 years	₹1,200,282		
Service provider cost/GB per month	₹13.55		
Amount of bandwidth needed (GB) per month	1		
Total service provider cost per month	₹13.55		
Total network hardware and software costs over 3 years	₹7,202,179	Total networking cost for 1 GB / Month over 3 years	₹0

Figure 3(d). Cost Analysis

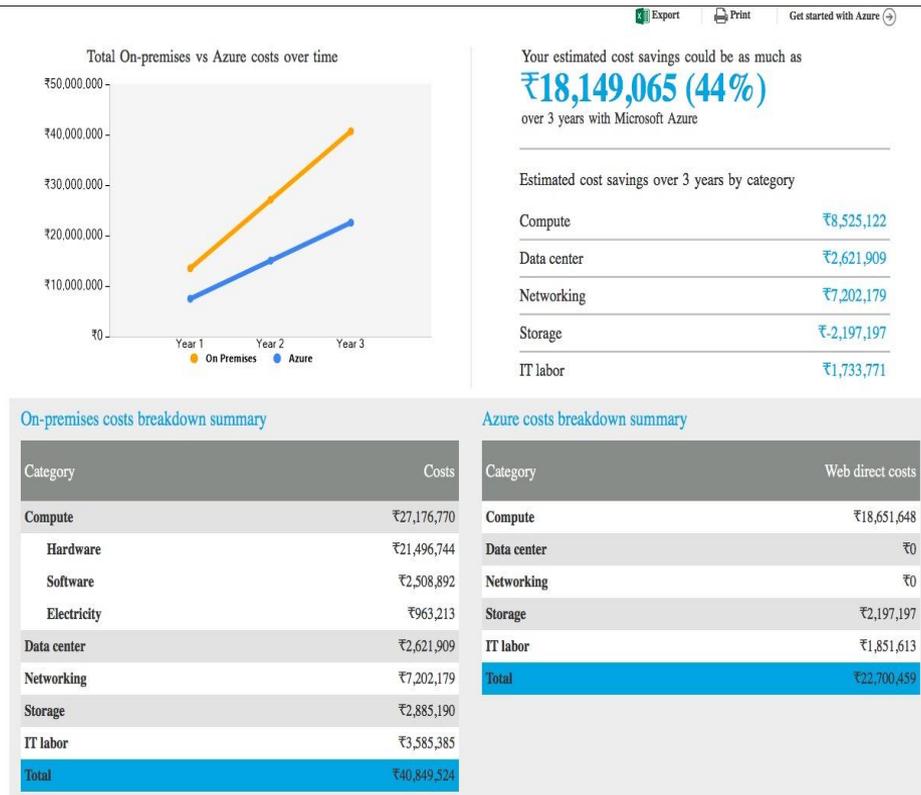


Figure 3(e). Cost Analysis Comparison

5. CONCLUSION

The Proposed System, in implementation at prototype status has yielded results with exquisite excellence and remarkable distinction. Not only the student have another level has the freedom and power of getting through their practical list at their desired hours but the Institute itself cuts the expenses of lab setup multiple fold. At an even higher level of implementation the expenses is mere fraction of the cost it would need via the classic methodology. With features of being remotely accessible, platform independent, greatly secure and being a mere load on institute expenditures, it is the probably the best known method to not only target and rectify the hassle in the current lab setups but also grants new features in the hands on institute as well as student itself.

Since the dawn of Information Technology the world has taken another leap in every sector, its Education Labs turn and this is the leap this sector is needing.

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