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Client Virtualization using VMware for Manageable Learning Environment at CSIBER

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Abstract: Every educational institution has a mandatory requirement of installing multiple operating systems and/or computing environments which is in line with the academic curriculum followed by the institution. Further, the fast growing and a dynamic IT trend demands constant upgradation and installation of new operating systems and supporting applications as the requirements change. To be competitive enough and to stay ahead in market place every educational institution tries its level best to tune itself as per various industry requirements. As such lab preparation is a constant ongoing process which poses a great burden on the shoulders of a system administrator involved in managing the learning environment in an educational institution. In order to support multiple operating systems on a single PC hard drive needs to be partitioned. At the same time this also poses greater inconvenience to students as they need to reboot the system every time they need to switch from one operating system to another. All these issues are addressed by VMware workstation software which enables to run multiple x86-compatible desktop and server operating systems simultaneously on a single machine, in fully networked, portable virtual machines with no rebooting or hard drive partitioning required which proves to be an indispensible tool for every educational institution. In the current paper, the authors have proposed a model for the smooth functioning of a computer lab using VMware workstation software which dynamically gets tuned to the users requirements. The different levels of users are identified and tasks are assigned as per their role in the institution. Three-tier architecture is employed wherein different levels of users will be operating at different layers of the architecture. At the lowest layer VMware solution is proposed and only the admin has the privileges to interact with this layer. The model proves to be extensively user friendly for all levels of users.

Keywords: Access Control List, Authentication, Operating System, Three-tier Architecture, Ubuntu, Virtual Machine, Windows 2003, Windows XP.

I. INTRODUCTION

Cloud computing offers a new form of computing that cuts through IT complexity by leveraging the competent pooling of on-demand, self-managed virtual infrastructure, consumed as a service.

The VMware cloud computing solution in education focuses on allowing academic institutions to realize the effectiveness and flexibility of cloud computing. With virtualization institutes can build cloud architectures that are flexible enough to sustain a unified private and hybrid cloud model [4].

A. IT Transformation in Education

Academic institutions want to spend in state-of-the-art solutions that improve IT effectiveness as they continue to ask workforce to do more with less. To attract students and staff, IT is striving to provide the most sophisticated educational environment in the classroom and online. Educational institutes are adopting cloud computing as the most strategic approach. Cloud with virtualization is an IT transformation that preserves existing investments. Key benefits of implementing VMware solutions in any organization are:

1. Cost reduction
2. Standardization
3. Improved security
4. Application portability and mobility

Types of services can be enabled by VMware solutions are [7]:

1. Course curriculum
2. Distance learning and remote access
3. Enrollment
4. Flexible device access with IT control
5. Lab and classroom provisioning and image management
6. Library and kiosk access
7. Fee payments
8. Transcript administration

B. VMware Solutions

VMware provides variety of solution which enable the educational institutes to cope up with fasting changing learning environments by exploiting the dynamicity and flexibility available in the solutions. The following list summarizes such few prominent solutions [1,5].

1. End user computing deals with moving towards user centric management and cloud ready services
2. VMware cloud application platform helps in build, run and manage applications for cloud deployment

3. VMware forms the base for building cloud infrastructures for clients across all industries
4. It helps in achieving lower cost of ownership by minimizing IT infrastructure investments, management and maintenance resources etc.
5. It provides agility with control by easy, self-service access to IT services and deployment.
6. It achieves increase in security by reducing risks
7. Flexibility is provided by retaining existing operating system and application stack

VMware workstation software enables to run multiple x86-compatible desktop and server operating systems simultaneously on a single PC with the need for rebooting the system every time. With Workstation, one spends less time in procuring and configuring, and more time in testing, deploying, teaching, or running demos. VMware workstation uses the term host computer for the physical computer on which the VMware Workstation software is installed and its operating system is called the host operating system. The operating system running inside a virtual machine is referred to as a guest operating system. VMware enables create a virtual library of end-user configurations on a shared drive. VMware facilitates computer-based training and software demos in the following ways:

- Enables packaging and deployment of classroom material in virtual machines.
- Allows students to experiment with multiple operating systems, tools and applications in a secure and isolated virtual machines.
- Virtual machines can be configured to undo all changes at shutdown.
- Prevents the need for rebooting the system every time while switching from one operating system to another.
- No hard disk partitioning is needed to install multiple operating systems on the same machine.
- Further, workstation teams enable setting up of a virtual computer lab on a single host computer. Teams enable to power on multiple associated virtual machines with a single click. Team settings control the timing for teams virtual machines and their start up order. To distribute the host CPU load specific delays between booting virtual machines can be set up. Teams automatically launch virtual machines in the right order, with delays that you specify to ensure that each virtual machine stabilizes before the next virtual machine boots.

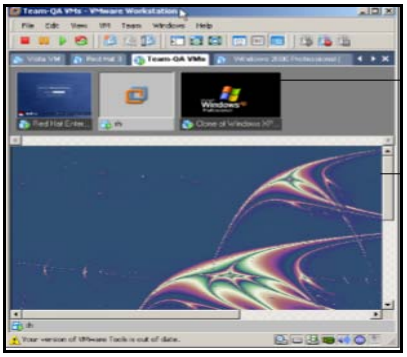


Figure 1. Console Window for a Team

II. LITERATURE REVIEW

A contributory article by Kable reveals the importance of VMware in higher education in satisfying needs [2]. The VMware can help organization in achieving higher degrees of IT production and cost savings, increased reliability and quality of service for business applications, and to an on-demand approach for consumption of IT as more and more automation capabilities brought online.

Michael Russell mentioned that by reducing the time and costs associated with maintaining IT infrastructure, VMware put more resources into their primary business, which is delivering an exceptional learning environment to community [3]. This approach allowed transforming server, storage and networking resources into secure, effective resource pools to enable IT as a Service.

SkallyBrade designed and reported set of questions to check the ability for recognition of technical requirements for cloud management, computerization and alignment of the technical solutions that meet those requirements [6].

VMware accelerates cloud and shared services adoption. It fully supports student and staff requirements by easy to implement, scale to support departmental and institutionwide clouds. It enables consortium, hybrid, private and public clouds [7]. The VMware cloud infrastructure enables cloud and establishes a technology standard for building and delivering shared services within and among departments in the institute.

Chris Stott explained reduction of server, hardware, and better resource management in Manukau Institute of Technology, New Zealand with the implementation of VMware [8]. Some of the benefits reported here are improved application availability with eliminated the need to reboot servers for, increase in server uptime, reduced capital expenditures on new hardware etc.

III. CONCEPTUAL FRAMEWORK

Application Architecture

The authors have designed a model for a VMware solution at the department of computer studies, CSIBER, Kolhapur. Three main entities interacting with the model with distinct pre-defined roles are

- Admin
- Faculty and
- Student (User)

Based on the role privileges, different modules are accessible to different entities as depicted in Table 1.

Table I Module Access Privileges for Different Roles

Role	Name of the Module				
	Authentication	Post Request	Process Request	Install OS/App	Send SMS
Admin	✓			✓	✓
Faculty	✓	✓	✓		
Student	✓	✓			

Figure 2. depicts interaction between different modules of VMware application. The corresponding layered application architecture is shown in Figure 3. The students can log into the system and either access the existing virtual machines or post a request for new operating system or application software clearly stating the reason for the same. A faculty can view all the pending requests and approve or reject them with the appropriate justification. Admin can periodically view for the

requests and send the SMS after the installation procedure is completed. The changes will take effect permanently or for the specified period of time as the concerned faculty deems fit. The faculty also can post a request as the academic curriculum is upgraded which does not need any further authorization. As illustrated in Figure only admin has the right to interact with the VMware workstation while faculty can set new rules or post new requests and the student can access existing virtual machines or post requests for new operating systems or applications on existing virtual machines.

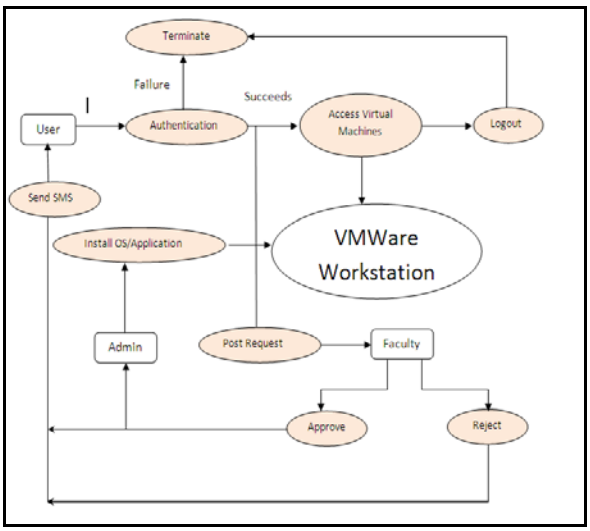


Figure 2. Interaction between Different Modules of VMware Application

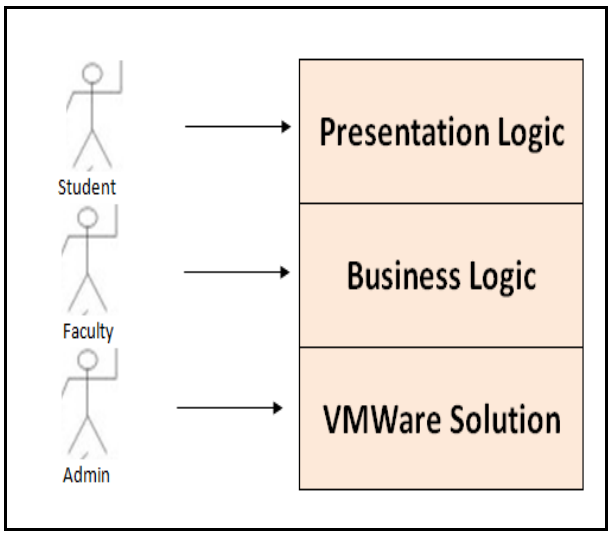
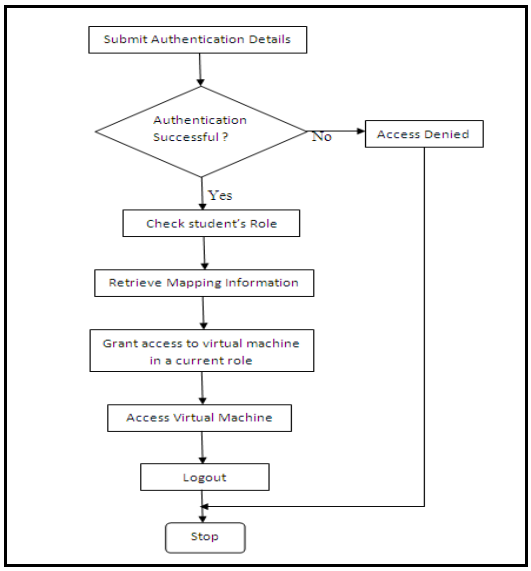


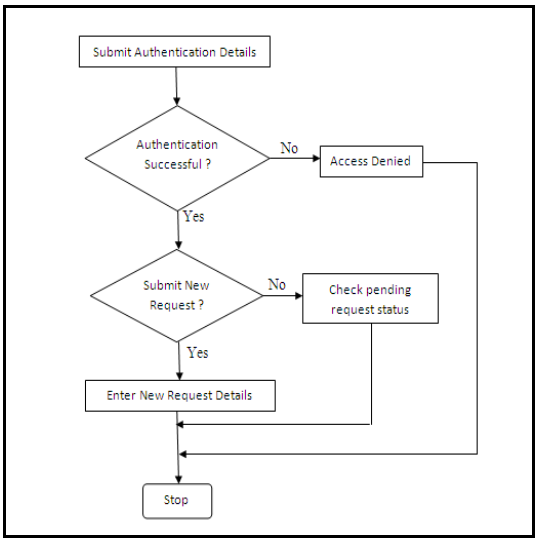
Figure 3. Layered Application Architecture showing Layer-Role Mapping.

Control Flow Logic

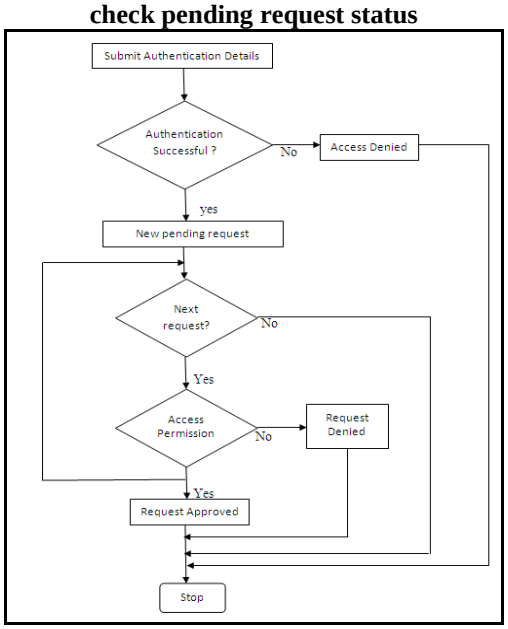
Figure 4. shows control flow logic for virtual machine access by students, submission of a new request or checking the status of a pending request, control flow logic for processing pending requests by a faculty and installing new machines/applications by admin, respectively.



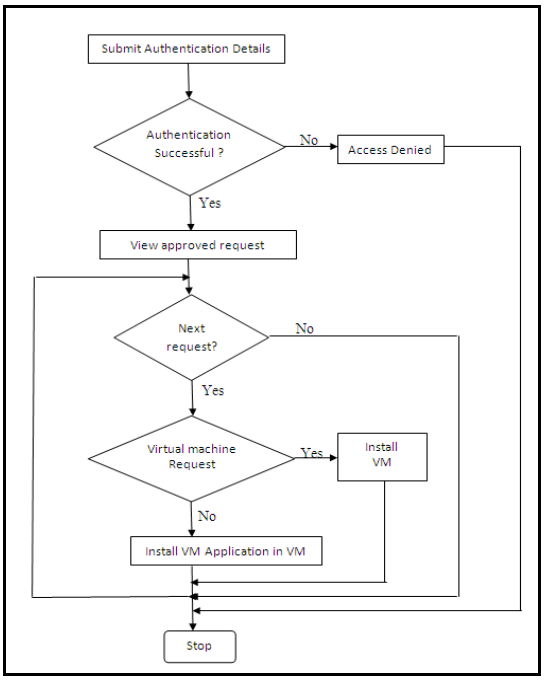
Control Flow Logic for Virtual Machine Access by Students



Control Flow Logic for Student submit new request and check pending request status



Control Flow Logic for faculty for processing pending requests



Control Flow Logic for Admin

Figure 4. Control Flow Logic for Different Entities of the Application

Table 2. lists the names of softwares installed on different virtual machines.

Table II. Softwares Installed on Different Virtual Machines

Application → Role ↓	TC	IIS	JDK	Oracle Server	Oracle Clinet	Visual Studio VB.NET/ASP.NET	Visual Studio 6	XAMP/ WAMP	Eclipse	NetBeans	Mysql
Windows XP	√	√			√	√	√	√	√	√	√
Windows 2003	√			√							
Ubuntu	√		√	√	√			√			√

Based on the current curriculum, the access control list (ACL) for virtual machines and applications for different roles is depicted in Table 3(a) and Table 3(b), respectively.

Access Control List

Table III (a) Virtual Machine Access Control List for Different Roles

OS → Role ↓	Windows XP	Windows 2003	Ubuntu
MCAISEMI	√	√	
MCAISEMII	√	√	
MCAIISEMIII	√	√	
MCAIISEMIV	√	√	
MCAIIISEMV	√	√	√

Table III(b) Virtual Application Access Control List for Different Roles

Application → Role ↓	TC	IIS	JDK	Oracle	Visual Studio VB.NET/ASP.NET	Visual Studio 6	XAMP	Eclipse	NetBeans	Mysql
MCAISEMI	√	√								
MCAISEMII	√									
MCAIISEMIII			√	√				√	√	
MCAIISEMIV			√	√	√			√	√	√
MCAIIISEMV					√	√	√			√

IV. RESULTS AND ANALYSIS

The model proposed above is implemented partially in VB. The structure of the database employed and the relationship between different tables in the database is shown in Figure 5.Figures 6(a) - 6(c) show VMware workstation running on a host computer and two guest operating systems corresponding to Windows 2003 and Ubuntu virtual machines.

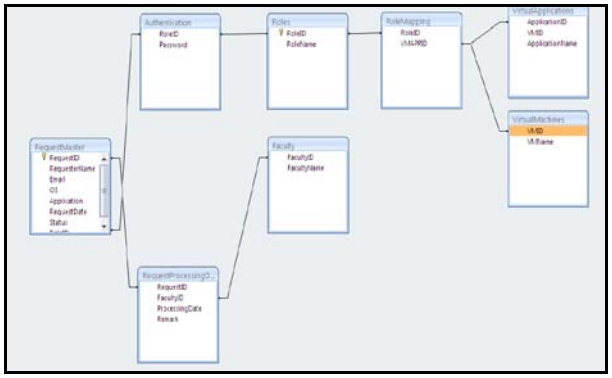


Figure 5. Database Structure for Front End Application

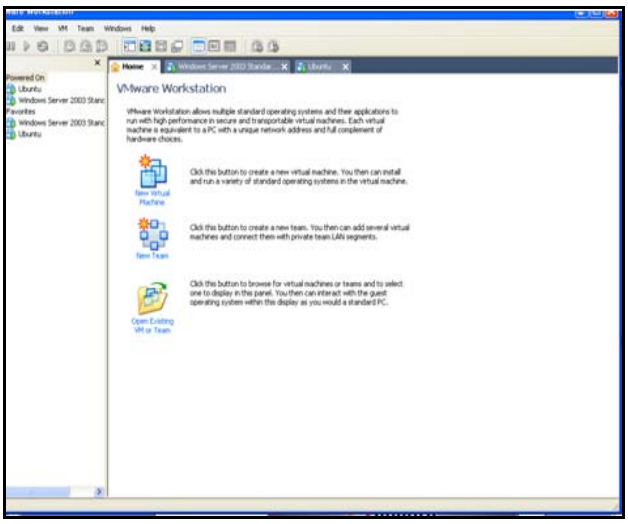


Figure 6 (a).VMware Workstation

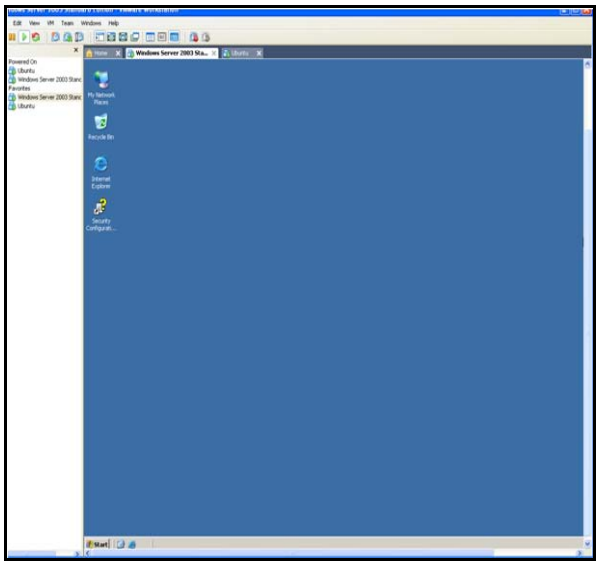


Figure 6 (b). Virtual Machine for Windows 2003.

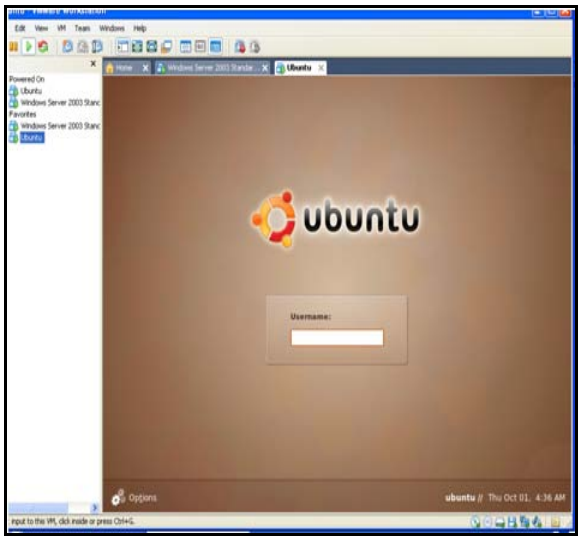


Figure 6 (c). Virtual Machine for Ubuntu

Figures 7(a) – 7(c) show snapshots of front end application to be hosted in a presentation tier for role management, role-machine mapping and listing the currently installed virtual applications on different virtual machines, respectively.

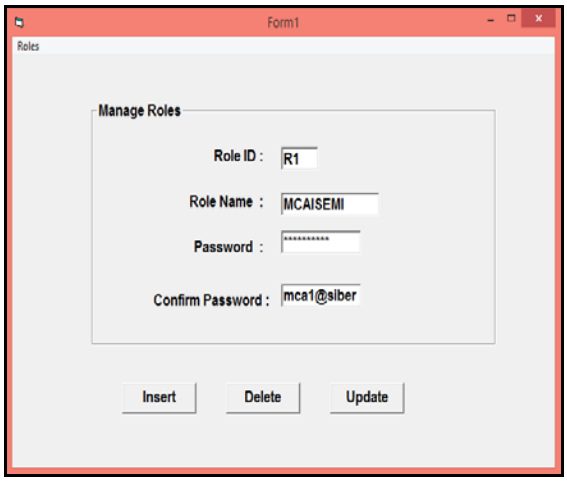
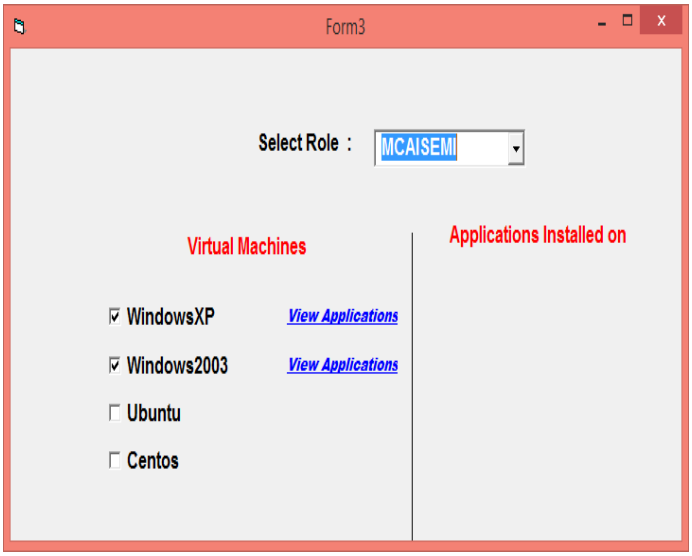


Figure 7(a) Managing Different roles



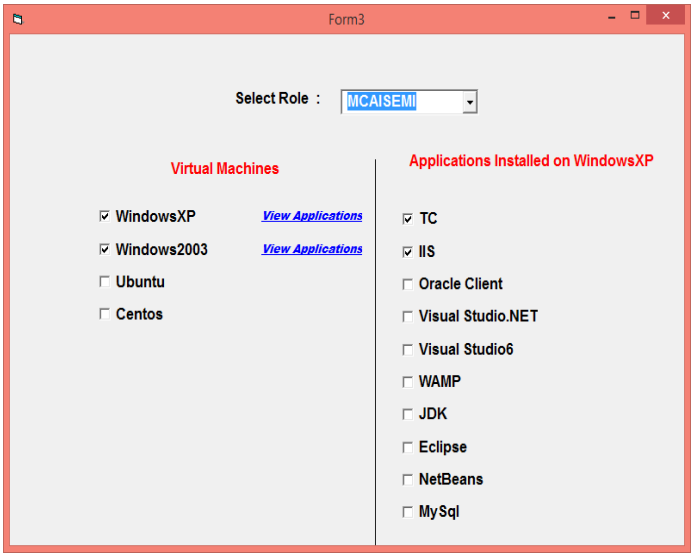
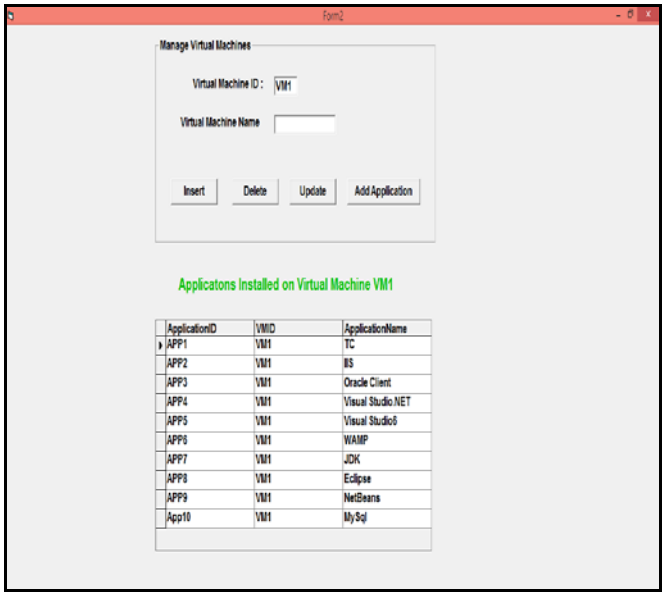


Figure 7(b) Snapshots showing Mapping of Different Roles to Virtual Machines and Applications



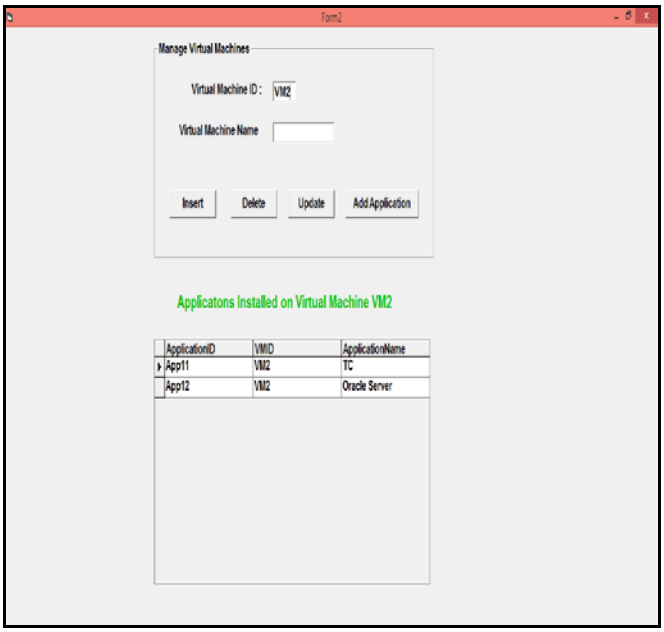


Figure 7(c). Listing Virtual Applications Installed on Different Virtual Machines

V. CONCLUSION AND SCOPE FOR FUTURE WORK

In the current work, authors have implemented VMware workstation 6.5 on a host computer on which two guest operating systems Windows Server 2003 and Ubuntu have been installed. A prototype model is developed in which currently only few virtual applications have been installed on guest operating system. A front end application provides the necessary configuration information to the lower layers by manipulating the requisite configuration files from the host computers file system. The entire system is planned to be automatic which involves minimum user intervention. VMware workstation 8 and later versions enable sharing of virtual machines on VMware workstation from a host computer, and access them from remote workstations through network. Our future work focuses on upgrading VMware workstation 6.5 to VMware workstation 9.0. Instead of deploying same virtual machine on different computers, we can just share it from single host and access it from multiple remote hosts. Multiple users can be created and different access levels can be assigned for shared VMs. VMware 9.0 enables upto 100 remote users connection to a single shared virtual machine at the same time.

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