Teaching Period: Spring Semester 2008 (29/7/2008 to 14/11/2008)

Undergraduate Subject: ICT Design (48481)

Green Team: Visitor Monitoring System

The Green Team has extensively used multiple virtual machines (VM) to setup the Eclipse Java development environment, as well as their SQL database development. Students have actively collaborated in their work environment around ODVLab not only for test development, but also to reduce dependency on external hardware to install open-source applications and software resources. Students have noted that the consistency of the test environment has allowed them to focus on design requirements, while minimising time taken to install development environments on their machines. Students from the Green Team have synchronised their development framework of their virtual machines to the central code repository to simplify development processes.

Students have noted that the assistance of experienced team members allowed for streamlined development using ODVLabs, while also providing a simpler way to deploy project work quickly, without worrying about data backups and security constraints placed within the university network infrastructure. As a result, student collaboration has been maintained significantly online compared to previous semesters, as previously students would need to meet up on weekends or free-time to test and run system components on their local computer. Testing tasks are assigned online as development testing can be performed from the team member's home computer, or at their workplace.

Project tasks and organisational planning in the development and testing phases of the assignment was also documented on ODVLabs by a VMS team member. This allowed for an easy transition in the documentation control process, as team meeting notes and project scheduling commitments were electronically completed with ODVLabs, while also complimenting the work of individuals who preferred to keep hand-written process logs. The following server components have been successfully integrated using ODVLabs:

- **Persistence Tier: Database Server**
The Database Management System (DBMS) running on the ODVLabs VM is MySQL. The database server is responsible for user accounts and personal attributes for visitor information, for which this information will be processed and analysed accordingly using specified heuristic techniques in the middleware services layer.

- **Application Tier: Web Components**
The team decided on a Web Application development approach for their system architecture. Using the J2EE Framework for their application tier, business components written in Java were deployed on the VM for the Web User Interface, Web Adaptor and Data Store Packages. Struts were used to interface presentation pages (Java Server Pages) to the application logic responsibilities (Java Runtime Applications).

- **Presentation Tier: Web Container**
On the same VM as the application tier, the web container used for the project was Apache Tomcat. The Web service container essentially facilitates access between external actors of the system (visitors, rangers and administrators) and the Visitor Monitoring System itself.
Blue Team: Smart Hospital System

The primary purpose of ODVLabs for the Blue Team was to use the virtual machine as a database server for their patient information management (PIMs) system. Design of the SQL database system was completed by the PIMs team leader on his local computer, and later deployed on the virtual machine for use by team members in the PIMs team.

Some minor collaboration work on the database access tier using the .NET Framework was completed using the virtual machines, but mainly on a limited capacity. Scheduling and organisational constraints meant that development of the PIMs system was achieved late in the academic semester, and thus the majority of development work was completed using engineering lab computers or the team members' own computer systems.

As the development team members had existing experience to virtual machine environments, the most benefit to the PIMs team members were that students had remote accessibility to the test server within the university network. Apart from the technical constraints of ODVLabs which are being rectified over the semester, students had a common consensus that ODVLabs has the potential to become a core resource to collaborate in group project environments, especially when team members need to conduct virtual team meetings due to personal or work commitments.

The students deploying the PIMs services on ODVLabs decided on the following approach:

- **Persistence Tier: Database Server**
  The PIMs team decided to use a MySQL DBMS for their VM. The database server is responsible for user accounts, staff and patient information. The PIMs team decided it would be a development tool server that everyone should have access to at any time.

- **Application Tier: Web Components**
  On the same VM as the persistence tier, Microsoft Internet Information Services (IIS) was used to deploy the .NET Framework service applications using Visual Studio 2008 Express Edition. IIS is included with the Windows XP Professional base installation, with IIS's integrated web container facility to host the .NET web application of the PIM's user interface. The presentation logic tier, including Active Server Pages (ASP) and the C# code-behind, is also developed on the same VM.

The real-time components of the SHS, including services for robot control and image detection, were completed using the engineering lab computers, with the team member's own systems for development. There was a lack of interest to use ODVLabs due to their unfamiliarity with virtual machine environments, as well as limited time constraints to develop the SCADA data acquisition and control mechanisms in time for deployment to the VM. While there was initial interest on the part of SHS team members to use ODVLabs for the persistence aspects of controlling the real-time components and robotics, students had to be convinced of the merits of the system.

It was later noted by a team member that the request to setup Citect SCADA was only proposed late during the academic semester, as well as technical problems on one of the engineering lab computers, meant they had to do a last-minute recovery of their development work during one of their service deployments on a test machine. In retrospect, if their real-time development work was done on ODVLabs, such backup and recovery concerns would be accomplished automatically.
Postgraduate Subject: Software Architecture & Middleware (48481)

Team 1: Smart Factory Process Control
Team 1 intended to use ODVLabs for their Smart Factory implementation, to interface the wireless sensor networks on the ‘factory floor’ to their middleware system using the .NET framework. Their database system tier would be running on the single virtual machine. The team members, while reluctant to try virtualisation systems, warmed to the idea when advised of the rapid development environment of their test bed. Unfortunately, due to the team’s time and scheduling limitations, they were unable to use ODVLabs for their development and deployment. Thus, work was primarily completed on their computers.

Team 2: Smart Hotel System
Team 2 proposed to use two virtual machines for their development: one VM for their server and middleware tier and a second VM for their client tier to demonstrate interconnectivity between the subsystems. Their implementation of a Smart Hotel system would use the .NET Framework and .NET Remoting to obtain source data from wireless sensor infrastructure, process the data in the middleware VM and display the results in the client VM.

Students in Team 2 had familiarity with VM environments, and understood the technical advantages of a maintained server that streamlined productivity and reduced deployment periods. However, time constraints to complete system documentation deliverables meant development was completed on their home computers, and depending on their final project re-scheduling, deploy their final environment on ODVLabs. Team 2 noted that if more time was scheduled for prototype development, that the development stages would be done with ODVLabs instead.

Team 3: Smart Agriculture System
Team 3 wanted to use ODVLabs for their database system development for their Smart Farming system. The single virtual machine was intended to simplify deployment of the .NET database connectivity components and setup of their database server, as team members had only limited experience in setting up a database with the sufficient security parameters and patches installed. While some initial setup stages were completed using ODVLabs, Team 3 are currently yet to use ODVLabs for their development and prototype deployment of their system. Thus, their current work was primarily completed on their computers.

Team 5: Smart Hospitality System
Team 5 planned for ODVLabs for their database and middleware services tier to comprise of their Smart Hotel System. A single VM would be used for the Java Axis2 Web Service development and MySQL database design, which would also be used to assist team members less familiar with Java Web Services to understand top-down and bottom-up web service implementation methodologies, without being constrained by redeploying the system development components on each of the team members’ computers.

While the team members were supportive of the deployment and prototype testing to be done on ODVLabs, internal team scheduling constraints meant that that most development was initially done on the team member’s own computer. Depending on the team’s future scheduling commitments, the deployment of the prototype implementation will be done on the ODVLabs environment.

Notice: Teams 4 and 6 declined to request ODVLab facilities for prototype development.
Student Survey Analysis

General Observations
It has been observed from both an undergraduate and postgraduate level that students who have existing familiarity with virtual machine environments in their workplace, and those with the technical curiosity in mind to develop their prototype systems, have benefited most from ODVLabs. Furthermore, there is a significant flow-on effect in terms of knowledge transfer from students who embrace ODVLabs early in the development cycle to the team members who have insufficient technical capability, from a software development and programming perspective.

Students involved in the ODVLabs pilot study, particularly with the undergraduate subject ICT Design, have recognised the collaborative design capability of ODVLabs for development, deployment and testing on a common ‘clean’ test-lab environment. This ensures consistency when performing uniform system tests according to specified standards.

Students who are already familiar with installing base system components, such as the operating system, development frameworks and integrated development environments are no longer subject to manually requesting system administrators to perform these system-administrator privileged tasks; as these operations are automatically deployed when a VM request is made at the beginning of the subject.

In future, students have requested multi-user VM access so team members can access the common VM environment to complete their particular development responsibilities. This will enhance group collaboration efforts and serve as a potential teaching environment for students with stronger technical abilities to educate fellow team members by example.

Ultimately, the personal responsibilities of students will not necessarily change by the use of ODVLabs. However, as personal commitments are logged and recorded for all team members to view upon request, there is an impetus for students to contribute in team environments for greater visibility and transparency in work facilitation.

Improvements to Teaching Responsibilities
In combination with the Subversion Version Control Repository (swordfish.eng.uts.edu.au), tracking and control of group collaboration projects become much more manageable for students; with students also learning how to effectively use revision control management tools in team environments. Coupled with the wiki personal logs, students can keep electronic logs of their learning and development goals while also sharing new ideas online, akin to online ‘brainstorming’.

Furthermore, risk mitigation strategies when planning any software project is always a concern for students. As batch-script data backup responsibilities are automatically performed with ODVLabs, students have noted that development risks such as their personal computers having corrupted hard disks have been mitigated.

Subject coordinators and tutors are no longer in doubt as to the personal ethics of students when their team project work is either incomplete or stalled, as all access logs are archived to verify that students have been performing the required tasks to the best of their ability. Thus, ODVLabs instil that students need to be accountable for the efforts of their team, without resorting to unsubstantiated reasons to disown responsibility of assigned commitments.
Student Comments

Potential Improvements

Note: Many of the technical improvements have been progressively taken account of; with the next release of ODVLabs building on the requests and requirements made by students over the academic semester.

- Network ports not being forwarded in time for main project development. Students mentioned that although port forwarding has been enabled at time of writing, there are still some network firewall rules to be ironed out properly.
- Inability to access services outside university during critical development times. Students deployed servers on their home computers to finish work requirements, and then later deploy their projects on ODVLabs when they came to university.
- If the VM system experiences a kernel-level abnormal termination, such as the Windows BSOD or Linux Kernel Panic, the user must contact technical support to do a ‘hard reset’ to restart the virtual OS. This process should be automated.
- To allow more than one user to access the Operating System through the Remote Virtual Desktop simultaneously; or at least allow multiple users to access the common disk space environment.
- Base OS installation could have a base software setup (such as pre-installed installations of MySQL or Visual Studio) to simplify deployment, instead of manually installing the software on the VM.
- The ability to connect external components to the ODVLab Server Environment, such as installing a USB equipment pool to connect embedded equipment and interfacing it to a specific VM system.
- Streamlining user requests from students, such as VM machine requests, enabling ISOs and port forwarding; so a request is completed within a maximum turnaround time, ideally within 2-3 business days.

General Comments

- ODVLabs is quite good and will be useful for many students. Hopefully it can be used in future semesters as long as there are no major issues with the system.
- Student groups benefited from ODVLabs as they had a central server to test deployment projects in a common environment.
- As a development tool many students saw ODVLabs as a server that facilitated in teaching activities, while providing a common access platform at any time of day.
- VM virtualisation allows consolidation of separate servers and databases to provide more economic operations, thus reducing technical requests from students to repair or maintain physical desktop servers. Students noted that this will minimise hardware downtime in the longer term.
- Students with experience in VM systems in their work environments commented that commercial-off-the-shelf software, such as vendors from Citrix or VMware, would be a more expensive alternative and less suitable for academic environments, compared to open-source initiatives.
Student Survey Sample
A voluntary email survey was conducted with undergraduate and postgraduate students in ICT Design and Software Architecture and Middleware respectively. The identities of submissions were confidential throughout the process. The small population sample (54% participants for ICT-D; 63% for SAM) indicate that the error rate could be further minimised of variation with greater student participation.

The survey consisted of 5 qualitative, multiple choice questions, followed by an open-ended personal feedback.

1. **What is your previous experience in virtual machine environments?**
   - Highly Experienced: Skilled from previous domains, such as current/previous employment and/or industrial traineeships - An understanding of the technology framework.
   - Moderate Experience: Generally skilled, some familiarity with the domain via personal pursuits/hobbies or previous academic environments.
   - No Experience: No or little familiarity with virtual machine environments.

2. **Did you find ODVLab to assist in improving Team Productivity?**
   - Reduced time spent on deployment by greater than 75%
   - Reduced time spent on deployment by greater than 50%
   - Reduced time spent on deployment by greater than 25%
   - Did not reduce time spent on deployment. Add reason(s) in question 6.

3. **Did you find ODVLab to be a place to collaborate and share development?**
   - Improved time to collaborate development by greater than 75%
   - Improved time to collaborate development by greater than 50%
   - Improved time to collaborate development by greater than 25%
   - Did not improve collaborative development. Add reason(s) in question 6.

4. **What experience have you gained from ODVLabs this Semester?**
   - Highly Gained Practical Skills and Knowledge: The skills gained from using ODVLabs will suit future academic and/or professional pursuits in future.
   - Moderately Gained Practical Skills and Knowledge: The skills gained will serve potential use in academic pursuits. Some industrial skills could be harnessed as a result.
   - Some or minor new skills gained: The skills gained from ODVLabs are not relevant in a professional capacity at the moment. Add reason(s) in question 6.

5. **Would you recommend ODVLabs for future subjects?**
   - Highly Recommended (75%-100%): Strong recommendation implies a high willingness to recommend it to students for next subjects and/or capstone projects.
   - Moderately Recommended (50%-74%): There is a potential for recommendation and adoption for further subjects and/or capstone projects.
   - Partially or not Recommended (1%-49%): The system is not relevant for recommendation for future subjects and/or capstone projects. Add reason(s) in question 6.

6. **Do you have any additional comments you would like to suggest?**
# Survey Result Statistics

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<th>Postgraduate Subject (SAM 49266)</th>
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