ACEing the Delivery of Technical Content Online

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Abstract

There are many issues involved when it comes to the online delivery of technical content, particularly content that involves information and communications technology (ICT). McCarthy and Ross (2005) described and analysed an eLearning initiative where the students enrolled in a programme of study were brought together for block courses from geographically dispersed locations. One of the reasons for doing this was to enable some of the higher end technical content to be delivered in a more efficient manner as some of this content required student to have access to multiple operating environments that might not have been possible in their home situation. The use of virtual machine technology for delivering such aspects has been described, analysed and explored by Watson and Correia (2004) and others and has provided a sound solution for situations like this. Martin and Nesbit (2007) have explore the notion of context when it comes to eLearning and the importance of recognising the different aspects of context with these including the differing comprehension levels, preferred learning styles and cognitive abilities of the students enrolled. This notion of context can also be extended to the operating environment of the students. This particularly applies where the operating systems and versions of applications that these online students have at their disposal may be different from each other and from the resources

The purpose of this paper is to describe and analyse how VMware ACE (Assured Computing Environment) was used to create DVD-based virtual machines for the delivery of both an operating systems and a multimedia applications course from the Diploma in Information and Communications Technology (DipICT), and in particular how this is able to deal with issues surrounding different versions of operating systems and applications, as well as some software licensing issues. The conclusions of the paper highlight the advantages of using products such as VMware ACE and some of the potential pitfalls that exist. The findings should be of interest to institutions who are contemplating the delivery of similar types of online courses where it is important that students have access to the same versions of operating systems and applications.

Keywords: eLearning, Virtualisation

1   Introduction

This paper explores how the use of VMware ACE (Assured Computing Environment) was used to provide a stable operating environment for the online delivery of two courses from the Diploma in Information and Communications Technology (DipICT) at Christchurch Polytechnic Institute of Technology (CPIT). CPIT have been delivering a number of DipICT courses online for a number of years with some of these courses presenting issues relating to the consistency of equipment, software and resources used by students in their home setting.

Two of these courses were an introductory multimedia course (MA500 – Introduction to Multimedia) and an introductory operating systems course (OS500 – Operating Systems). The main issue raised with the multimedia course was the availability of the software, with the main issue raised with the operating systems course was the need for students to have the same versions of operating systems available to install and configure where students are working from home.

Part of the solution for both courses was to create a virtual machine on a DVD with the required operating systems and applications installed and configured as required for the course in question. These DVDs were then distributed to the students who were enrolled in the courses so that they could run the virtual machines on their home computers irrespective of the operating systems and other applications installed.

2   Background and Literature Review

CPIT delivers a range of DipICT in a flexible distance learning environment. As discussed by Ross and McCarthy (2005) CPIT delivered a blended method of delivery within the Community Technicians (ComTech) Programme, where theory (and appropriate practical) was presented to student using a Learning Management System (LMS). Then students travelled to CPIT to complete technical learning objectives on site that were not possible to complete in their home setting. This enabled the students to use operating systems, hardware and other resources that had been configured pecifically for their courses in a controlled environment or context.

The implications and benefits of teaching using Virtualisation as a tool in the classroom have been explored by Correia and Watson (2004). The nature of the courses where Virtualisation has been explored by Correia and Watson have been related to operating systems and networking where it has been desirable to have all students using virtual machines that can be worked on and experimented on without causing any problems for the

physical machines that they are running on. This approach was followed for some of the courses that were delivered as part of the ComTech Programme that was described in McCarthy and Ross (2005).

The notion of context in eLearning and in particular the differing contexts of students were explored Martin and Nesbit (2007). The different contexts identified in this work included the differing comprehension levels of the students, the differing preferred learning styles of the students and the differing cognitive abilities of the students. One of the cases explored included the development of online based learning resources for Microsoft Office. In this particular case it was identified that students could have many differing versions of the product on their computers at home that it was decided to develop the learning material for several versions of the product. While this approach worked, it would have been considerably easier to develop the material if it was only being developed for one version of the product, however, this would have required some way of ensuring that all students had the same version of the product installed on their home computers.

The notion of context in this particular case was taken into account by allowing students from multiple different contexts (versions of product) to be able to participate in the course, where as the approaches taken in Correia and Watson (2004) and McCarthy and Ross (2005) were to control the contexts (versions of products) so that they were all the same. The decision to run DipICT courses such as OS500 and MA500 online required some way of dealing with this notion of context and the decision to use VMware ACE enabled the context of the students to be controlled in such a way that they were the same, so that learning material did not need to be developed for multiple versions of the same product as they were in Martin and Nesbit (2007).

3. Investigation

This section of the paper presents the reasons why VMware ACE was chosen over other virtual machine software technology that have been used at CPIT.

3.1 VMware Workstation

Once the decision was made to deliver fully online, CPIT was already using VMware Workstation and Virtual PC virtual machine technology to deliver OS500 and a range of other courses using this virtual technology. One important factor to consider when teaching online is that the students host environment is setup and configured by the IT Division (in consultation with academic staff) which allows the staff member to step through a basic file copy with students to start their learning. Some background learning is involved to use the tool, but is conducted informally with the students at the beginning of the course.

One perspective was that in order to achieve the learning outcomes, one only needed to distribute the existing machines from the classroom to the student and they could complete the class materials. In reality there are many mechanisms that support the student learning environment at CPIT.

The software at the time of development used within the teaching network was VMware Workstation version 4 and 5 (mixed between some rooms). To replicate this on the students host machine raised a number of issues; VMware

licensing, software tool licensing, host software, hardware requirements & vendor conflicts and setup of the virtual machine image.

3.1.1 VMware licensing

At the time of investigation the licensing costs were per-license and paid at an academic rate. There were 42 VMware Workstation version 5 licenses and 21 out of a possible 63 VMware Workstation 4 licenses were in use in the classroom. This was due to the academic and upgrade licenses being comparative in price, so whole new licenses were left over for use around the institute.

It was deemed that students in online delivery could use these licenses at home; however retrieving the license for re-use afterwards would require management and a certain amount of trust within the student community. There would be ramifications should a student not release the licence and it was reused in the next semester for the school.

There was investigation into making a student pay for an academic licence to complete the OS500 course, however as the course fee was comparative to the fee for the licence this was deemed to be too cost prohibitive and reduce the likelihood that a student would enrol given the course related cost.

3.1.2 Software tool licensing

At the time of investigation into the use of virtual technology for the operating system classes, a discussion arose around the issue of multimedia applications. Software that was in use in the classroom in some cases was freeware, however to maintain industry relivance many of the software tools in use was proprietary requiring expensive licenses.

While the operating system courses have no software tools required (other than supplied by Microsoft Academic Alliance) it made sense that the multimedia software was distributed by virtual machine. This alleviated the overall install time per student, the reissuing of software licensing as well as the high level of software tool customisation required to perform many of the tasks required by the tutor for the course. It was also perceived that by distributing the software in this manner that the student was obtaining a static environment, and as the tools were set up by IT Division within the appliance using the install notes from the face to face image, the course notes should not change.

One challenge that would remain would be that the software tool licensing, even though they are within a virtual machine, would still need to be voluntarily released by the student (by destruction of the virtual machine). Once again this was placing an unacceptable trust upon the students.

3.1.3 Host hardware & software requirements and vendor conflicts

While the host system software requirements are not overly excessive for VMware Workstation, it existed that a possibility that the student may not have the required Windows NT family operating system which VMware Workstation (or any of the other derivative VMware products) rely on. While Windows 98 is now aged, some students report that it is still in use. It was deemed that a serious student who would complete this course online should have software on the computer that should support the learning tool, or have it upgraded (possibly using the

school's Academic Licence versions of Windows 2000 or XP).

Should the software requirements be met, there is also a minimum hardware requirement. While the VMware specification sheets report that the host computer must have a 500MHz or greater processor, it is the memory requirement that may affect the VMware Workstation software, as the student would require the host system software minimum (128MB for Windows 2000, 256MB for XP) they would also need in addition to that the guest virtual machine minimum as well. In this case Windows XP was chosen (as notes were already written to support the students in their learning) so on top of the minimum mentioned previous the student would require a further 256MB, as an absolute minimum. http://www.vmware.com/support/ws5/doc/intro_hostreq_ws.html This does not take into account any additional software that the VMware appliance requires, nor the students requirement to have PDF files or Microsoft Word documents open to facilitate their learning or to complete assessments as they work.

Host hardware vendor support was a recognised issue previous to this investigation. CPIT uses Intel hardware where possible, but as academic staff started transporting virtual machines to AMD based hardware at home for development of materials it was apparent that some issues arose. At best the virtual machines would perform poorly at startup, at worst they would blue screen with Hardware Abstraction Layer (HAL) issues. Later this would prove to become an issue for other online courses running, and one academic staff member chose to recreate a number of machines on their machine at home for any student using an AMD based machine.

3.1.4 Setup of the virtual machine image and software

Because of the nature of the VMware Software, you must first install the VMware software tool, then create a whole new machine or copy a pre-configured machine.

The target audience for both papers have little or no knowledge or experience with file systems beyond the use of My Documents. They also have a relatively similar lack of skill in the installation of the software tool, which can get complex for novice users.

At CPIT, a majority of the above issues were dealt with by either IT Division or the tutor in the classroom reasonably quickly. Also the concept of virtualisation was informally covered in the classroom over the duration of the course. These informal tutorials were not incorporated within the distance learning course. It is also important to consider that the entry criteria for these courses is open within the realm of computing experience; this was seen to be a major issue.

Because of the above requirements, VMware Workstation 4 and 5 were ruled out as the software tool of choice.

3.2 Further Investigation

Investigation of alternatives to the VMware Workstation problem revealed a number of choices, firstly that the student use their own host computer in completing the learning outcomes and secondly free software such as VMware Server. Due to the nature of how the face-to-face students' experimental use of system software could lead to complications and support issues (such as deleting profiles and user accounts) which would cause a change in the class materials, using the host software would be an absolute last choice. A further issue regarding the use of host operating system software as Microsoft Vista was to be released during the timeframe of the course and the move to Vista purchasing a new machine in this timeframe was considered to be almost certain. This was considered to be a last resort. Secondly VMware Server 1 was investigated, as this was a free alternative at the time. It was also seen that students would have to download the base software and apply for their own VMware Server key as their license agreement prohibits the distribution of the software or license key (except in a reasonable manner such as a backup) http://www.vmware.com/download/eula/server.html. The hardware and setup problems still remain.

Further investigation was conducted into Virtual PC as it could be distributed under the Microsoft Academic Alliance license agreement however similar problems on copying machines and setup remained an issue. We would also have to rebuild the software image using Virtual PC due to the nature of the course as converters between the products at the time were troublesome. The installation issues still remain. This was preferred over using the host machine option at the time, and tutorial staff would need to support the student with their setup.

In the timeframe of investigation this was the time that the multimedia issue was raised and a product release for VMware ACE was received.

3.3 Investigation into VMware ACE

About the same time as the final investigation was concluding, a product announcement was distributed on VMware ACE. While this was aimed at the corporate market mainly for software testing, the software requirements seem to meet the needs of the distance learning student environment. A test was conducted using evaluation licence and it was deemed to fulfil the needs of the level 5 courses.

VMware ACE licensing was a cost, but at academic rates were comparative to the classroom tool. The key function of this was that the licenses could be reused because of the deactivation mechanisms that could be built in to the virtual machine; the ACE virtual machine has its own installer, which installs VMware Player as well as the virtual machine in one installation mechanism; the ACE management console can split the setup into CD's or DVD's and write across multiple media if the images were too large and as a bonus there are many more security features that can be enabled.

While there were many advantages, there were still areas that did not cover the areas of concern. These were mainly minimum hardware and host software requirements. Students still required up-to-date hardware to run the VMware ACE Virtual Machine and a Windows NT Family host system software product.

Some of the advantages for the Multimedia area included the expiration of the virtual machine, meaning that at the conclusion of a course the virtual machine is disabled, and the software tools within the virtual machine cannot be used. There is no requirement to retrieve multimedia tool licenses. This is useful for a software tool licence that is open ended,

allowing re-use of the license at the beginning of the next semester.

Further advantages include encryption of the virtual hard disc, and locking of various devices. The virtual machine hard disc can be encrypted to stop someone from attempting to access the data stored on the disc, or transferring the content at any stage to another virtual appliance (including VMware Workstation machines as well). This is particularly useful to stop anyone from retrieving data from a Virtual Machine once expired, such as a licence key stored in the registry. Locking of enabled or disable device and tools settings allows the administrator to lock the drag and drop functionality from the desktop as well as CD devices, Floppy drives, network devices etc.

There were a number of other advantages that could be investigated in the future which were not used at CPIT including security updates and network access control. Updates for the Virtual Machine and Security Policy can be distributed from a Management Server, and use of the ACE environment can be secured using Active Directory. The management server is available free of charge from VMware if you purchase more than 20 licenses from VMware. There is also a security mechanism that will remove networking access dependant on a set of rules on the Virtual Machine Policy. This is distributed from the Management Server.

3.4 Setup of the VMware ACE machine versus classroom setup.

The setup process was not too dissimilar to setting up a set of virtual machines for classroom use. Once that was completed a set of security policies are applied and the package is created.

- Create the ACE master machine. Using the VMware Management Console (VMware Workstation 6 has been released with this component built in) you create a template machine called an ACE Master. This could be based on an existing VMware Workstation virtual machine, a physical machine that has been virtualised or a brand new install. In the master, you must install the full set of VMware tools. The ACE master can then be cloned if necessary (such as a template for both OS500 and NM500), and has so far worked on different hardware vendor platforms.

- Install software. Once the virtual machine master is created, you can then install any software that you want the virtual machine to run. For MA500 there were a number of software packages required to create multimedia applications. For OS500 only a base install of Windows XP was supplied.

- Set the security policy or the Management Server location. Using the Management Console an instructor can set the ACE machine to read security policy and check in with a management server (over a physical network) or create a number of static security policies. In either case this is where you can set encryption and device settings for each distributed machine. The management server could not be used as it was unknown at the time how students would connect to the Internet to retrieve security information.

- Package the Virtual Machine for distribution: The VMware Management Console allows the instructor to split the virtual machine onto a CD or DVD, or across multiple CD's or DVD's. It also packages a version of VMware Player, and creates an installer to install both the machine and player on the target host machine. This process is likened to installing a piece of software such as Office, but more of an unattended installation as there are few installer decisions for the user to make.

4. Results and Conclusion

The use of VMware ACE addressed many of the issues that would have surrounded the use of other virtualisation technologies including both other VMware products and Virtual PC. VMware ACE worked successfully from a technical point of view in both the operating systems and multimedia courses. This approach deals with the notion of knowing the students' context as outlined in Martin and Nesbit (2007) in a manner that allows for only one set of learning materials to be developed, and that does not require students to be brought onsite to experience a controlled context as described in McCarthy and Ross (2005).

The main issue that emerged from the use of VMware ACE was a software licensing issue where the software vendors required each student to have a different license, even though the software could be disabled once the course had been completed – a concept that it was hoped would enable the license to be used by another student in a later course.

Provided this issue of software licensing can be overcome by use of agreements such as the Microsoft IT Academy software licensing the use of VMware ACE could dramatically change the way in which such courses are delivered. A possible example would be the creation of a Project Management course with a DVD based virtual machine created using VMware ACE that had the following installed on it: Microsoft Windows XP, Microsoft Project and Microsoft Visio.

Should this uptake in the use of VMware ACE become a reality, the use of time saving mechanisms such as the Management Server would be the next logical step in the development of eLearning resources where the context of students can be managed.

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