



At the Forefront of Educational Excellence, Republic Polytechnic Uses VMware for Innovative Problem-Based Learning

VMware® Workstation and ESX Server Reduce Hardware Costs by 200 Percent, Provide Scalable Infrastructure for Future Growth

RESULTS

- Achieved 200 percent reduction in hardware costs for specific learning modules
- Replicated realistic environment for students to learn about intrusion detection and disaster recovery
- Reduced deployment time from a day to an hour
- Allowed staff to have multiple environments for testing and development
- Reduced capital and operational costs by having fewer machines
- Saved space in labs and data center
- Created scalable infrastructure to support more labs in future

Polytechnic Needs More Machines, But Has No Space to Spare

Republic Polytechnic (RP) is Singapore's newest polytechnic school and enrolls 3,500 students. It is the first educational institution in Singapore to fully adopt the advanced Problem-Based Learning (PBL) approach. Instead of students shuffling from one class to another during the day, RP uses a different strategy. Its academic staff facilitates a one-day-one-problem learning process with classes of 25 students. The students work in teams throughout each day to build solutions to the problems they receive, developing a deeper understanding of their field with practical applications.

RP also prides itself on being on the cutting edge of technology. The staff firmly believes in leveraging the latest technology to enable students to prepare themselves for the working world.

RP is in an ideal position to capitalize on technology. "As a new institution, we don't have problems with legacy systems," says Tay Kheng Tiong, director of the School of Information and Communications Technology. "As such, we can put in systems that not only enrich students but also give us the ability to grow in a cost-effective and easy-to-manage way."

VMware software plays an important role in the School of Information and Communications Technology, where it is used in training and application development.

Tay adds: "We want to be a center of excellence in the use of innovative technologies such as virtualization. We thought we would start by using VMware software in lessons and for application development."

The school uses VMware technology for its modules on business continuity and intrusion detection. As part of the PBL pedagogy, the school wanted to create a realistic environment for training its students. Tay says: "We want to immerse students in a real-world experience, but we had to work within our limitations - such as hardware and software costs."

Another issue was real estate. For the intrusion detection module, the school wanted to create a relatively complex environment of six machines per group of students, but did not have the space to do it with physical machines. The school also needed to be able to prepare the systems at the end of each school day for the next day quickly and easily.

The Technology Development Center's application developers faced a different problem. Staff needed to create multiple production, testing and development environments to run projects but the data center did not have enough space for more machines. In addition, the Center has different teams of developers working on different research projects - some of which requiring confidentiality - so it needed a way to ensure that these developers have access to relevant resources while limiting their access to confidential projects or files.

"VMware Workstation and ESX Server have given us a platform to build a much larger infrastructure when we move to our new campus. In addition, they helped us save money on hardware and real estate without compromising our ability to deliver a real-world experience to our students."

*Tay Kheng Tiong
Director of School of Information and Communications Technology*



VMWARE VIRTUAL INFRASTRUCTURE AT WORK

- VMware ESX Server on IBM xSeries 445, 4CPU server with 3GB RAM
- VMware ESX Server on HP DL380, 2CPU server with 2GB RAM, connected to SAN
- Guest operating system: Redhat, Windows 2003 Server, CentOS, Ubuntu
- Production Applications: MS SQL, IIS, Apache, MySQL, IDS sensors
- VMware Workstation on Fujitsu and HP notebooks
- Guest operating system: Windows XP, Windows 2003, Redhat AS 3

VMware Leads in Features and Performance

After considering its options, the school chose VMware Workstation and VMware ESX Server. Seow Khee Wei, manager of the Technology Development Center for IT Security, explains: "We evaluated VMware Workstation and we compared it to Microsoft Virtual PC, and honestly, there was no comparison. VMware Workstation came out on top in terms of features, functionality and performance. Workstation is the more versatile and cost-effective solution."

Seow says the staff was able to implement the solutions in-house because the school's academic staff was technically capable. "It took about a month and a half to deploy because we did it during our free time in between classes. Had we focused on it full-time, it would probably have taken us less than a week. Essentially the deployment was smooth and there were no issues."

"Whenever we needed any assistance, all we had to do was turn to the VMware support site, the VMTN forum, and the VMware knowledge base. All our queries were answered there. They were a fantastic resource for our staff."

VMware Gives Students Real-World Experience, Gives Developers More Environments

The school uses VMware Workstation on notebooks to simulate an environment with multiple machines for the intrusion detection module set-up. For this module, the school provides a cluster of five students with two notebooks, each of which is loaded with Microsoft® Windows® 2003 Server host operating systems with three virtual machines on each notebook. This adds up to an environment with a total of six virtual machines for each student cluster.

According to Tay, space was the biggest issue for the project. "To engage students in solving problems, we wanted to create a real environment where students can be totally immersed. We want them to experience for themselves what the real world will be like once they graduate from the polytechnic."

"Giving students six physical machines is expensive in terms of real estate. By using VMware Workstation, we were able to reduce the number of PCs needed from six to two without sacrificing the experience that students would undergo."

For the business continuity module, the school uses VMware ESX Server to enable one single physical server to be loaded with three guest operating systems, to illustrate server consolidation and how it supports disaster recovery.

For this module, the school installed VMware ESX Server on six HP DL380 two-way servers, which are connected to two Storage Area Networks consisting of Cisco MDS 9216 switches and Hitachi Thunder 9570 storage subsystems. Backup images of the virtual servers are stored on a Nestor Storage Appliance.

The school loads each physical server with three guest operating systems to illustrate server consolidation. As part of the course, students consolidate images onto a few server boxes and copy them to a disaster recovery site. The main site is then taken down and the students must restore it with images copied from the disaster recovery site.

For the Technology Development Center, VMware ESX Server provided the ideal solution for developers who needed multiple environments. Seow explains: "ESX Server provides an effective server management solution that helps us save money and manage our resources. It's administrator-friendly, easy to install, and enables us to set-up different environments rapidly for staff and students. It has helped boost our responsiveness to the needs of students, faculty and staff."

The Technology Development Center uses VMware ESX Server on two IBM xSeries 445s. "We can use a single box to support four servers. When we need more servers for testing, we can just create new virtual servers. We don't need to buy additional hardware," said Seow.



VMware Offers Significant Savings in Hardware and Space

By using VMware, RP was able to achieve the following:

- **Hardware cost savings.** Overall, Tay says RP has made a 200 percent savings by using VMware over purchasing physical servers. "By using VMware software in some of our learning modules, we have been able to provide students with engaging problems and we have allowed them to experience, as close as possible, the 'real' world," says Tay.
- **Space saving and desktop and server optimization.** With VMware Workstation on 15 notebook computers, the school is able to replicate more than 50 machines. VMware software enabled RP to achieve an optimal class size of 25 while preserving and even improving the learning experience.
- **Faster deployment and development time.** The school's technical officers can quickly install, deploy, and reset their systems. It only takes them an hour to prepare the system for the next batch of students whereas it used to take up to a day. This enhanced efficiency frees the support staff for higher-value tasks such as preparing class curricula or furthering their development projects.
- **Stronger security.** Administrators can create a virtual machine with a user account and only allow access to certain computing resources or particular files. This prevents students or part-time staff from getting access to resources not meant for them.
- **Easy backup and recovery.** Backup and recovery are now much easier. According to Seow, "We simply copy the virtual machines from our NAS to our SAN. For recovery, we restore the virtual machine

images from the SAN. Because we have the image backups, we can restore the system on any ESX Server, any time. Restoring backups is simple and painless."

- **Enriched learning experience.** Students are able to learn valuable skills without risking the school machines. In such an environment, students are encouraged to experiment, to make mistakes and to learn. Said Seow: "Students install the OS, the applications and handle the disaster recovery. If they make a mistake, all they have to do is revert to the virtual machine's initial setup and start again."

Future Plans to Expand Virtual Infrastructure

"According to Tay, the school would like to work closely with VMware to develop expertise in virtualization technologies. "We would like our staff to build up their competency in this very important area."

Building this expertise is a priority as the school plans to add many more labs in future. The school expects to grow from four labs to more than 30 when it moves to its new campus in 2006. Notes Tay: "By having a virtual infrastructure in place, we are in a good position to scale up as we add on more labs. VMware software will make managing all those labs a lot easier."

Ultimately, the student learning experience is the most important reason for continuing to expand the school's virtual infrastructure and the staff's expertise. "We want our students to learn not just how to use the technology, but how to use it to meet business objectives," says Tay. "So for example in the business continuity module, it's not just about restoring the server. It's about meeting recovery time objectives. VMware technology allows us to do that."

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