Chapter 19
Remotely Accessible Systems for Computing Sciences Disciplines

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ABSTRACT
Like most other academic disciplines that require any amount of hands-on learning, requiring access to specific technologies, delivering computing curricula, and performing computing research online can be a difficult task. By using system virtualization and remotely accessible computing however, a near real world environment can be realized. When rolled out in tandem, these remotely accessible virtualization initiatives can use a common hardware set and/or existing computing resources within the academic organization or via cloud computing, thus reducing the initial and ongoing costs for servers, storage, and support. The goal of this chapter is to present a logical and technical framework from which educators can implement complex systems laboratories accessible at a distance. The chapter will also document the history of the use of virtualization in systems laboratories, the many benefits of virtualization, and future trends in the remoting and virtualization technologies.

INTRODUCTION
The computing sciences or informatics disciplines include computer science, information systems, information technology, software engineering, and computer engineering as defined in the Computing Curricula 2005 Overview Report published by The Association for Computing Machinery (ACM), The Association for Information Systems (AIS) and the Computer Society (IEEE-CS) (2006). These disciplines rely heavily on the use of computer systems and software.

For most coursework within the computing disciplines, especially information technology, a hands-on component is a requirement. This means that students not only need to learn the theory behind a computing topic but also how to implement solutions. This “applied science” approach readies them for work outside academia and solidifies their learning of the ideas being taught. Applied
research in computing disciplines also necessitates access to develop and test computing solutions.

To carry out this applied study, computer systems require the installation and management of several specialized pieces of software to be used in coursework and research. Some examples of such software include: software development tools, network analyzers, digital media encoders, network design software, network simulation software, operating system virtualization software, and database development/query tools, among others.

**Computer Laboratories**

Generally universities offering such degrees provide managed computer laboratories for students to use and/or require students to use their own computers on which they will install and configure any necessary software for use in their classes and research. Faculty will either use the computing facilities in the university computer laboratories or individual laptop or desktop computer systems. Students and faculty prefer to have managed computer laboratories available on campus, even though most will have access to their own computer systems. This preference stems from the complexities involved with installing and managing the various software and operating system configurations.

Using a computer laboratory, trained Information Technology (IT) professionals have to install various software packages on the computer systems and make sure they are all configured properly and not conflicting with one another or the host operating system. All of this is tested on a single computer then, when everything is successfully installed and configured, replicated throughout the laboratory to each station through an imaging process. Each computer in the laboratory has the same hardware specifications so this imaging process requires little technician intervention or reconfiguration.

**Individually Owned Systems**

If faculty and students are left to install and configure the software on their own computer systems, troubleshooting problems can quickly arise. Each computer will have a different hardware, operating system, and existing software footprint. Each of these layers of diversity adds to the likelihood that an issue could arise that requires a new solution. In other words, while a specific piece of computing software may have no problems installing and running on Student A’s computer (a Dell laptop with a 64 bit version of Windows 7 installed) it may not install or run properly on Student B’s computer (an Hewlett Packard desktop with a 32 bit version of Windows Vista installed). Even two computers with exactly the same hardware and operating system owned by different students may produce different results because they have different software already installed. These problems will not only frustrate students and faculty but also put an undue burden on the college’s computer support personnel to assist in troubleshooting and fixing separate issues.

For courses and research surrounding systems technologies (installing and configuring operating systems to work independently and with other systems on a network) the ability to work at a distance becomes even more problematic. Most students and faculty do not have the necessary hardware to implement large networks of multiple computers (enterprise networks) on their desktop computers. In a residential computing program offering such a specialty, specialized laboratories are in-place and equipped with high-end computers capable of system virtualization enabling multiple systems to run on a single physical computer. Students and faculty can work with multiple computers to simulate a larger network.