

# Methodologies to the Strategy of Computer Networking Research laboratory

Mr. Sagar R. Mali<sup>1</sup>, Mr. Yogesh B. Amane<sup>2</sup>

<sup>1,2</sup> Assistant Professor, Dept. of Computer Science and Engineering, AITRC Vita, Maharashtra, India

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**Abstract** - The preparation of computer networking laboratories is a required task for academic platforms that clarify computer networking connected issues. The following paper delivers a study of the features and possible development of different types of laboratory strategies traditionally used in educational institutions.

**Key Words:** Research laboratory, Networking, Strategy, Topology, Philosophy etc.....

## 1. INTRODUCTION

The significance of computer networking tools types the devices and facilities used in the delivery and innovation of knowledge related to them very important in the planning of curricular activities at any educational institution. Computer networking laboratories are a essential element for organizations that communicate computer networking related issues. A sufficiently designed laboratory design should allow for easy organization and flexibility in the type of involvements that can be performed in it. Consuming an onward looking attitude is essential in the preparation of these services to ensure a lasting educational impact. Also relevant is the acceptable planning of the involvements that the students will conduct in the lab so that they estimated or duplicate real world experiences is also relevant. This work provides an analysis of the methods to the strategy of computer networking laboratories. For this analysis, a review of the collected works related to the operation methods for these facilities as well as the technical experiences of one the authors have been used. The common types of laboratory designs will be analyzed; the effect on teaching methods for each design and the issue of remote access to a computer networking laboratory facility will also be addressed. The main types are laboratories based on a physical, virtual organization. Among the challenges to setup these facilities are the allocation of physical universe, their cost to shape and maintain. Reproduction software allows one to build networks and instantiate network devices at will through the software's graphical user interface. When Arranged properly, the software will simulate the network as if it were a real one. Some advantages of this type of setup include that there is no real network to possibly damage and therefore simulation provides a very safe environment for learning. The size of the simulated network depends on the computational power and time allocated to this effort. The problem with this type of design is that the results of the simulation are only as good as the code written into the software and therefore there is a risk of not getting accurate or accurate results from the simulations. Virtual is important

to understand that the term 'virtual' has recently taken on several different meanings. In some examples 'virtual' has come to mean remote access. For our purposes, a virtual networking lab is one that uses virtualization software to create virtual images of the software and hardware components of a network. Figure 1 illustrates the different design approaches for computer network laboratories.

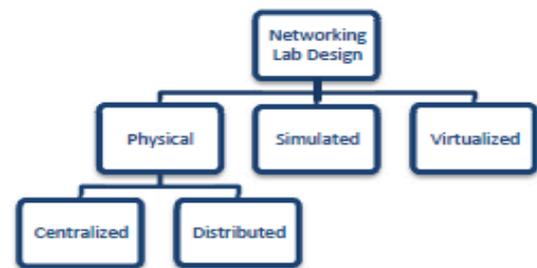


Figure 1. Laboratory design approaches

## 2. LITERATURE SURVEY

The following section will survey some of the literature already published about designing networking laboratories. Again, this is neither a thorough nor mutually private list only an effort to provide some reasoning behind the different approaches to laboratory design. Their design also makes use of virtualization technology. The use of virtualization allows for the managers to easily create virtual OS images that can be easily transferred to the student's computers. According to the authors a 75% reduction in time required to set up the lab can be attained by using virtualization methods to arrange 18 student computers for the many types of lab involvements supported. This is an example of how the use of virtualization and physical organization are not mutually select in lab development. Vivar and Magna [10] propose creating a physical networking lab that connects to a central hub that is then connected to the internet allowing for a physical lab available to anyone remotely. There are many references featuring the virtual lab as the most actual method of teaching students about networking.

Girds and Tilley [6] propose using a virtual laboratory to solve three issues.

- i. High upfront costs
- ii. Space constraints
- iii. Cost of maintenance and monitoring

They note that cost savings for hardware are rather moderated by the need for high performance machines capable of running multiple virtual machines.

Baumgartner et al. [3] describe the use of virtual routers to match physical networks. Virtual routers are individual software procedures that process data packets just as a real router would. They are not subject to the problems of simulations nor are they subject to the high cost involved with using physical networking hardware. Although there are many advantages to using virtual routers one must be careful when running multiple virtual routers on one machine as the host OS will allocate resources according to its own commands and therefore may interfere with the real time processing of packets.

Perez-Hardy [11] proposes the use of network simulation tools in an effort to solve the following problems

- i. Cost of monitoring equipment
- ii. Maintaining hardware and software
- iii. Scalability
- iv. Remote access

Remote access abilities to laboratories are a topic of rising interest in the design of computer networking lab facilities. The independent of remote access is to provide students with the ability to control and arrange physical, simulated or virtualized hardware and software from a location other than that where the hardware and software are physically presented. Sloan [12] notes that although there are many benefits to remote access the designer needs to take into account three important challenges.

- i. Safety
- ii. Manageability
- iii. Authenticity

Security refers to the ability of adjusting access to the lab's resources. Manageability is the quality of making the lab easy to change, modify and repair. Authenticity is the ability to provide thought irritating activities that help capable learning of important concepts.

### 3. SELECTING A DESIGN

The following analysis is not designed to reach a conclusion as to which type of design is the best but, just to associate and contrast the different types of designs so others may use this to help them make choices about which design to implement based on academic and budget purposes. Concessions are recognized on the basis of accessibility of physical space and of funds for the laboratory, costs of software licenses and previously installed infrastructure to just mention a few. Physical labs, as discussed above, are established using physical hardware and associated software. There are two topologies for a physical lab setup:

centralized and spread. A centralized topology, as illustrated in Figure 2 refers to having only one set of network hardware devices centrally located for easy access and maintenance. This however limits the disposal to students as only one group can work at a time.

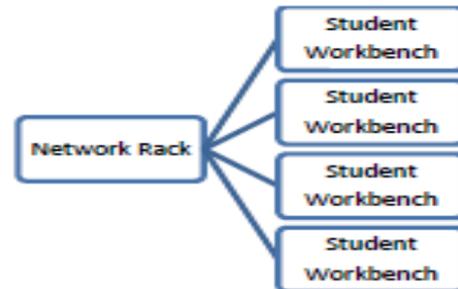


Figure 2. Centralized topology

A distributed (decentralized) topology, as illustrated in Figure 3 is collected of several worktables each with its own network devices agreeing more than one group to work at a time and even interconnect worktables. This style however is more costly and its management requires more planning.

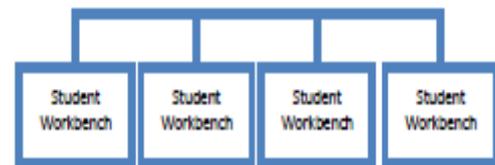


Figure 3. Distributed topology

The most important advantage to using a physical organization is that it delivers true hands-on experience that is most similar to the environment students will be working on when they leave school. Although some might consider that communications with physical hardware are of restricted value as most equipment outline is done through a software interface [6], it is the task of the mentor to design laboratory involvements that will go elsewhere having the student blindly use the guides provided by a software interface and instead help serious sophisticated and hands-on work. The greatest disadvantages to setting up a physical lab are space, cost and power. Simulation is a great option for those who have limited funds, and lacking organization to support physical hardware. All one needs is a personal computer capable of running the software. One of the most visible problems with simulation is the assumed accuracy of the software. If the software is not developed correctly the network will not work properly and students may not get accurate results. Without constant updates simulation software may not provide for capabilities that follow the latest technology changes but updating simulation software is generally easier than updating or upgrading real networking devices. Virtualized laboratories take some aspects of physical hardware and simulation based labs. Virtualization allows many physical devices and software examples to be instantiated within a single physical machine.

Elements such as hosts with different operating systems, router devices and the connections between them can be virtualized. An example of a virtual network might look something like Figure 4. The use of virtualization for laboratory operation involves using limited amounts of physical systems and creating virtual instances of operating systems and networking hardware including routers in them [3]. Virtual labs can be seen as cooperation between a completely physical organization design and a simulation based design. An attractive feature of virtual labs is that one can growth the size of the lab by adding limited amounts of new physical hardware and instantiating in them new network hosts/devices.

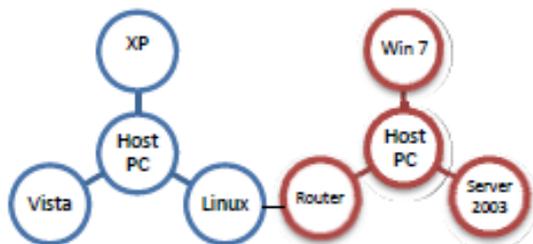


Figure 4. Virtualized topology

A general choice in labs with virtualization is to setup student PC's using virtual images of the proper operating system setup. This allows the lab administrator to create one correct setup and easily transfer it to each student computer. There are several Marketable software applications that will help to create and manage a virtual lab. The most popular is VMware's suite of applications that are used for creating and managing virtual machines. For setting OS permissions and virtual image management Microsoft Application Virtualization provides a good solution. In an effort to summarize some of the features of the different lab designs methods table 1 provides a comparison among them.

A popular decision in labs with virtualization is to setup student PC's using virtual images of the proper operating system setup. This allows the lab administrator to create one correct setup and easily transfer it to each student computer. There are several commercial software applications that will help to create and administer a virtual lab. The most popular is VMware's suite of applications that are used for creating and managing virtual machines.

#### 4. REMOTE ACCESS TO COMPUTER NETWORKING LABS

In a world of growing inter-connectedness, physical boundaries are increasing and lab designers need to take into account those who strength need or want access to the lab from remote locations. Any of the three design approaches mentioned earlier can be prepared for remote access.

A physical lab can be connected to a web server that is available to anyone with an internet connection and can authenticate user identifications to allow access to

equipment. In general, if remote access to physical devices in a lab infrastructure is a difficult undertaking that requires alert planning. Redundancy of connections to the lab and availability to its configuration platform need to be measured.

Table 1. Comparison of lab design approaches

	Initial Costs	Reoccurring cost items	Operational Requirements	Physical availability	Space/ Power
Simulation	Low	Software licenses	Steep learning curve	High	Low
Virtualization	Moderate	Software licenses, hardware upgrades	Lots of setup	Moderate	Moderate
Physical (Centralized)	High	Hardware upgrades	Easy maintenance	Low	High
Physical (Decentralized)	High	Hardware upgrades	More difficult maintenance	Moderate/Low	High

Remote access to simulation based labs can be provided through remote desktop technology or by having the student install the simulation software on a personal computer. Virtual labs can also be accessed with the use of remote desktop technology and if all of laboratory's functionalities, including connectivity setup are implemented through virtualization software, the remote access would provide an almost equal involvement to the remote user as that of the user.

#### 5. INSTRUCTION AND LAB STRATEGY

The design of an instructional lab must be based on well-informed academic purposes which aim at effectively providing involvements to students that enhance their learning and understanding.

Lawson and Stack pole [8] performed an experiment with their Introduction to Network Administration class at RIT. They had one group using remote access to a VMware server and another group using a physical lab with VMware workstations installed. Therefore one group was using a physical lab with virtual machine images installed and the other group used a remotely Available virtual environment. The experiment found using a 95% confidence interval that the students' success was not depending upon the type of lab that they used.

Students mentioned problems with self-motivation while using the completely virtual lab due to the added difficulty of using the virtualization software. Students using the virtual lab expressed their desire in not being forced by lab access which is one thing their peers had complained about. Students using the in-class lab however had easier access to the instructors.

Students in the in-class group scored better on all three direct assessment measures: Lab Execution, Exams and Workshop. The variations were: 5%, 5%, and 8% respectively. Qualitative surveys were administered to both groups; some obvious differences arose. Remote students

found the teaching assistants more helpful but also reported feeling the pace of the class was too quick. Some students in the remote group also experienced technical difficulties with the remote interface. An exciting assumption was that the remote lab provides a very good environment for repeating lab projects even if the students had access to the physical lab the first time.

From these studies we can see that learning outcomes can be similar if not equal when comparing remote access to local access. This issue needs further testing but is very interesting to the authors.

## 6. SUMMARY AND CONCLUSION

Laboratory involvement is a necessary element in computer networking courses as a solid base of theory is of no use without the knowledge of how to put it into exercise. When building a new networking laboratory it is necessary to decide upon the type of approach to use: physical, virtual, simulated, or some grouping of the three depending on which one better suits academic goals and needs.

Among the issues to consider when deciding which type of lab to use include the following: cost, space, power, availability, remote access, course requirements, and commercial support. Cost will likely be the causal factor but sometimes a higher upfront cost will allow for greater accessibility, better devices and therefore greater use of the facility. If current trends are any sort of model for the future, remote access will be one of the most important features of any laboratory facility for the teaching of computer networking topics and their design, management and academic value should be explored further.

## REFERENCES

- [1] Sam Disston and Carlos E. Caicedo, "Approaches to the Design of Computer Networking Laboratories" in ITERA conference, Nashville TN, in 2010
- [2] S. Abbott-McCune, A. J. Newton, J. Girard, and B. S. Goda, "Developing a reconfigurable network lab," in 9th ACM SIGITE conference on Information technology education, 2008, pp. 255-258.
- [3] F. Baumgartner, et al. "Virtual Routers: A Tool for Networking Research and Education." *Computer Communications Review* 33 (2003): pp. 127-135.
- [4] C. E. Caicedo and W. Cerroni, "Design of a Computer Networking Laboratory for Efficient Manageability and Effective Teaching," in ASEE/IEEE Frontiers in Education Conference San Antonio, TX, 2009.
- [5] P. Dillenbourg, "What do you mean by 'collaborative learning'?" in *Collaborative Learning: Cognitive and Computational Approaches*. Advances in Learning and Instruction Series. New York: Elsevier Science, Inc., 1999, pp. 1-15.
- [6] J. Girds and S. Tilley, "A conceptual overview of the virtual networking laboratory," in 8th ACM SIGITE conference on Information technology education, 2007, pp. 75-82.
- [7] C. Gravier, et al. "State of the Art About Remote Laboratories Paradigms-Foundations of Ongoing Mutations." *IJOE* 4.1 (2008): 19-25.
- [8] E. A. Lawson and W. Stackpole, "Does a virtual networking laboratory result in similar student achievement and satisfaction?," in 7th conference on Information technology education: ACM, 2006.
- [9] P. Roy, I. Altas, and J. Howarth, "An Implementation of a Remote Virtual Networking Laboratory for Educational Purposes," in Information Technology Based Higher Education and Training, 2006. ITHET '06. 7th International Conference on, 2006, pp. 71-76.
- [10] M. A. Vivar and A. R. Magna, "Design, implementation and use of a remote network lab as an aid to support teaching computer network," in Digital Information Management, 2008. ICDIM 2008. Third International Conference on, 2008, pp. 905-909.
- [11] S. Perez-Hardy, "The use of network simulation to enhance network curriculum," in 4th conference on Information technology curriculum: ACM New York, NY, USA, 2003, pp. 93-95.
- [12] J. D. Sloan, "A remotely accessible networking laboratory," *Journal of Computing Sciences in Colleges*, vol. 18, pp. 215-222, 2002.

## BIOGRAPHIES



Mr. Sagar R. Mali, M. Tech CSE  
Worked as Assistant Professor  
AITRC, Vita. Sangli,  
Shivaji University Kolhapur,  
Maharashtra, India.



Mr. Yogesh B. Amane, M. Tech CSE  
Worked as Assistant Professor  
AITRC, Vita. Sangli,  
Shivaji University Kolhapur,  
Maharashtra, India.