

Enhancing Practical Skills in Data Communication and Networking Course by Usage of Modern Tools

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Abstract : Computer Networks is an important subject in many engineering and Science degree programmes. Computer network domain requires experts with strong knowledge in networking with hands-on experience. With the recent technology improvement in this domain, the demand for qualified engineers in networks is expanding. Hence after learning using network simulators provide effective environment to understand the networking concepts. Nevertheless, the network simulators may not give the same experience of physical devices like wiring between the end systems. The simulation of the physical connectivity can be visualized to the students. The main purpose of the study is to see the effectiveness of the use of Cisco Packet Tracer and OPNET (Optimized Network),

as a primary method of learning the technical knowledge related to the course. Student's feedback on the new methodology used will also be discussed. This paper discusses how modern simulation tools help students understand the technicality involved and make data communication and networking course more engaging and interesting.

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1. Introduction

Data communication and networking is a significant course for the students in engineering and science stream. Students cannot understand the course without the technical base of it. For e.g., If TCP/IP model is taught to students but they are not able to analyze the protocols working and packet transmission visually. Henceforth a strong analyzing capacity is required for them to interpret the same. To succeed in this perceptive a simulation of all the scenarios is required. The simulation tools benefit us in this response. Engineering organizations created different simulators such as Cisco Packet Tracer, Boson NetSim, OPNET and GNS3, NS2, etc. These simulation tools help both the students and the instructor. Understanding the primary method in learning the subject mainly in attainment of technical knowledge is strengthened by using the Cisco Packet Tracer for learning needs to be investigated. This paper discusses about how Packet tracer and OPNET tools helped in understanding data communication and networking concepts and make them more engaged in learning.

2. Previous Studies

Yongbin et.al [3] describe how they have used packet tracer tool in demonstrating computer network problems in the laboratory. They have experimented

on non-computer students to teach networking concepts.

Shivaraj Hublikar et.al [4] describe use of network simulators how it helped students in effective learning of networking concepts with the creation of virtual network environments. Using OPNET to solve some of the complex network programs in the curriculum. This tool provides greater experience to students as only teaching theory may not suffice them to learn the concepts clear and usage of OPNET provided easy understanding of the concepts which is like testing with physical hardware devices. It also provided more interactive sessions which motivated students to correlate with the real-world cases.

Jorge Crichigno et.al [5] presented a model on education in computer networks to provoke students. The model comprises mixture of organizational and collegiate divisions. The emphasis is given to more practical sessions of solving real world problems. This will bridge the gap between the demands of industries for skilled professionals in computer networking. The past few years results shown tremendous difference in student's learning curve and attraction of new students to the domain.

Jayalaxmi et.al [6] describes how the Computer Network concepts teaching are made simpler. They describe a new idea on teaching the networking course using group activities. The students are given with Request for Comment documents, Survey papers to understand and come up with the solution to the problem by discussion among the group. At the end of the session the students are more satisfactory with the course and are more knowledge and motivated to put an extra effort to succeed in the field. This also helps them to gain confidence and build good communication skills which are required for the industrially needs.

The present work describes about

- How the learning skills of the student can be increased by the usage of the modern tools
- How the programme outcomes can be increased for a course.
- How visualization of the course makes student understand the concept more clearly. e.g., packet transmission inflow with protocols.

- Increase student's ability to understand the technical part of the course. E.g. protocol suite of TCP/IP.
- Creating peer to peer learning among the students and help them to build team building skills

3. Proposed Methodology

A. Participants

UG students-120 students comprising boys and girls.
Course- Data Communication and Networking.

B. Materials

A brief overview of technical details of Packet Tracer and OPNET is discussed.

i. Packet Tracer

Packet Tracer is used to simulate the behavior of various protocols used in computer networks. It includes Layer two protocols Point-to-Point and Ethernet, Layer three protocols like Internet protocol, Internet Control Message Protocol and Address resolution protocol, and layer four protocols like Transmission control protocol and User Datagram protocol. Packet tracer helps to gain knowledge on how the packet transfers happens between the systems but it is not a replacement to the physical hardware testing. Students are energized to correlate the output from Packet Tracer models with the physical hardware testing [1]

ii. OPNET

OPNET simulator is a tool to simulate the behavior and performance of any type of network. OPNET is a network simulator with many components like packet format to specify protocols, a node model for enumerate network component unite, a process model for abstracting nature of a specific network module, a project window for determining the geography of the network and various connections, and a simulation window that can capture and show the output of network reflection. [2]

OPNET eases the analysis and design of computer networks, application protocols and devices. OPNET also has development environment that grant to modeling any type of network and different technologies such as MPLS, IPV6, TCP and VOIP. This software works same on both 32 bits and 64-bit

platforms and supports easy to build with various libraries, secondary object files and other network simulation tools. OPNET provide different networking results for managing network performance, application performance, and network Research and Development. These available implementations are successfully and operational by various organizations worldwide including government entities, network service and hardware providers [2].

C. Procedure

For the UG students who had a course related to networking had a laboratory component. The open ended experiments were designed where students were given an option to select any network simulator tool to solve their respective open ended problems. The instructors of the course as prerequisite taught the students Packet Tracer(Cisco Packet Tracer 6.0.1 version) and OPNET (Riverbed Modeler Academic Edition (free version)) tools to them. Then they were given an option of using the same to solve their problems or could select any other simulator tool to solve. Students was also asked to team up with maximum 4 to 5 in a group to demonstrate their problem solving methodology and how they obtained the solution to it and document them effectively.

The procedure followed was an integrated course taught in the regular odd semester which had a lab component included was choosen. The strength of the class was 60 students there were two sections in total 120 students per semester. The regular laboratory cycle was designed by the instructors of the course and lab cycle had 10 experiments designed and there were 12 students per batch for a faculty to handle in laboratory component.

The course marks distribution was:

CIE:50 marks and SEE: 50 marks.

CIE marks distribution: Theory:25 marks and Laboratory Component:25 marks.

Laboratory Component marks distribution : Lab Test: 15 marks and Demo with review :10 marks. Students were asked to build a team minimum of 2 to 5 maximum in a batch for demonstration. The students were given opportunity to design one open ended experiment which must be approved from their

instructors, they were given a chance to either select either OPNET,Packet Tracer or any other simulation tool. Two reviews were conducted where first review they were supposed to propose the problem. In review 2 the selected problem was to be demonstrated in a team.

The parameters for the measurement was: Usage of modern technological tools,Communication and Presentation skills, Designing, Analysis of Experimental results,Documentation. The review process was evaluated on basis with course instructor evaluation and peer to peer evaluation procedure.

ii. List of Sample solved open ended experiments using OPNET

- Design a network with three nodes point-to-point networks with duplex links between them. Set the queue size and vary the bandwidth and find the number of packets dropped. Compare the results considering different scenarios.
- Design a network with a laptop, tablet and mobile phone to be connected via wireless network.
- List of Sample solved open ended experiments using packet tracer
- Design a network for an organization that has three floors. It has 5 departments (HR, IT, Finance, Management, Trainee). The departments are in turn connected to each other. There are approximately 25 users in each department. The users in the different departments should be interrering accessible. Compare the design with static and dynamic routing algorithms.
- Design and set up the network for the following requirements. Assume that you are a network administrator at a XYZ company. Company has three departments
- Connected with wan links. Development department have 74 computers. Production department have 52 computers. Administrative department have 28 computers. All departments are connected with each other via wan link. Each wan link requires two IP addresses.

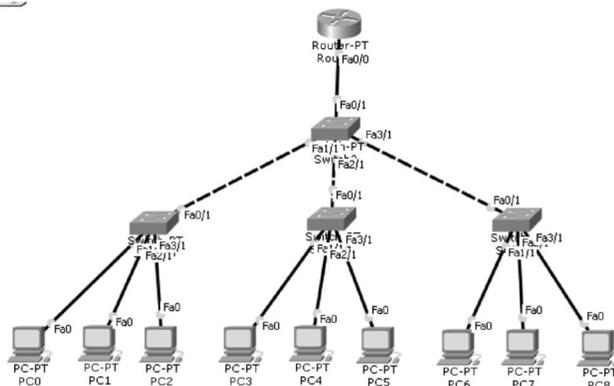
4. Results

The results are outlined in the following format

- A. Case Study: Examples solved by students using Packet Tracer and OPNET are illustrated with examples.
- B. Instructor's Observation
- C. Attainment of the Programme Outcome for the course
- D. Practical Results
- E. Discussion of Results
- F. Limitation of the study with future enhancement

A. Case Study: Examples solved by students

i. Illustration of an example using Packet Tracer



ii. Illustration of an example using OPNET

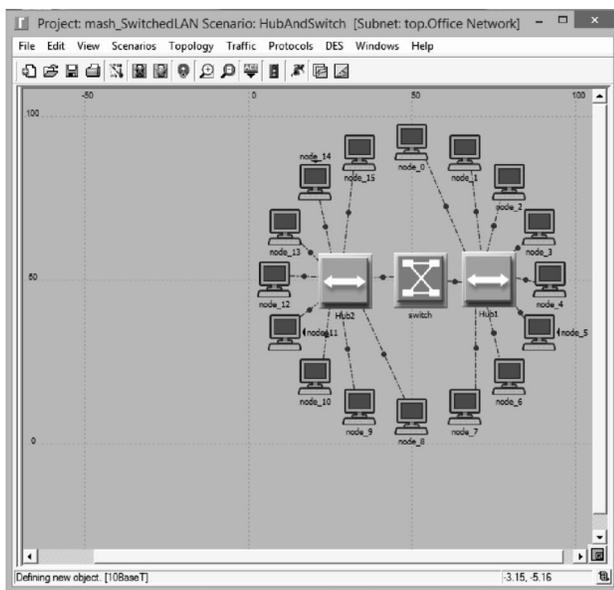


Figure 2. Snapshot of implementing Switched Local Area Network using OPNET

Figure1. Snapshot of implementing VLAN [Virtual Local Area Network] using single DHCP [Dynamic Host Configuration Protocol] Server using Packet Tracer

Figure 1 shows the snapshot of the topological implementation of VLAN using DHCP server which was one of the best solved scenario of the open-ended experiment by the students. This example gives clear understanding of Virtual Local Area Network setup using Dynamic Host Configuration Protocol Server demonstrating his with the Packet Tracer tool.

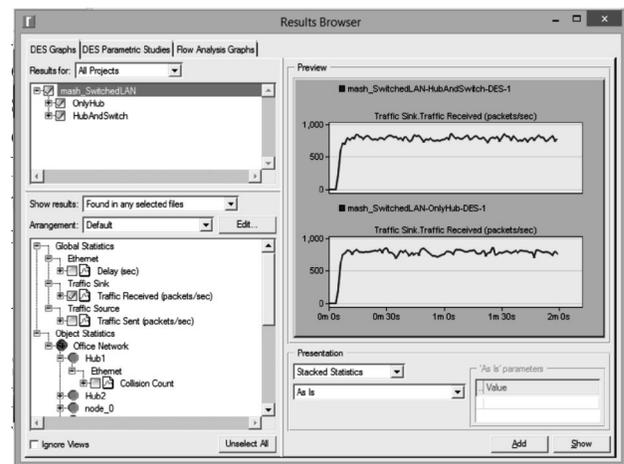


Figure 3: Snapshot of results for Traffic Sink

very much interested in learning various concepts of networking using simulation tools They were very much interested in creating their own scenarios and always kept on asking what if questions. They had a better understanding of connecting physical devices, using appropriate cables and assigning proper IP address to various networking devices.

B. Attainment of the Programme Outcomes[PO] for the course

Course outcomes written for data communication and networking course before introduction of the open-ended experiments a course data communication and networking had attainment of PO1, PO2, PO3, and PO4. After the introduction of the Open-ended experiments with usage of two simulation tools Packet Tracer and OPNET. The students were asked to demonstrate their problem-solving skills for those experiments. A detailed report was submitted. These parameters helped in spreading of PO's to PO5, PO9, and PO10. This improved the communication skills both written and presenting

skills and effective team building skills. The CO-PO mapping for the course is shown in the table 1.

The Programme outcomes attained for the course were:

PO1: Engineering knowledge

PO2: Problem analysis

PO3: Design/development of solutions

PO4: Conduct investigations of complex problems

PO5: Modern tool usage

PO9: Individual and team work

PO10: Communication

Table 1: CO-PO mapping table

| | | |
|-----|--|-----------|
| CO1 | Acquire knowledge about the various principles of communication | |
| CO2 | Apply the data link layer protocols to solve real life problems. | PO1 |
| CO3 | Analyze the protocols used in MAC layer. | PO2 |
| CO4 | Design wireless LAN, any network using internet networking concepts and protocols. | PO3, PO5 |
| CO5 | Conduct experiments on designing different networks, packets transmission and protocols working using modern engineering tool. | PO4, PO5 |
| CO6 | Demonstration and presentation of the network related concepts in a team. | PO9, PO10 |

C. Practical Results

Student's feedback was received for the methodology followed. To measure how approachable, it was to them. The feedback analysis is shown in the Figure.4 which shows the responses received from all the 120 students on a scale ranging from Strongly Agree to Disagree. The analysis of effectiveness of Packet Tracer tool is, the percentage of students strongly agree are 55%, agree are 35%, partially agree are 1% and <0.5% disagree with this tool usage. The analysis of effectiveness of usage of OPNET tool is, the percentage of students who strongly agree are 33%, agree are 33%, 25% partially agree and 1% students disagree with the tool. In

equivalence with the analysis taken from the student's response we clearly understand that they are very much satisfied with the usage of modern tool. It indirectly shows that they have understood the concepts better with the introduction of the simulation tool in their curriculum.

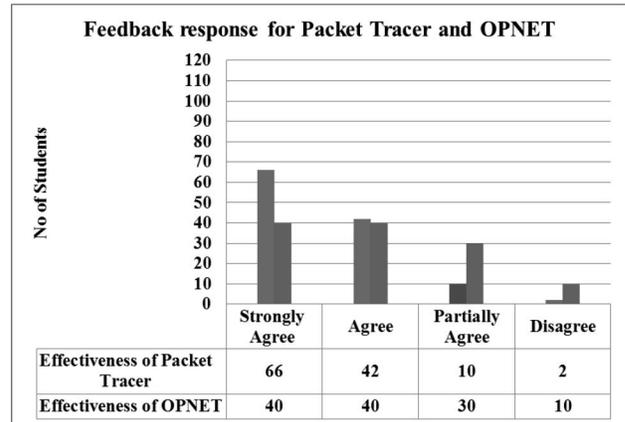


Figure 4: Analysis of feedback responses obtained from students

D. Discussion of Results

The demonstration of the Packet Tracer tool experiments from the students showed their placidity to instructor's how well the understanding capacity of the student is increased. And OPNET tool demonstration also increased the instructor's confidence by analyzing the student's thoughtful clarity in technical concepts. There is also clear understanding about the difference in working of various networking devices and their appropriate use in connecting various hosts together. The multi-user functionality of a packet tracer helped the students to collaborate and compete to increase and enhance the learning of different concepts. The OPNET simulator tool also made students to understand concepts strongly about data link layer and network layer functioning. The programme outcomes attained for the course is increased. It addresses communication and team building skills as the highlight with introduction of open ended experiments demonstration. With respect to the feedback taken from students the effectiveness of usage of tools, proved that it did have an impact on the learner. Learning and understanding was made easy with the usage of these tools. The classroom teaching of the networking course can be made effective by using simulation tools.

E. Limitation of the study with Future enhancement

The current teaching methodology implementation was included with only two simulator tools. There are few more networking simulation tools available which could be introduced to students. The learning could be improved in students where they are able to compare the implementation using different tools. The result analysis of the student scores could have helped in gauging the students understanding capability. With feedback from students their scores could also be considered and included in the evaluation process.

4. Conclusion

The conventional method of organizing lab was based on predetermined problem statement provided in the curriculum. With the innovative approach, it has been found that the modern way of conducting laboratory by giving open-ended experiments and introduction of OPNET and Packet tracer simulator tool were effective for simulation assignments. The simulation tools helped students to understand networking concepts more clearly. It also helped to perceive how the network packets travel between the source and destination nodes. Our innovative activities resulted in better learning for the students and thus increasing their confidence level. Another important fulfillment is that multiple teams of students can work in parallel, thus nurturing student interaction and team work experiences.

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