Classroom-based Multi-player Network Simulation

Experiences of interactive scenarios using Packet Tracer

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***Abstract*— The delivery of group-based remote collaborative work in the practice based learning domain of computer networking, historically has presented challenges in scale, management, security and technological resource to support delivery, assessment and learning. In partnership with the Packet Tracer development team at Cisco Systems, this paper explores the outcomes of a series of class based experiments, supporting the research into the development of a 'simulated' Internet using Packet Tracer.**

Keywords- packet tracer; practice based; collaborative; Cisco; virtual labs; Networking Academy; CCNA; Supported Open Learning; gaming;

I. INTRODUCTION

The Open University in the United Kingdom has offered the Cisco Certified Networking Associate (CCNA) and Cisco Certified Networking Professional (CCNP) via blended distance learning to over 3000 students since 2005, as discussed by Moss and Smith [1].

Research into the creation of learning solutions for students taking the CCNA and CCNP programmes via blended distance learning has already taken place with work on the NDG [2] system in the management of remote tutorials using Skype by Smith and Moss [3] and the utilization of the virtual laboratory by the setting of course assessment items, Prieto-Blázquez, J. et al. [4]. The utilization of the Packet Tracer environment led to the initial development of a remote relay server using a one:many community of practice, where each participant connected their remote simulated network (the client) to a central simulated network (the server), as described by Smith and Bluck [5].

A conclusion of the research by Smith and Bluck is that there was the potential to develop group-based activities, where learners in an online situated learning environment, Lave, J. et al [6] could work on a simulated practical to create a large infrastructure, based on a set 'local' task to create a Wide Area Network (WAN) connection with a Local Area Network (LAN).

This paper explores how the research was extended into classroom-based experiments, how these were designed, the rationale for group selection.

A. *The group-based scenario*

The group-based activity is presented to students in two parts. A reflection on previous work accomplished with packet tracer was that many students as well as their instructors did not as yet understand the full feature and function of the inbuilt 'multiuser' tool. To overcome this, the student group would commence the activity with a formative warm-up exercise, where students are paired with the task of creating a simple network of two hosts and being able to send a 'virtual' ping from one Packet Tracer instance to the other across the academic network as illustrated in Fig. 1.

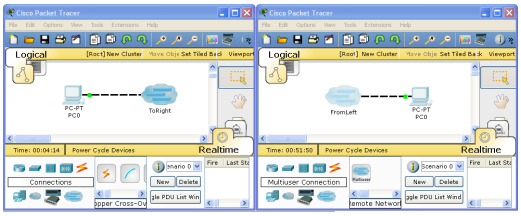

Figure 1. Peered example of Packet Tracer Multi-user communication.

This short exercise sets the scene and ensures all participants are working from the same stand-point in their ability to use the software. All of the participants are already low-level users of Packet Tracer, by virtue of their membership as students of the Cisco Academy programme, CCNA discovery and exploration curricula [7], in the integrated use of this application in their studies. By introducing the participants to the 'multiuser' tool, their understanding of the additional tools available in Packet Tracer is increased.

Following the formative activity, the students participate in the large-scale activity to build a large-scale simulated WAN, with multiple individual simulated LAN's inside the confines of the typical academic network. Having no physical connection or contact with the underlying 'real' network environment, by virtual of the simulated nature of Packet Tracer and its use of the Packet Tracer Messaging Protocol (PTMP) [8].

The structure of the activity is a duplication of the experimentation explored in the paper by Smith and Bluck [5], with the relay, no longer a remote server, but the

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teachers computer. This assists the learning process experienced by the students and observing instructor, discussed by Laurillard [9] as in each session, the teacher's computer is attached to a classroom data projector. Each student is able to see their own multiuser connection locally as well as their remote connection on the teachers Packet Tracer instance. This reinforces the assurance they are correctly participating in the practical task and students are also successfully building a remote (otherwise normally unseen) connection.

The relay instance of Packet Tracer, run a router with a series of switches all connected to a core switch (Fig. 2). The simulated protocol selected is the Extended Interior Gateway Routing Protocol (EIGRP), in technical terms; has a lower device configuration overhead. The simulated WAN uses a class A, IP address, of 10.x.x.*n* and each simulated LAN is a Class C, with each student having 192.*n*.x.x. For each system, *n*, is a unique number issued to each participating student. The relay has been designed to cope with 120 participants, the activity will by virtual of the second class C IP address octet support 254 participants.

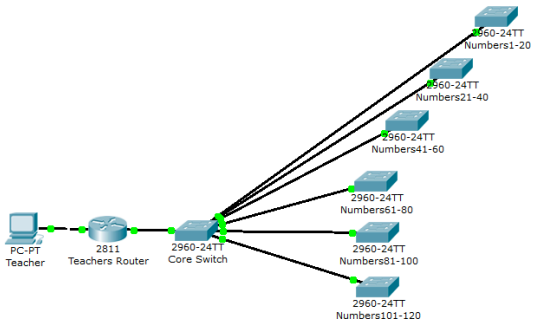

Figure 2. Teacher relay-server structure

Routing protocols as with many network technologies can be configured many different ways to achieve the same goal. To remove any confounding variance, all students are presented with an instruction sheet, with the commands they must use, and where they need to be applied. Fig 3, lists the routing commands on the teachers relay-server, which all students are able to see during the activity. Fig. 4 illustrates the routing commands the students have to apply onto their own Packet Tracer instances.

Figure 3. Teacher relay-server routing commands

```
interface FastEthernet0/0
no shutdown
ip address 10.255.255.254 255.0.0.0
interface FastEthernet0/1
no shutdown
ip address 200.200.200.200 255.0.0.0
router eigrp 123
network 10.0.0.0
network 200.200.200.0
no auto-summary
```

```
interface FastEthernet0/0
no shutdown
ip address 10.0.0.n 255.0.0.0
interface FastEthernet0/1
no shutdown
ip address 192.n.0.1 255.0.0.0
router eigrp 123
network 10.0.0.0
network 192.n.0.0
no auto-summary
```

Figure 4. Student Packet Tracer instance routing commands

The students own instance of packet tracer is a self-constructed system which when assembled should resemble the illustration in Fig. 5. The system is deliberately simplified to reduce any potential confounding variance, by ensuring the students had two specific devices and cable types to implement.

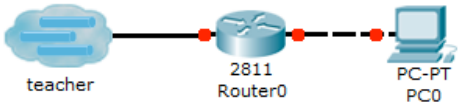

Figure 5. Student Packet Tracer instance

B. *Selecting the groups*

The challenge in any activity requiring volunteers is the recruitment of the volunteers themselves. In the time span since the initial research and paper there have been three successful interactive scenarios. The timing of these have been principally driven by centre availability and timetabling constraints, collaborating teacher availability and ensuring the session fits in with the students learning, where the activity is in harmony with their studies and their current curriculum.

All participating students need to have a minimum of the equivalent to Cisco CCNA exploration or discovery first course behind them to have a comprehension of the networking terminology and technology.

The student age range was kept to a small window, with participating students being either second years on a high school equivalent technical vocational programme [10] or first years on an undergraduate honours degree programme. This gave a range of 17-20 years of age with the majority in the 18/19 year-old age group.

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The sessions were in May, November and December 2010, reflecting the academic calendars of each group and availability. The May and November sessions were with two groups of 18 and 11, 17-19 year olds at a college of further education. The December session was with a group of 30, 18-20 year-old year one undergraduate students at a London University.

Group selection was based on the class/group available at the time suited to the demands of timetable, and availability of the willing volunteer teacher and the researcher.

II. MANAGING THE ACTIVITIES

The sessions were scheduled for a three hour ½ day block, according to timetabling. The first was a morning session 09:00 to 12:30 with break, the second session was 10:30 to 15:00 with intervening lunch break and the third session was a PM session from 14:00 to 17:00 with a short break.

Each session used the majority of the time, with an average of thirty minutes remaining to enable the students to complete an optional challenge activity.

In each session the researcher acted as teacher/facilitator whilst the normal session teacher/instructor acted as class-room assistant and secondary observer.

Each session was facilitated as a in-class teaching session, where each of the student participants were aware that they were helping to test the multiuser functionality of Packet Tracer and get in return additional networking skills (learning).

Using a data projector connected to the teacher's computer running the relay instance of packet tracer, provided an essential conceptual and visual tool for students already discussed by Janitor and Kniewald [11]. Enabling them to see how their own LAN and WAN was behaving in relation to the greater WAN infrastructure.

Typical of an academic network, each computer running had the same hardware specification and operating system installation, including local policy constraints and user rights, therefore ensuring that each student participating had the same technological advantage/disadvantage, as all others during the lifecycle of the activity.

The activity was managed in a systematic follow-the-leader step-by-step format, keeping all students to the same position in the process. By having the additional facilitator, the students were able to remain engaged and have their questions/misunderstandings answered.

III. OBSERVATIONS

Qualitative feedback was collected from each cohort, the intention was to understand their personal viewpoint of their experience participating in the sessions as well as participating in the activities.

At the end of each session, before departure, the students were asked to complete a short anonymous questionnaire, with questions listed in Table 1.

TABLE I. QUESTIONAIRE

Question Number	Question
1	Has this exercise enhanced your practical understanding of IP addressing? (Y/N)
2	Have you used the Packet Tracer Multiuser tool before this session? (Y/N)
3	In your own view, has this given you some understanding of routing protocols? (Y/N)[a]
4	Would you consider continuing to use Packet Tracer in the way demonstrated today? (Y/N)

a. this was contextualized for some students, describing their use of EIGRP

The questionnaire results are summarized in Table 2. As the groups are small, and the questionnaire short, there are no missing responses. The students were able to drop the forms into a box on departure. There was no additional personal information requested.

TABLE II. QUESTIONAIRE RESULT DATA

Question Number	Feedback					
	May (18)		*November (11)*		*December (30)*	
	Y	***N***	***Y***	***N***	***Y***	***N***
1	14	4	11[a]	0	21	9
2	0	18	0	11	2	28
3	15	3	11	0	*24*	6
4	16	2	11	0	26	4

a. this is earlier in the academic year for this cohort

From the results in Table 2, the dominant feedback implies that the students believed that using the simulated practical was a personal benefit, where the responses to questions one and three indicate a high percentage (Table 3) of positive responses to the enquiry.

TABLE III. QUESTIONAIRE RESULT PERCENTAGE

Question Number	Feedback as a percentage					
	May (18)		*November (11)*		*December (30)*	
	Y	***N***	***Y***	***N***	***Y***	***N***
1	77.7	22.3	100	0	70	30
2	0	100	0	100	6.7	93.3
3	83.3	16.7	100	0	*80*	20
4	88.8	11.2	100	0	86.6	13.4

It is notable that for the November cohort, the groups of students were in the early stages of their learning for the

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academic year, whereas the May and December cohorts were either at the end of their respective academic year or semester.

Questions two and four explored the student's experience of Packet Tracer. Apart from two outliers (reason unknown), question two indicated that the majority had not used the multiuser tool beforehand. With Question four, the response indicates an interest held by the students to continue using the multiuser tool in packet tracer. This may have been stimulated by their feelings regarding the preceding session.

In engaging with the practical activities, the students could be seen to link constructivist personal concepts as described by Piaget [12] and readily connect their own private concepts to a visual, simulated physical network environment.

IV. NEXT STEPS

The centres involved are willing to host future sessions, inviting the researcher back to continue the same exercise as well as different scenarios.

Other centres are interested in participating in the research and are willing to engage in the activities described in this paper, as well as working towards more complex scenarios. The challenge for these centres as for the original participants is finding the right group, at the right time in their year as well as in the study week.

More complex systems have already been designed, where the students will participate in an activity to create a relay-mesh, with the students working in a group to build one system around a local relay. The local relay will connect to a central relay, illustrated in Fig. 6, as a relay-relay.

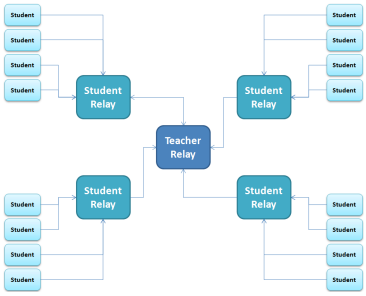

Figure 6. A relay-relay model

Once the centres, the students and also the teacher/instructors become familiar with the technology and the constructivist learning experience, the plan is to move the activity to a remote 'central' relay server model. This is reflective of the work carried out by Smith and Bluck [5] in 2009 and able to support a larger collaboration of participants.

V. CONCLUSIONS

The activities have demonstrated that once the student has been given an introduction to the multiuser tool, they are able to engage in a structured activity to build a complex simulated network environment, reflecting the model of situated learning discussed by Lave and Wenger [6].

Formal questionnaire feedback as well as the in class anecdotal experience of the researcher, reflects an enthusiasm from the learners to continue studies using the Packet Tracer application in this mode.

Research discussed in this paper, allied with prior research suggests that the structured development of a system to create a simulated Internet would provide an alternate learning methodology for in class as well as remote distance based learners.

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