

## Development of a vendor practice-based distance-learning programme

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### Abstract

The case study describes the methods used to provide laboratory activities, or their equivalents, to students pursuing Open University (OU) modules delivered by distance learning at undergraduate and postgraduate level in networking. The modules incorporate the study of Cisco Academy materials and prepare students for Cisco professional qualification exams as well as OU assessment for HE credit.

Three modes of experimental activity are described:

1. attendance at physical laboratories
2. remote online access to equipment
3. use of online simulation software.

The merits of each mode of operation are presented and discussed.

### Background

The Open University [1] has about 240,000 active students at any one time undertaking home based study, predominantly on a part time basis. Its core operational model involves the design and development of module curriculum and media content by its academic staff and a module presentation system based on provision of student support through a network of OU employed Associate Lecturers. Students access their learning materials and support services through the OU's Moodle based VLE. So each student currently benefits from online access to high quality teaching media and participation in a student group (~20), enjoying the close support of an Associate Lecturer who is expert in both module content and the challenges of study through distance learning. The Open University has from its launch in the early 70's presented a wide programme in STEM subjects tackling the challenges of provision of laboratory experience through a number of mechanisms:

1. Attendance at residential schools that utilise the laboratory equipment and facilities of face-to-face institutions for intensive laboratory or field study based teaching and learning.
2. The provision of Home Experiment Kits specially designed to enable students to carry out realistic experiments in their home environment.
3. Use of media such as DVD and online media to provide materials for observation or simulation of experimental activity.

Patterns of use have changed over the institutional lifetime with changing technologies and financial considerations.

The team responsible for the modules set out to pioneer two significant innovations to the OU standard operational model; firstly to develop a module in which the majority of the teaching material would be derived from an outside source, namely materials available through the Cisco Network Academy system, and secondly to address the challenges of providing distance learning students with access to the equipment and resources needed to provide the practical experience and skills development integral to Cisco programmes.

### **Overview of project**

Open University Module T216 Cisco Networking was planned to fulfil a dual function; to provide a module providing the knowledge and skills required as the networking element of a number of first degree study paths, and also to provide a route to enable students to secure the Cisco Certified Network Associate (CCNA) qualification [2]. Many other universities provide similar dual purpose modules but the OU team have been the first to devise mechanisms for effective delivery at large scale by distance learning with student cohorts of 600 or so. From the outset there are some obvious parallels between the way the CCNA curriculum is delivered through the Cisco Networking Academies [3] and the UKOU's supported open learning model. Looking within the Cisco CCNA programme, for example, these include the use of the universities internal 'student home' site, an on-line curriculum, the use of simulation tools such as Packet Tracer, and on-line assessment, both formative and summative. The one obvious difference is that the CCNA is primarily intended for delivery in the classroom.

Teaching the practical skills using real equipment is an essential learning outcome for the CCNA curriculum. The integrity of the final examinations is important for maintaining the credibility of the programme. Maintaining both of these features is therefore critical, even if blended teaching is used. Both of these provided a challenge for the UKOU, where normal practice is for students to take much of their formative assessment at home unsupervised, and when the use of residential schools was diminishing as a result of advances in on-line labs.

On the other hand, the ordered structure of the curriculum and the end of chapter tests both fitted naturally with the flexible timetabled teaching used on other courses.

The blended solution, that enabled the UKOU to make full use of its experience in supported open learning and meet Cisco's requirements for hands-on practical and proctored final exams, was achieved with the use of dedicated day schools and the online Netlab+ suite providing access to remote equipment [4][5]. The opportunity for students to develop and practise their skills with configuring networks has also been enhanced by the rapid developments of the Packet Tracer online simulation

system. How the UKOU has used each of these elements to deliver the CCNA Exploration curriculum is explained below.

### Day Schools

Students who wish to study the CCNA Exploration courses with the OU do so as part of an undergraduate degree programme. Currently all four CCNA Exploration courses are offered as a single undergraduate course titled *Cisco Networking*, (university code T216). Because this course is part of a degree programme, students are expected to have some prior knowledge of networking computers, their use in the workplace and basic study skills; such students are termed experienced learners in the Cisco Academy. On this understanding of student profile together with recognition that T216 would also include Netlab+, it was agreed with the UK Cisco Networking Academy that four laboratory days would be dedicated to practical skills development. As UKOU students live all over the country, attendance at a single centre is not feasible, especially when it would be better to align one day with each CCNA Exploration course.

Partnerships have been established with 11 Cisco Networking Academies in the UK and one in the Republic of Ireland to deliver the four schools. This co-operation has brought benefits to both students and academies. Students can now attend day schools closer to their homes, they are taught by experienced Cisco qualified instructors, and in some of the best equipped UK academy labs. The academies have gained extra business on a Saturday, allowing them to use facilities that would normally be dormant, leveraging extra benefit from the investment in networking equipment. Students are able to book each of their day schools, from a selection of venues and dates, using an on-line booking system developed from the normal UKOU residential management system. This system also feeds an attendance mark to each student's assessment record, in order to check that the student meets the course requirement for compulsory day schools.

A written handbook is produced for each day school, setting out the learning activities and outcomes, and is supplied to all students and day school centres, ensuring that all students gain a similar learning experience.

### Netlab+

The Netlab+ Academy Edition provides remote access to Cisco networking equipment such as routers and switches. It has been specifically designed by Network Development Group (NDG) to host Cisco training equipment on the Internet for student and instructor use, and is particularly well suited for blended distance learning [6]. It is important to remember that Netlab+ is not a simulator, but allows students to access the console port of real networking equipment, such as routers and switches. All UKOU academy students are given access to Netlab+ for the full duration of their study, normally nine months. Students' accounts on Netlab+ are organized in tutor groups to enable tutors to monitor students' use and lead sessions as necessary. Some will have accounts on the UKOU's own Netlab+; others will use

systems belonging to our partner academies, who lease access to the UKOU. Student access is provided 24/7 using the self-booking facility provided by the system. Students can access Netlab+ at any time to undertake labs as specified in the curriculum, or just to practise and develop their configuration skills. All students are required to use Netlab+. Activities specific to Netlab+ are included in the UKOU's assessment to ensure that students complete practical work that can be assessed by their tutor.

## Packet Tracer

This is a Cisco developed simulation package that allows single or multiple users to design and simulate network traffic and its routing [7]. With the advent of multiuser functionality in Packet Tracer 5.0 and the development of the Packet Tracer Multiuser Protocol [8], the Packet Tracer application enables students in disparate locations to interact on a common simulated practical activity. This potentially leads to an understanding of the practical and underpinning principles of complex computer network environment [9]. Figure 1, presents a view of a typical network that can be created on Packet Tracer and used in university assessment.

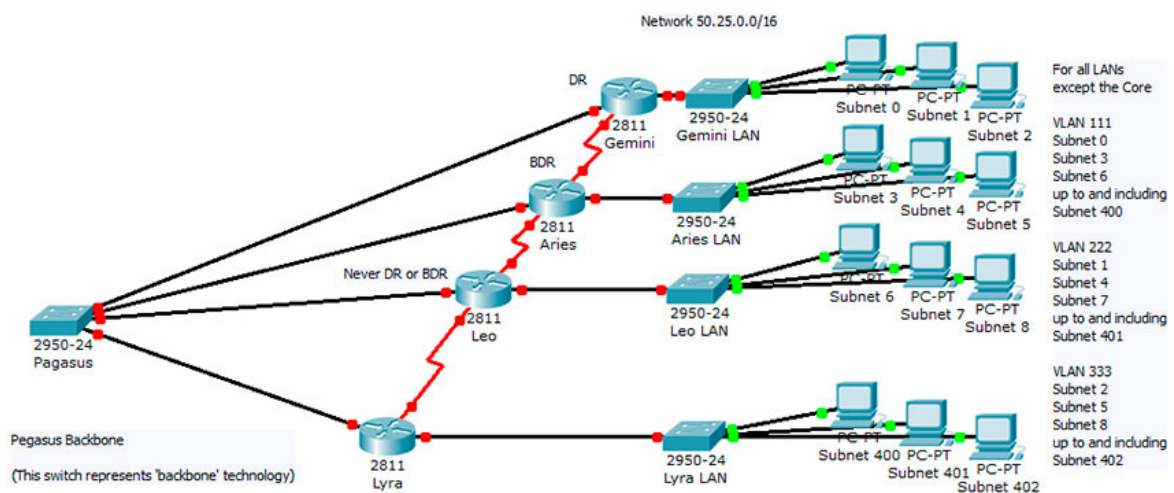


Figure 1 : An example of a Packet Tracer network used in assessment

### *The mechanics of Packet Tracer*

As a simulation environment, Packet Tracer offers router, switch, server, workstation and protocol functionality for students and educators to create diverse and complex routed scenarios, extending the pedagogical and practical experience during participation in the Cisco Academy programme. The Cisco CCNA version 4.x Exploration and Discovery curriculum contains embedded lab exercises for the students to complete. These are either in class on live technology, or remotely via the Netlab+ system. Otherwise labs exist within the online content produced by Cisco Systems, by clicking on an icon within the learning material, the student is able to launch different networking challenges using the Packet Tracer application.

### *The pedagogic advantage of Packet Tracer*

When launched, the Packet Tracer activity is goal based, giving students milestones and rewards, indicating completion percentage based on the activity scenario. As a

simulation tool, the 'network operating system' deployed on the included devices is a subset of the real-world equivalent, having the same behaviour, performance and idiosyncrasies within a contained experience. The multiuser functionality allows students and academic centres to create environments that can interact, irrespective of locale and supporting academic environment [10].

Our experience indicates that at undergraduate level, teaching objectives can now be met through use of online simulation through Packet Tracer; whereas at postgraduate level the use of the Netlab+ system giving access to remote physical equipment is necessary to fulfil programme objectives.

### **Impact on academic practice**

These activities have had impact on two major areas of academic activity relating to programme development and delivery. Use of vendor originated materials represented a major shift in OU practice: OU staff were previously responsible for the development of all teaching materials. Particular attention has been paid to assessment policies and practice to ensure that learning outcomes address generic aspects of the subject as well as the specifics of the Cisco academy syllabus. The success of T216 and related courses has been replicated by adoption of Microsoft materials [11] as the basis for other modules, but overall this mode of module development is likely to be restricted to areas in which high quality materials are freely available.

The second area of innovation relates to the provision and organisation of online laboratory access to physical equipment, and the constraints relating to reservation systems. Students are driven by assessment deadlines and in courses with high student numbers bunching of booking occur, where for individual access creates significant availability problems. Hence it is a challenge to provide sufficient access time. Use of simulation relieves the time constraints arising from shared use of real equipment.

### **Difficulties encountered**

The primary challenge for this project focussed on encouraging the understanding of two large organisations, each with successful programmes and cultures of learning, to work together and allow their established cultures of learning to absorb practice from each other.

For the Open University:

- Use of a 'vendor' certification within the discipline of networking was a new academic venture, presenting the faculty with the challenge of understanding and evaluating the academic levelling.
- Mixing four compulsory practice-based day schools into the delivery model, the costs and logistics this would involve.

- Understanding how the costs would move from ‘high production and low presentation’ to ‘very low production and higher presentation’.
- Incorporation of an established face to face practice into a blended distance learning environment.
- Recruitment of the day school partners and ensuring geographic reach as well as quality of delivery.

For Cisco Systems:

- Allowing their predominantly (and preferred) model of face to face teaching to be delivered in a blended distance learning environment with a reliance on Netlab+ and Packet Tracer.
- Understanding the change in scale of delivery from their previously typical encounters of 20-30 students at an academy raised to 600 students at the OU at any given moment.

All of these have been resolved, in part through developing a relationship of trust with Cisco Systems, also through clear evidence of the resulting high standards in delivery.

### **Benefits**

In 2009, a postgraduate programme in advanced networking was created, based on the Cisco Certified Networking Professional (CCNP) certification as well as vendor certifications in network security [12]. Per annum there are around 250 students studying at this level. The mode of delivery and remote lab practice was developed based entirely on the experiences acquired from the work accomplished on the undergraduate module.

Additionally, the module team have been involved in the development and documentation of Packet Tracer. This simulation resource now has ‘features’ that have some relationship to the contributions from the OU. NDG, the owner of Netlab+, now has enhanced virtualisation resources. There have also been contributions to Cisco course content and professional development of Cisco instructors worldwide.

There has also been development of modules connected to Microsoft and Linux [13] certification, based on the experiences acquired from working with Cisco Systems.

### **Advice to others**

There is a clear demand for practice based learning in higher education, using technologies and programmes already established in different vendor education communities. Many HE students want the blend of ‘academic’ practice as well as ‘technological’ experience. The model employed in the development of the Cisco modules at the Open University is a framework for how this may be accomplished in a range of different distance based educational environments.

## Future Plans

There is current work on a cyber-security master's degree, which may use some of the experiences gathered with Cisco Systems. Other programmes are currently being reviewed, with a view that the experiences gained from the development of this programme may be incorporated.

## References

- 1 Open University Student numbers, <http://www.open.ac.uk/about/main/the-ou-explained/facts-and-figures> last accessed 1/05/13
- 2 Cisco CCNA, Certification page <http://www.cisco.com/web/learning/certifications/associate/ccna/index.html> last accessed 1/05/13
- 3 Cisco Networking Academy site, (netspace), <http://www.netacad.com> last accessed 1/05/13
- 4 NetDevGroup, Netlab+ Product <http://www.netdevgroup.com/products/> last accessed 1/05/13
- 5 Prieto-Bla'zquez, J. et al. 2008. An integrated structure for a virtual networking laboratory IEEE transactions on Industrial Electronics 55, no. 6: 2334"42
- 6 Smith, A. and Moss, N. (2008). Cisco networking: using Skype and Netlab+ for distance practical learning. In: IADIS e-Learning 2008 conference, Amsterdam, Netherlands, 22-25 July 2008,
- 7 Frezzo, D. (2009) Using Activity Theory To Understand The Role Of A Simulation- Based Interactive Learning Environment In A Computer Networking Course, PhD Dissertation
- 8 Smith, Andrew (2011). Classroom-based multi-player network simulation. In: ICNS 2011: The Seventh International Conference on Networking and Services, 22-27 May 2011, Venice, Italy.
- 9 Smith, A (2011). Development of a simulated Internet for education. In: ALT-C 2011 Conference Proceedings, 5-8 Sep 2011, University of Leeds, Leeds, UK.
- 10 DiCerbo, K.E. "Hands-On Instruction in the Cisco Networking Academy," Networking and Services, 2009. ICNS '09. Fifth International Conference on , vol., no., pp.581-586, 20-25 April 2009
- 11 Open University Microsoft Server Technologies : <http://www3.open.ac.uk/study/undergraduate/course/tm128.htm> last accessed 1/05/13
- 12 Open University CCNP based Advanced Networking programme : <http://www3.open.ac.uk/study/postgraduate/qualification/f56.htm> last accessed 1/05/13
- 13 Linux Professional Institute press release on Open University Linux programme : <http://www.lpi.org/news/open-university-uk-adds-linux-certification-academic-program> last accessed 1/05/13