# Dynamic patterns for low vision internetworking students

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ABSTRACT: Internetworking is the enabling of communication between networks. Much of the configuration of internetworking devices is performed via remote access using a secure telnet. Cisco is a major provider of such devices. The Cisco Network Academy Program (CNAP) is a worldwide educational programme delivering a range of courses in internetworking. A group of potential internetworking students are those with low vision. Many people classified as blind retain some residual vision. Dynamic Pattern System (DPS) enables the detection of combinations of large coloured areas on a screen known as a pattern to represent text characters. Such patterns can be based upon the student's remaining visual capacities. Sequences of patterns delivered at a set rate and can represent words, sentences or signs. DPS has the potential to enable students classified as blind to have hands-on experiences in networking and internetworking using combinations of patterns to represent both internetwork device configuration information and network topology diagrams.

## INTRODUCTION

Internetworking is enabling communication between networks and it forms the foundation of the Internet. In the networking industry, much of the configuration and testing of networking or internetworking devices is performed via remote access, often using a secure telnet. Within an educational setting, some internetworking students may not be able to access the hands-on laboratories made available to university internetworking students due to time clashes and commitments such as employment or family demands or because they live a long distance from these facilities. Other students may have low vision that would restrict them from reading the configuration screens that often form an integral part of internetworking laboratory exercises.

Cisco is a leading provider of equipment on the Internet and the Cisco Network Academy Program (CNAP). CNAP is found in high schools, in Technical and Further Education colleges (TAFE in Australia), known as Further Education (FE) in the UK, and also universities [1]. There are now over 9,000 CNAP academies worldwide [2]. Often students both on CNAP based and non-CNAP based networking units may be using a Cisco-based operating system known as the Internetwork Operating System (IOS) [3]. This is a character-based system. However, laboratories can also be made available remotely. There may be many reasons why students choose to access the laboratories remotely. These can include clashes with work and family commitments, distance, or not wishing to travel at certain times. Furthermore, travel and parking can involve the students in extra time commitments and expense.

Furthermore, potential students of internetworking may suffer from a disability such as those classified as blind. However, many people though classified as blind still have some residual vision which can form the basis of a visually-based communication system. The Royal Blind Society of NSW notes that having 10% or less of the sight of a person who possess their full sight is required for a person to be legally classified as blind [4]. A report has noted that:

> *An estimated 1.8 million persons age 6 and older (0.7%) have a severe vision impairment, defined as an inability to see words and letters in ordinary newspaper print, even when wearing glasses or contact lenses* [5].

## ACCESSIBILITY

There are large numbers of people with low vision that makes it difficult to read standard text based information. There are many cases of legalisation such as the Americans with Disabilities Act (ADA) [6] in the USA which was recently amended [7] and the Disability Discrimination Act in the UK [8]. It has also been noted that:

*Participation in the broader community depends on the individual capacity to receive and use visually-based information. Limited access to visually-based information affects all aspects of the lives of people who are blind or vision impaired* [9].

It is important to use pools of available talent and to promote education in new technologies including networking. Many universities and other organisations promote and enable an inclusive approach to students and staff with disabilities. The importance of CNAP-based education for the vision-impaired has been noted by Armstrong and Murray [10]. There exists the possibly of using the remaining vision of a potential student with low vision to be able to configure and troubleshoot such devices using a computer program to convert standard text into patterns that can be detected by the low vision networking student. Cisco systems are one of the main providers of internetworking devices. Internetworking is the ability of enabling communication between networks and lies at the foundation of the Internet. Such education often has a significant hands-on component such as access to internetworking devices.

## DYNAMIC PATTERN SYSTEM

Dynamic Pattern System (DPS) is designed to run on standard PCs and uses sequence of on screen patterns matched to the blind persons remaining vision attributes [11]. The patterns consist of coloured areas of screen of up to five elements. Each pattern can represent an alphanumeric character or sequence of such pasterns can represent a word. A sequence of patterns may also be used to represent a sign [12].

Although the present version of DPS is in English, it could be used with only minor modification in a range of languages written in Latin-based characters and could also be modified for other non-Latin-character-based and non-character-based languages. It is also possible to represent a character or a sign by a sequence of patterns. This gives the ability to include movement-like effects to increase further the range of uses of the DPS. Furthermore, each individual can have their own set of patterns built for them, which are based upon their individual residual vision. These patterns are based on ASCII characters. This means that the output of such a system can be viewed either as a sequence of on-screen patterns or as standard text. Figure 1 shows a typical screen of DPS in a form where both patterns and text can be seen simultaneously in this case. This form may be typically used by the enabler to check and set up DPS for a low vision user or also deaf users.

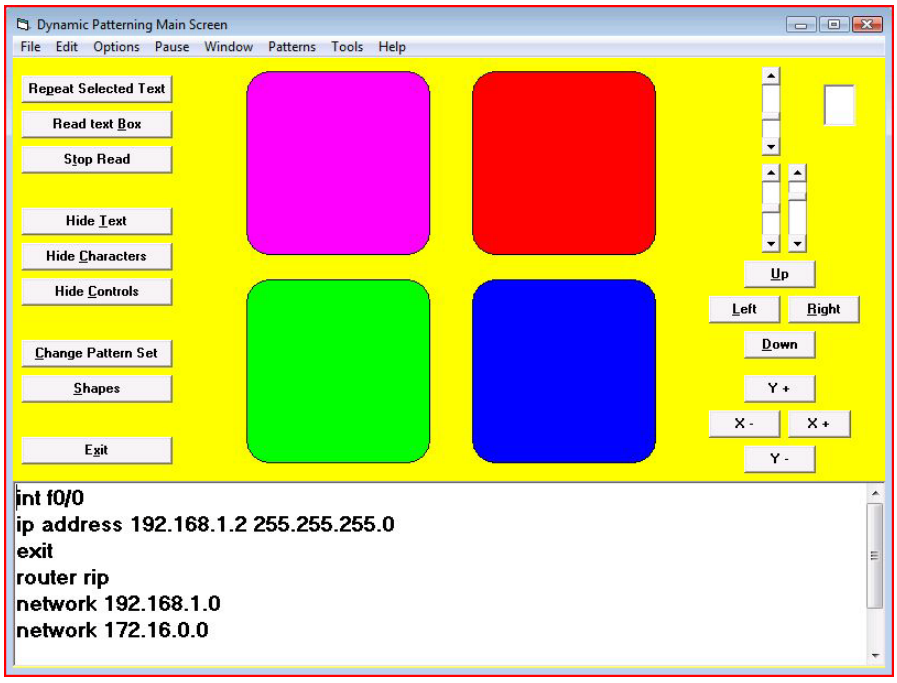



Figure1: The DPS main screen for setup by an enabler.

The DPS can receive output and input in an ASCII form and such word processor or Command Line Interface (CLI) files can be loaded into or stored as outputs from the DPS system. The CLI is Cisco's character-based user interface for its Internetwork Operating System (IOS), which is often used by networking professionals. Figure 1 shows typical Cisco IOS commands being used with the DPS. Presently, text files are copied and pasted between the DPS and the CLI as a *proof of concept.*

There is also an extensive range of Graphical User Interfaces available to enable configuration to be performed for a range of specialist tasks on Cisco internetwork devices [13].

Previous research using DPS has found that it is best to allow users to select their own patterns with the assistance of an enabler who is familiar with the system [14]. Often, the most commonly occurring letters are the most easily recognisable. By comparison, other text representation systems such as Morse code have the least number of dots or dashes corresponding to a text character representation used for the most commonly-used letters in the English language. In addition, to avoid the need to remember too many patterns and so reduce the cognitive burden on low-vision users, the DPS treats lower and upper case letters as identical in its present version which may have the potential to degrade some case-sensitive information.

The screen used to select the colours for a pattern is shown in Figure 2. DPS also avoids timed sequences that could possibly induce epileptic fits in photosensitive epileptics [15].

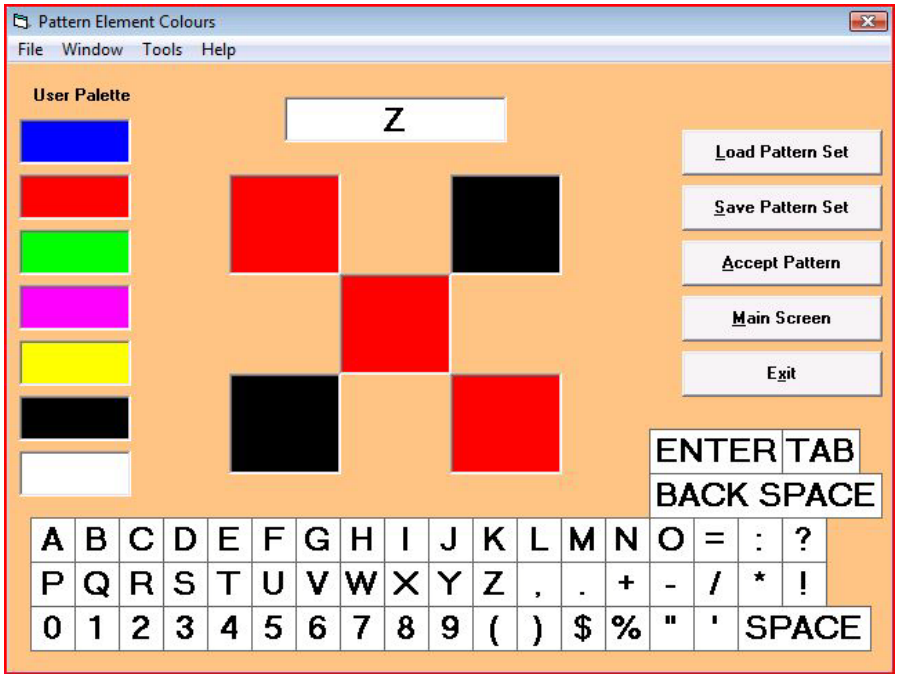



Figure 2: The DPS pattern creation screen.

The help files may themselves be fed back into the DPS to enable reading by the low vision users.

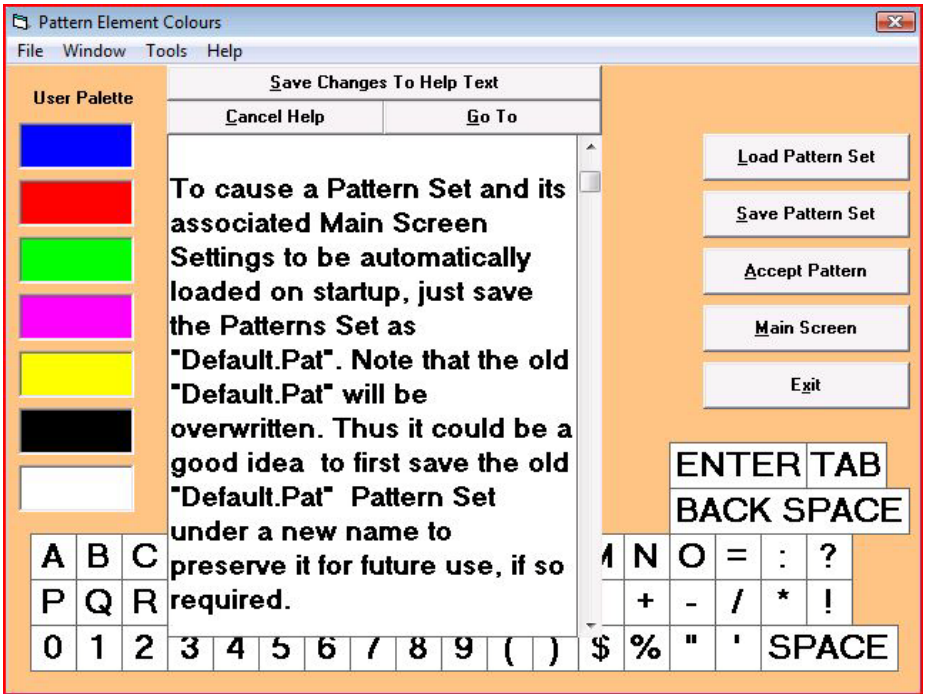



Figure 3: Text based DPS help.

The DPS has been designed so that the users can view the screen with only the patterns showing, the controls and patterns showing with or without the standard text showing. This is to enhance the flexibility of the use of DPS. The

DPS speed can be adjusted both in the time that each pattern remains on the screen and the inter-word wait time. A user's set of patterns, and size and shape of these patterns, and their presentation timing requirements can be stored and used as their default at the start-up of the DPS program. The timing of the characters and the space between words can aid word recognition as in Morse code. It is possible in extreme cases of low vision to use this system to read and write in a form of Morse code hence demonstrating the flexibility of the DPS as a potential test bed.

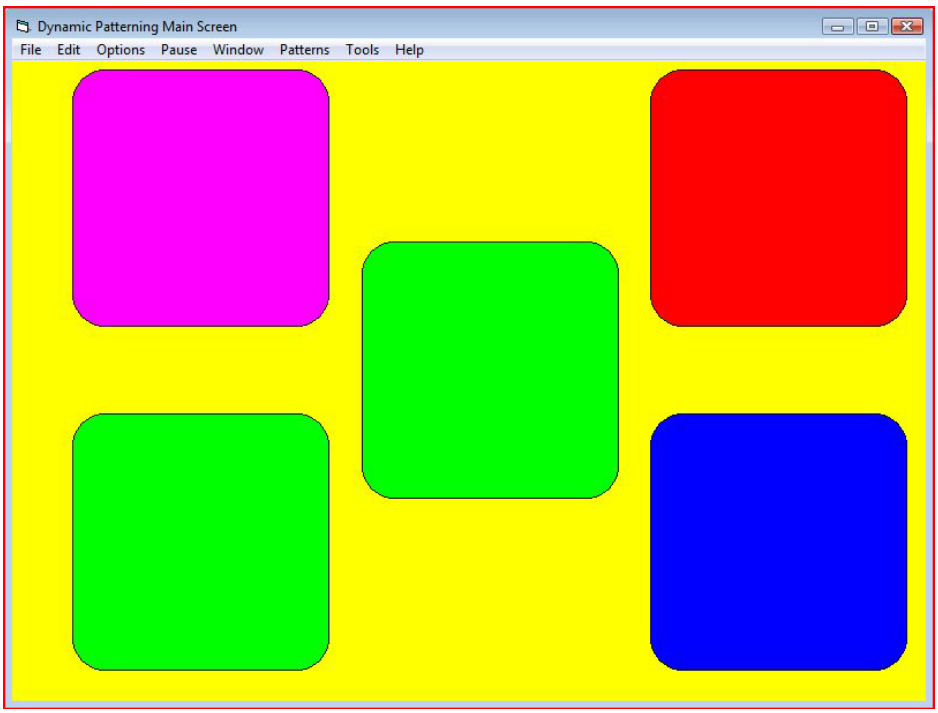



Figure 4: A DPS for use by a low vision user.

It should be noted that earlier research using the DPS systems found that many low vision users preferred striking colour combinations to help users to see them on screen patterns more readily. Furthermore, their choice of a background colour was often very bright or very dark.

TOPOLOGY REPRESENTATION

Topology diagrams are typically used to describe computer network and internetwork device names, types, interface types, connections and addressing information [3], as shown in Figure 5.

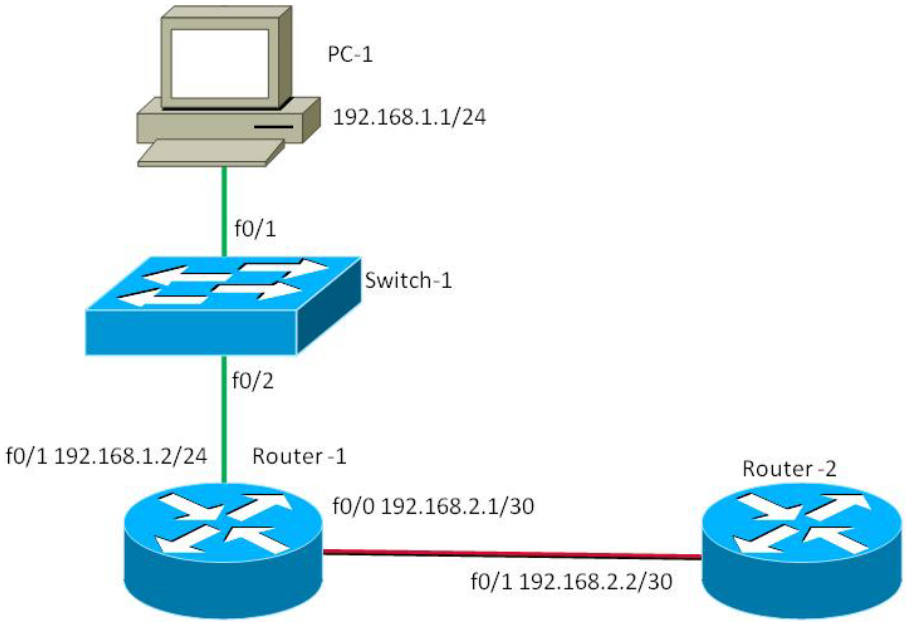
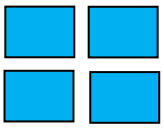
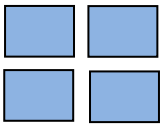
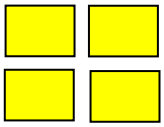
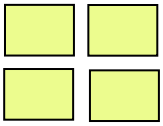
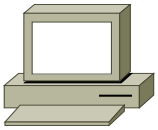
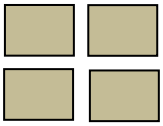
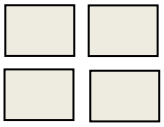
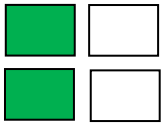
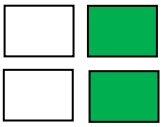
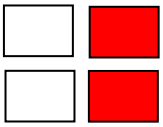
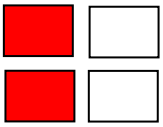
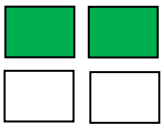
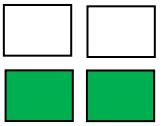
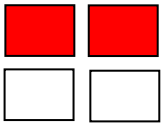
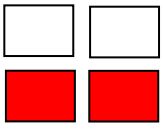



Figure 5: A simple example topology diagram.

Such a topology may be described serially starting at the top and working left to right as [PC] PC-1 [Down the straight-through Ethernet] f0/1 Switch-1 F0/2 [Down the straight-through Ethernet] f0/1 [Router] Router-1 f0/0 Crossover [Ethernet cable Left Direction]. An example equivalent subset of possible DPS patterns to be used with a topology diagram is shown in Table 1, where items in the square brackets could be denoted by the appropriate DPS sequence. For example, the PC is replaced with a sign such as a flashing stone. The *Down Fastethernet straight-though Ethernet* statement could be replaced with a sequence of two upper areas of colour green followed by to lower coloured areas of green with the upper areas of green having the longer wait time. The actual DPS patterns used would depend upon the users remaining visual capacities. The cable representation has a direction to give a sense of the layout of the topology diagram to a low vision user.

Table 1: A subset of possible DPS symbols for use in internetwork topology diagrams.

| Item Name | Item Symbol | DPS 1st pattern Longer display time | DPS 2nd pattern Shorter display time |
|---|---|---|---|
| Router |  |  |  |
| Switch |  |  |  |
| PC |  |  |  |
| Straight-through Ethernet Cable Right Direction (Green) |  |  |  |
| Crossover Ethernet cable Left Direction (Red) |  |  |  |
| Straight-through Ethernet Cable Lower Direction (Green) |  |  |  |
| Crossover Ethernet cable Lower direction (Red) |  |  |  |

It should be noted that it is also possible, under this system, to denote diagonal traversal of a cable in a similar manner to that shown in Table 1.

Using such DPS in the manner described above, along with internetwork devices, configuration commands and device responses could enable low vision students to both configure and test internetwork devices.

## CONCLUSIONS

DPS is of potential use for remote access internetworking students with low vision. Such a system also incorporated the possibility of using directional and other information to represent topology diagrams to such students. Furthermore, DPS can make use of students remaining visual capacities by allowing them to choose their own sets of patterns to represent a character set. Pattern sets that represent low vision students' preferences can be selected and loaded as a default along with the student's speed of pattern presentation along with other presentation selections such as pattern shape and size. There is a need to test such a system on remote low vision students and to develop a means to input and output text directly from the CLI to and from the IOS instead of having to copy and paste files as is presently the case. More research into DPS is needed and its use with remote access low vision internetworking students.

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