

Network Design Computer-Aided Learning Tool

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Abstract—Computer-Aided Learning (CAL) tools could offer a better learning environment for computer science students. This paper presents a CAL tool that helps students understand the essential knowledge about networking design. The aim of the CAL tool is to simplify the process of network designing by using a user-friendly computer based program.

Index Terms—Computer-Aided Learning, network, networks design.

I. INTRODUCTION

A large number of computer applications are being developed to make the learning experience more efficient, flexible, yet at the same time enjoyable. They provide an excellent opportunity to apply and test the management skills the students learned in classrooms, but never had a chance to implement in reality.

Computer-Aided Learning (CAL) tools have been developed to support students' learning in different educational areas [1]-[6]. CAL can be defined as the use of computers to provide educational instruction. The main advantages of CAL are the time, the place, and the pace at which student can learn [7]-[12].

Many CAL programs exist in the market that teaches students the networking design. They vary in cost and quality of the presented information. Network design refers to the process of planning a computer network infrastructure implementation [13]-[17].

Designing, maintaining, and supporting an efficient Information Technology (IT) infrastructure can be a daunting task for any company, especially for a corporation such as Airlines with hubs, facilities, offices, and personnel scattered across the globe. That's why Airlines and all corporations are working hard to optimize its IT design processes across the enterprise.

Network designing is very important before setting up any kind of efficient network from a functionality and cost point of view, the designing phase will give us the possibility to set a network with optimum design requirement by using the least required devices to ensure minimum cost and optimal performance.

Currently in the market there are mainly many vendors, which provide the ability to design a network by providing specialized software. The most common used software being designed by Cisco is called Packet Tracer. Also Boson created "NetSim", which is considered one of the simplest software from functionality and flexibilities point of views.

Cisco Packet Tracer is a network simulator software that

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allows users to simulate the configuration of Cisco devices using a simulated command line interface. This software teaches how networks can be configured. It gives a real time experience like other simulating devices. Packet Tracer is ideal for the CCENT and the CCNA Routing & Switching certificates. One of the disadvantages of Cisco Packet Tracer is that it doesn't support non-Cisco devices. Boson NetSim also has some disadvantages, such as absence of topology information and customization, and an inability to modify active topology.

In the next section we will describe the Network Designer tool. Section 3 describes the system data design and implementation. Section 4 describes the system features and user interface. Section 5 evaluates the tool and reports results of the user acceptability tests. Finally, the conclusion.

II. THE NETWORK DESIGNER

The Network Designer is a tool that satisfies any network designs needs, complexity and range (LAN, WAN, etc.), it can be used as a reference to any network in case a design change is needed in the future or for maintenance issues.

The Network Designer can be used for educational purposes:

- Instructors: The instructors could use the Network Designer as a visual tool to help students in the network design process or by providing a clear vision about network topologies; also the students will have clearer view of network components.
- Students: The Network Designer will allow them to interact with real network components. Also the Network Designer will provide them with the essential knowledge about networks. On the other hand, students will be familiar with network objects and what they look like.

The main goals of the Network Designer are to allow users to build/design a network by many functions as listed below:

- The ability to select and drag and drop the device from listed devices into drawing panel.
- The ability to connect the devices with each other by selecting tow devices and choose the cable type.
- The ability to move any devices in the panel at any place with all connection at that device.
- The ability to store any action by the user to the database.
- The ability to design many layers (sub networks) in one network, which mean we can design a network inside network in-side network, etc.
- The ability to keep controlling layers if the network consists of many layers, by providing a guide which will help users to navigate their layers in the network.
- The ability to use any network or layer as a layer into another network.

A huge network can be designed by using a software like Cisco Packet Tracer r or Boson NetSim, by design each part

or sub network separately (i.e. many files needed). Moreover, in the worst case we can use Adobe Photoshop to draw the network, but this process takes a lot of time and effort (if we ignore the efficiency part). But by using the Network Designer we can design any network with the ability to control at all sub networks belonging to the network. Moreover, it has the ability to use any network or part of a network as a sub network into another network.

The Network Designer has a database which stores any user action such as, the coordinates of any device, the type of the device, and the connections at any device, so any network will be stored in the database with all its devices and connections, this mean we can retrieve any network at any time. So if any network is stored in the database we can design a network inside a network (layers) by storing each layer as a network (each layer is a network and each network is a layer). Second, by storing each layer as a network, any network can use any layer or network as a layer in it. Finally, the Network Designer interface has a layer navigator which will help users to navigate through layers.

III. SYSTEM DATA DESIGN AND IMPLEMENTATION

If you are using *Word*, use either the Microsoft Equation Editor or the *MathType* add-on (<http://www.mathtype.com>) for equations in your paper (Insert | Object | Create New | Microsoft Equation *or* MathType Equation). "Float over text" should *not* be selected.

IV. UNITS

All paragraphs must be justified alignment. With justified alignment, both sides of the paragraph are straight.

- The Network Designer database tables schemas consists of:
- Networks Table (NetID, NetworkName, NetworkBGImage, NetworkDesc)
- Layers Table (LayerID, NetID, LayerName, LanID)
- Switches Table (SwitchID, NetID, SwtName, SwtType, SwtPorts, SwtporConn, SwtX, SwtY, SwtConEth, SwtConSer, SwtConWi)
- Routers Table (RouterID, NetID, Rou.Name, Rou.Type, Rou.Ports, RouporConn, Rou.X, Rou.Y, RouConEth, RouConSer, RouConWi)
- Clients Table (ClientID, NetID, CliName, CliType, CliPorts, CliporConn, CliIP, CliSebne, CliGate, CliX, CliY, CliConEth, CliConSer, CliPortWi)
- Servers Table (ServerID, NetID, Ser.Name, Ser.Type, SerPorts, SerporConn, SerIP, SerSebne, SerGate, SerX, SerY, SerConEth, SerConSer, SerPortWi)
- Connections Table (ConnectionID, NetID, ConnType, ConnColor, ConnX1, ConnX2, ConnY1, ConnY2, ConnFromID, ConnToID, ConnFromIDPort, ConTOIDPort)
- Miscellaneous Table (MiscID, NetID, MiscName, MiscType, MiscPorts, MiscporConn, MiscIPIN, MiscIPout, MiscX, MiscY, MiscConEth, MiscConnSe, MiscConnWi, MiscOth)

Fig. 1 shows the Network Designer database class diagram.

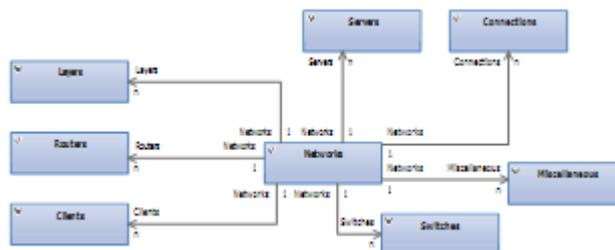


Fig. 1 The Network Designer database class diagram

V. FEATURES AND USER INTERFACE

Features and User Interface Detailed submission guidelines can be found on the journal web pages. All authors are responsible for understanding these guidelines before submitting their manuscript.

The Network Designer features:

- A friendly yet powerful Graphical User Interface (GUI) equipped with menus and toolbars containing most common network objects, these objects providing the user with the basic elements to build a network. The main network objects are: Connection Types, Switches, Routers, Servers, and Clients, also Miscellaneous Objects such as (Printer, Firewall, Wireless Access Points, etc.).
- The network objects panel includes objects categorized by functionality.
- The Drawing Panel is a wide space area in which the user can insert objects from the network objects panel. This Drawing Panel will hold the final design of the network.
- Backup and restore database.
- Load and Unload network background image.
- Editing network object labels.
- Delete any device from drawing panel.
- Print network diagram.
- Multi layering feature: One and the most important problem is the size of the network (i.e. if the designers/users want to design a huge network, they can't fit the network diagram into one area due to computers screens, so they have to design every part of a network into separate file which mean less flexibility and more complexity moreover inflexible controlling on these files). The Network Designer will store network diagrams into the database as records rather than files. The Network Designer can divide the network into multi layers (sub networks), and the ability to control all these layers, for example, in any given company, we found departments such as marketing and accounting, each of these departments uses part of the whole network, the user can build any department's network in the Network Designer separately and then combine it with other parts of the network. Combing these parts will form the final network. So the Network Designer will satisfy any network

designs needs, complexity, and range.

- Every layer will store into layers' table, also into networks table, to ease the open procedure for this sub network later, this means each layer is a network and each network is a layer, so by storing every layer as a network that mean we can use that layer into another network (i.e. all we need is to design it once then we can use it as many time as needed into any network design).

The interface of the Network Designer as shown in Fig. 2 consists of the following parts: the menu bar, tool bar, devices and connections, drawing panel, network layers, and status bar. The menu bar and tool bar provide two different ways of accessing options provided in the system. The user can select and drag and drop the device from listed devices. The drawing panel is the area were the user can build/design a network. The network layers panel will help user to navigate layers in the network (if the network consists of many layers).

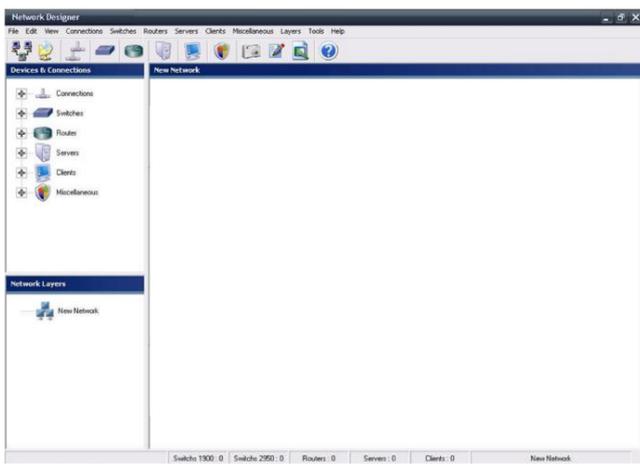


Fig. 2 The graphical user interface of the Network Designer CAL tool

VI. EVALUATION

The Network Designer will allow students to interact with real network components. As it will provide them with the essential knowledge about networks. On the other hand, students will be familiar with network objects and what they look like. The Network Designer will allow users to drag and drop network devices to the drawing panel, and the ability to move the devices and to connect these devices with each other's with different types of network connection. On the other hand, the Network Designer tool will allow the user to store and retrieve a network design at any time to modify or to use it as sub network in another network. A User Acceptance Test (UAT) [18]-[20] was conducted to evaluate the Network Designer by asking the targeted students to fill a questionnaire after using the Network Designer. Results showed that 95% of the tested students thought that the tools were easy to use and a very effective way to learn the network design. About 5% of the students thought that the Network Designer did not add much to their knowledge.

VII. CONCLUSION

The Network Designer aims to provide a tool that satisfies any network design needs, plus this will become a reference to any network in case a design change is needed in the future. The Network Designer is very useful in supporting students to understand computer networks courses. The presented tool has proven its feasibility and usefulness.

The Network Designer can assist companies that provide penetration testing services:

- to give approximate knowledge about the architecture of targeted network in blind testing strategy.
- to increase the outcome in targeted testing strategy.

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