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Software Used in the Design of Telecommunication Networks

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Abstract. In this article, the design of telecommunication networks and their software solutions are reviewed. At the same time, the network devices in the simulator are discussed about the commands and functions programmed into them, as well as the advantages and disadvantages of the simulators.

Key words: Cisco Packet Tracer, Boson NetSim, GNS3, VIRL, EVE-NG.

Networking professionals need practice. You can practice on both real and virtual equipment. Practice on real equipment has obvious advantages, but requires a certain work space and high costs for devices and consumables. Practicing on virtual equipment is a less expensive process, but you need to choose software that meets all the requirements for practical tasks.

The purpose of the study is to review simulators and emulators of network equipment in the educational process, taking into account the advantages and disadvantages of specific software.

There are many simulators and emulators, but the most popular ones are Cisco Packet Tracer, Boson NetSim, GNS3, VIRL, EVE-NG. Many of these tools can also be used to test network technologies and deploy networks in the real world. To take a closer look at the programs listed above, it is necessary to understand the difference between emulators and simulators.

A simulator is, as the name suggests, software that simulates a network topology consisting of one or more network devices. Simulated network devices are not real devices and cannot transmit "live" network traffic. Every network device is a piece of software that claims to be a real device based on its capabilities [1].

Network devices in the simulator are limited to the commands and functions programmed into them. Therefore, many additional functions available in real network devices are not available in simulated analogs.

The main advantage of simulators is that they usually do not require a lot of resources - the simulator program can run on almost any modern computer.

An emulator is software that runs and connects virtual network devices. Emulators virtualize real network devices that offer a more "advanced" feature set than the devices presented in

simulators. The behavior exhibited by virtual network devices more closely mirrors the behavior of real physical devices in the real world [1].

In other words, an emulator allows you to create a model of a computer or other device and run the original software inside it. All major components of the device are simulated, including the processor, memory, and I/O devices. In Cisco's case, the emulator creates a router model and runs the real Cisco IOS operating system inside it. So you can get a fully functional router. A simulator, such as Cisco Packet Tracer, simulates the behavior of a system and its interface.

Packet Tracer is a Cisco visual modeling tool that simulates network topologies consisting of routers, switches, firewalls, etc. Packet Tracer was originally developed as a training tool for the Cisco Network Academy (better known as NetAcad), but has since can be used. simulator for learning.

Packet Tracer has a number of advantages over other considered programs.

To work, you must create a free Cisco Networking Academy account. Works on most operating systems. It has various facilities for simulation [2]. Provides many options for connecting network devices. Offers various methods for connecting and configuring devices. Works in real time. You can configure, test, and troubleshoot network devices through the CLI tab. Allows you to create your own tasks using the Task Wizard feature.

When you create a custom exercise, you should save it as a file to distribute to all interested parties. The lack of a centralized method of distribution leads to some problems.

All programs have bugs, and Packet Tracer is no exception. Packet Tracer errors are probably more noticeable than other simulators or emulators due to its popularity and widespread use [3].

Despite its shortcomings, Cisco Packet Tracer remains the "gold standard" for virtual network simulators. For free software, it offers a rich environment for experimenting with a large number of network device types, platforms, and connections. In addition, the Cisco IOS software simulation shows the closest behavior to real network devices, and its built-in terminal client is very similar to the real one.

Boson's product is NetSim, a program that simulates Cisco network routers and switches.

Boson NetSim has several advantages as a paid network simulator.

The Boson licensing model is cumulative, as are Cisco certification levels. Each Boson license is tailored to the Cisco certification exam and includes assignments for previous exams.

The number of exercises available depends on the license. Each exercise comes with detailed instructions on what to install and test in the corresponding network topology.

Each exercise is evaluated after completion. Lab progress can be tracked from the app, allowing you to instantly see completed and outstanding work and attempts.

All purchased workouts are easily accessible from the app. All tasks are loaded, executed and evaluated from the program itself.

If you create a network topology that you want to share, you can easily upload it to the NetSim community, and vice versa, you can see other people's uploaded projects and use

them in the simulator itself.

Terminals are labeled, so they appear on their own label for each device. If this is inconvenient, then you can place the tab in its own window.

Almost every window can be easily positioned and moved so that the interface can be adapted to the user's preferences.

defines which modules to include in the device when added to the network topology. NetSim defines the type of interfaces that each module adds [4].

After a device is configured and added to the network topology, devices with the same physical configuration are stored in the Recent Devices window and can be easily re-added to the topology from there.

Boson NetSim has built-in tasks that intersect with exam topics for specific Cisco certification exams. The exercises are available directly through the NetSim application.

The NetSim terminal has some features not found in the Packet Tracer terminal, such as keyboard shortcut support.

The Network Topology window displays a limited amount of information, especially during a simulated topology. Once the network topology is up and running, it cannot be changed until it is stopped. There is no way to see the contents of individual packets passing through the network. All network devices are simulated in real time. NetSim is only available for Windows operating systems.

Active network topology does not provide sufficient visual feedback on the status of devices, links and data transmission. NetSim, which emulates Cisco IOS, has strange behavior that is not seen on real Cisco hardware, especially when using context-sensitive support or executing commands that are not available.

Graphical Network Simulator (GNS3) is a free and open source client-server interface for network emulation and virtualization. It's a Python-based platform that uses a software called Dynamics to emulate mainly Cisco software and hardware.

GNS3 supports a wide range of virtual network devices from various network equipment vendors using easy-to-import templates.

Since GNS3 is a client/server application, it is recommended to install GNS3 VM (Virtual Machine) as a server. You can then install the GNS3 client application on your local computer and connect to the GNS3 virtual machine server. After installation, you can create network topologies using the client side of the software running on the server.

As a free and open source network emulator, GNS3 has several advantages.

The open source code of the emulator can be viewed for free on GitHub. If the user finds a bug in the software, he can report it to the community or the developer himself. May try to reproduce the bug, fix it, and submit modified source code to improve the software.

GNS3 has a community of developers and users, its main advantage is the positive feedback created by a group of like-minded people who want to help others learn, work.

The emulator includes illustrations for beginners or advanced configuration instructions if needed.

In GNS3, each network virtual device can be started and stopped independently of other virtual devices.

The emulator not only supports Ethernet connections between network devices, but also allows you to establish serial connections between devices that support the corresponding modules.

GNS3 software does not have network operating system images installed. Therefore, to emulate any Cisco routers or switches, you must first have an existing GNS3-compatible Cisco IOS firmware image.

The main disadvantage of GNS3 is that you have to create your own firmware images of network devices for emulation. It's not GNS3's fault. Integrating Cisco IOS software images into GNS3 will be illegal. The availability of these images is an important factor to consider before using GNS3 for personal or commercial purposes.

If Cisco Packet Tracer is the gold standard in virtual network simulators, GNS3 is the gold standard in virtual network emulators. The GNS3 open source community has created feature-packed, well-documented software that is completely free. Despite following a traditional server/client application model, the server component is easy to deploy, configure, and maintain [5].

VIRL (Virtual Internet Routing Lab) is a proprietary Cisco virtual network emulator designed for educational institutions and individuals. It is very similar to Cisco Modeling Labs, a highly scalable VIRL option designed for modeling and simulating enterprise networks for medium and large enterprises. VIRL works in a client-server model similar to GNS3. The VIRL server is installed on a stand-alone server or as a virtual machine, then network topologies are created and the VM Maestro client application interacts with the server.

VIRL has several advantages as a paid emulator.

A VIRL server installation provides legal, licensed access to various Cisco software images. These software images can be downloaded from the VIRL server and installed on other network emulators such as GNS3. For this reason, many VIRL users do not use the VIRL server to test their network topologies, preferring to use other network emulators. Instead, they see VIRL subscriptions as a legitimate way to get modern software images.

If you want to share your network topology and run it on another VIRL server, exporting your network topology is easy. This is especially useful if the topology always uses the basic, unconfigured images shipped with VIRL.

The emulator includes the AutoNetKit feature, which allows you to automatically populate key feature configurations on nodes across the entire network topology.

VIRL has a few issues that need to be addressed.

Access to VIRL Personal Edition costs $199 per year. However, the Personal Edition license allows you to run only 20 nodes simultaneously in all active simulations.

The emulator requires more processing power and memory than other solutions.

VIRL only supports Ethernet interfaces. Therefore, if you need access to serial interfaces, you will need to use Packet Tracer or NetSim.

The emulator has two views for network topology - design and simulation views. The constructor is designed to place and connect nodes, as well as to define automatic and manual configuration for each node. It allows you to manage and connect to active network devices.

Once a topology is initialized, it cannot be changed. You cannot add or remove nodes or add or remove connections between nodes.

VIRL has a number of disadvantages, such as the resource-intensive operation of the VIRL server and the lack of support for serial interfaces.

EVE-NG (Emulated Virtual Environment Next Generation) is a multi-user virtual network emulator designed for individuals and small businesses like VIRL Personal Edition. The company offers a free edition as well as a professional edition for $110.75 per year.

EVE-NG Community Edition has several important advantages, including being completely free and easy to learn.

But there are also two big differences between these editions of EVE-NG:

The free edition has a virtual lab limit of 63 nodes. And the professional edition lacks a number of administrative features, including support for multiple users, user roles.

The EVE-NG client is the main feature that sets this emulator apart from VIRL and GNS3. Designing, connecting, and managing network topologies in EVE is done through a browser. To virtualize, connect and configure network devices, it is not necessary to download and install a separate program in addition to the server. You just need to deploy the server via installation or virtual machine, and do the rest using a browser. Working through the browser does not cause problems even when working with large topologies.

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