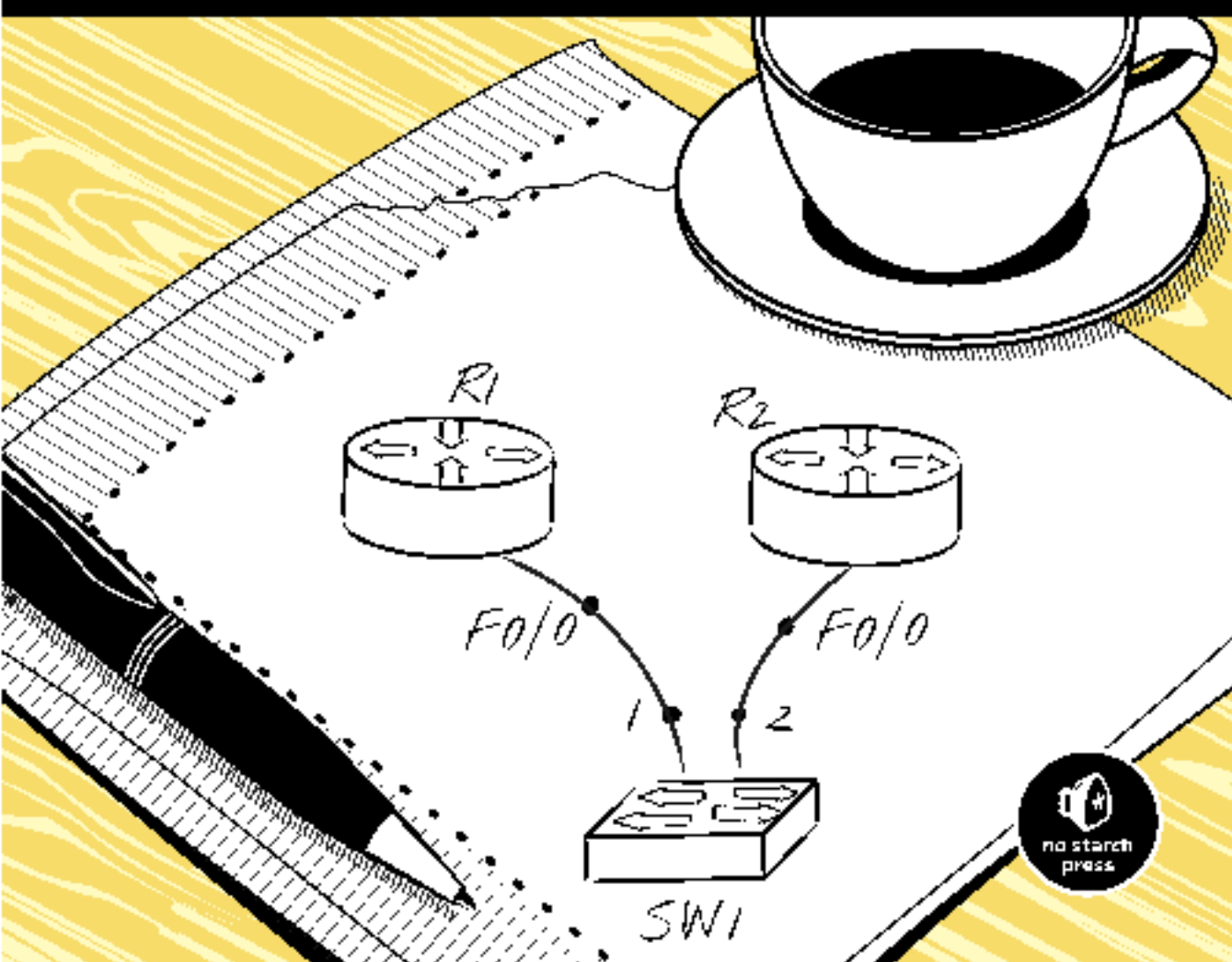


THE BOOK OF GNS3

BUILD VIRTUAL NETWORK LABS USING
CISCO, JUNIPER, AND MORE

JASON C. NEUMANN



THE BOOK OF GNS3

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**Build Virtual
Network Labs Using
Cisco, Juniper, and More**

by Jason C. Neumann



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press**

San Francisco

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FOREWORD

Networks are everywhere. They connect all kinds of businesses, from local bookshops to huge corporations to universities, across multiple cities and continents. Networks are conceptually simple to understand, yet they are becoming more and more complex, with innovation in areas such as Software Defined Networks (SDN), the Internet of Things (IoT), and other technologies just around the corner.

To understand, design, and manage today's complex networks, network professionals must not only master the theory but also practice and validate concepts in these ever-changing environments. This is where GNS3 comes in: it gives users immense flexibility to build their own networking labs, allowing them to experiment with new network features, capture packets to dissect protocols, and verify configurations for later deployment on real devices. All of this is done without the need to invest in expensive hardware.

GNS3 is a powerful and adaptable tool, evolving to now integrate multiple vendors and iterating to meet the growing needs of network professionals. But how do you master GNS3 itself and where do you start?

In *The Book of GNS3*, Jason covers everything that network engineers, administrators, and people studying for certifications need to get started, from walking you through installing and configuring GNS3 to creating and managing your projects. Jason digs deep while showcasing the true breadth of the software, covering topics like how to capture network packets, how to connect to real networks and live switches, and how to include advanced systems such as Juniper's vSRX Firefly and Cisco's IOS-XRv in your labs. He spends significant time explaining concepts and giving tips that will make you an expert user in no time.

Jason's book is ideal to harness GNS3 and make the most out of your network labs. Whether you are a beginner in the networking space or a seasoned professional, I can guarantee that you will walk away learning something new.

Jeremy Grossmann
Co-founder of GNS3
May 2015

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It's been said that it takes a village to raise a child, and GNS3 is everyone's baby. I'd like to thank all the people who have helped to create and promote GNS3 and make it the awesome software tool that it is. You're all great!

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- Julien Duponchelle, the silent code master
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- Mark Blackwell, GNS3 evangelist extraordinaire
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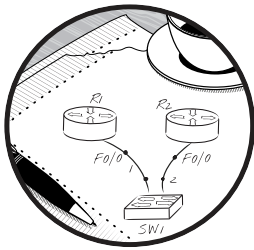
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I'd also like to extend special thanks to everyone at No Starch Press for all their help with creating *The Book of GNS3*. In particular, I'd like to thank:

- Jennifer Griffith-Delgado—you're the best!
- Serena Yang—you've been very patient with me, and you're awesome!
- Bill Pollock, the NSP overlord

Because I'm a schmuck, I'm sure that I've forgotten loads of important people, but rest assured that I appreciate you too! Let me now say to all you unnamed souls out there: thank you!

INTRODUCTION



I started using GNS3 early in its development and took to it like a duck to water.

From the beginning I could see it was going to be an invaluable networking tool. I've used it to get hands-on experience with operating systems such as Cisco IOS, Junos OS, and Arista, as well as to pass quite a few network certification exams. To this day, I use it on a regular basis to test router configurations before deploying real equipment to the field. *The Book of GNS3* is my way of sharing this great resource with other networking professionals, like you.

Who This Book Is For

This book is for anyone involved with networking routers, switches, or firewalls. Whether you use Cisco, Juniper, Arista, Vyatta, or some other network operating system, GNS3 is a great alternative to building physical labs. Unlike labs that use physical equipment, GNS3 virtual labs let you create

and save unlimited network configurations, without having to tear apart an existing lab. This book covers all the details to get your projects up and running fast.

What's in This Book

The Book of GNS3 guides you through installing, configuring, and running GNS3 on Windows, OS X, and Linux, and it shows you some geeky and fun tricks along the way. Whether you're just getting started or have used GNS3 before, I think you'll find a new appreciation for how much is possible when you have the right tool. I don't cover TCP/IP networking fundamentals, but I do provide plenty of examples of how to configure GNS3 devices.

My Approach

The most effective way of learning is by doing. That's why I use a tutorial-based approach to creating fully functional multivendor labs using GNS3. The tutorials explain how to build and configure labs using the virtual devices introduced in the chapters. I provide examples of configuring Cisco IOS, Junos OS, and Juniper vSRX Firefly, and more. You don't need to be an expert with network operating systems because I'll guide you step-by-step through the configurations. You could spend days, or even weeks, searching the Web to figure out how to configure features such as connecting to live switches, creating a virtual access server, or connecting your virtual labs to the Internet. But there's no need to do that after you read *The Book of GNS3*.

Book Overview

The Book of GNS3 guides you through the installation and use of GNS3, and each chapter introduces new concepts that build on skills from previous ones. You'll learn how to create and manage simple to complex projects, using only a single computer or sharing the load across multiple computers.

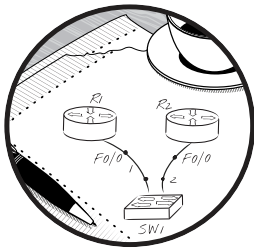
- **Chapter 1, Introducing GNS3**, covers what GNS3 is and how it works, provides an overview of GNS3, and discusses the benefits of virtual networks.
- **Chapter 2, Installing a Basic GNS3 System**, discusses installing GNS3 on Windows, OS X, and Linux, and it explains the benefits of using virtual appliances to run GNS3 as an alternative to installing it directly on your PC.
- **Chapter 3, Configuration**, looks at installing a Cisco IOS image and setting up your first virtual router using Dynamips. You'll also learn the importance of setting an Idle-PC value for Dynamips routers.
- **Chapter 4, Creating and Managing Projects**, teaches you to configure a virtual router. After that, you'll look at all the toolbar options and create a simple two-router network.

-
- **Chapter 5, Integrating Hosts and Using Wireshark**, shows you how to install VPCS and use it to add simple PC-like hosts to your projects. You'll learn how to add full-blown virtual PCs using VirtualBox and create a lab using a virtual Cisco IOS router and a VirtualBox Linux PC. You'll then learn about capturing packets using Wireshark.
 - **Chapter 6, Juniper Olive and vSRX Firefly**, explains how to install QEMU and use it to create your own virtual Juniper router. You'll create a network using Juniper and Cisco, learn how install Juniper vSRX Firefly, and configure a basic vSRX firewall.
 - **Chapter 7, Device Nodes, Live Switches, and the Internet**, demonstrates the built-in device nodes in GNS3 and explains how they can be used to conserve resources on your PC. You'll also learn how to connect your GNS3 projects to live switches and the Internet.
 - **Chapter 8, Cisco ASA, IDS/IPS, and IOS-XRv**, takes you from setting up GNS3 devices to configuring them. You'll create a Cisco ASA firewall and an IDS/IPS and create a network lab using Cisco IOS-XRv.
 - **Chapter 9, Cisco IOS on Unix and NX-OSv**, continues the theme of device creation. You'll learn how to install Cisco IOS on Unix and create a virtual NX OS switch using NX-OSv.
 - **Chapter 10, Cool Things to Do on a Rainy Day**, presents some fun things you can do with your new GNS3 knowledge, such as creating a simulated access server to managing your devices and deploying GNS3 virtual device configurations to real Cisco routers.
 - **Appendix A, Help! I've Fallen and I Can't Get Up**, discusses some common problems that you may encounter in GNS3 and provides solutions to correct them.
 - **Appendix B, Cisco Hardware Compatible with GNS3**, lists Cisco routers that are compatible with GNS3 and what Cisco IOS image files work best.
 - **Appendix C, NM-16ESW and IOU L2 Limitations**, provides information about IOS on Unix and NM-16ESW Cisco switches that are used in GNS3.

Now, get ready to dive into GNS3. Before embarking on this journey, be sure to kiss your family goodbye because once you get started, you won't be able to stop!

1

INTRODUCING GNS3



GNS3 is a cross-platform graphical network simulator that runs on Windows, OS X, and Linux, and it's the collaborative effort of some super-talented, industrial-strength nerds—folks such as Christophe Fillot, Jeremy Grossmann, and Julien Duponchelle, just to name a few. Fillot is the creator of the MIPS processor emulation program (Dynamips) that allows you to run Cisco's router operating system, and Grossmann is the creator of GNS3. He took Dynamips and integrated it, along with other open source software, into an easy-to-use graphical user interface. Duponchelle assists with coding GNS3, and his contributions have helped to advance the software.

GNS3 lets you design and test virtual networks on your PC, including (but not limited to) Cisco IOS, Juniper, MikroTik, Arista, and Vyatta networks, and it's commonly used by students who need hands-on experience with Cisco IOS routing and switching while studying for the Cisco Certified Network Associate (CCNA) and Cisco Certified Network Professional

(CCNP) exams. But that merely scratches the surface of what GNS3 can do. In this chapter, I discuss what GNS3 is, as well as the benefits and limitations of the software.

Why Use GNS3?

Before the wonders of virtualization, network engineers, administrators, and students had to build labs with physical hardware or rent time on a rack. Both options can be expensive and inconvenient, and they limit the network designs available to you. Software simulation programs such as RouterSim and Boson NetSim have been around for a long time, too, but these limited applications merely simulate the commands of Cisco IOS. Cisco Education does offer cheaper virtualized rack rental, based on Cisco IOS on Unix (IOU), but it allows you to practice on only specific preconfigured network configurations. It also requires that you have an active Internet connection to access the labs. Cisco also offers a product named Virtual Internet Routing Lab (VIRL) that's similar to GNS3, but it requires an annual fee, limits the number of objects you can use in your labs, and uses only simulated Cisco operating systems.

GNS3, on the other hand, allows you to customize your network labs to exactly meet your needs, create unlimited projects using Cisco and non-Cisco technology, add unlimited objects to your projects, and access those projects anytime, regardless of Internet connectivity. GNS3 provides maximum flexibility for your designs through a combination of emulated hardware devices that run real network operating systems such as Cisco IOS, simulated operating systems such as NX-OSv, and the ability to share resources across multiple computers.

Emulated Hardware

GNS3's graphical interface allows you to create virtualized network labs with a variety of routers, switches, and PCs, but it really shines when it's paired with Cisco IOS. Unlike similar applications, GNS3 doesn't merely mimic Cisco IOS commands or features. Instead, it uses a backend hypervisor application to emulate the hardware that runs Cisco IOS. Because only the hardware is emulated, you run an actual IOS image file on your PC. All the configuration commands and output come from a real IOS, and theoretically, any protocols or features that an IOS version supports are available to use in your network designs. This functionality distinguishes GNS3 from programs such as RouterSim, Boson NetSim, or VIRL, which simulate the entire experience and provide only limited environments, commands, and scenarios for you to work with.

Simulated Operating Systems

In addition to emulated hardware, GNS3 integrates simulated operating systems, and they can be fully networked to other GNS3 devices. One such

example is Cisco IOU, which I cover in Chapter 9. IOU consists of a series of Linux binary files that emulate the features of IOS images, and it's fully supported by GNS3.

In addition to Cisco IOS, GNS3 can integrate Quick Emulator (QEMU) and VirtualBox virtual machines running operating systems such as Linux, BSD, or Windows. For example, to practice installing and configuring an Apache web server on Linux, just add a VirtualBox virtual machine (VM) running Linux and Apache to GNS3 and test it by browsing to it from another VirtualBox host. All of this is done within the GNS3 user environment. If you want to throw a firewall in front of your Apache server, you could use a Cisco router, adaptive security appliance (ASA) firewall, or even a Linux-based firewall such as Vyatta.

Scalability with the GNS3 Server

GNS3 leverages client-server technology; much like a web browser connects to a web server to access and display web pages, the GNS3 graphical user interface (GUI) program accesses a GNS3 server, allowing it to start, stop, and otherwise control GNS3 devices. This allows your projects to scale because they're not restricted to running on a single computer. If you work with large or complex topologies, you can also run the GNS3 server program on a different PC than the GNS3 GUI program. If you have access to a high-end server with a lot of memory and processing power, you can install the GNS3 server program on the server hardware but control all the devices from the GNS3 GUI program running on a more modest PC.

Virtual Connectivity

The true beauty of GNS3 lies in its ability to network your virtual devices together, usually using protocols such as Internet Protocol version 4 (IPv4) and Internet Protocol version 6 (IPv6), to create labs that can run on just a single computer. Some of the simplest designs may have only a few components, like the project shown in Figure 1-1.

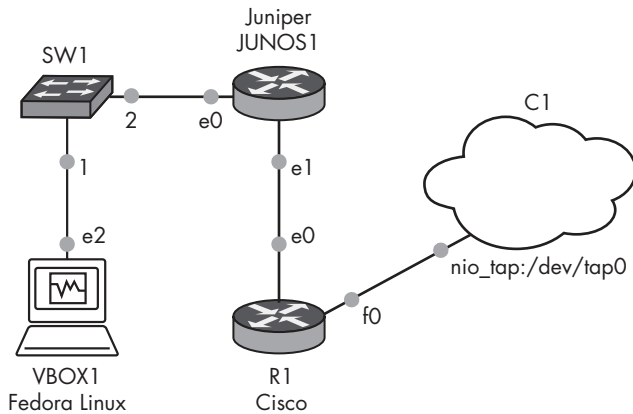


Figure 1-1: A GNS3 topology integrating Fedora Linux, Cisco, and Juniper routers

The project in Figure 1-1 allows a Fedora Linux host to access the live Internet via a switch, a Juniper router, a Cisco router, and finally a GNS3 Cloud node. That's a simple network, but you can create complex networks made up of a dozen or more routers, switches, and PCs, like the design in Figure 1-2.

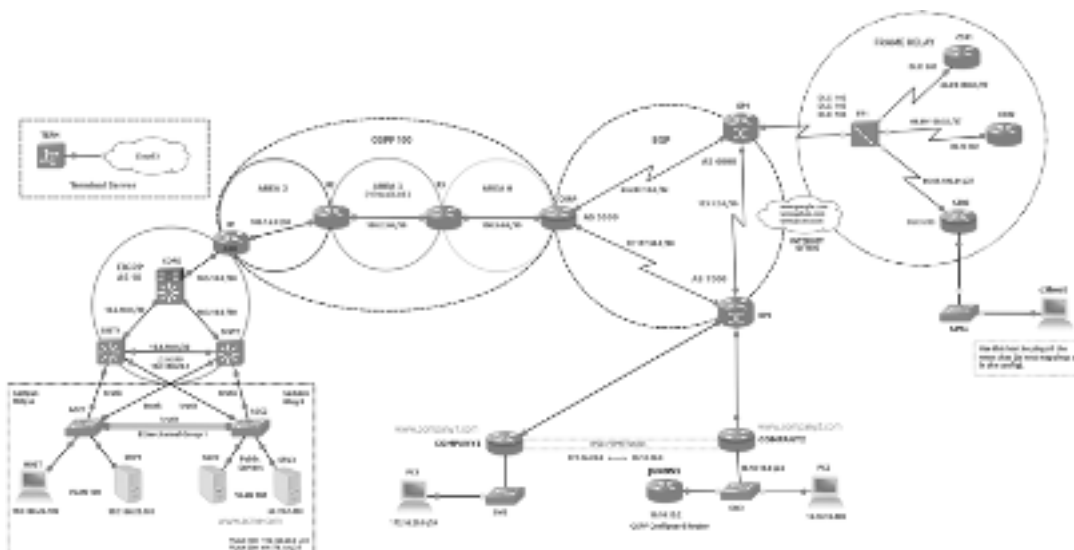


Figure 1-2: A complex, multiprotocol GNS3 topology

The project in Figure 1-2 is configured with more than 25 devices, including redundant switch blocks, EtherChannel, L2 Hot Standby Routing Protocol (HSRP), Frame Relay, Enhanced Interior Gateway Routing Protocol (EIGRP), Open Shortest Path First (OSPF), and Border Gateway Protocol (BGP), but the project can be run on a modestly configured PC. To keep your devices straight, you can also annotate your designs with colored, scalable text, as I've done in this example. If you have a laptop, you can even take projects on the road to present to clients, solve design issues, or study for certification exams. CCNA or CCNP candidates can also create all the training labs necessary to learn Cisco's exam material, practice with real operating systems, and study from anywhere.

GNS3 has the ability to bridge virtual interfaces in your lab devices to one or more physical Ethernet interfaces in your PC. This allows you to connect your virtual networks to real hardware such as routers, switches, and other PCs. For example, you can run two or more GNS3 networks using multiple PCs and connect the PCs together using an Ethernet crossover cable or a physical switch. Doing so gives you the capability to connect all GNS3 devices across all the PCs. (I affectionately refer to this as a GNS3 *ubernet!*)

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