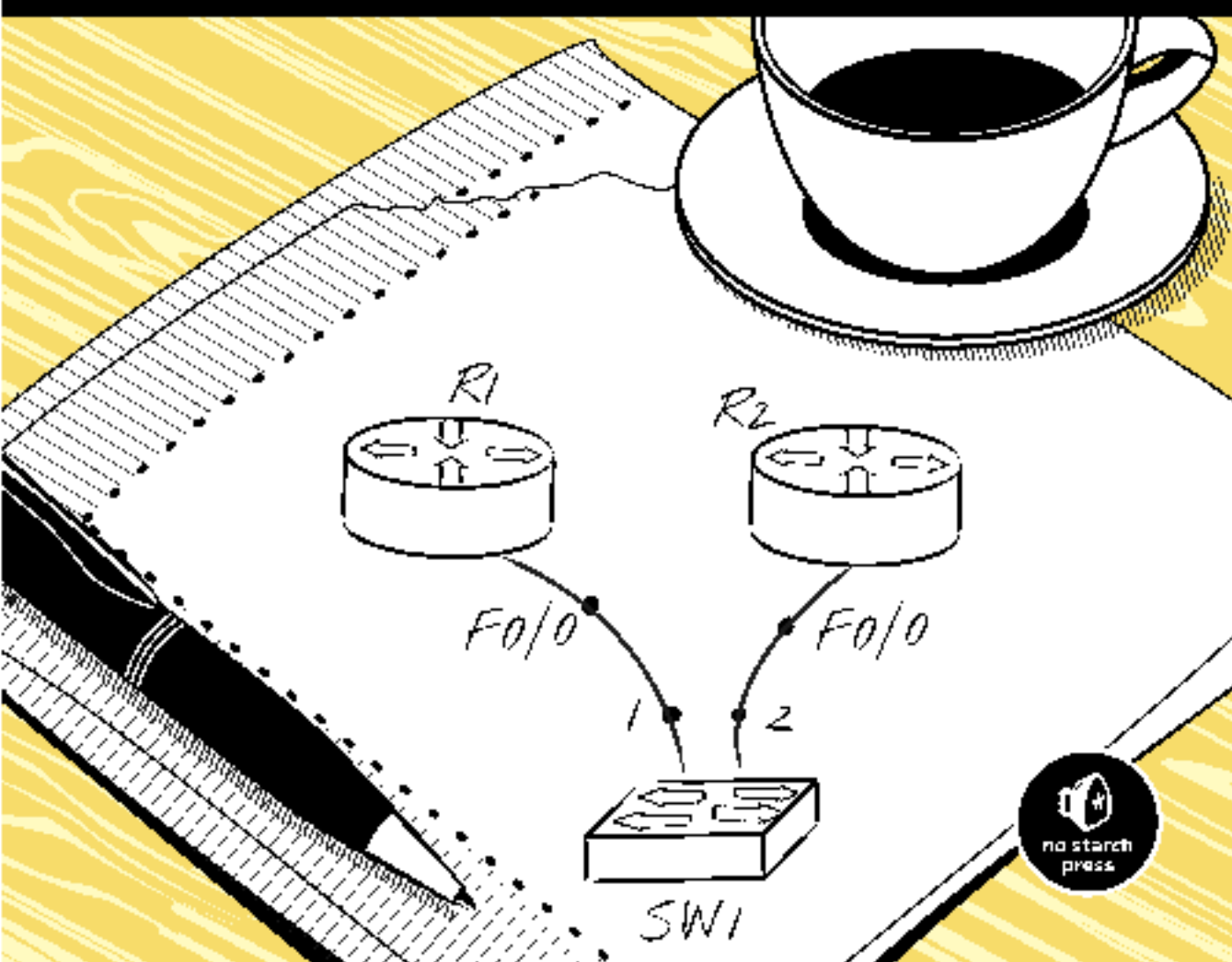


THE BOOK OF GNS3

BUILD VIRTUAL NETWORK LABS USING
CISCO, JUNIPER, AND MORE

JASON C. NEUMANN



THE BOOK OF GNS3

THE BOOK OF GNS3

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

by Jason C. Neumann



**no starch
press**

San Francisco

THE BOOK OF GNS3. Copyright © 2015 by Jason C. Neumann.

All rights reserved. No part of this work may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage or retrieval system, without the prior written permission of the copyright owner and the publisher.

Printed in USA

First printing

19 18 17 16 15 1 2 3 4 5 6 7 8 9

ISBN-10: 1-59327-554-4

ISBN-13: 978-1-59327-554-9

Publisher: William Pollock

Production Editor: Serena Yang

Cover Illustration: Tina Salameh

Interior Design: Octopod Studios

Developmental Editor: Jennifer Griffith-Delgado

Technical Reviewer: Jeremy Grossmann

Copyeditors: Gillian McGarvey and Kim Wimpsett

Compositor: Susan Glinert Stevens

Proofreader: James Fraleigh

Indexer: BIM Indexing & Proofreading Services

For information on distribution, translations, or bulk sales, please contact No Starch Press, Inc. directly:

No Starch Press, Inc.

245 8th Street, San Francisco, CA 94103

phone: 415.863.9900; info@nostarch.com

www.nostarch.com

Library of Congress Cataloging-in-Publication Data

Neumann, Jason C.

The book of GNS3 : build virtual network labs using Cisco, Juniper, and more / by Jason C. Neumann.

pages cm

Includes index.

Summary: "Shows readers how to create and manage virtual networks on a PC using the popular open-source platform GNS3, with tutorial-based explanations"-- Provided by publisher.

ISBN 978-1-59327-554-9 -- ISBN 1-59327-554-4

1. Computer networks--Computer simulation. I. Title.

TK5105.5.N4865 2015

004.6'8--dc23

2014040973

No Starch Press and the No Starch Press logo are registered trademarks of No Starch Press, Inc. Other product and company names mentioned herein may be the trademarks of their respective owners. Rather than use a trademark symbol with every occurrence of a trademarked name, we are using the names only in an editorial fashion and to the benefit of the trademark owner, with no intention of infringement of the trademark.

The information in this book is distributed on an "As Is" basis, without warranty. While every precaution has been taken in the preparation of this work, neither the author nor No Starch Press, Inc. shall have any liability to any person or entity with respect to any loss or damage caused or alleged to be caused directly or indirectly by the information contained in it.

BRIEF CONTENTS

Foreword by Jeremy Grossmann	xiii
Acknowledgments	xv
Introduction	xvii
Chapter 1: Introducing GNS3	1
Chapter 2: Installing a Basic GNS3 System.	7
Chapter 3: Configuration	19
Chapter 4: Creating and Managing Projects	31
Chapter 5: Integrating Hosts and Using Wireshark.	47
Chapter 6: Juniper Olive and vSRX Firefly	63
Chapter 7: Device Nodes, Live Switches, and the Internet.	93
Chapter 8: Cisco ASA, IDS/IPS, and IOS-XRv	123
Chapter 9: Cisco IOS on Unix and NX-OSv	151
Chapter 10: Cool Things to Do on a Rainy Day.	177
Appendix A: Help! I've Fallen and I Can't Get Up	203
Appendix B: Cisco Hardware Compatible with GNS3	217
Appendix C: NM-16ESW and IOU L2 Limitations	223
Glossary	227
Index	233

CONTENTS IN DETAIL

FOREWORD by Jeremy Grossmann	xiii
-------------------------------------	-------------

ACKNOWLEDGMENTS	xv
------------------------	-----------

INTRODUCTION	xvii
---------------------	-------------

Who This Book Is For	xvii
What's in This Book	xviii
My Approach	xviii
Book Overview	xviii

1	
INTRODUCING GNS3	1

Why Use GNS3?	2
Emulated Hardware	2
Simulated Operating Systems	2
Scalability with the GNS3 Server	3
Virtual Connectivity	3
Open Source Integration	5
The Dynamips Hypervisor	5
QEMU and VirtualBox	5
A Few Limitations	5
Some Assembly Required	5
Limited Emulation	6
Hamstrung Network Performance	6
Final Thoughts	6

2	
INSTALLING A BASIC GNS3 SYSTEM	7

General Requirements	8
Installing on Microsoft Windows	8
Installing on OS X	10
Installing on Ubuntu Linux	11
Installing GNS3 from Packages	11
Installing GNS3 from Source Code	11
GNS3 Appliances	14
A Few Pros and Cons	15
GNS3 WorkBench	15
Installing GNS3 WorkBench	16
Final Thoughts	17

3		19
CONFIGURATION		
Acquiring an IOS Image	19	
Setting Up Your First IOS Router.	21	
Configuring Dynamips.	21	
Adding IOS Images to GNS3.	23	
Setting a Manual Idle-PC Value.	26	
Final Thoughts	29	
4		31
CREATING AND MANAGING PROJECTS		
Project Management Overview	31	
Terminology	32	
Screen Layout.	32	
Using the GNS3 Toolbar	34	
First Toolbar Group	34	
Second Toolbar Group	34	
Third Toolbar Group	35	
Fourth Toolbar Group	35	
Using the Devices Toolbar.	37	
Creating Your First Project.	37	
Working with Routers	38	
Creating Links Between Your Routers	39	
Configuring Virtual Hardware.	40	
Starting, Stopping, and Pausing Routers.	41	
Logging On to Routers.	41	
Ethernet Switch Nodes	44	
Changing Symbols and Organizing Your Devices	45	
Final Thoughts	46	
5		47
INTEGRATING HOSTS AND USING WIRESHARK		
Virtual PC Simulator	47	
Installing VPCS	48	
VPCS Commands	48	
VPCS IP Addressing.	49	
VirtualBox	50	
Installing on Windows.	50	
Installing on OS X.	51	
Installing on Linux	51	
Importing Appliances.	51	
VirtualBox Preferences	52	
VirtualBox Virtual Machine Settings	53	
Using VirtualBox Hosts in a Project	55	
Linking VirtualBox Host Nodes to Other Devices	56	
Simple VirtualBox Project Using a Linux Virtual Machine	57	
Wireshark.	58	
Installing on Windows.	58	
Installing on OS X.	59	

Installing on Linux	59
Capturing Packets in GNS3	59
Final Thoughts	62

6 JUNIPER OLIVE AND VSRX FIREFLY 63

Installing QEMU on Windows and OS X	63
Installing QEMU on Linux	64
Introducing Juniper	65
Installing Juniper	66
Process Overview	66
Acquiring FreeBSD	67
Acquiring Juniper Olive Software	67
Creating a Juniper Olive CD Image File	67
Creating an ISO in Windows	67
Creating an ISO in OS X	68
Creating an ISO in Linux	68
Installing and Configuring FreeBSD Using QEMU	69
Preparing Your Build Directory	69
Installing a Junos-Friendly FreeBSD System	69
Installing the Juniper Olive Package in FreeBSD	78
Getting Your Olive Up and Running	78
Backing Up Juniper Olive	80
Configuring a Juniper Router in GNS3	81
Adding the Juniper Virtual Machine to GNS3	82
Adding Ethernet Interfaces	82
Testing a Juniper Router	83
Running Juniper vSRX Firefly	84
Creating a Firefly Virtual Machine with VirtualBox	85
Giving Your Virtual Machine More Processors	87
Adding vSRX Firefly to GNS3	87
Creating a Project with a Zone-Based Firewall	88
Final Thoughts	91

7 DEVICE NODES, LIVE SWITCHES, AND THE INTERNET 93

Built-in Device Nodes	94
Node Configurator	94
Ethernet Hub	95
EtherSwitch Router	96
Frame Relay Switch	97
Simple Frame Relay Hub and Spoke Configuration	98
Creating a Frame Relay Switch Using IOS	101
ATM Switch	102
Cloud Nodes	104
Connecting GNS3 Devices to Physical Hardware	105
Dynamips Permissions	105
Preparing Your PC for a Bridge	106
Using a Loopback Adapter on Windows	106

TUN/TAP Drivers on OS X	108
TUN/TAP Drivers on Ubuntu Linux	109
Connecting to Live Switches	109
Configuring a Standard 802.1Q Trunk	109
Creating the Elusive Breakout Switch	112
Optional Breakout Switch Configuration	117
Using Multiple Adapters in Your PC	119
Connecting GNS3 Devices to the Internet	120
Configuring Windows	120
Configuring Unix-Based Systems	120
Creating a Simple Network	120
Final Thoughts	121

8 CISCO ASA, IDS/IPS, AND IOS-XRV 123

Cisco Configuration Professional	124
Project Configuration	124
CCP Installation	125
Running CCP	125
Cisco ASA Firewall	126
Acquiring an Image	127
Prepping the ASA Image for GNS3	127
Configuring GNS3 for ASA	127
Testing an ASA in GNS3	131
ASDM Installation	132
Cisco IDS/IPS	135
Acquiring an IDS/IPS Image	135
Creating a QEMU-Ready IDS/IPS System	135
Hijacking the Hardware	137
Testing IDS/IPS (or Patience Is a Virtue)	141
Configuring GNS3 for IDS/IPS	141
Verifying IDS/IPS in GNS3	143
Cisco IOS-XRv	144
Configuring GNS3 for IOS-XRv	144
Creating a Simple IOS-XR Project	146
Final Thoughts	149

9 CISCO IOS ON UNIX AND NX-OSV 151

Cisco IOU	151
What IOU Means to GNS3	152
Switching, Switching, and More Switching!	152
IOU Images	153
Things to Know Before Installing IOU	153
Setting Up IOU on a Linux PC	154
Installing IOU	154
Creating a License File	155
Configuring GNS3	156

Using the GNS3 IOU Virtual Machine on Windows and OS X	160
Importing the GNS3 IOU Virtual Machine into VirtualBox	160
Uploading IOU Image Files	162
Configuring GNS3 for IOU	163
IOU in Action	167
NX-OSv	168
Importing NX-OSv into VirtualBox	169
Configuring GNS3 for NX-OSv.	170
NX-OSv in Action	171
Final Thoughts	175

**10
COOL THINGS TO DO ON A RAINY DAY 177**

Managing Devices from an Access Server	177
Installing the Virtual Interface	178
Preparing the GNS3 Server	180
Creating a Virtual Access Server in GNS3	181
Configuring a Cisco IP Hostname Table	184
Seeing the Virtual Access Server in Action	186
Deploying Configurations to Real Hardware	187
Exporting GNS3 Configurations to Cisco Routers	187
Importing Cisco Router Configurations into GNS3.	188
Copying GNS3 Projects Between Platforms	189
IOS-Only Projects	189
Projects with IOU Devices	189
Projects with VirtualBox Devices	190
Exploring the GNS3 Console	190
Creating Projects Using Multiple PCs	191
A Dynamips Client/Server Setup	192
Creating a GNS3 Uberlab.	198
Nerdy Labs for Fun and Profit	199
Preparing for Cisco Exams	199
Securing Your Networks	199
Practicing Real-World Scenarios	200
Final Thoughts	201

**A
HELP! I'VE FALLEN AND I CAN'T GET UP 203**

Identifying the Problem	203
Sudden Problems	204
Stopping Dynamips Crashes.	204
When IOS Images Fail to Load	204
Resolving IOS Memory Errors	206
Resolving Network IO Errors.	207
Correcting Console Problems	208
Feature Problems	210
Configuration Issues	210
Using Unsupported IOS Images	211

The Nuclear Option	211
Overburdened Hardware	212
Resolving Port Number Conflicts	212
Troubleshooting an ASA	213
Conserving Resources.	214
Select Devices Carefully.	214
Optimize Idle-PC Values.	214
Backing Up Your Projects	214
Welcome to the Jungle	215
Final Thoughts	216

B
CISCO HARDWARE COMPATIBLE WITH GNS3 **217**

Supported Cisco Hardware	217
IOS Compatibility	220

C
NM-16ESW AND IOU L2 LIMITATIONS **223**

Unsupported NM-16ESW Features.	223
Unsupported Features in Cisco IOU L2 Images.	226

GLOSSARY **227**

INDEX **233**

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

ACKNOWLEDGMENTS

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!

Special thanks to:

- My wife, Sharon, for her patience and for allowing me to be a GNS3 übergeek
- Jeremy Grossmann, our benevolent GNS3 dictator
- Christophe Follot, the creator of Dynamips, the man who started it all
- Julien Duponchelle, the silent code master
- Stephen Guppy, who answers more email in a day than I do in a year
- Mark Blackwell, GNS3 evangelist extraordinaire
- Flávio J. Saraiva, Dynamips guru
- Chris Welch, the creator of GNS3 Workbench and Jungle crowd control
- Radovan Brezula, who can make any network OS run in GNS3
- Daniel Lintott—we can convert that project, but let's use Debian!
- Rene Molenaar of gns3vault.com, u bent groot. Dank u veel!
- Chris Bryant of the Bryant Advantage, Bulldogs unite!

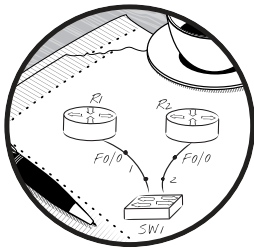
-
- Jeremy Cioara, Cisco God extraordinaire (grip #1)
 - Keith Barker, Cisco God extraordinaire (grip #2)
 - Andrew Coleman, GNS3 Super Moderator, get some sleep!
 - The GNS3 Crowd Funders—you know who you are!

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.

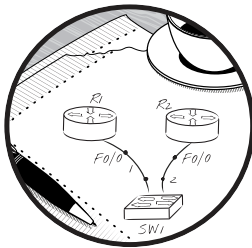
- **Chapter 1, Introducing GNS3**, covers what GNS3 is and how it works, provides an overview of GNS3, and discusses the benefits of virtual networks.
- **Chapter 2, Installing a Basic GNS3 System**, discusses installing GNS3 on Windows, OS X, and Linux, and it explains the benefits of using virtual 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.

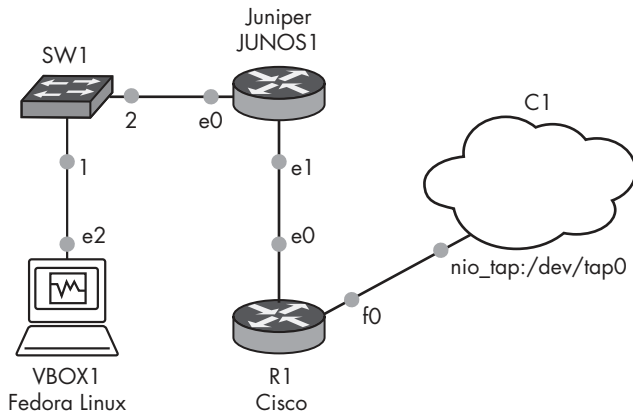


Figure 1-1: A GNS3 topology integrating Fedora Linux, Cisco, and Juniper routers

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.

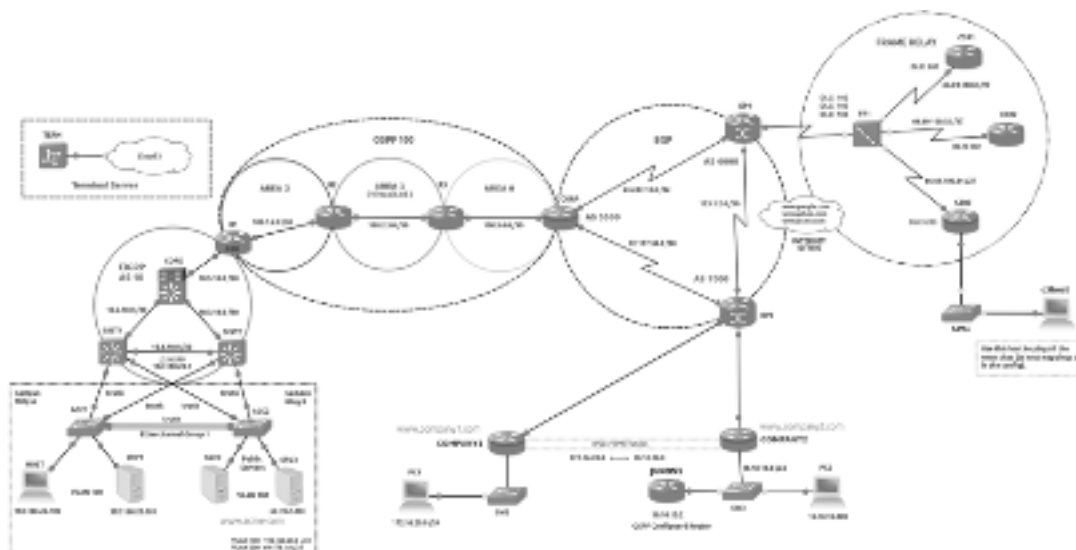


Figure 1-2: A complex, multiprotocol GNS3 topology

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!*)

- [download online *Cooking the Spanish Way: Revised and Expanded to Include New Low-Fat and Vegetarian Recipes \(Easy Menu Ethnic Cookbooks\)*](#)
- [download online *Greening Aid?: Understanding the Environmental Impact of Development Assistance*](#)
- [download online *Why Men Don't Listen and Women Can't Read Maps: How We're Different and What to Do About It*](#)
- [The Southern Bite Cookbook: 150 Irresistible Dishes from 4 Generations of My Family's Kitchen.pdf](#)
- [click **The October Revolution in Prospect and Retrospect: Interventions in Russian and Soviet History \(Historical Materialism Book Series, Volume 37\)**](#)
- [read The New Yearbook for Phenomenology and Phenomenological Philosophy: Volume 6](#)

- <http://schroff.de/books/Dragon-Hero.pdf>
- <http://dpsam.org.my/freebooks/Greening-Aid---Understanding-the-Environmental-Impact-of-Development-Assistance.pdf>
- <http://chelseaprintandpublishing.com/?freebooks/Monster-Hunter-Alpha.pdf>
- <http://rodrigocaporal.com/library/Yoga-for-a-World-Out-of-Balance--Teachings-on-Ethics-and-Social-Action.pdf>
- <http://xn--d1aboelcb1f.xn--p1ai/lib/The-October-Revolution-in-Prospect-and-Retrospect--Interventions-in-Russian-and-Soviet-History--Historical-Material>
- <http://musor.ruspb.info/?library/William-Empson--Volume-2--Against-the-Christians.pdf>