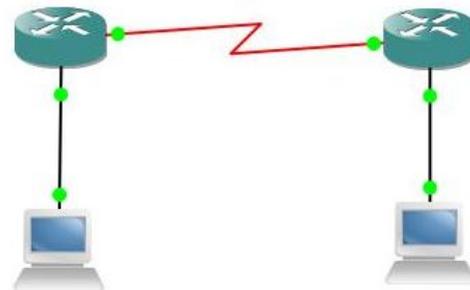


GNS3

Graphical Network Simulator

By Mike Fuszner - version 1.0

GNS3 is a **Graphical Network Simulator** that allows emulation of complex networks. You may be familiar with VMWare or Virtual PC that are used to emulate various operating systems in a virtual environment. These programs allow you to run operating systems such as Windows XP Professional or Ubuntu Linux in a virtual environment on your computer. GNS3 allows the same type of emulation using Cisco Internetwork Operating Systems. It allows you to run a Cisco IOS in a virtual environment on your computer. GNS3 is a graphical front end to a product called Dynamips. Dynamips is the core program that allows IOS emulation. Dynamips runs on top of Dynamips to create a more user friendly, text-based environment. A user may create network topologies using simple Windows ini-type files with Dynamips running on top of Dynamips. GNS3 takes this a step further by providing a graphical environment.



GNS3 allows the emulation of Cisco IOSs on your Windows or Linux based computer. Emulation is possible for a long list of router platforms and PIX firewalls. Using an EtherSwitch card in a router, switching platforms may also be emulated to the degree of the card's supported functionality. This means that GNS3 is an invaluable tool for preparing for Cisco certifications such as CCNA and CCNP. There are a number of router simulators on the market, but they are limited to the commands that

```
Dynamips(0): R0, Console port
*Mar 1 00:01:35.563: %LINK-5-CHANGED: Interface Serial1/0, changed state to administratively down
*Mar 1 00:01:35.575: %LINK-5-CHANGED: Interface Serial1/1, changed state to administratively down
*Mar 1 00:01:35.587: %LINK-5-CHANGED: Interface Serial1/2, changed state to administratively down
*Mar 1 00:01:35.603: %LINK-5-CHANGED: Interface Serial1/3, changed state to administratively down
*Mar 1 00:01:36.559: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to down
*Mar 1 00:01:36.563: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to down
Router>
Router>en
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname RTR1
RTR1(config)#enable secret cisco
RTR1(config)#line con 0
RTR1(config-line)#logging synchron
RTR1(config-line)#logging synchron
RTR1(config-line)#logging synchronous
RTR1(config-line)#password cisco
RTR1(config-line)#login
RTR1(config-line)#exit
RTR1(config)#exit
RTR1#sh ip
*Mar 1 00:02:31.211: %SYS-5-CONFIG_I: Configured from console by console
RTR1#sh ip int brief
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    unassigned      YES unset   administratively down down
Serial1/0          unassigned      YES unset   administratively down down
Serial1/1          unassigned      YES unset   administratively down down
Serial1/2          unassigned      YES unset   administratively down down
Serial1/3          unassigned      YES unset   administratively down down
RTR1#
```

the developer chooses to include. Almost always there are commands or parameters that are not supported when working on a practice lab. In these simulators you are only seeing a representation of the output of a simulated router. The accuracy of that representation is only as good as the developer makes it. With GNS3 you are running an actual Cisco IOS, so you will see exactly what the IOS produces and will have access to any command or parameter supported by the IOS. In addition, GNS3 is an open source, free program for you to use. However, due to licensing restrictions, you will have to provide your own Cisco IOSs to use with GNS3. Also, GNS3 will provide around 1,000 packets per second throughput in a virtual environment. A normal router will provide a hundred to a thousand times greater throughput. GNS3 does not take the place of a real router, but is meant to be a tool for learning and testing in a lab environment. Using GNS3 in any other way would be considered improper.

GNS3 was developed primarily by Jeremy Grossmann. Additional developers involved in creating GNS3 are David Ruiz, Romain Lamaison, Aurélien Levesque, and Xavier Alt. Dynamips was developed by Christophe Fillot. Dynamips's primary developer was Greg Anuzelli. There are a lot of other people that have assisted in

various ways in the development of these products. Development is an ongoing process as each product evolves.

This documentation will begin with a **Quick Start Guide** followed by a more in-depth discussion. Finally, in this introduction, I'd like to list a variety of Web sites that you will find useful:

- <http://www.gns3.net> GNS3's primary Web site
- <http://wiki.gns3.net> GNS3's Wiki site
- http://www.ipflow.utc.fr/index.php/Cisco_7200_Simulator Dynamips – the actual emulator
- <http://www.ipflow.utc.fr/blog/> Dynamips blog
- <http://dyna-gen.sourceforge.net/> Dynagen
- <http://www.ipflow.utc.fr/bts/> Dynamips/Dynagen bug tracking
- <http://7200emu.hacki.at> Hacki's forum

The most useful sites will be www.gns3.net and <http://7200emu.hacki.at>. The GNS3 site will be specific to GNS3. However, the hacki site is an invaluable forum where you'll find many how-to's and be able to interact with other users. I highly recommend that you visit both sites.

GNS3 Quick Start Guide for Windows Users

This section will take you through the steps to get started with GNS3 in a Windows environment. All of the critical and most important things to know will be covered, but for an in-depth discussion, see later sections of this document. If you use Linux, there is a **GNS3 Quick Start Guide for Linux Users** in the next section.

Step 1: Download GNS3.

Use your Web browser to access <http://www.gns3.net>.

Click on the green *Download* button.

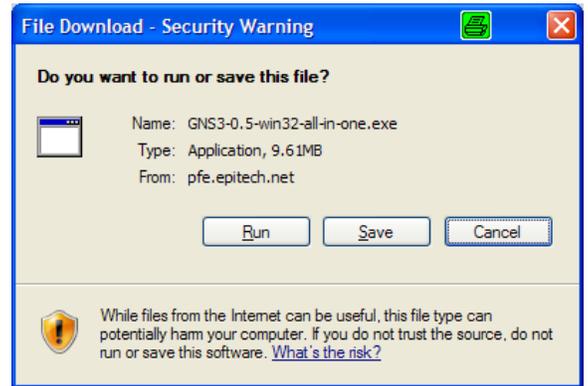


The easiest way to install GNS3 in a Windows environment is to use the top file: *GNS3-0.5-win32-all-in-one.exe*.

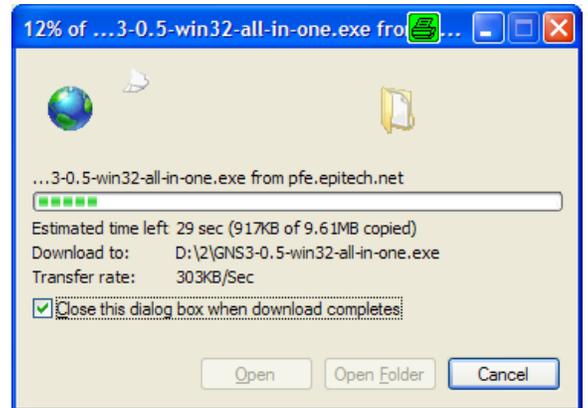
Click on *Mirror 1* or *Mirror 2* to begin the download.



Click the *Save* button and then choose a location on your hard drive to save the file.



Your download will begin. The file is a little under 10 MB in size and will take less than minute to download on a DSL or cable connection. Dial-up connections will take somewhat longer.



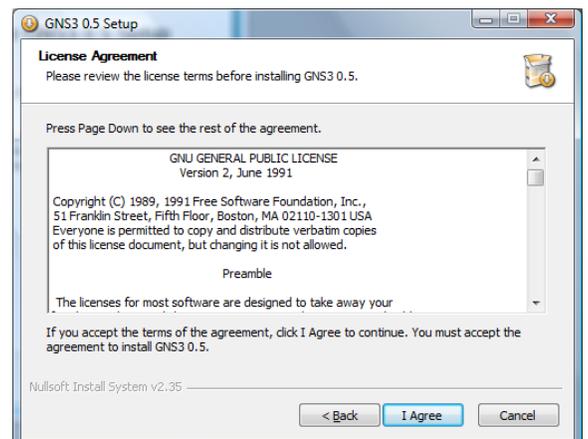
Step 2: Install GNS3

Find the file you download and double-click on it to begin installing GNS3.

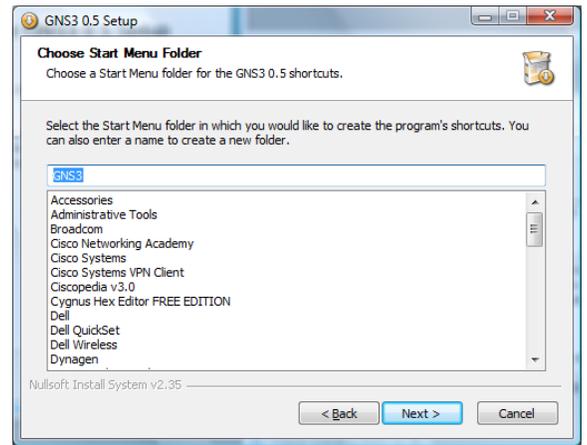
The GNS3 Setup Wizard will begin. Click the *Next* button.



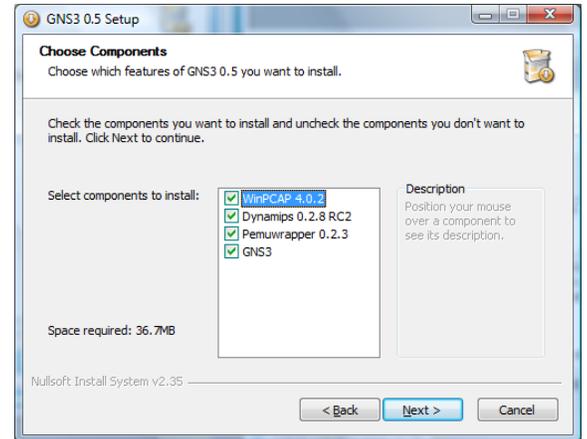
Click the *I Agree* button to continue.



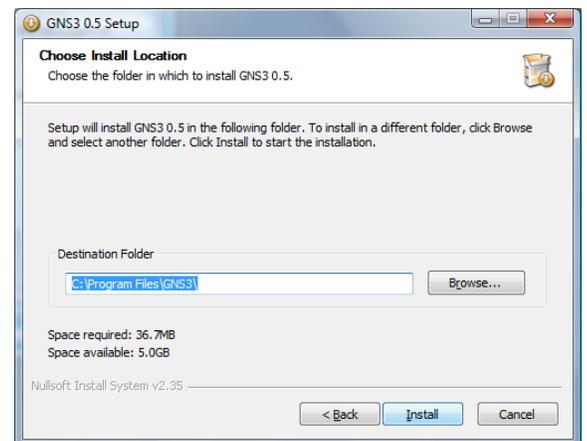
Allow GNS3 to create a Start Menu folder with the default name GNS3 by clicking the *Next* button.



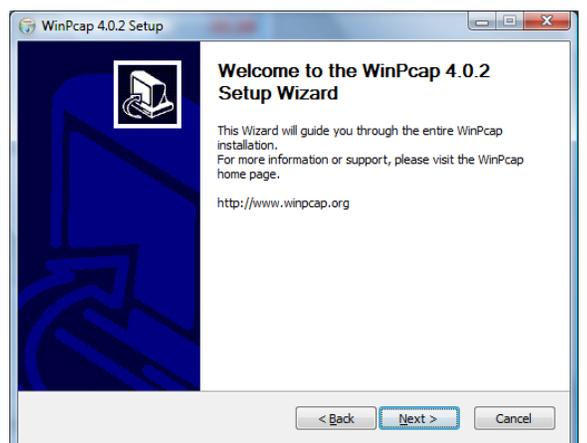
GNS3 depends on several other programs to operate. Those dependencies include WinPCAP, Dynamips, and Pemuwrapper. These components along with GNS3 are all chosen by default for installation, so just click the *Next* button to continue.



A default location is chosen for GNS3. Click the *Install* button to accept the default location and to begin the actual installation of files.

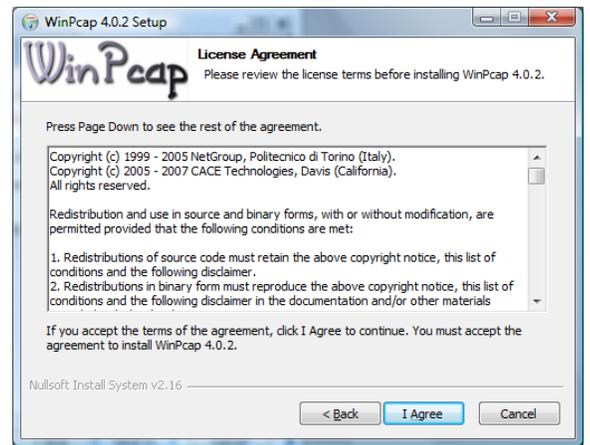


The first dependency for GNS3 is WinPcap. Click the *Next* button to begin the WinPcap Setup Wizard.

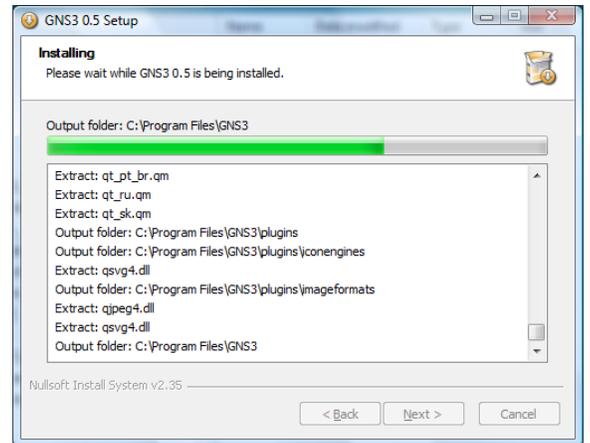


Click *I Agree* to accept the License Agreement for WinPcap.

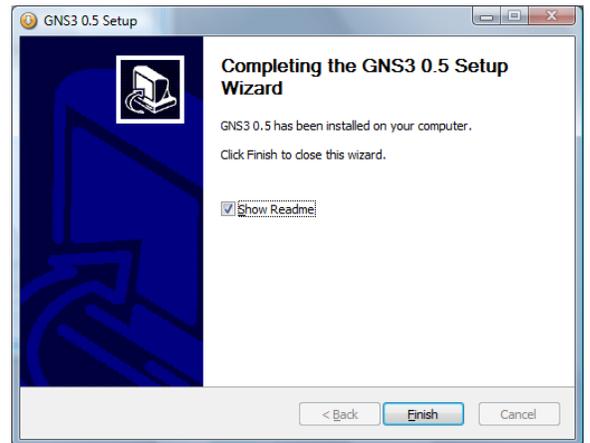
The installation for WinPcap will begin. However, if you have a previous version of WinPcap on your computer, the wizard will ask to remove the older version and will then install the newer version.



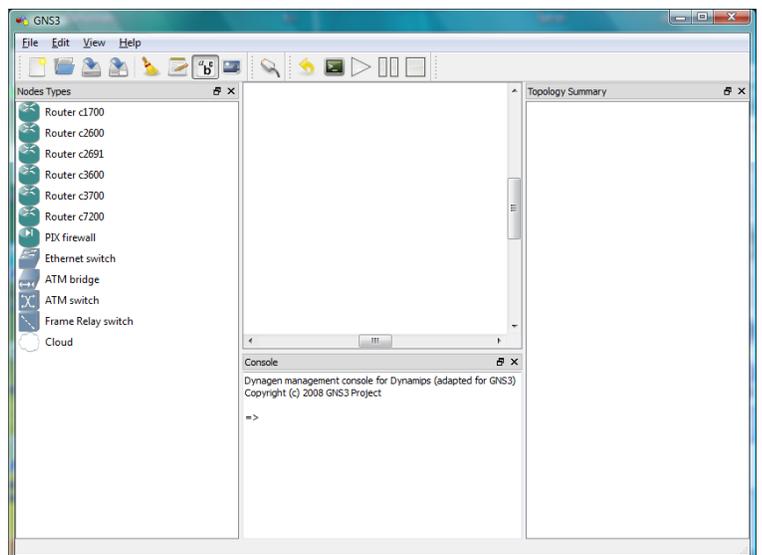
After WinPcap is installed, the GNS3 Setup Wizard returns to installing GNS3.



When the wizard finishes, you may uncheck *Show Readme* and then click the *Finish* button.



You have now completed the installation of GNS3. Click the *Start* button, *All Programs, GNS3*, and then choose *GNS3* out of the list of applications installed. You'll see the main GNS3 window. We'll discuss its panes in a later step, but first we have to configure the location for a Cisco IOS.

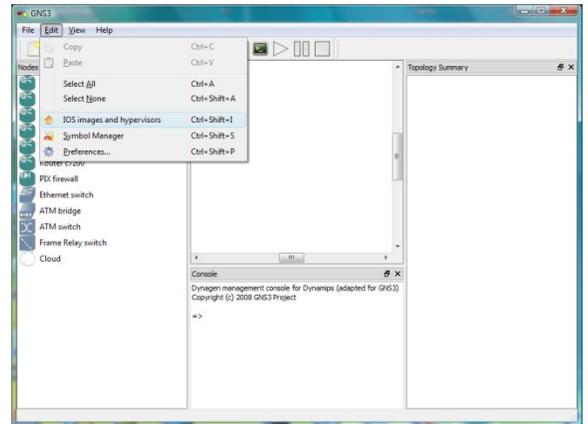


Step 3: Defining Cisco IOS files

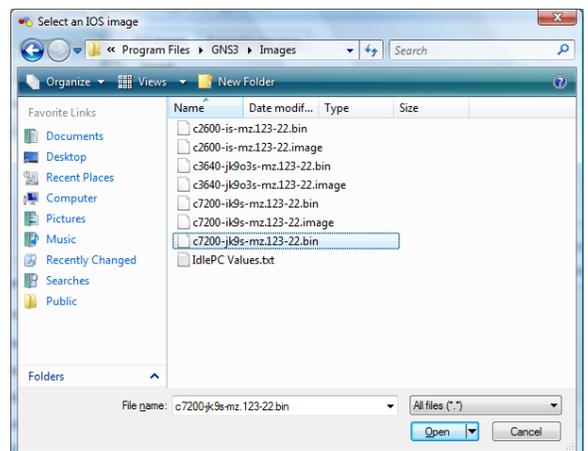
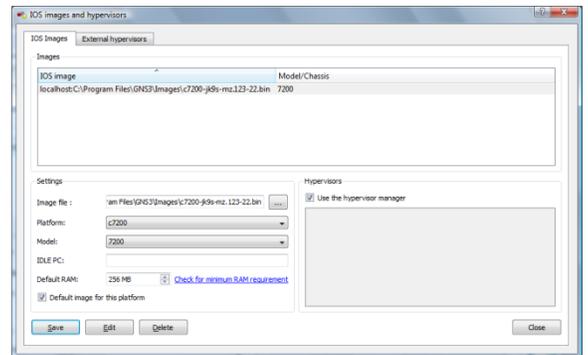
As mentioned earlier, you must provide your own Cisco IOS to use with GNS3 due to licensing issues. GNS3 is meant to be used in a lab environment for testing and learning. Once you have obtained your own copy of a Cisco IOS for one of the supported platforms, you are ready to continue. Current platforms supported include:

- 1710
- 1720
- 1721
- 1750
- 1751
- 1760
- 2610
- 2610XM
- 2611
- 2611XM
- 2620
- 2620XM
- 2621
- 2621XM
- 2650XM
- 2651XM
- 2691
- 3620
- 3640
- 3660
- 3725
- 3745
- 7200

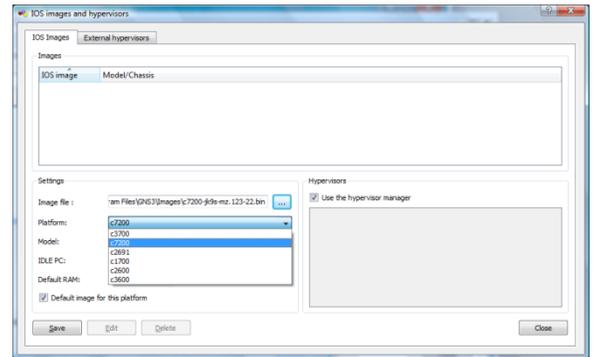
On the *Edit* menu, choose *IOS image and hypervisors*.



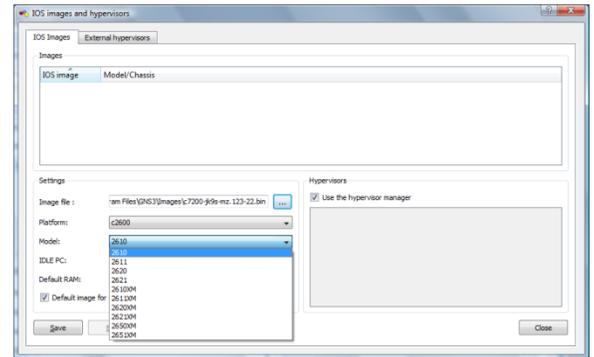
Under the *IOS Images* tab, click  and then find your Cisco IOS file and click *Open*. The file will appear as your Image file.



Next, click the drop-down arrow next to *Platform* and choose the platform that corresponds to your IOS file.



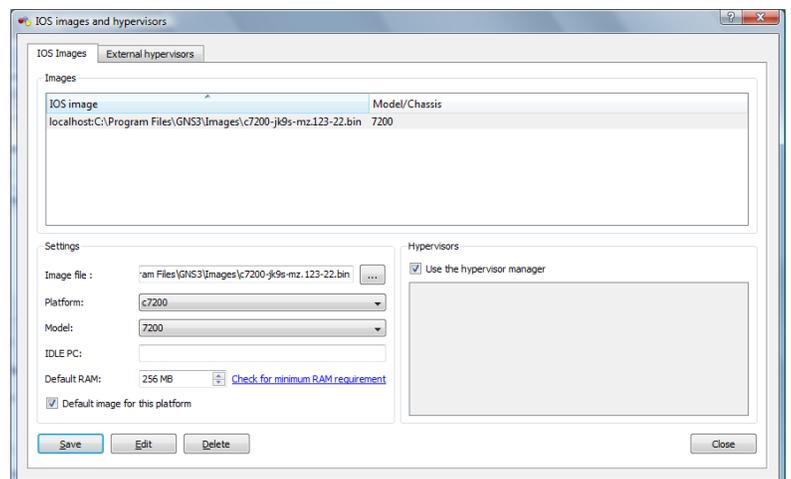
Now click the drop-down arrow next to *Model* and choose the model corresponding to your IOS file.



For now, we'll accept the default values that remain. However, there is a very important value called the IDLE PC value that we will want to include. We'll get to that later.

Click the *Save* button and then the *Close* button. This will return you to the default GNS3 window.

It's time to create our very first simple topology. But before that, the next section will present a **GNS3 Quick Start Guide for Linux Users**.

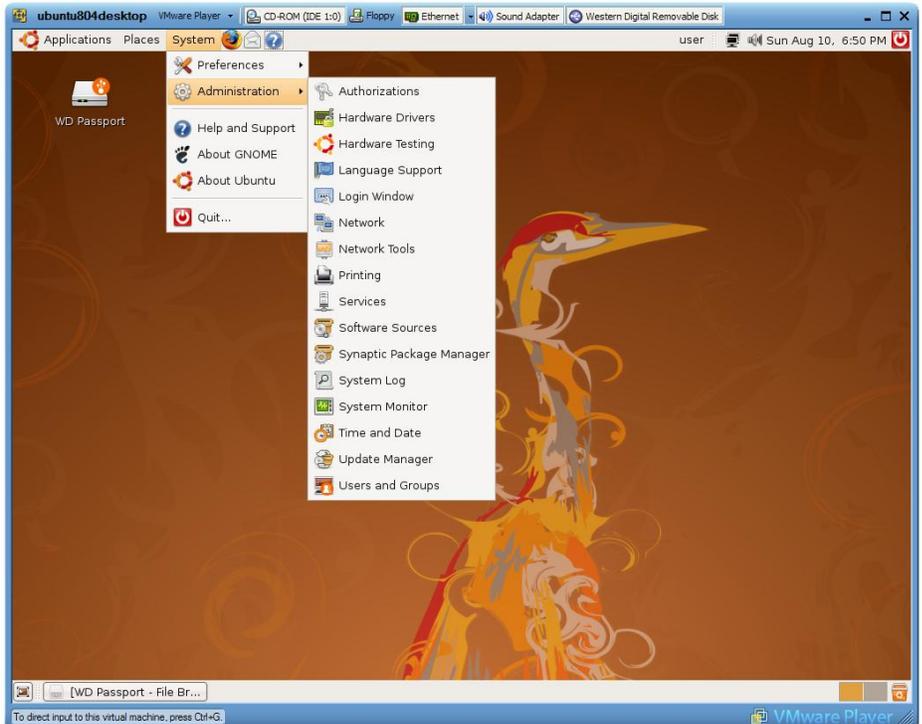


GNS3 Quick Start Guide for Linux Users

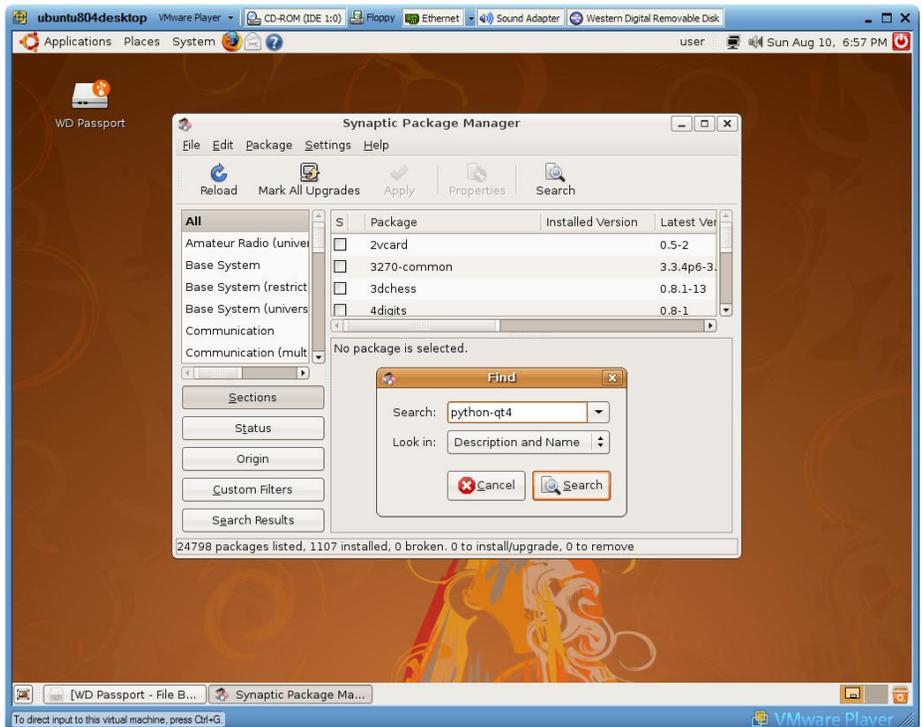
Let's turn our focus to Linux users now. Our examples will use Ubuntu. Anyone can download Ubuntu from www.ubuntu.com for free – it just may take awhile since it's a large file. Performance is somewhat better in a Linux environment, but the difference is not significant. First, we'll install necessary dependencies.

Step 1: Install necessary dependencies

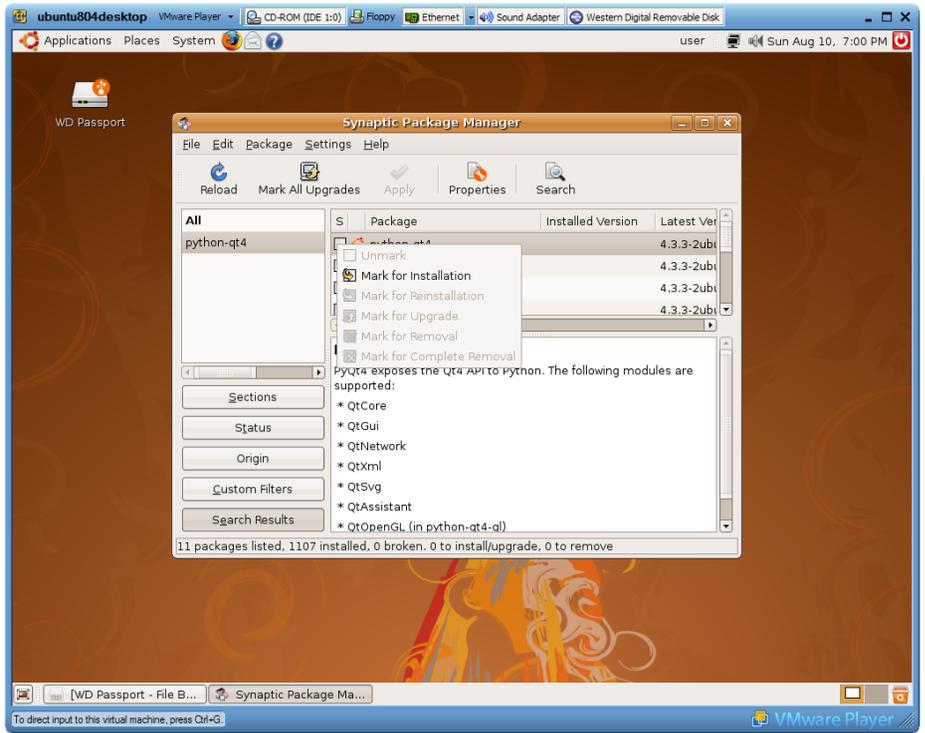
Open the **Synaptic Package Manager**. Go to the **System** menu, then **Administration**, and finally **Synaptic Package Manager**.



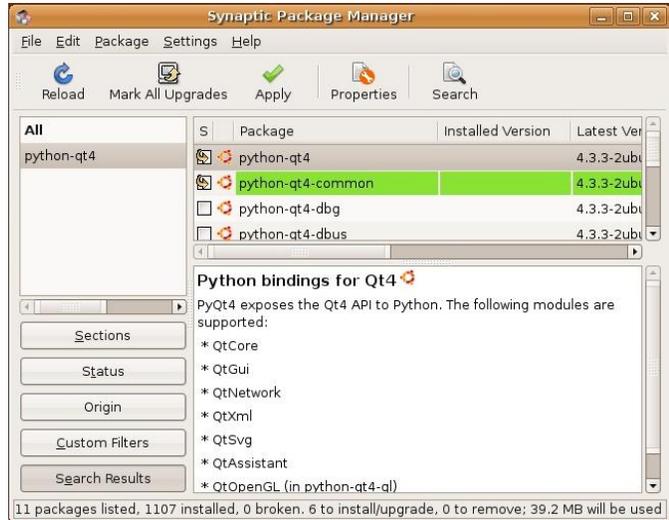
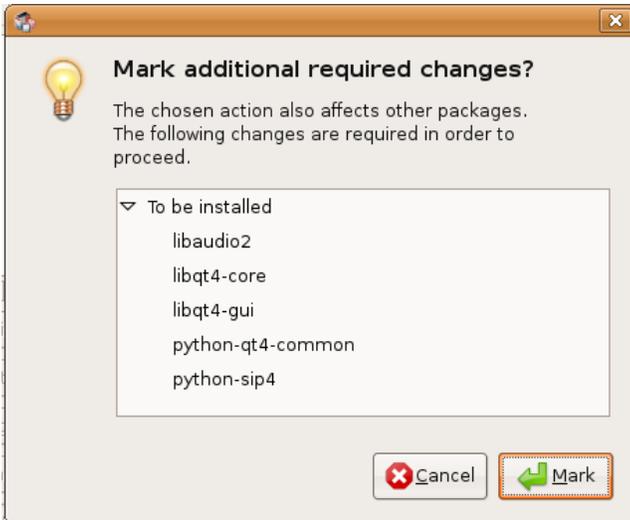
Click the **Search** button in the toolbar, type **python-qt4** in the **Search** box and click the **Search** button.



When you find python-qt4, click on the white box in front of it, and choose *Mark for Installation*.



Click *Mark* and then click the *Apply* button in the toolbar.



On the *Summary* window, click *Apply*.



Step 2: Download GNS3.

Use Firefox to access <http://www.gns3.net>.

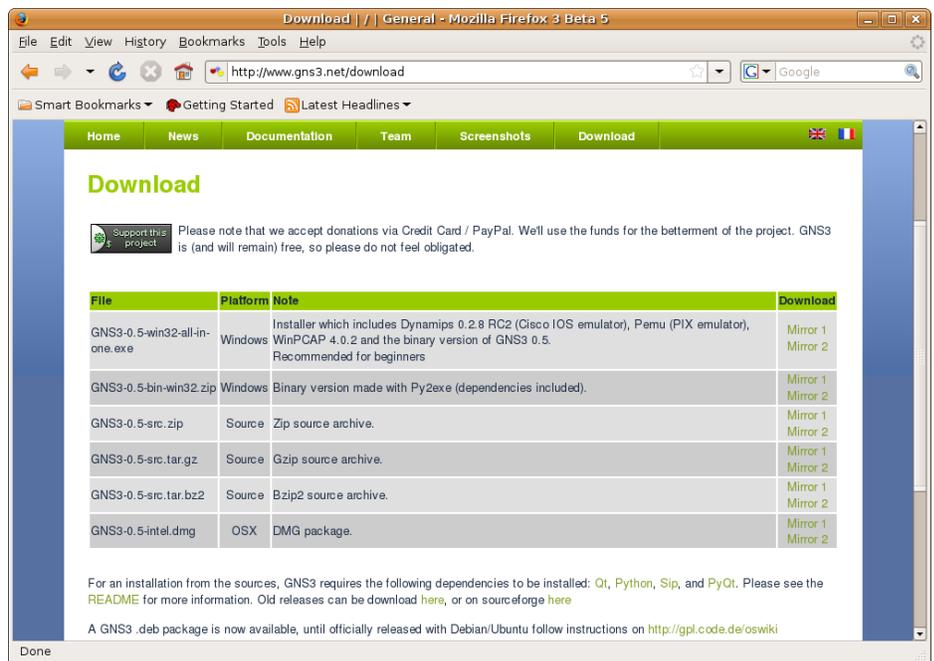
Click on the green *Download* button.



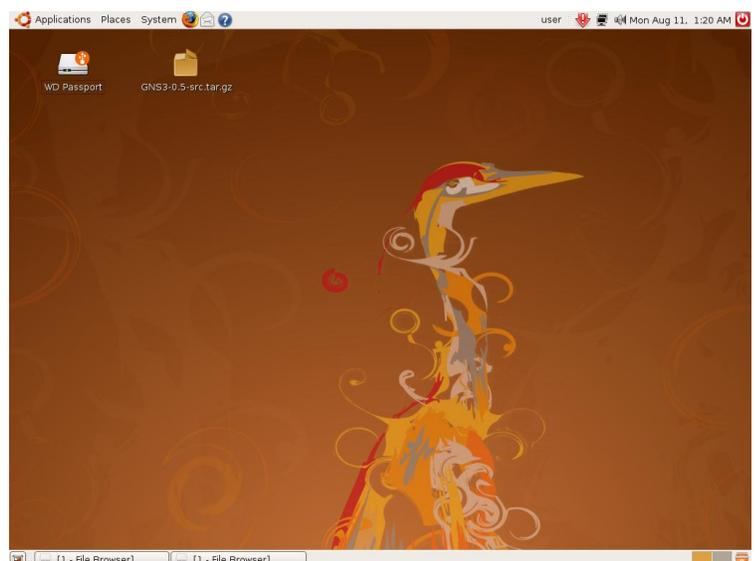
You may choose any of the source archives for Linux. We will use **GNS3-0.5-src.tar.gz**.

Click on *Mirror 1* or *Mirror 2* to begin the download.

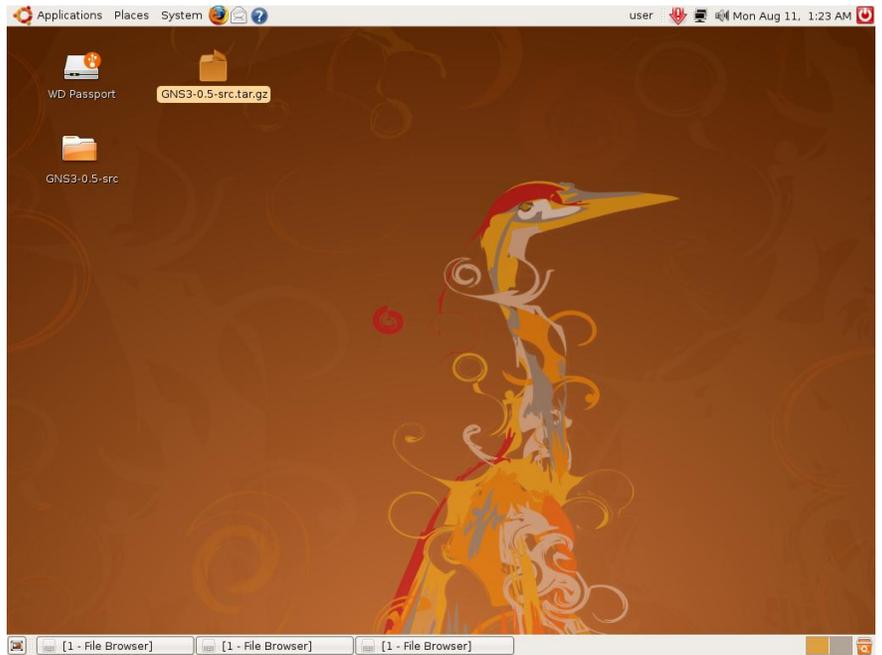
By default, the file will be downloaded to the desktop.



Next, right-click on the file on the desktop, **GNS3-0.5-src.tar.gz**, and choose *Extract Here*.



You'll see a new icon on the desktop labeled GNS3-0.5-src.

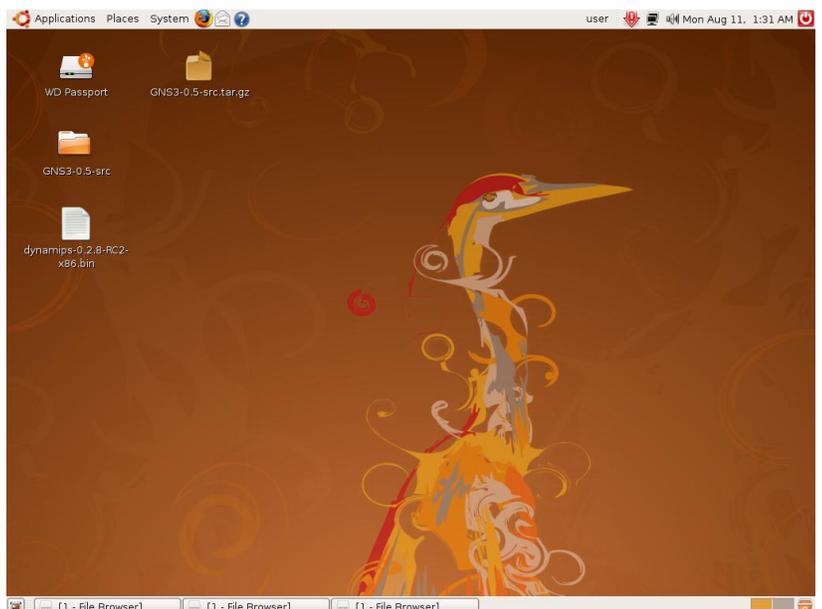


Now we need to download the latest Dynamips binary for Linux. Use Firefox to visit the Dynamips blog Web site at: www.ipflow.utc.fr/blog/

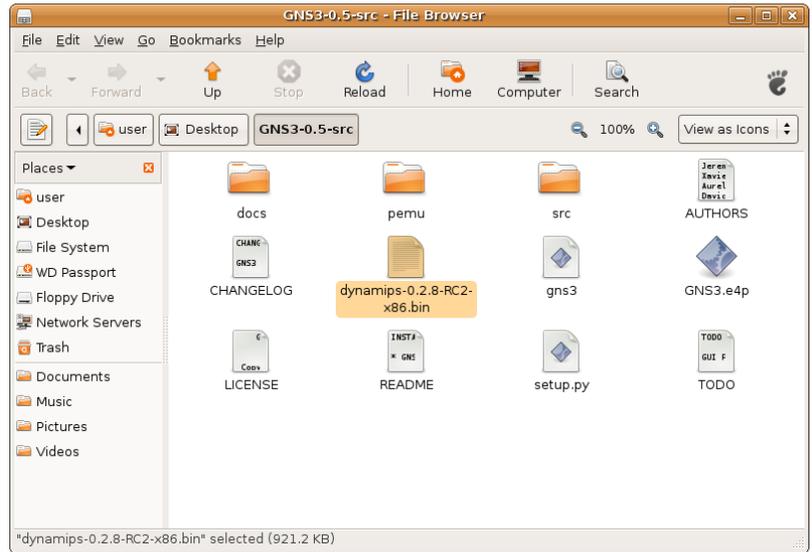
In our example, it is found farther down the page as **0.2.8-RC2 binary for Linux x86 platform**.



Drag the downloaded file, **dynamips-0.2.8-RC2-x86.bin** into the GNS3-0.5-src folder.



Let's change the Dynamips permissions to allow execution. Double-click on *dynamips-0.2.8-RC2-x86.bin* and choose *Properties*.



Click on the *Permissions* tab, and then click the box next to *Execute: Allow executing file as program*. Then click *Close*.

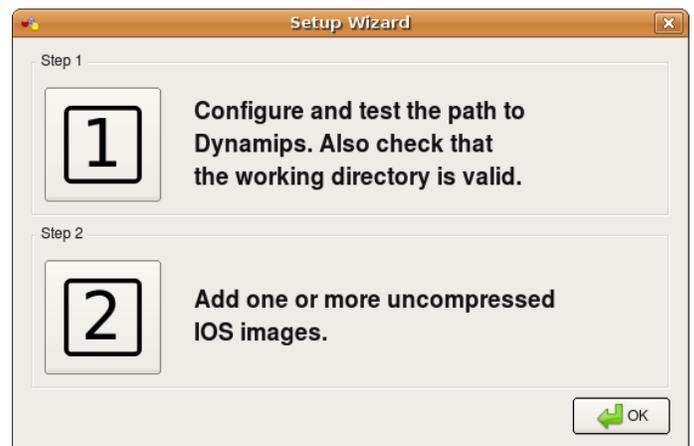


Step 3: Configuring GNS3

Double-click the *gns3* icon to start the application. Click the Run button.

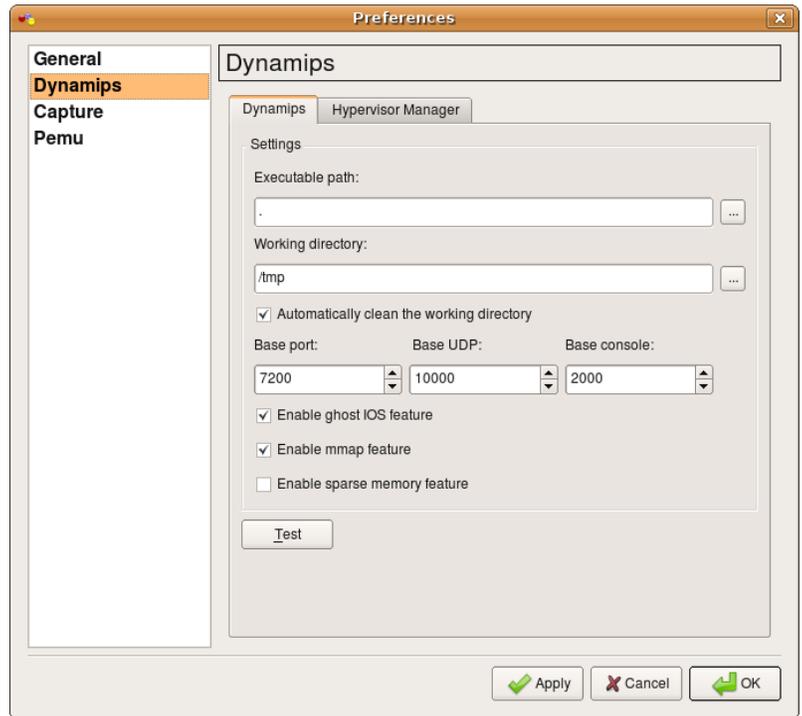


The *Setup Wizard* begins with a message as shown. Click on the **big number 1** to open the *Preferences* window (actually located under the *Edit* menu in GNS3).

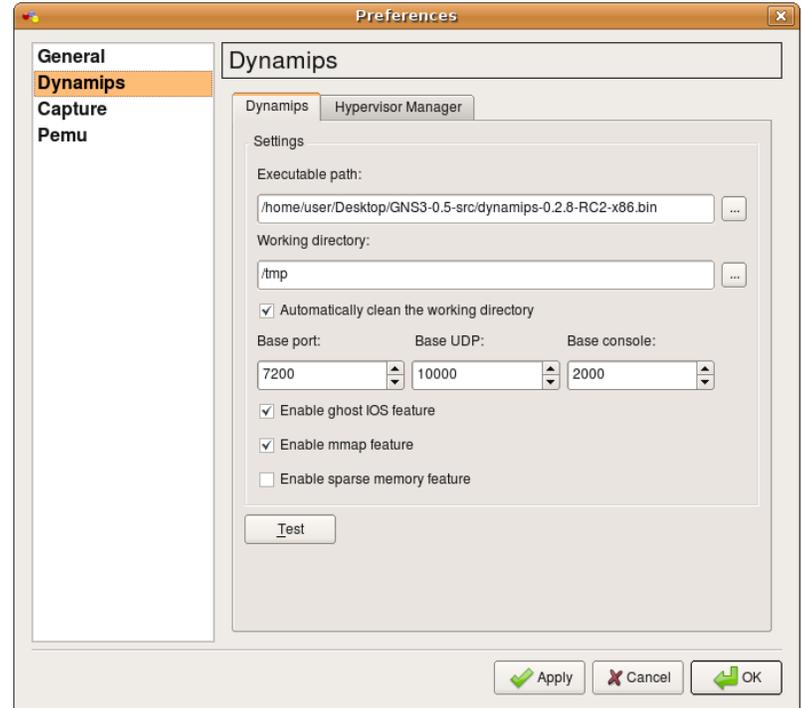


Then click *Dynamips* in the left-hand pane.

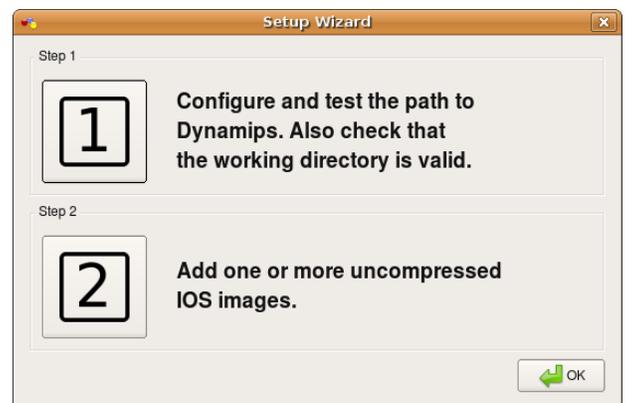
Click the ellipses next to *Executable path* and then click *dynamips-0.2.8-RC2-x86.bin* and followed by the *Open* button.



When you return to the Preferences screen, click OK.

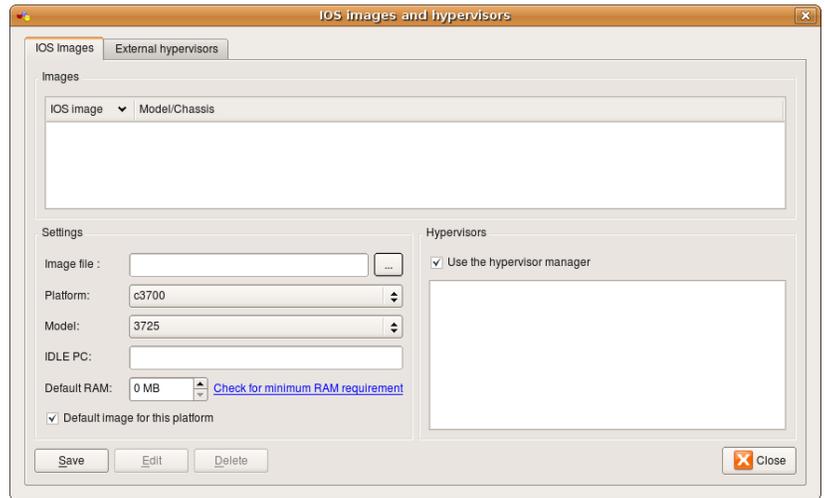


Now you return to the *Setup Wizard*. Click the **big number 2** to open the *IOS images and hypervisors* window (actually located under the *Edit* menu in GNS3).



Use the ellipses button next to the *Image file* box to locate an IOS image.

As mentioned earlier, you must provide your own Cisco IOS to use with GNS3 due to licensing issues. GNS3 is meant to be used in a lab environment for testing and learning. Once you have obtained your own copy of a Cisco IOS for one of the supported platforms, you are ready to continue. Current platforms supported include:



- 1710
- 1720
- 1721
- 1750
- 1751
- 1760
- 2610
- 2610XM
- 2611
- 2611XM
- 2620
- 2620XM
- 2621
- 2621XM
- 2650XM
- 2651XM
- 2691
- 3620
- 3640
- 3660
- 3725
- 3745
- 7200

Then click the *Save* button followed by the *Close* button. You'll return again to the Setup Wizard window. Click OK to finish.

It's time now to create our first simple topology. So whether you are Windows user or a Linux user, continue to the next section. We have often used screen shots from Windows when describing GNS3 usage, but the screen shots from Linux would look identical except for the title area.

Creating the Simplest Topology

We describe how to build a more complex topology later, but for now, let's just learn how to place one router on the desktop, start it, and console into it. We will then learn how to find an idlepc value for the IOS we are using. This is a very important step. When an IOS is running, it will consume up to 100% of your CPU time. This will cause your computer to become very sluggish and will prevent building more complex topologies. However, if we use an idlepc value, we can reduce CPU usage dramatically. It puts the IOS into a sleep state when it is not in active use and wakes it up only when it is necessary. A more technical explanation will be given later.

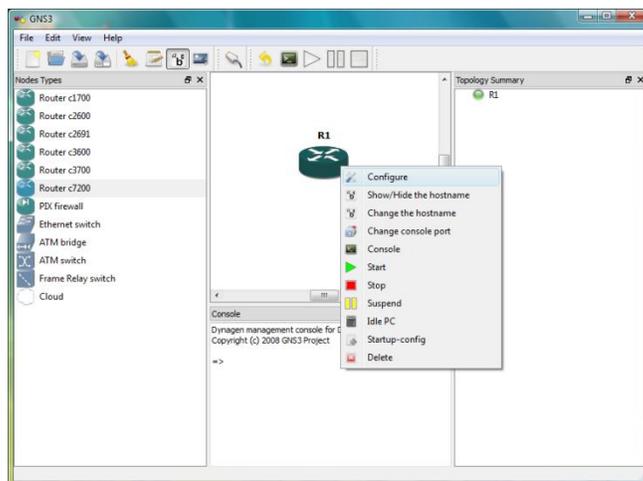
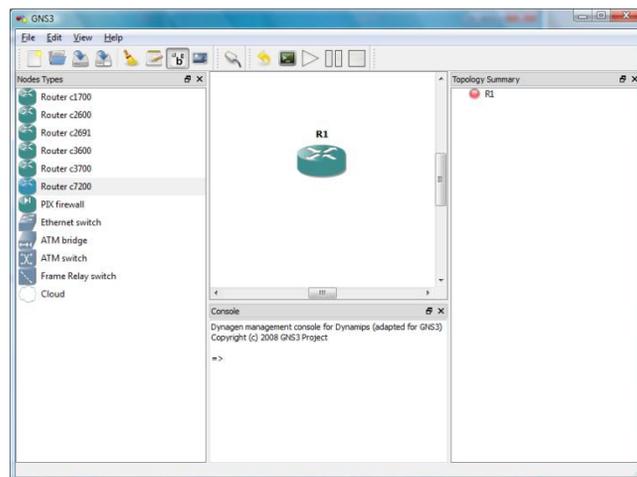
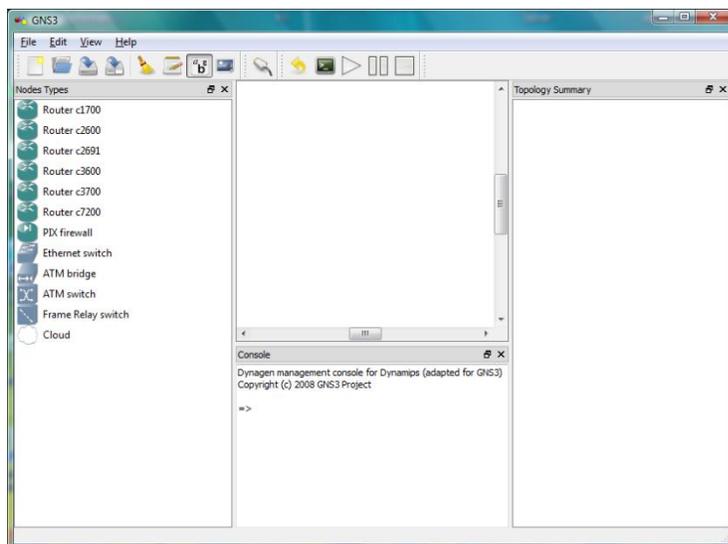
The GNS3 window is divided into four panes by default. The left-most pane lists the types of nodes available. You will see router icons for the various platforms, a PIX firewall, Ethernet switch, ATM bridge, ATM switch, Frame Relay switch, and Cloud. Other node types may be added as explained later.

The right-most pane will provide a topology summary that will be better understood when we built more complex topologies. For now, just know that the pane exists.

The middle section contains two panes. The top pane is your work area where a topology may be graphically built. The bottom pane, called the **Console**, shows Dynagen at work. Dynagen, as you recall, is the text-based front end to Dynamips, the core emulator being used. Learning how to use Dynagen is like learning how to use DOS the first time, so we will not get into that here. However, we will use a very few simple but useful commands in the Dynagen pane.

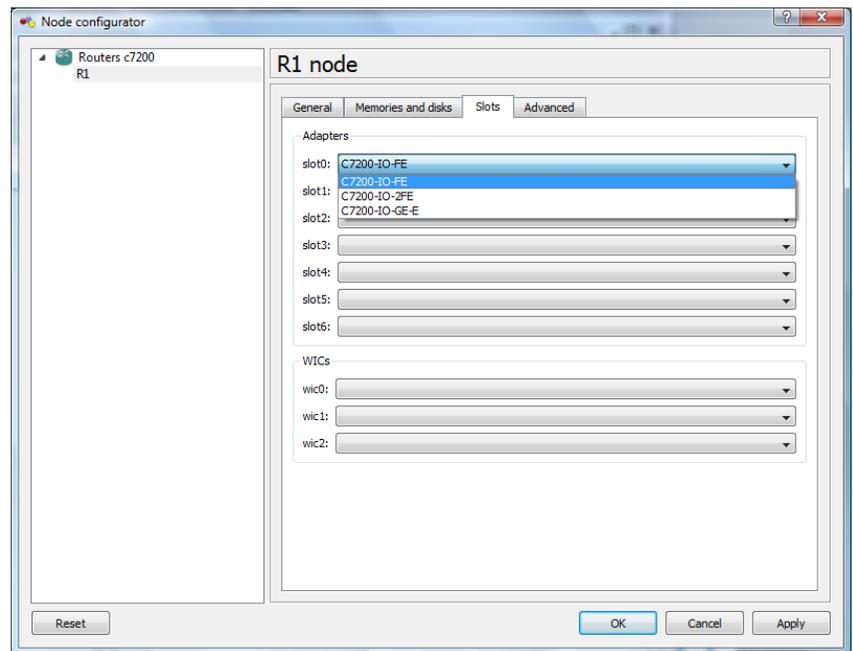
Click on a router icon under Nodes Types corresponding to the IOS platform you are using. In our example, we are using a 7200 platform. You must use a platform for which you defined an IOS. Drag an appropriate router node type over to the workplace pane in the middle and let go. We now have a router ready to configure.

Right-click the router and choose *Configure*.



Click on *R1* and then the *Slots* tab. Click the drop-down arrow next to slot0 and choose an adapter that says FE at the end. This will add a FastEthernet adapter to the router. Next, click the drop-down arrow next to *slot1* and choose *PA-4T+*. This will add four serial interfaces to the router. Click OK.

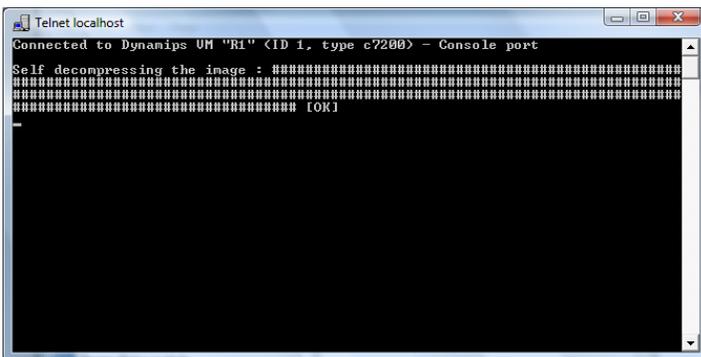
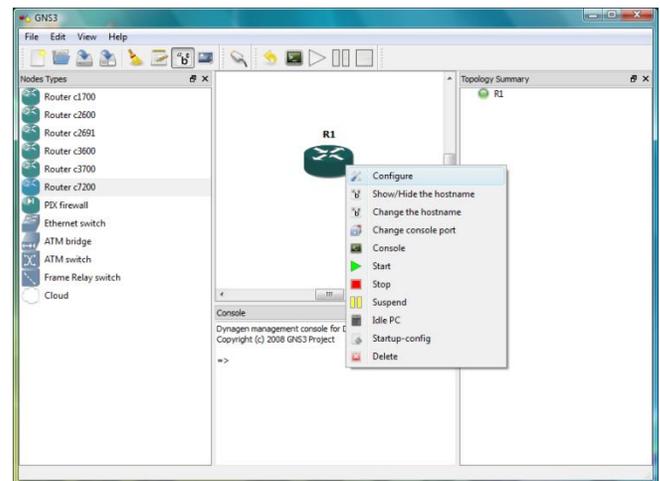
(Note: If you do not have these exact adapters, just choose something close.)



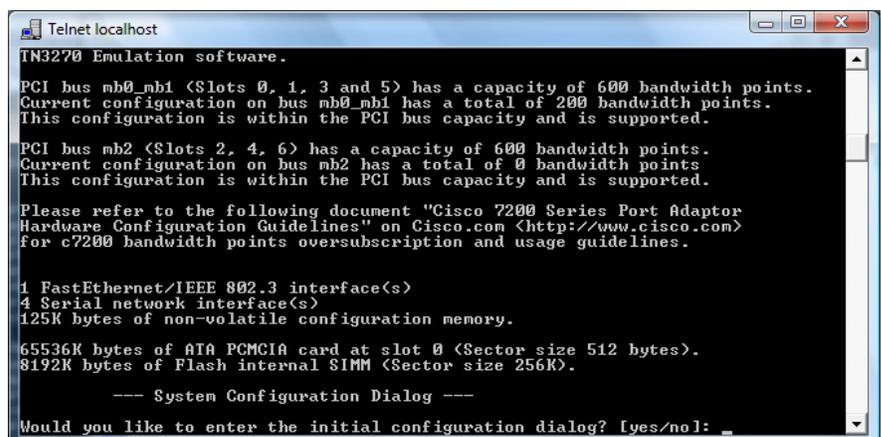
Right-click the router and choose *Start*.

Right-click the router again and choose *Console*. A telnet console opens up.

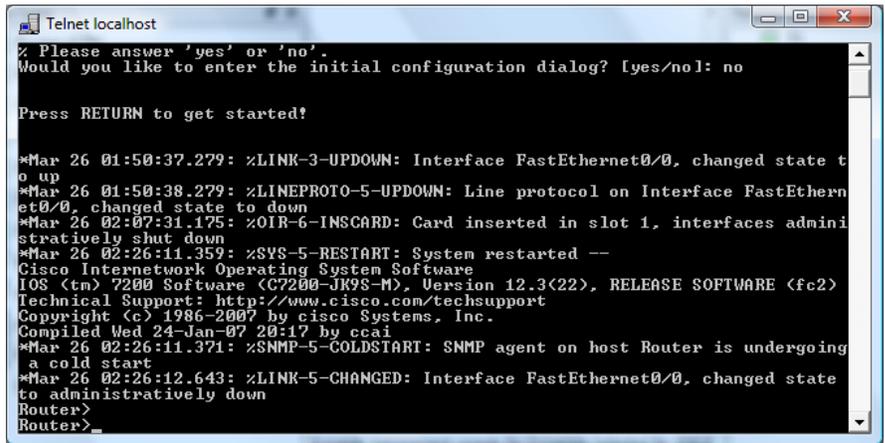
(Note: In Windows Vista, the telnet client is not automatically installed as in previous versions of Windows. Click on the *Start* sphere and choose *Control Panel*. Click on *Programs*. Under *Programs and Features*, click on *Turn Windows features on or off*. Click next to *Telnet Client* to place an x in the box. Click OK.)



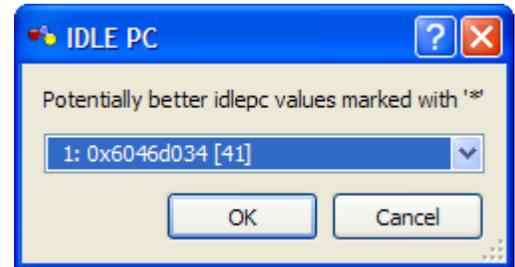
You may need to press *Enter* once initially in the Console window. When asked "Would you like to enter the initial configuration dialog?", enter *no* and press *Enter*. Wait for the router to settle down at a *Router>* prompt. You may need to press *Enter* once or twice to get there.



After the router has settled down to a `Router>` prompt, return to the main GNS3 window.

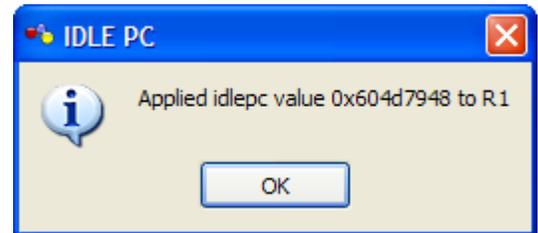
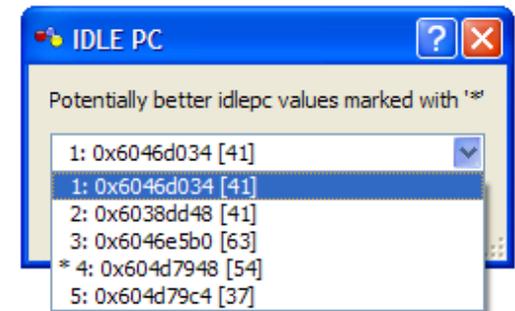


Right-click R0 and choose *Idle PC*. GNS3 will spend a moment calculating an Idle PC value before presenting the screen to the right. If you click the drop-down arrow, you see a list of possible idlepc values. Potentially better idlepc values are marked with an asterisk. Choose one of the values with an asterisk (in our example, we will choose number 4) and click OK.

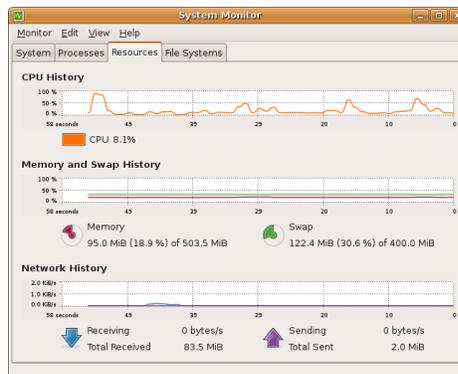


You'll receive a confirmation that the idlepc value has been applied.

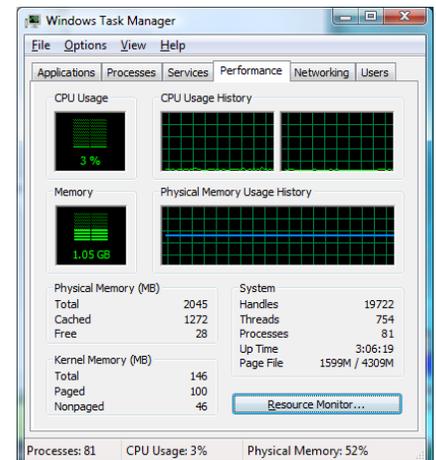
If you choose *IOS images and hypervisors* on the *Edit* menu, and double-click on the image under the *IOS Images* tab, you'll see the new idlepc value displayed under *Settings*.



You may repeat this process to find the value that reduces CPU usage the most. To observe CPU usage in Windows, press `Ctrl+ALT+DEL` and choose *Task Manager*. Click on the *Performance* tab to view CPU usage. In Ubuntu, choose *System Monitor* under *Administration* on the *System* menu. Click the *Resources* tab.



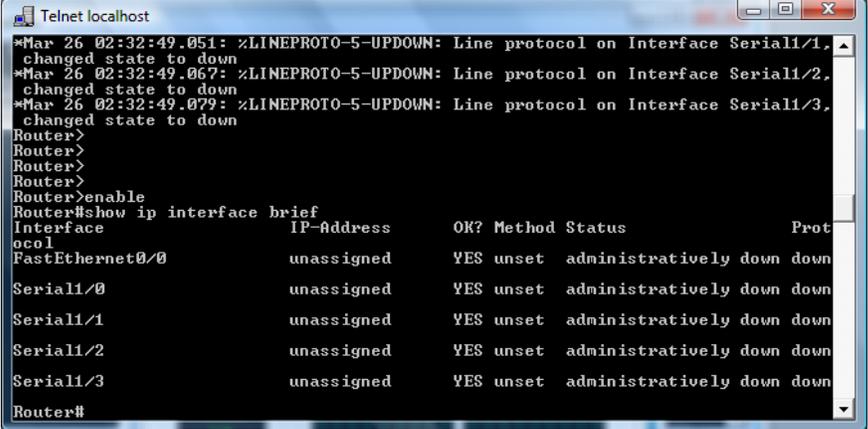
You will observe that without an idlepc value, CPU usage will be at or near 100%, but with an idlepc value, CPU usage will drop to a very low value.



Enjoy using your router!

You may now return to your telnet window to use your router. You are actually running the Cisco IOS that you chose. All commands supported by the IOS are available.

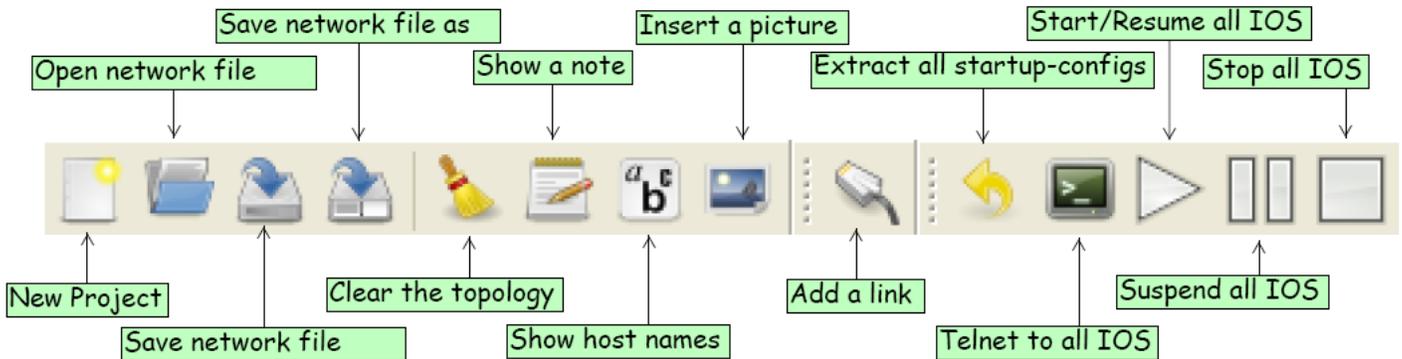
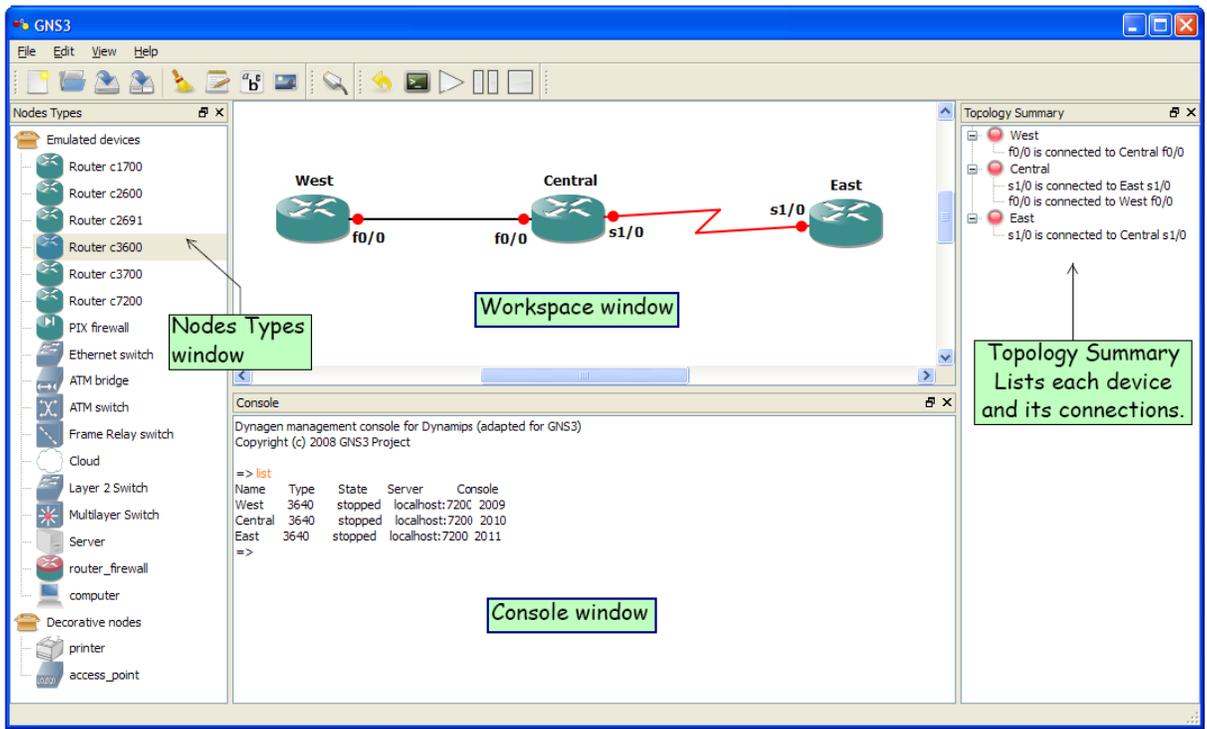
Remember earlier we chose a FastEthernet adapter and a four-port serial adapter. If you issue the *show ip interface brief* command as shown, you'll see the designations for these four ports on the router. In our example, they are fa0/0, s1/0, s1/1, s1/2, and s1/3 (in abbreviated form).



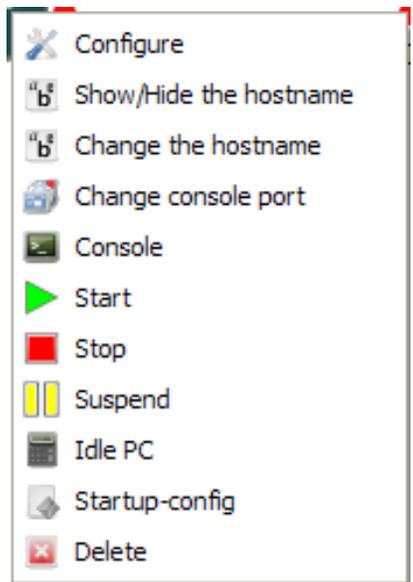
```
Telnet localhost
*Mar 26 02:32:49.051: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1,
changed state to down
*Mar 26 02:32:49.067: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/2,
changed state to down
*Mar 26 02:32:49.079: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/3,
changed state to down
Router>
Router>
Router>
Router>
Router>enable
Router#show ip interface brief
Interface                IP-Address      OK? Method Status  Prot
FastEthernet0/0          unassigned      YES unset  administratively down down
Serial1/0                 unassigned      YES unset  administratively down down
Serial1/1                 unassigned      YES unset  administratively down down
Serial1/2                 unassigned      YES unset  administratively down down
Serial1/3                 unassigned      YES unset  administratively down down
Router#
```

GNS3 Main Interface

Before continuing you may want to take a moment to view the following labeled graphics:



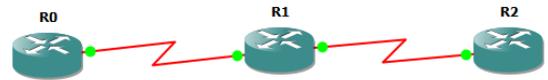
Drop-down menu from right-clicking on a router:



Building More Complex Topologies

Although a single router is useful to get familiar with commands, it would be nice to build more complex topologies. With GNS3 very complex topologies may be built. Just as performance when running virtual machines within VMware or Virtual PC depends on your computer resources, running many router instances will affect the performance of your computer. The faster your CPU and the more RAM that you have, the better. However, idlepc does a lot to help with CPU usage. Ghostios and sparsemem are two additional utilities that will help with RAM usage. Ghostios is enabled by default in GNS3. Sparsemem must be enabled, since it is off by default. These will be discussed in detail in the section on Memory Usage. As an example, with 2 Gigabytes of RAM and a 2.5 GHz processor, you should have no problems running a lab with good performance with a half dozen routers and several workstations.

Let's build the topology shown with three routers. Start GNS3. Drag three routers running an IOS you have configured into the workspace. Right-click each router and choose *Configure*. Under the *Slots* tab, include a *FastEthernet* adapter and *PA-4T* serial adapter.



Now we're ready to connect the routers together. Click the *Add a link* button on the toolbar at the top. Choose *Manual* from the drop-down menu. Your cursor will change to a cross.

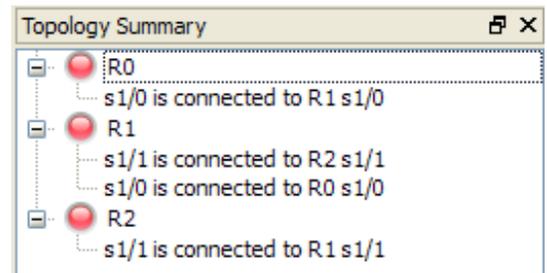


Click on R0 and select s1/0 – then click on R1 and select s1/0. Click on R1 again and select s1/1 – then click on R2 and select s1/1.



Now click the *Add a link* button again (now it looks like a red Stop sign with an X). After clicking on it, the icon will change back to a connector look.

Notice the right-pane call *Topology Summary*. Your connections are now available for viewing by clicking the plus next to each router.

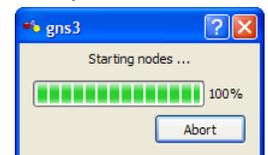


GNS3 gives each router a default name beginning with R. If you would like to change the name, right-click on a router and choose *Change the hostname*. For this example, we will continue to use the default names.

There are four buttons on the toolbar at the top:

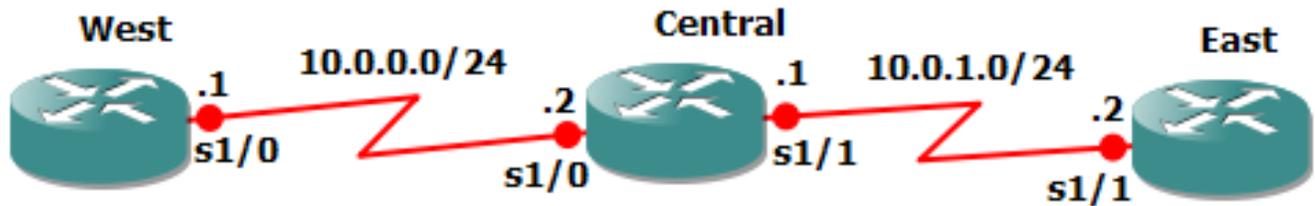


The first button is the *Telnet to all IOS* button. The next three buttons are the *Start/Resume all IOS*, *Suspend all IOS*, and *Stop all IOS*. The links are all red. Let's start the routers by clicking the *Start/Resume all IOS* button on the toolbar. A box will pop up indicating the routers are being started, and the links will turn green. If we click the *Telnet to all IOS* button, we may observe the boot-up process of each router. A separate console window will open for each router.



Answer *No* and press *Enter* for each router at the question "Would you like to enter the initial configuration dialog?".

You may now configure each router. In our example, we will change the hostnames, configure the secret password, enable synchronous logging, assign IP addresses to the interfaces and turn them on, enable RIP version 2, and finally test connectivity by using pings.



```

Dynamips(3): West, Console port
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname West
West(config)#enable secret cisco
West(config)#line con 0
West(config-line)#logging syn
West(config-line)#exit
West(config)#interface s1/0
West(config-if)#ip address 10.0.0.1 255.255.255.0
West(config-if)#clock rate 64000
West(config-if)#no shutdown
West(config-if)#exit
West(config)#router rip
West(config-router)#vers
*Aug 6 14:16:50.091: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
West(config-router)#version 2
West(config-router)#
*Aug 6 14:16:50.091: %ENTITY_ALARM-6-INFO: CLEAR INFO Se1/0 Physical Port Administrative State Down
West(config-router)#network 10.0.0
*Aug 6 14:16:51.095: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
West(config-router)#network 10.0.0.0
West(config-router)#no auto-summary
West(config-router)#end
West#
*Aug 6 14:16:55.027: %SYS-5-CONFIG_I: Configured from console by console
West#
  
```

```

Dynamips(4): Central, Console port
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname Central
Central(config)#enable secret cisco
Central(config)#line con 0
Central(config-line)#logging synchronous
Central(config-line)#exit
Central(config)#interface s1/0
Central(config-if)#ip address 10.0.0.2 255.255.255.0
Central(config-if)#no shutdown
Central(config-if)#interface s1/1
Central(config-if)#ip add
*Aug 6 14:18:18.175: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
Central(config-if)#ip address 10.0
*Aug 6 14:18:18.175: %ENTITY_ALARM-6-INFO: CLEAR INFO Se1/0 Physical Port Administrative State Down
Central(config-if)#ip address 10.0.1.1 255.255.255
*Aug 6 14:18:19.179: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up
Central(config-if)#ip address 10.0.1.1 255.255.255.0
Central(config-if)#clock rate 64000
Central(config-if)#no shutdown
Central(config-if)#exit
Central(config)#router rip
Central(config-router)#version 2
Central(config-router)#network
*Aug 6 14:18:24.639: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
Central(config-router)#network 10.0.0.0
Central(config-router)#net
*Aug 6 14:18:24.639: %ENTITY_ALARM-6-INFO: CLEAR INFO Se1/1 Physical Port Administrative State Down
Central(config-router)#network 10.0.1.0
Central(config-router)#
*Aug 6 14:18:25.643: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed state to up
Central(config-router)#no auto-summary
Central(config-router)#end
Central#
*Aug 6 14:18:28.799: %SYS-5-CONFIG_I: Configured from console by console
Central#
  
```

```
Dynamips(5): East, Console port
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname East
East(config)#enable secret cisco
East(config)#line con 0
East(config-line)#logging syn
East(config-line)#exit
East(config)#interface s1/1
East(config-if)#ip address 10.0.1.2 255.255.255.0
East(config-if)#no shutdown
East(config-if)#exit
East(config)#router rip
East(config-router)#version 2
East(config-router)#network 10.0.1.0
East(config-router)#no auto-summary
East(config-router)#end
East#
*Aug 6 14:21:45.767: %SYS-5-CONFIG_I: Configured from console by console
East#
```

```
Dynamips(5): East, Console port
East#sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

 10.0.0.0/24 is subnetted, 2 subnets
R       10.0.0.0 [120/1] via 10.0.1.1, 00:00:14, Serial1/1
C       10.0.1.0 is directly connected, Serial1/1
East#ping 10.0.0.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.0.0.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 168/177/216 ms
East#
```

As you can see, East can ping West which verifies connectivity from end-to-end. You may also see that East has the 10.0.0.0/24 network in its routing table.

Now let's drag three Ethernet switches and place one under each router. Use the *Add a link* button to add a connection from each router's Fa0/0 port to port 1 on each switch. Note that the built-in Ethernet switch has 8 ports. They may act as access ports or dot1q trunking ports. By default, they act as access ports. If you right-click a switch and choose configure, you'll see that you may specify several options. We will use the default values. If you wish to configure more advanced options with switches, then you'll need to add a router with an NM-16ESW EtherSwitch adapter. These adapters support many more switching functions but not all. We'll discuss EtherSwitch adapters in a later section.

It's time to add PCs to your topology.

Adding PCs to Your Topology

There are three possible ways to add a computer to your topology. If you just need to check for connectivity using ping or traceroute, the best way is to use the Virtual PC Simulator. You may also add another router but configure it to act like a PC. Finally, you may use your real PC.

Using the Virtual PC Simulator (and the Symbol Library)

The Virtual PC Simulator is a program that runs within Windows or Linux. It has limited functionality, but most important, it allows pings and traceroutes. These are the most common testing commands used during CCNA or CCNP training and are often the only commands needed. Using VPCS you will save memory and CPU cycles. If you do not need more functionality in a workstation within your topology, I highly recommend VPCS. The Virtual PC Simulator is a free product available at the following Web site: <http://wiki.freecode.com.cn/doku.php?id=wiki:vpcs>

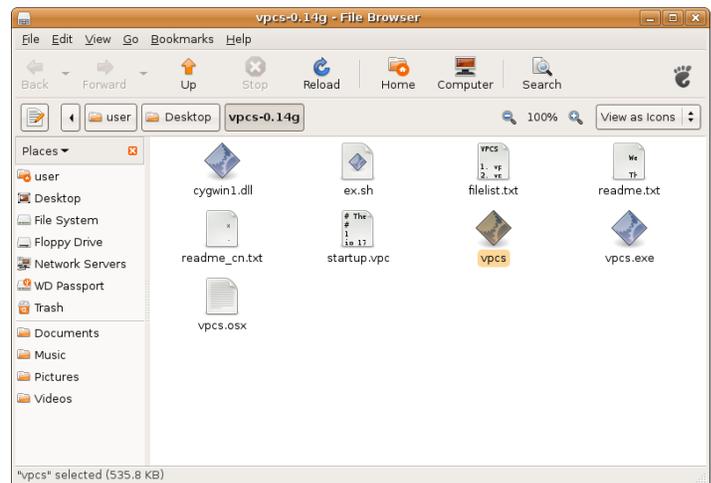
Extract the archive to your PC, and then in Windows run **vpcs.exe**.

If you are running Linux, right-click the **vpcs** (not vpcs.exe) and choose *Properties*.

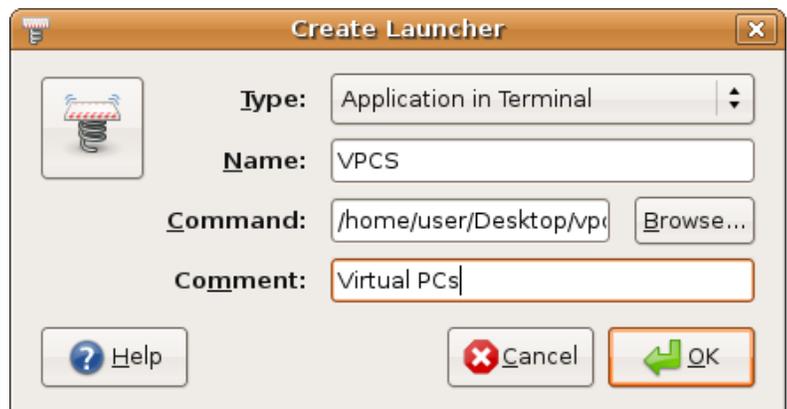
Click on the *Permissions* tab. Then click on the box next to *Execute*. Click Close.



It is best to open the Virtual PC Simulator before starting GNS3.



Now right-click the desktop and choose *Create Launcher*. Click the down arrow next to *Type* and choose **Application in Terminal**. For *Name*, type **VPCS**. For *Command*, you may browse to the vpcs program. For *Comment*, type **Virtual PCs**. Click OK. Now just click the VPCS icon on your desktop.



For help, just type ? at the prompt. VPCS supports up to nine PCs. Just type a number to switch to another PC. Use the Show command to view a PC's IP or MAC address. To assign an IP address, subnet mask, and default gateway to a PC, follow this format at the prompt:

```
ip 10.0.0.5 10.0.0.1 24
```

The above command assigns the PC an IP address of 10.0.0.5 with a /24 subnet mask and a default gateway of 10.0.0.1. To switch to PC2, just type a 2 and press Enter.

The program is very easy to use.

You'll find more information at the above Web site.

To integrate VPCS into GNS3, we will first make use of the **Symbol Library**. Choose **Symbol Manager** on the *Edit* menu after opening GNS3.

Click the *computer* symbol under *Available symbols*, then click *right arrow* button between the windows. This will move the symbol into the *Customized nodes* column. In the *Name* box, type **computer**. Use the drop-down arrow to change the type to **Cloud**, if necessary. Click the *Apply* button. Then click *OK*. In the GNS3 Nodes Types column, you should now see a computer icon.

```

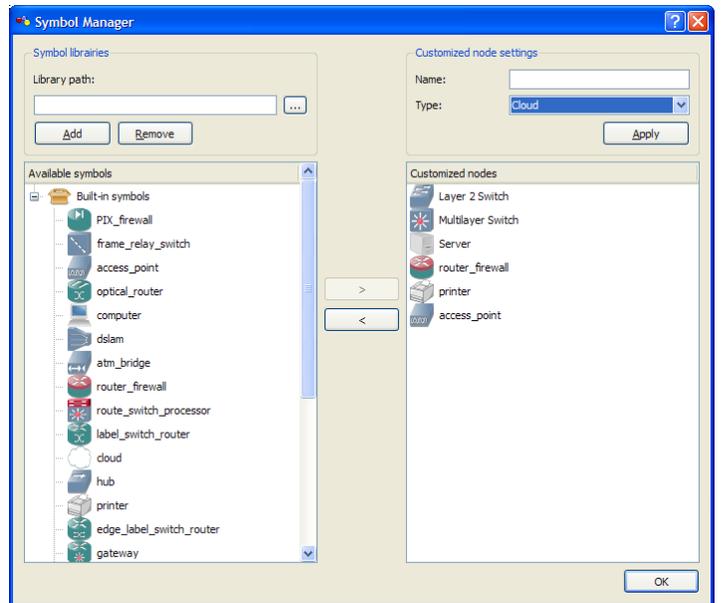
C:\ Virtual PCs
Welcome to Virtual PC Simulator for dynamips, v0.14g
Dedicated to Daling.
Build time: Apr  2 2008 10:27:30
All rights reserved.

NOTICE: MAY NOT use this software for commercial purposes unless
you get an appropriate commercial license for it.

Please contact me at mirnshi@gmail.com or http://mirnshi.cublog.cn
if you have any questions.

Press '?' to get help.

Executing the startup file
PC1 : 172.16.1.1 255.255.255.0 gateway 172.16.1.10
PC2 : 172.16.1.2 255.255.255.0 gateway 172.16.1.10
PC3 : 172.16.1.3 255.255.255.0 gateway 172.16.1.10
UPCS 1 >
  
```



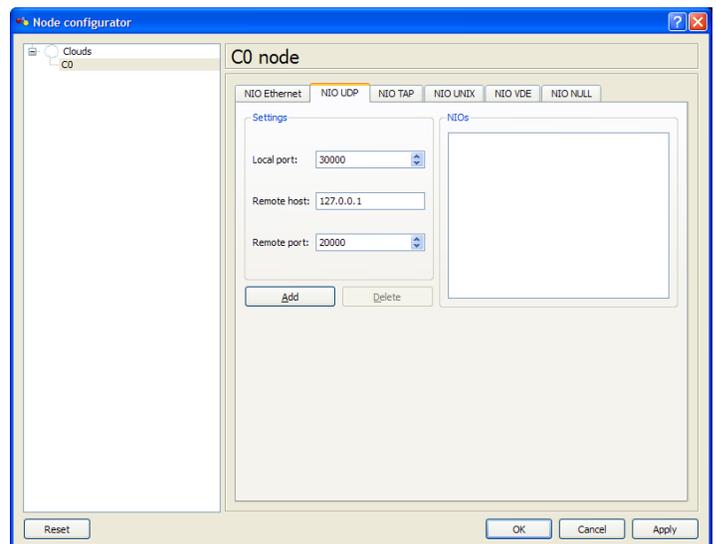
Drag three computers into the workspace, placing one below each switch. Right-click the computer under West, and choose *Configure*. Click on *C0* under *Clouds*. Click the *NIO UDP* tab.

Type in the following values under *Settings*:

```

Local port: 30000
Remote host: 127.0.0.1
Remote port: 20000
  
```

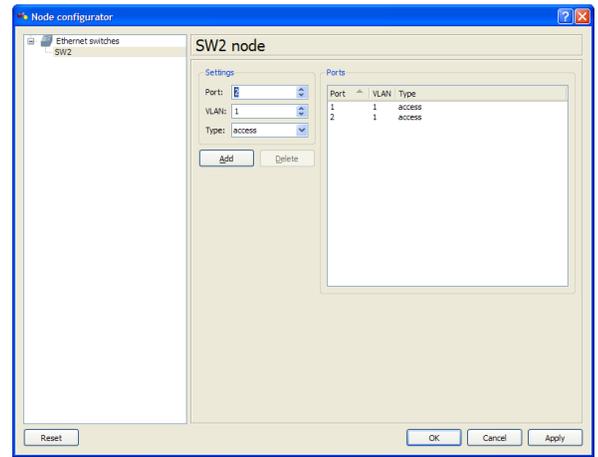
These settings correspond to VPCS 1. Click the *Add* button and then *OK*.



Now right-click each of the other computers and choose *Configure*. Use the following settings:

Computer	Local port	Remote host	Remote port
C1	30001	127.0.0.1	20001
C2	30002	127.0.0.1	20002

We have just configured each of the computers as clouds that connect with GNS3 through the UDP ports designated. Before we can connect our VPCs to our switches, we'll need to add a port to each switch. Right-click each switch and choose *Configure*. Click on the switch (SW0, SW1, or SW2), change *Port* setting to 2, and click the *Add* button and then OK.



Now click the *Add a link* button on the Toolbar and choose *Manual*. Connect **port 2** of each switch to its corresponding VPC's **nio_udp port**. Click the *Add a link* red stop sign button to stop adding links.

Now configure the VPCs within the VPCS window. Configure IP address, default gateway, and subnet mask (24) for each PC with the values shown in the topology.

Here are the commands that you would use:

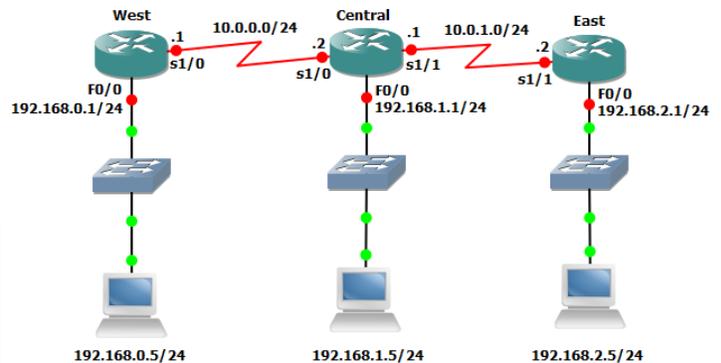
```

UPCS 1 >ip 192.168.0.5 192.168.0.1 24
PC1 : 192.168.0.5 255.255.255.0 gateway 192.168.0.1

UPCS 1 >2
UPCS 2 >ip 192.168.1.5 192.168.1.1 24
PC2 : 192.168.1.5 255.255.255.0 gateway 192.168.1.1

UPCS 2 >3
UPCS 3 >ip 192.168.2.5 192.168.2.1 24
PC3 : 192.168.2.5 255.255.255.0 gateway 192.168.2.1

```



Return to each router's console window to configure its FastEthernet port. Use the addresses shown in the topology above. Be sure to use `no shutdown` to turn on the interface. Then add the network to RIP with the `router rip` command and `network` command.

The routes should show up shortly in the routing tables. Try to ping from West's computer to East's computer. This ping should work. A ping from West's computer to Central's computer should also work.

Using a Router that Acts Like a PC

You may also simply add another router to your topology and configure it to act like a PC. This method would use more memory and processor cycles than the previous method, so I would only recommend this method as a secondary choice.

Just add a router and enter the following commands:

Router(config)# no ip routing	Turns off IP routing function
Router(config)# interface fa0/0	Switches to FastEthernet interface
Router(config-if)# ip address <i>address subnet_mask</i>	Assigns IP address and subnet mask to interface
Router(config-if)# no shutdown	Turns interface on
Router(config-if)# exit	Returns to global configuration mode
Router(config)# ip default-gateway <i>gateway_address</i>	Configures the default gateway
Router(config)# ip http server	Optional – starts http server process

Connect the router (acting as a PC) to the rest of your topology.

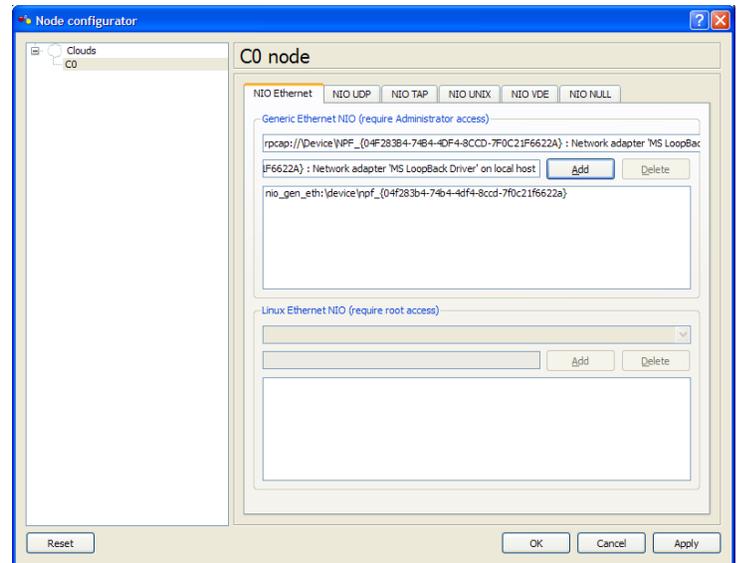
Using your Real PC – Talking to Real Networks

One of the interesting things about GNS3 and Dynamips is that you can connect your topology to the real world. For some of your CCNA and CCNP studies you may need to run an actual Web browser or Cisco's Security Device Manager (SDM) among others. Just connect your topology to your real PC. You could even connect to virtual machines running on your computer inside VMware or Virtual PC. I've even set up two copies of Windows XP Professional running inside VMware virtual machines. Then I ran Cisco soft IP Phones that could talk to themselves. You could connect your virtual network to a real network as well. Connecting a virtual topology running within GNS3 and Dynamips to real devices is very exciting, but again, your throughput is going to be limited compared to using real equipment for the entire topology. It only makes sense to use GNS3 and Dynamips in a lab environment and for learning purposes. Any other usage is highly discouraged!

Connecting your topology to your real PC is very similar to the process used with the Virtual PC Simulator above. Drag a *computer* (defined as cloud) into your workspace. Right-click the *computer* and choose *Configure*. Click on **CO** under *Clouds*, but choose the **NIO Ethernet** tab. Administrator rights are required (root account under Linux).

For Windows users, click on the box directly beneath *Generic Ethernet NIO*, and choose the network adapter you wish to use. For Linux users, click on the drop-down box to choose your network adapter (either your real adapter or a loopback adapter).

Click the *Add* button and *OK*. You will need to configure the IP settings for your computer's adapter, and then use the *Add a link* toolbar button to create your connection.



You may use your regular network adapter, but I usually create an **MS Loopback adapter** to connect to. In Windows, use the *Add Hardware* wizard in *Control Panel*. Choose "Yes, I have already connected the hardware." On the next screen, choose *Add a new hardware device* at the end of the list and click *Next*. Choose to "Install the hardware manually..." and click *Next*. Choose *Network Adapters* in the list and click *Next*. Choose *Microsoft* as the manufacturer and then *Microsoft Loopback Adapter* as the network adapter. Finish the wizard. Then right-click *My Network Places* and choose *Properties*. You may wish to rename the new *Local Area Connection* as *MS Loopback Adapter*. Also, assign the proper IP settings to the adapter in order to connect to your topology. Linux has a built-in loopback adapter already installed.

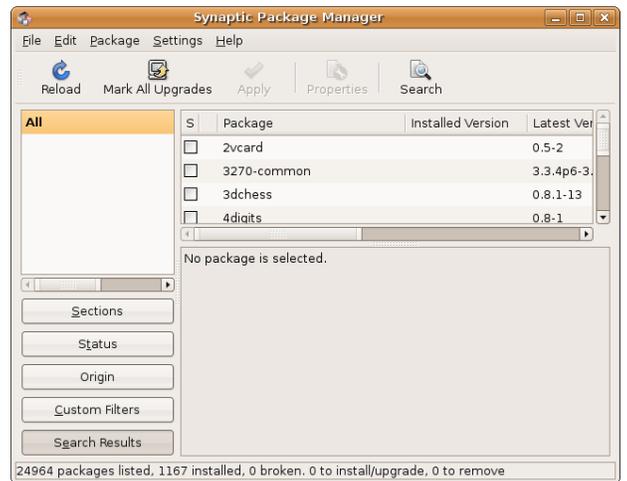
Konsole (Multiple tabs for Linux)

If you are using a topology that opens several console windows, it becomes a bit of a challenge switching from one device to another. You may consolidate all of these windows into one application where the windows are located under tabs. For Linux users, I recommend using **Konsole**, but the version is very important. If you open Konsole and then choose *About Konsole* under the *Help* menu, your version should be 2.0 or greater (using KDE 4.0 or greater). It is installed automatically if you are using the KDE4 desktop. If you are using the GNOME desktop (the default in Ubuntu), then you will need to install Konsole using KDE4.

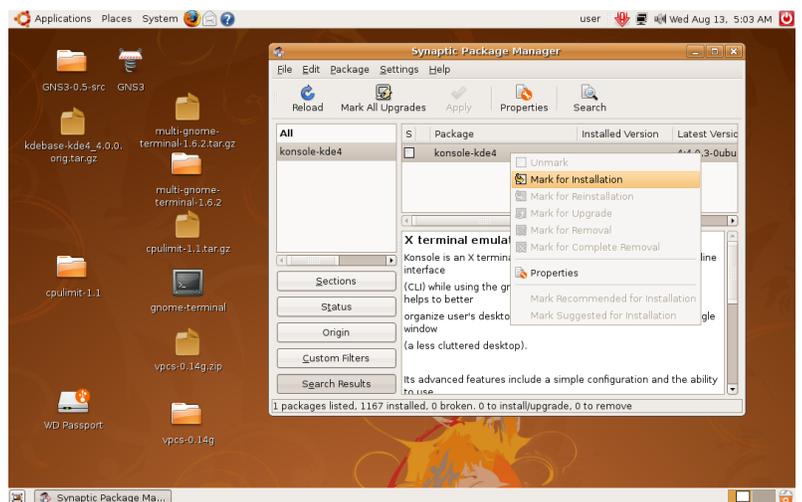
Synaptic Package Manager is a Linux tool that finds, installs, or removes software. Let's use it to find and install Konsole using KDE4. Click on *Synaptic Package Manager* under *Administration* on the *System* menu.



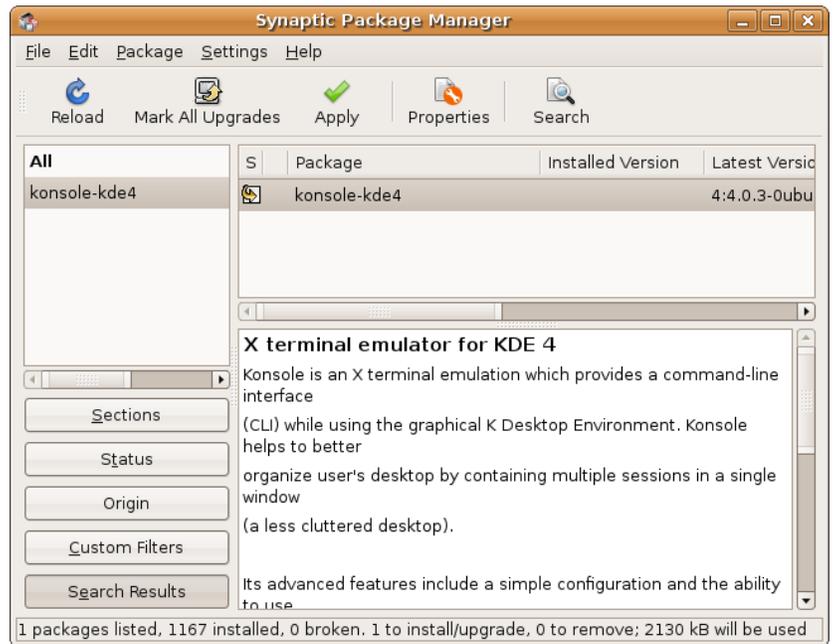
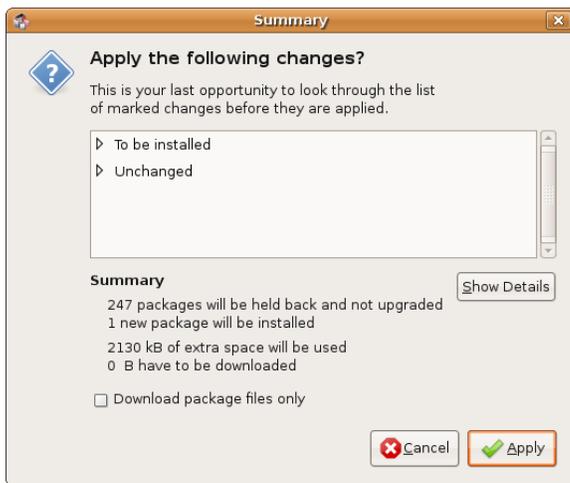
Click the *Search* button and look for *konsole-kde4*.



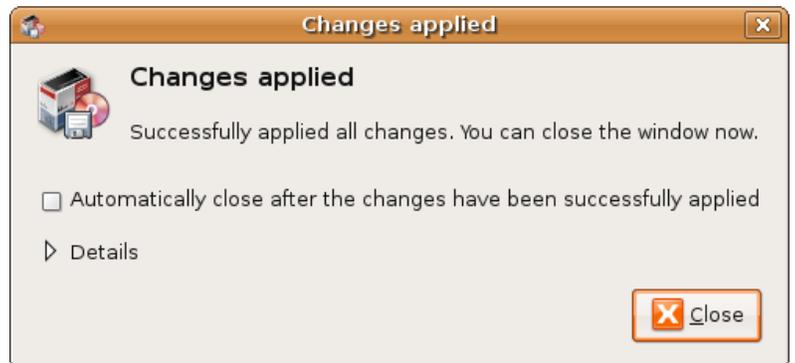
Right-click *konsole-kde4* and choose *Mark for installation*.



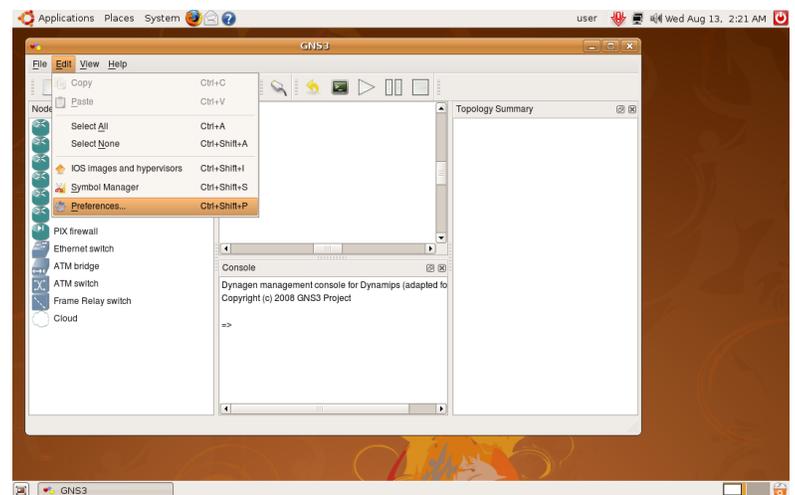
Click *Apply* on the toolbar. Then click the *Apply* button on the Summary window.



The package files are downloaded and installed, and the final changes are applied.



Next, open GNS3 and choose *Preferences* on the *Edit* menu.

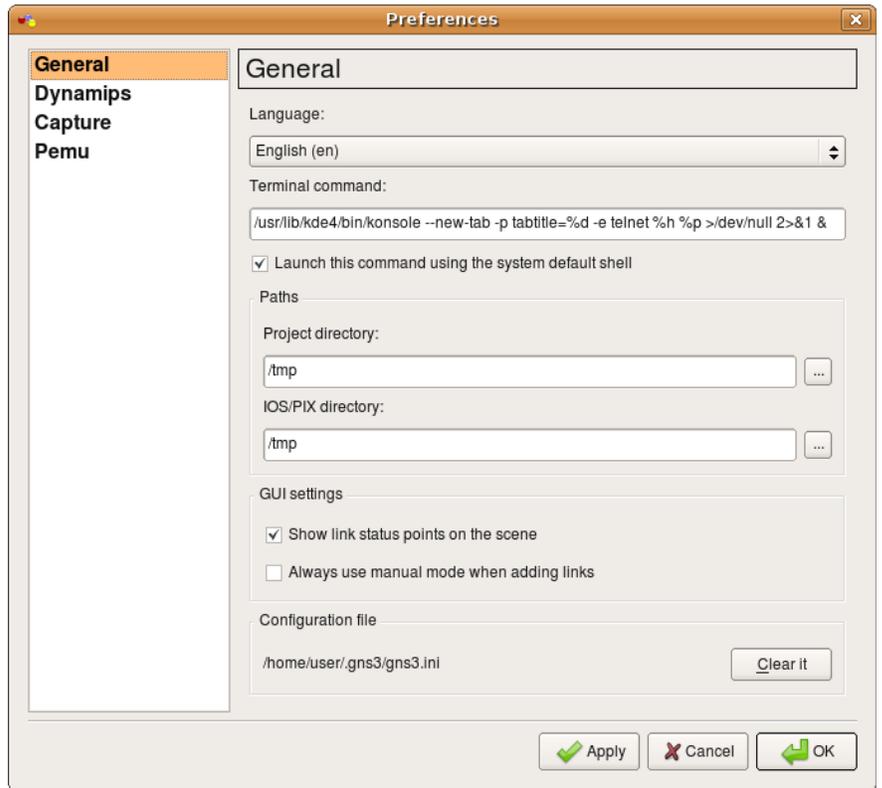


Choose *General* in the left-hand pane of the *Preferences* window.

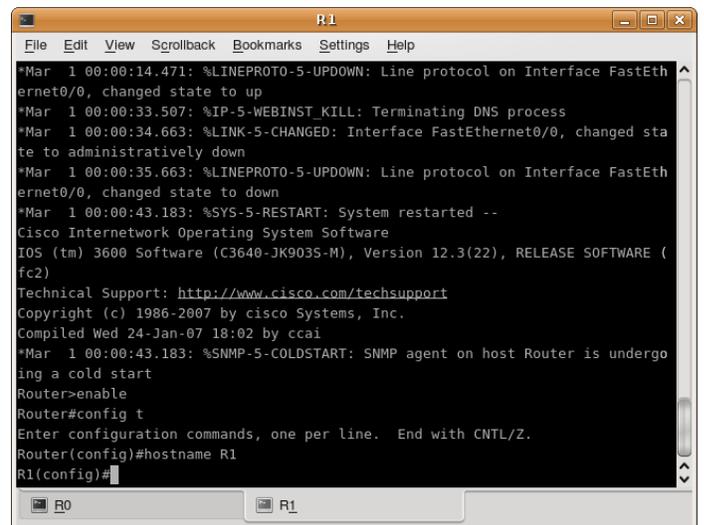
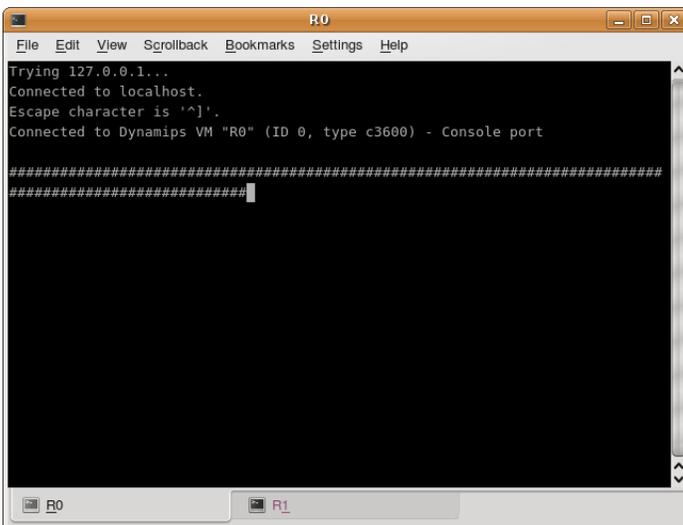
For *Terminal command*, use the following:

```
/usr/lib/kde4/bin/konsole --new-tab -p tabtitle=%d -e telnet %h %p >/dev/null 2>&1 &
```

Click *OK* to commit the change.



Now when you console into a device, you'll have each window in a tab along the bottom. Just click the tab to switch to another window or device.



Memory and CPU Usage

When you use a topology with multiple devices, issues of memory usage and CPU usage occur. To address the CPU usage issue, an idle-pc value needs to be included. This value is dependent on the IOS version and not the PC. To address memory usage, ghostios and sparsemem must be included.

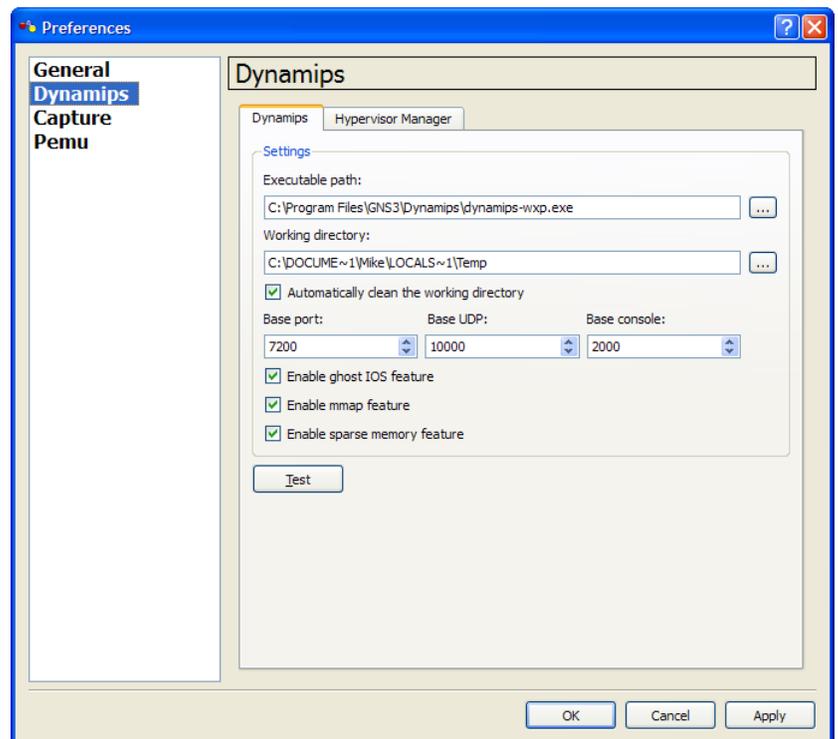
Memory Usage

Labs can consume a large amount of real and virtual memory. The “ghostios” and “sparsemem” options were added to address both of these issues, respectively.

The Ghostios option can significantly reduce the amount of real host RAM needed for labs with multiple routers running the same IOS image. With this feature, instead of each virtual router storing an identical copy of IOS in its virtual RAM, the host will allocate one shared region of memory that they will all utilize. So for example, if you are running 10 routers all with the same IOS image, and that image is 60 MB in size you will save $9 \times 60 = 540$ MB of real RAM when running your lab. Ghostios is enabled, by default, in GNS3.

The “sparsemem” feature does not conserve real memory, but instead reduces the amount of virtual memory used by your router instances. This can be important, because your OS limits a single process to 2 GB of virtual memory on 32-bit Windows, and 3 GB on 32-bit Linux. Enabling sparsemem only allocates virtual memory on the host that is actually used by the IOS in that router instance, rather than the entire amount of RAM configured. This can allow you to run more instances.

Both features rely on mmap, so this must also be enabled. Select Preferences under the Edit menu within GNS3. Check the appropriate boxes to enable these features.



CPU Usage

We talked about CPU Usage a bit earlier when we learned how to determine idlepc values. Without idlepc values configured, you may have noticed that your system’s CPU was running at 100%. This is because Dynamips, the core emulator running under GNS3, does not know when the virtual router is idle, and when it is performing useful work. The “idlepc” command performs analysis on a running image to determine the most likely points in the code that represent an idle loop in the IOS process. Once applied, Dynamips “sleeps” the virtual router occasionally when this idle loop is executed. This significantly reduces CPU consumption on the host without reducing the virtual router’s capacity to perform real work.

IdlePC values are particular to an IOS image. They will be different for different IOS versions, and even for different feature-sets of the same IOS version. However idlepc values are not particular to your host PC, operating system, or to the version of Dynamips that GNS3 is using. It is possible that Dynamips will not be able to find an idlepc value for an image, or that the values it does find do not work. If this happens, try repeating the process again.

To determine an idlepc value for a given IOS, start GNS3. Drag only one router set up to use the IOS version you are trying to configure. Right-click the router and choose *Start*. Then right-click the router and choose *Console*. You may need to press *Enter* once initially in the Console window. When asked “*Would you like to enter the initial configuration dialog?*”, enter *no* and press *Enter*. Wait for the router to settle down at a *Router>* prompt. You may need to press *Enter* once or twice to get there.

```
Telnet localhost
IN3270 Emulation software.

PCI bus mb0_mbl (Slots 0, 1, 3 and 5) has a capacity of 600 bandwidth points.
Current configuration on bus mb0_mbl has a total of 200 bandwidth points.
This configuration is within the PCI bus capacity and is supported.

PCI bus mb2 (Slots 2, 4, 6) has a capacity of 600 bandwidth points.
Current configuration on bus mb2 has a total of 0 bandwidth points.
This configuration is within the PCI bus capacity and is supported.

Please refer to the following document "Cisco 7200 Series Port Adaptor
Hardware Configuration Guidelines" on Cisco.com (http://www.cisco.com)
for c7200 bandwidth points oversubscription and usage guidelines.

1 FastEthernet/IEEE 802.3 interface(s)
4 Serial network interface(s)
125K bytes of non-volatile configuration memory.

65536K bytes of ATA PCMCIA card at slot 0 (Sector size 512 bytes).
8192K bytes of Flash internal SIMM (Sector size 256K).

--- System Configuration Dialog ---
Would you like to enter the initial configuration dialog? [yes/no]:
```

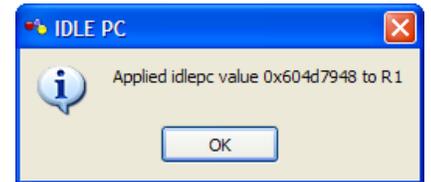
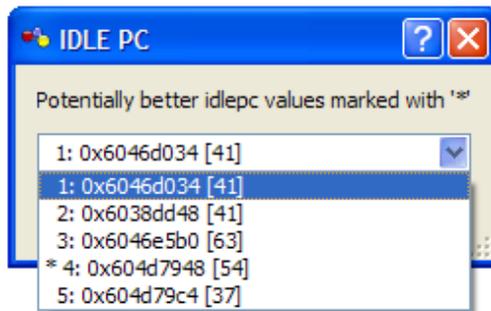
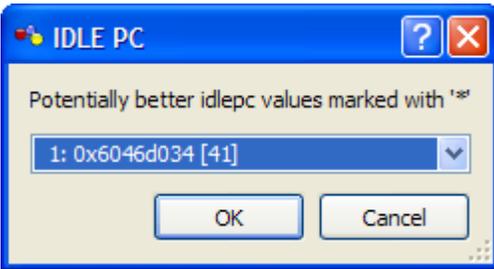
After the router has settled down to a *Router>* prompt, return to the main GNS3 window.

```
Telnet localhost
% Please answer 'yes' or 'no'.
Would you like to enter the initial configuration dialog? [yes/no]: no

Press RETURN to get started!

*Mar 26 01:50:37.279: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Mar 26 01:50:38.279: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to down
*Mar 26 02:07:31.175: %OIR-6-INSCARD: Card inserted in slot 1, interfaces administratively shut down
*Mar 26 02:26:11.359: %SYS-5-RESTART: System restarted --
Cisco Internetwork Operating System Software
IOS (tm) 7200 Software (C7200-JK9S-M), Version 12.3(22), RELEASE SOFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2007 by Cisco Systems, Inc.
Compiled Wed 24-Jan-07 20:12 by caaj
*Mar 26 02:26:11.371: %SNMP-5-COLDSTART: SNMP agent on host Router is undergoing a cold start
*Mar 26 02:26:12.643: %LINK-5-CHANGED: Interface FastEthernet0/0, changed state to administratively down
Router>
```

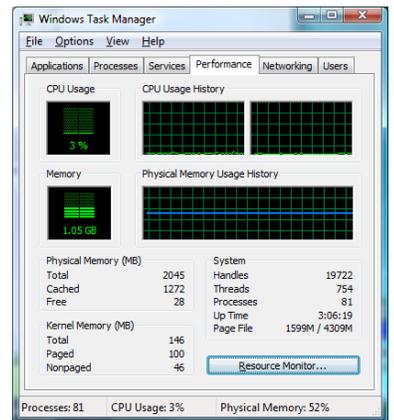
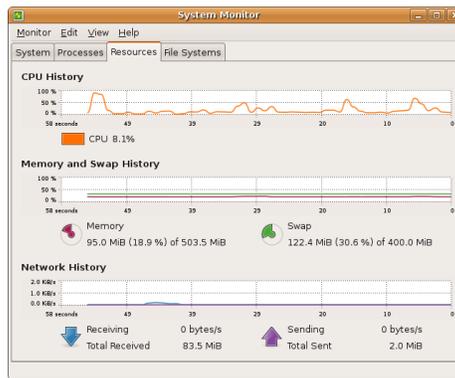
Right-click R0 and choose *Idle PC*. GNS3 will spend a moment calculating an Idle PC value before presenting the screen to the right. If you click the drop-down arrow, you see a list of possible idlepc values. Potentially better idlepc values are marked with an asterisk. Choose one of the values with an asterisk (in our example, we will choose number 4) and click OK.



You'll receive a confirmation that the idlepc value has been applied.

If you choose *IOS images and hypervisors* on the *Edit* menu, and double-click on the image under the *IOS Images* tab, you'll see the new idlepc value displayed under *Settings*.

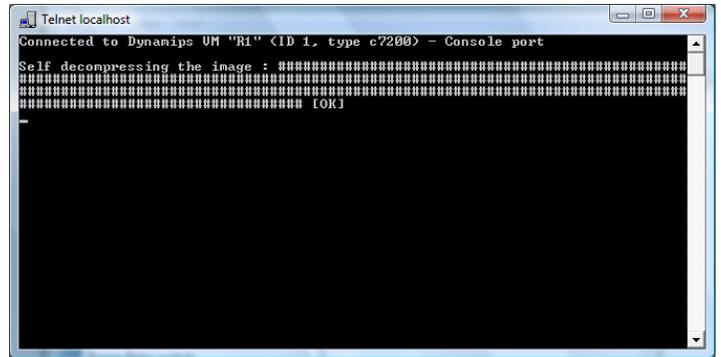
When searching for the best idlepc value, it is a good idea to monitor your CPU usage. To observe CPU usage in Windows, press *Ctrl+ALT+DEL* and choose *Task Manager*. Click on the *Performance* tab to view CPU usage.



In Ubuntu, choose *System Monitor* under *Administration* on the *System* menu. You will observe that without an idlepc value, CPU usage will be at or near 100%, but with an idlepc value, CPU usage will drop to a very low value. Experiment with various idlepc values to determine which one works best at reducing CPU usage.

I'm tired of those ##### across my screen!

Take a look at the ##### across the screen in the graphic to the right. Every time you boot up your router you've seen these go across the screen. Many of the Cisco IOSs are compressed. When you see the ##### going across the screen, the IOS is uncompressing itself. You can save time if you uncompress the image now, and then load the uncompressed image when you start your routers. I would recommend that you uncompress all of your IOS images that you plan to use with GNS3. This will significantly speed up your start up time. As a side note, 2600 series images should be uncompressed before using them. If you do not, they are more likely to crash on you.



To uncompress an IOS image in Windows, use a product such as UltimateZIP. You may download it from here: <http://www.ultimatezip.com/>

Download and install UltimateZIP. Then just right-click on an IOS compressed image, and choose *Extract to here*. To uncompress a file in Linux, just right-click the file and choose *Extract Here*. Linux has a built-in extractor.

Afterwards rename the extracted file with the same filename as the original except with an extension of **image** instead of **bin**. This will help you keep track of which image is uncompressed.

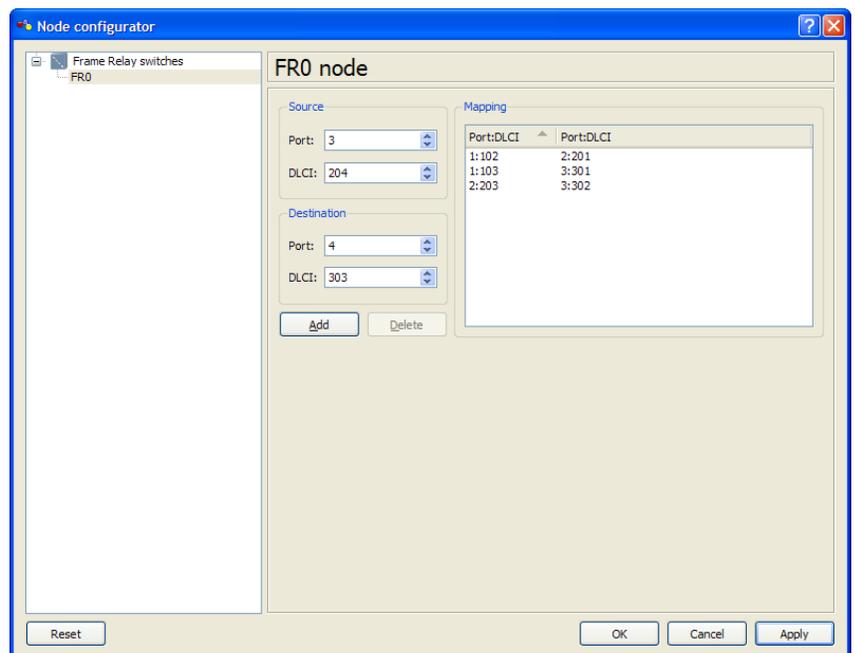
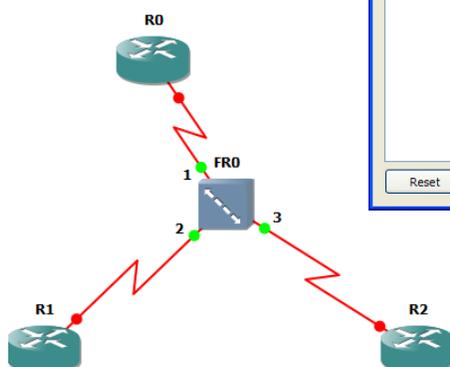
Then within GNS3 choose *IOS images and hypervisors* under the *Edit* menu. Choose the uncompressed version of your IOS when you choose an *Image file* under *Settings*.

Frame Relay and ATM Devices

An integrated Frame Relay switch is provided by GNS3. It is actually part of Dynamips. Just drag the Frame Relay switch from Nodes Types into the workspace. Right-click on the Frame Relay switch and choose *Configure*. Now you may assign your DLCIs at the source and destination – creating a frame relay map between the two.

In our example, local DLCI 102 on port 1 is mapped to DLCI 201 on port 2.

You cannot start, stop, suspend, or resume a frame relay switch. ATM switches are configured similarly.



Ethernet Switch Devices

GNS3 with Dynamips help integrates an Ethernet switch that supports VLANs with 802.1q trunking. Trunk ports trunk all VLANs known to the switch – no VLAN pruning here. It is just a basic virtual switch with limited functionality that provides the very basics you'd want in a switch. If you drag an Ethernet switch onto the workspace, right-click it and choose Configure, you'll see the options you may set.

By default, there are 8 ports in VLAN 1 configured as access ports. However, you may in theory have up to 10,000 ports and up to 10,000 VLANs. You are limited to either access ports or dot1q trunking ports.

You may connect the switch to the real world through a cloud device. The Console window in GNS3 may be used to show and clear the MAC address tables using the following commands:

```
show mac switch_name
clear mac switch_name
```

If want greater functionality that the virtual Ethernet switch provides that is integrated into GNS3, then you'll need to add a router with an EtherSwitch card.

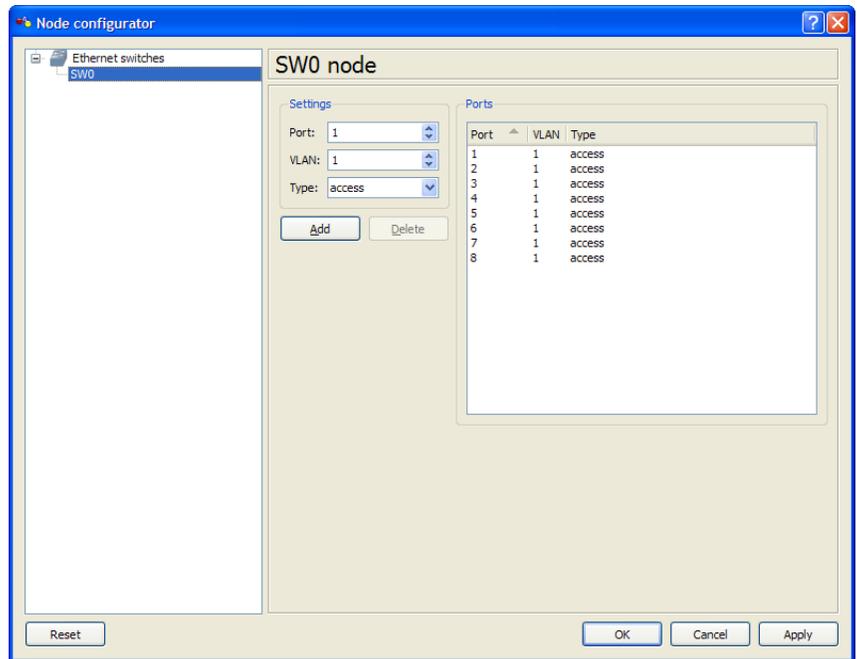
EtherSwitch Cards

You can buy an EtherSwitch card that may be inserted into a router. The card will function similar to a switch. In GNS3 you may also insert an EtherSwitch card into a router slot. The 7200 series routers do not support this adapter but many of the router platforms available in GNS3 do. The EtherSwitch card that is supported is the NM-16ESW. Here is a list of some of the features supported by the NM-16ESW card:

- Layer 2 Ethernet interfaces
- Switch Virtual Interfaces (SVI)
- VLAN Trunk Protocol
- EtherChannel
- Spanning Tree Protocol
- Cisco Discovery Protocol
- Switched Port Analyzer (SPAN)
- Quality of Service
- IP Multicast Support
- Storm-Control
- Port Security
- Stacking
- Flow Control

Not all commands that exist on an actual switch are supported by the NM-16ESW card, but as you can see, using an EtherSwitch card gives you a lot more features than the integrated virtual switch. If you wish to use this card, I recommend that you download documentation from Cisco's Web site about the module. Only vlan database mode is possible (not the newer global configuration mode) and the *show vlan* command is *show vlan-switch*, for example.

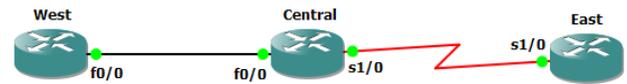
To use the card, just add a router and include the NM-16ESW adapter.



Packet Capture

GNS3 along with Dynamips can capture packets on virtual Ethernet or serial interfaces. It will write the captured output to a libpcap file that may be viewed using WireShark. WireShark may be downloaded from the following Web site:

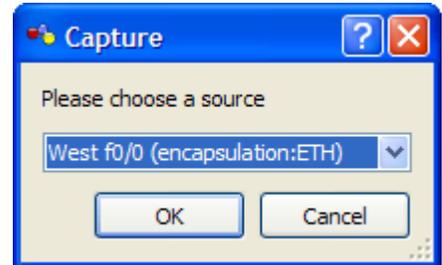
<http://www.wireshark.org>



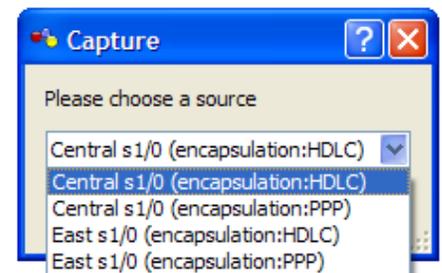
Suppose we want to capture packets passing through the FastEthernet interface on West (f0/0).

Right-click somewhere along the line representing the link between West and Central. Choose Capture.

The drop-down arrow will allow you to choose which interface to monitor (West f0/0 or Central f0/0). WireShark will automatically start, provided it has been configured under the Preferences window.



If we wanted capture packets on the serial link between Central and East, we would also have to choose the encapsulation type. Choices will be HDLC or PPP. If you are using a Frame Relay Switch, you'll have the FR encapsulation type as an option.



Now let's generate some traffic to test our capture. Ping East from West. Then let's refresh the WireShark window by pressing **Ctrl+R**. Scroll down to see the ICMP request and reply packets as a result of the ping. Packets are being captured whether we refresh the window or not.

West_to_Central.cap - Wireshark

Filter: Expression... Clear Apply

No.	Time	Source	Destination	Protocol	Info
17	60.004000	cc:0a:0b:f4:00:00	cc:0a:0b:f4:00:00	LOOP	Reply
18	65.551000	cc:09:0b:f4:00:00	cc:09:0b:f4:00:00	LOOP	Reply
19	67.200000	10.0.0.1	10.0.1.2	ICMP	Echo (ping) request
20	67.265000	10.0.1.2	10.0.0.1	ICMP	Echo (ping) reply
21	67.280000	10.0.0.1	10.0.1.2	ICMP	Echo (ping) request
22	67.296000	10.0.1.2	10.0.0.1	ICMP	Echo (ping) reply
23	67.301000	10.0.0.1	10.0.1.2	ICMP	Echo (ping) request
24	67.319000	10.0.1.2	10.0.0.1	ICMP	Echo (ping) reply
25	67.325000	10.0.0.1	10.0.1.2	ICMP	Echo (ping) request
26	67.341000	10.0.1.2	10.0.0.1	ICMP	Echo (ping) reply
27	67.345000	10.0.0.1	10.0.1.2	ICMP	Echo (ping) request
28	67.364000	10.0.1.2	10.0.0.1	ICMP	Echo (ping) reply
29	69.868000	cc:0a:0b:f4:00:00	CDP/VTP/DTP/PagP/U	CDP	Device ID: Central Port ID: FastEthernet0/0
30	70.002000	cc:0a:0b:f4:00:00	cc:0a:0b:f4:00:00	LOOP	Reply
31	73.321000	10.0.0.2	224.0.0.9	RIPv2	Response
32	75.564000	cc:09:0b:f4:00:00	cc:09:0b:f4:00:00	LOOP	Reply
33	80.004000	cc:0a:0b:f4:00:00	cc:0a:0b:f4:00:00	LOOP	Reply
34	85.576000	cc:09:0b:f4:00:00	cc:09:0b:f4:00:00	LOOP	Reply

Frame 1 (60 bytes on wire, 60 bytes captured)

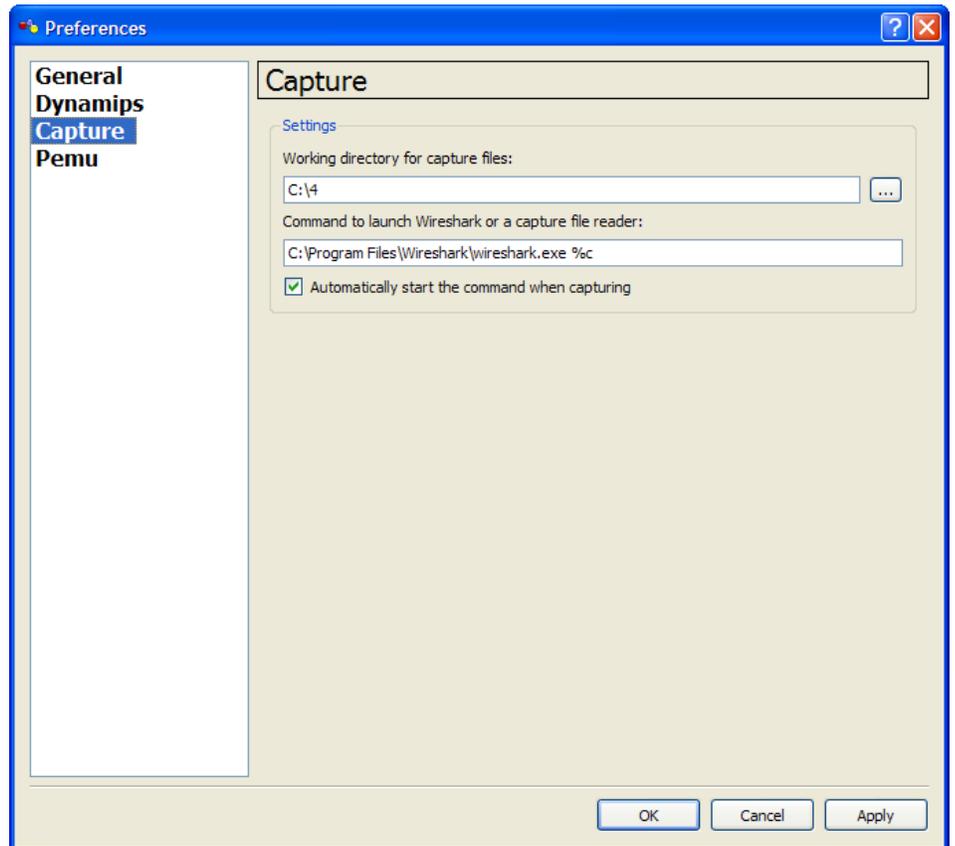
- Ethernet II, Src: cc:0a:0b:f4:00:00 (cc:0a:0b:f4:00:00), Dst: cc:0a:0b:f4:00:00 (cc:0a:0b:f4:00:00)
- Configuration Test Protocol (loopback)
 - Data (40 bytes)

```
0000 cc 0a 0b f4 00 00 cc 0a 0b f4 00 00 90 00 00 00 .....
0010 01 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0030 00 00 00 00 00 00 00 00 00 00 00 00 .....

```

File: "C:\West_to_Central.cap" 6865 Bytes 00:02:55 P: 58 D: 58 M: 0

Let's back up and talk about the preferences for capturing packets. Choose *Preferences* from the *Edit* menu in GNS3. Then click on *Capture* in the left pane. Now you may specify the working directory for capture files, the command to use to start WireShark, and whether to automatically start WireShark when you choose to capture.



Saving and Loading Topologies

GNS3 will save and load your network topologies using a Dynagen text format called a NET file. Just choose Save or Save As on the file menu. You may also use the buttons on the toolbar. This does not save your router configurations. It just saves your topology drawing, connections, settings, and so forth.

If you would like save just the topology drawing as a graphic file, choose *Export* on the *File* menu.

If you would like to save your router configurations, click the *Extract all startup-configs* button on the toolbar. You may then paste these configurations back into your routers at a later time. There are other ways to accomplish the same thing. In the Console window, type **export /all** or **export** followed by a device name to export the configuration(s). You may then type **import /all** or **import** followed by a device name to import the configurations back into your routers.

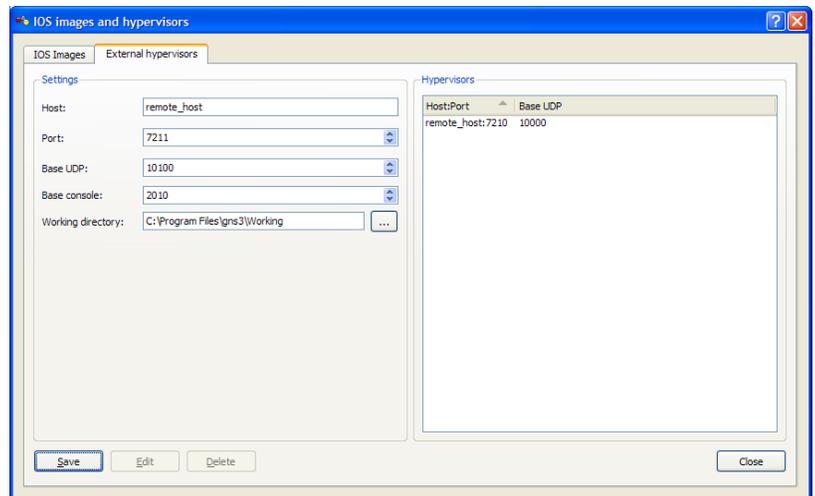
You may use the **push /all** or **save /all** commands in order to save the device configurations inside the NET file. When the NET file is opened in GNS3, everything (including router configurations) will be loaded. You must save your configurations within each router before using these commands (*write* or *copy run start*).

Note: GNS3 will handle a few things differently than Dynagen in NET files. Settings for ram, rom, nvram and the like are recorded in device subsections – not a model section. GNS3 records idle-pc and IOS filenames in device subsections. However, if you select *Default image for this chassis* under the *IOS Images* tab in the *IOS images and hypervisors* window under the *Edit* menu, a model subsection will be created. Saved NET files may be loaded into Dynagen or GNS3.

Client/Server and Multi-Server Mode

The Dynamips hypervisor mode used by GNS3 uses a TCP/IP communications channel. This means that GNS3 may run on one machine, while the Dynamips emulator may run on a different machine. Choose IOS images and hypervisor on the Edit menu in GNS3. Under the Hypervisors tab, manually specify a hypervisor.

Here we recorded a new hypervisor which will listen on port 7211 on the "remote_host" machine. You can also specify the fully qualified path to the *working directory* where the hypervisor will store all of its generated files on the Dynamips host. Be sure to use the correct directory separation character for the platform (here back slashes for a Windows system). You must use a DNS name or an IP address in the Host text box.



Base UDP is the base port for UDP NIOs that Dynamips uses to make the connections between your nodes. Dynamips will use a UDP port for each end of a link. For example, six UDP ports are used for a full meshed lab of 3 routers and a base udp of 10000. Here is an output of the netstat command that shows you the connections between the nodes and the UDP port picked up by Dynamips:

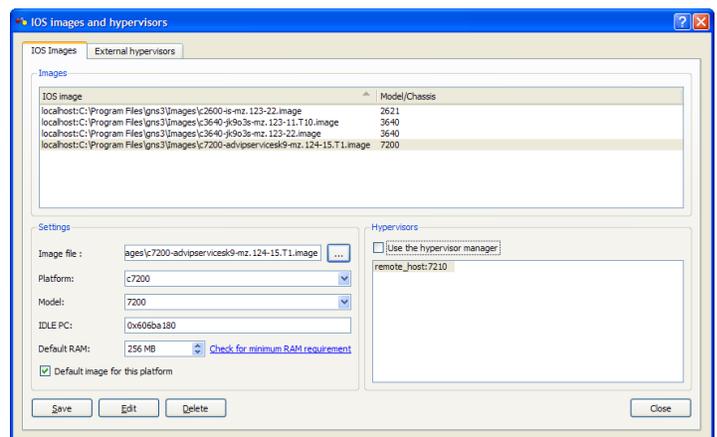
```
udp    0      0  localhost:10000    localhost:10001    ESTABLISHED
udp    0      0  localhost:10001    localhost:10000    ESTABLISHED
udp    0      0  localhost:10002    localhost:10003    ESTABLISHED
udp    0      0  localhost:10003    localhost:10002    ESTABLISHED
udp    0      0  localhost:10004    localhost:10005    ESTABLISHED
udp    0      0  localhost:10005    localhost:10004    ESTABLISHED
```

(NIO stands for Network I/O. These are the network interfaces coded in Dynamips that allow it to communicate in many ways, such as Ethernet, UDP, or TCP.)

Now let's imagine you want to run two connected IOS instances which are separately created on 2 different hypervisors on the same host, and you choose the same UDP base for the hypervisors. Each hypervisor will try to take the same UDP port (10000 in the previous example) for each end of the connection and, of course, this will collide because Dynamips thinks they are different servers and therefore those UDP ports are safe to re-use.

Base console is the TCP base port that the hypervisor will use when you open a console on an IOS. This value shouldn't collide because GNS3 uses the following formula to affect a console port to each router: base port + router id (which is unique). So it is safe to use the same value for every hypervisor.

Once your hypervisors are recorded, you can bind them to your IOS images. Select your image, uncheck the *Use the hypervisor manager* option, and then choose your hypervisor in the list. You may choose more than one hypervisor by holding the Ctrl key down. GNS3 will automatically load balance based on memory consumption. Now every router that is configured with this IOS image is able to communicate with the hypervisor(s).



Note: be sure that any host-based firewalls running on all your Dynamips servers (for example, XP SP2's firewall) are permitting the necessary traffic. This includes the Dynamips server port (defaults to TCP 7200), the console ports (e.g. TCP 2000, 2001, ...) and the ports used by the NIO connections between interfaces, which start at UDP 10000 and work up from there.

Console Window - DynaGen Commands

If you type a ? in the Console window, you'll see the list of commands supported. The table below will summarize the meaning of each command. Generally, you do not need to understand these commands, but they can extend your usage of GNS3.

```

Console
DynaGen management console for Dynamips (adapted for GNS3)
Copyright (c) 2008 GNS3 Project

=> ?

Undocumented commands:
=====
capture console disconnect filter idlepc push save start ver
clear copy end help import py send stop
conf cpuinfo exit hist list reload shell suspend
confreg debug export hypervisors no resume show telnet
  
```

Console Window Commands		
Command	Examples	Description
capture	capture West f0/0 west.cap no capture West f0/0 capture East s0/0 East.cap hdlc no capture East s0/0	Begins a capture of all packets in and out of an interface. The first capture is for an Ethernet interface. If capture a serial interface, the encapsulation must be specified: hdlc, ppp, fr (frame-relay). View results in WireShark.
confreg	confreg /all 0x2102 confreg R1 0x2102	Sets the configuration register value
cpuinfo	cpuinfo /all cpuinfo R1	Show cpu info for router
export	export /all "c:\temp" export R1 "c:\temp"	Saves router config files individually in directory
hist	hist	Prints a list of commands that have been used
list	list	Lists all devices
py	py <python statement>	Executes Python commands. For example, py print namespace.devices
save	save /all save R1	Stores router configs in the NET file
show	show mac <i>switch_name</i> show device show start show run show run R1	Shows mac address table of Ethernet switch Shows detailed information about devices in lab Shows startup lab configuration Shows running configuration of current lab Shows running configuration of router
suspend	suspend /all suspend R1	Suspends router
clear	clear mac <i>switch_name</i>	Clears mac address table of Ethernet switch
console	console /all console R1	Connect to the console port of a router
end	end	Exits from the console
filter	filter R1 s1/0 freq_drop in 50 filter R1 s1/0 none in	Drops 1 out of every 50 packets inbound to R1 on s1/0 Removes all inbound filters from R1 on s1/0
idlepc	idlepc get R1 idlepc show R1	Get a list of possible idlepc values for router R1 Show the previously determined idlepc value for R1

	idlepc set R1 0x12345 idlepc copy R1 /all idlepc save R1 idlepc save R1 default idlepc save R1 db idlepc idlemax R1 1500 idlepc idlesleep R1 30 idlepc showdrift R1	Manually set R1's idlepc value to 0x12345 Set the same idlepc as on R1 for same IOS Saves idlepc value for R1 Saves R1's idlepc value to defaults section of NET file Save R1's idlepc to the idlepc database Set the idlemax parameter for R1 Set the idlesleep parameter for R1 Display the drift of idlepc on R1
no	<i>no command</i>	Negates a command
reload	reload /all reload R1	Reloads a router
send	send bender hypervisor version	Sends a raw hypervisor command to a Dynamips server. Example: sends hypervisor version command to host named bender
start	start /all 30 start R	Starts a router. When using /all, you may specify a pause in seconds between starting devices.
telnet	telnet /all telnet R1	Telnets to the console port. Same as console command.
conf	conf localhost	Switch into configuration mode of the specific hypervisor
copy	copy run start	Copy running topology into startup topology
exit	exit	Exits from console
help	<i>help command</i>	Gives help for a command
import	import /all "c:\temp" import R1 "c:\temp"	Imports configuration files from directory
push	push /all push R1	Pushes router configs from NET file into nvram
resume	resume /all resume R1	Resumes a specific router after a suspend
shell	shell	Passes command to a system shell when line begins with !
stop	stop /all stop R1	Stops a router
ver	ver	Print the Dynagen version and credits

Using a Newer Version of Dynamips with GNS3

The version of Dynamips included with the Windows GNS3 installer requires Windows XP SP2. Download the Windows binaries from the Dynamips site (<http://www.ipflow.utc.fr/blog/>). For Windows XP / 2003 use "dynamipswxp.exe". For Windows 2000, use the file "dynamips-w2000.exe" instead. Then copy both your executable and "cygwin1.dll" to "C:\Program Files\GNS3\Dynamips", replacing the existing files. With Linux you download the latest Dynamips version as part of the install process, so this is not an issue.

PIX Firewall Emulation

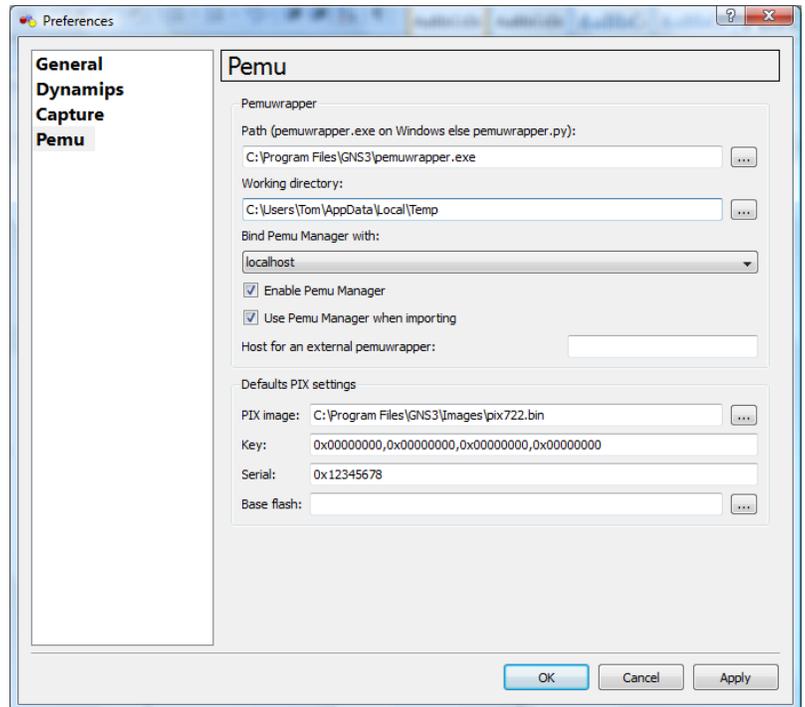
GNS3 is also capable of emulating PIX firewalls. Once again, you'll need to provide your own PIX image. If you want to run more than a restricted license, you'll also need to have a valid serial number and activation keys.

First, go to Preferences on the Edit menu in GNS3. Click on PEMU in the left pane.

The default path to the Pemuwrapper should be fine. You may want to specify a different working directory. Also, be sure to check *Enable Pemu Manger* and *Use Pemu Manager when importing*.

Under *Defaults PIX settings*, use the button next to *PIX image* to specify the location of your PIX operating system image.

You may use the default Key and Serial number, if necessary. This will provide a restricted license with limited features. You will need a valid serial number and activation keys to access additional features. The graphic on the left is a restricted image. Failover, VPN-DES, and VPN-3DES-AES are disabled. You are also limited to 6 physical interfaces and 25 VLANs. The graphic on the right is unrestricted. With an unrestricted license, these features are enabled along with support for additional interfaces and VLANs.



```
Licensed features for this platform:
Maximum Physical Interfaces : 6
Maximum VLANs              : 25
Inside Hosts                : Unlimited
Failover                    : Disabled
UPN-DES                     : Disabled
UPN-3DES-AES                : Disabled
Cut-through Proxy           : Enabled
Guards                      : Enabled
URL Filtering                : Enabled
Security Contexts           : 0
GTP/GPRS                    : Disabled
UPN Peers                   : Unlimited

This platform has a Restricted (R) license.
```

```
Licensed features for this platform:
Maximum Physical Interfaces : 10
Maximum VLANs              : 100
Inside Hosts                : Unlimited
Failover                    : Active/Active
UPN-DES                     : Enabled
UPN-3DES-AES                : Enabled
Cut-through Proxy           : Enabled
Guards                      : Enabled
URL Filtering                : Enabled
Security Contexts           : 2
GTP/GPRS                    : Disabled
UPN Peers                   : Unlimited

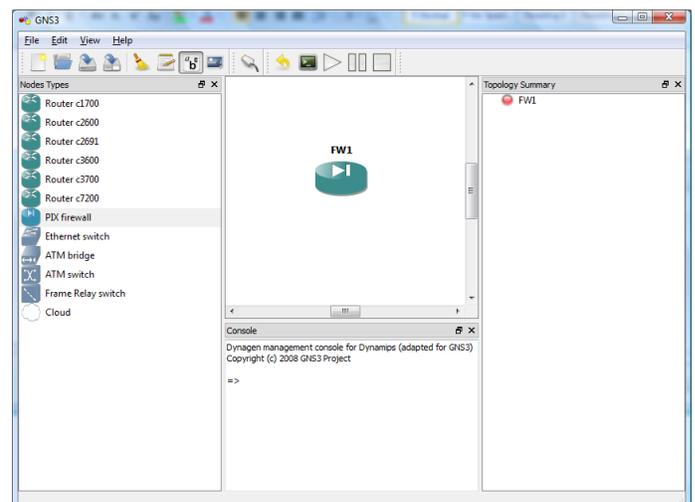
This platform has an Unrestricted (UR) license.
```

If you have a serial number and valid activation keys, you may move from a restricted license to an unrestricted license. Type in the activation keys separated by commas with no spaces. Use all lower case. Be sure your serial number is converted to hexadecimal. It is usually in decimal in a show version command. Use a calculator to convert from decimal to hexadecimal if necessary.

Click OK to return to the GNS3 main interface.

Drag a PIX firewall icon from the Nodes Types pane into the workspace.

Right-click on FW1 and choose Configure.



Click on FW1. Once again, choose a *PIX image* and type in your *Key* and *Serial* number (unless you plan to use the restricted license).

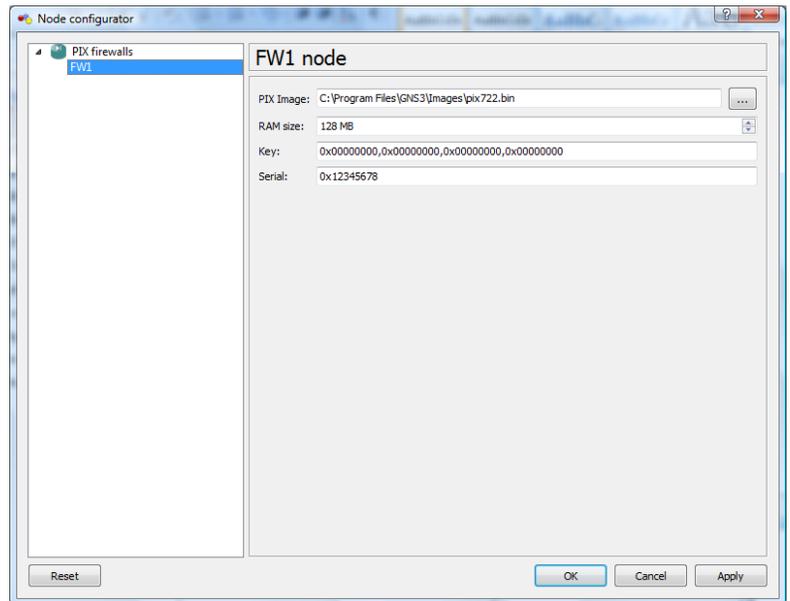
Click OK to return the main GNS3 interface.

Right-click FW1 and choose *Start*.

Right-click FW1 and choose *Console*.

Once you console into your PIX firewall, issue a show version command.

If the activation keys do not show up properly, then issue the following command from privileged mode (enable mode):



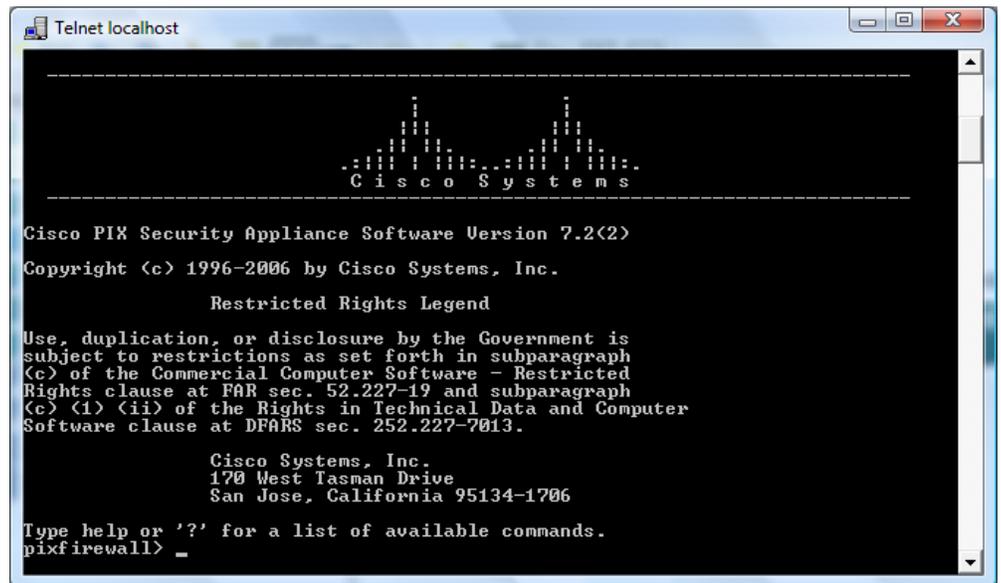
```
Pixfirewall# activation-key 0x12345678 0x12345678 0x12345678 0x12345678
```

The command is issued on one line with spaces between the activation keys. Use valid keys.

Save the configuration using either the *write* command or *copy run start*. Stop the device and restart it.

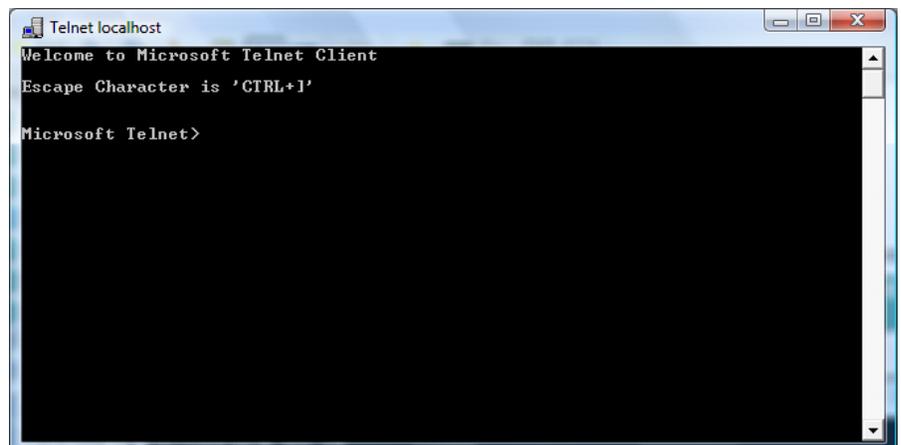
Congratulations! Your PIX firewall is up and running.

Interfaces on the PIX are Ethernet interfaces. To connect to other devices, you'll need to use either Ethernet or FastEthernet interfaces. You may not connect to a serial interface.



You may connect to other PIX firewalls, routers, and switches. You may not connect to a cloud. Consequently, to connect to your real PC or to a Virtual PC, you'll need to connect from the PIX to a switch, and then from the switch to your PC.

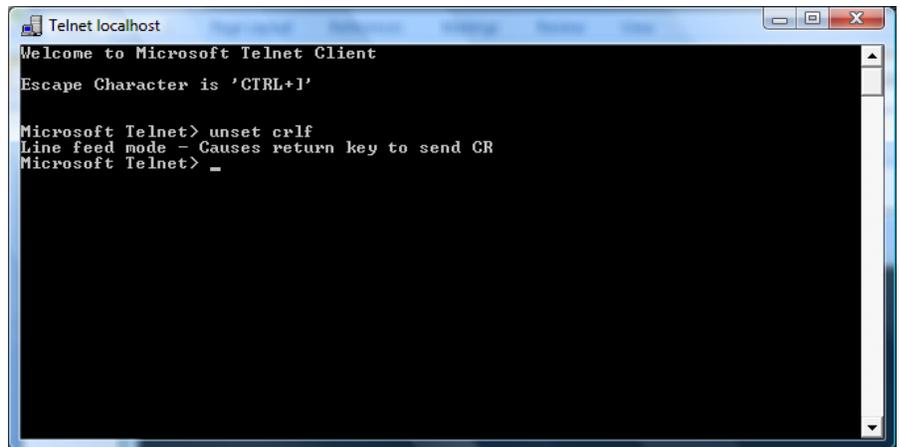
Sometimes when you console into your PIX, you will see that when you hit Enter after a command, a second line is added each time. Your PIX is set to echo commands. Similar to when you write a batch file and use the *echo off* command, we need to turn echo off inside our console session. Here is the procedure:



Hold down your Control key as press the right bracket key (**Ctrl+]**). This puts you into a Microsoft Telnet window.

Now type **unset crlf** and press Enter.

Press Enter again to return to the PIX window.

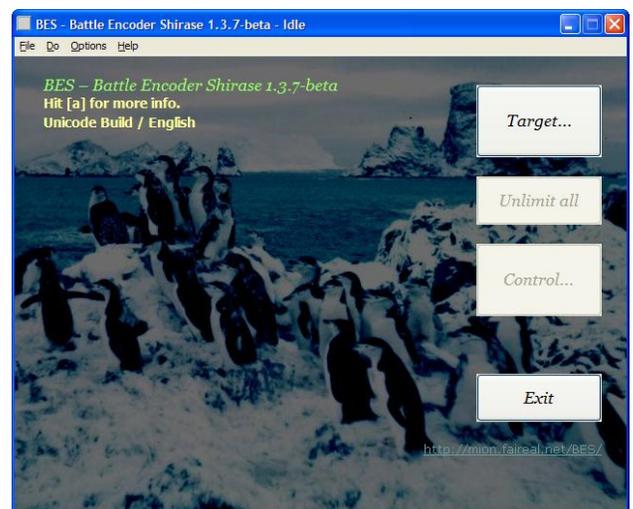


CPU Usage – BES and CPULimit

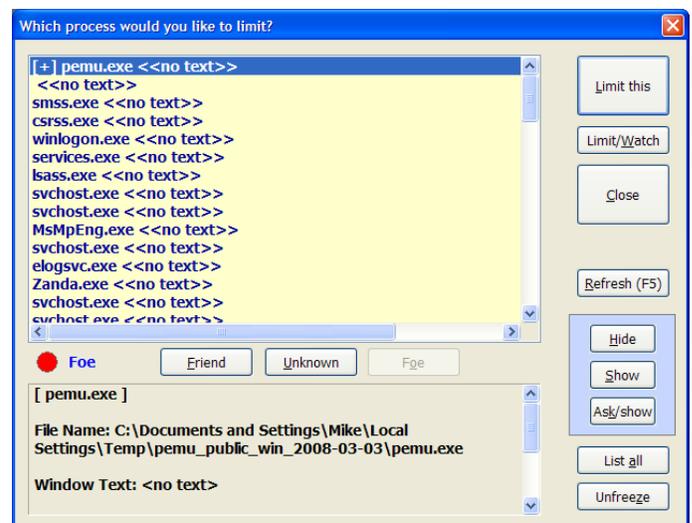
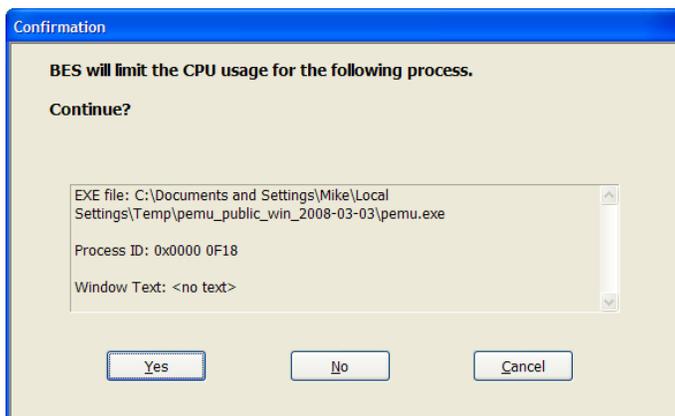
Just as with routers, CPU usage is an issue when emulating PIX firewalls on your computer. You will note that your CPU usage is most likely 100%. There are no idle-pc values available for PIX firewalls at this time. Instead, you may use third-party software to control your CPU usage. There are a variety of products on the market. The one that I use for **Windows** is called **BES** and is a free download at the following Web site:

<http://mion.faireal.net/BES/>

Complete documentation is available on the Web site along with the program download. Once you start your PIX firewall, start BES. Click the *Target* button.

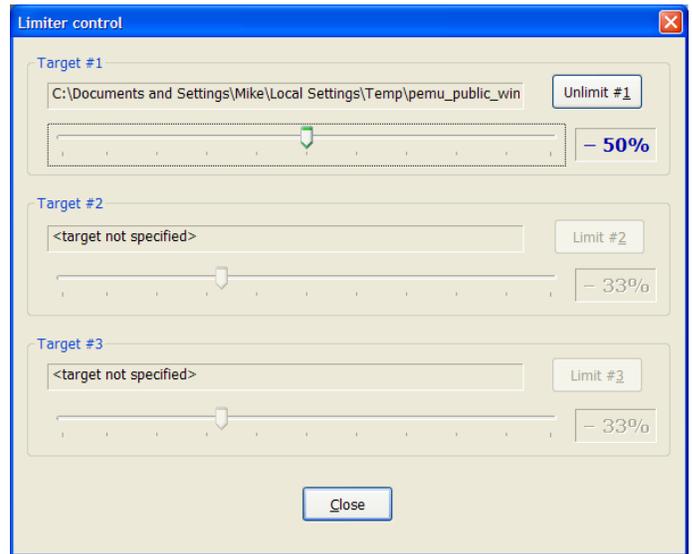


Choose the **pemu.exe** process and click the *Limit this* button. A confirmation screen will appear:



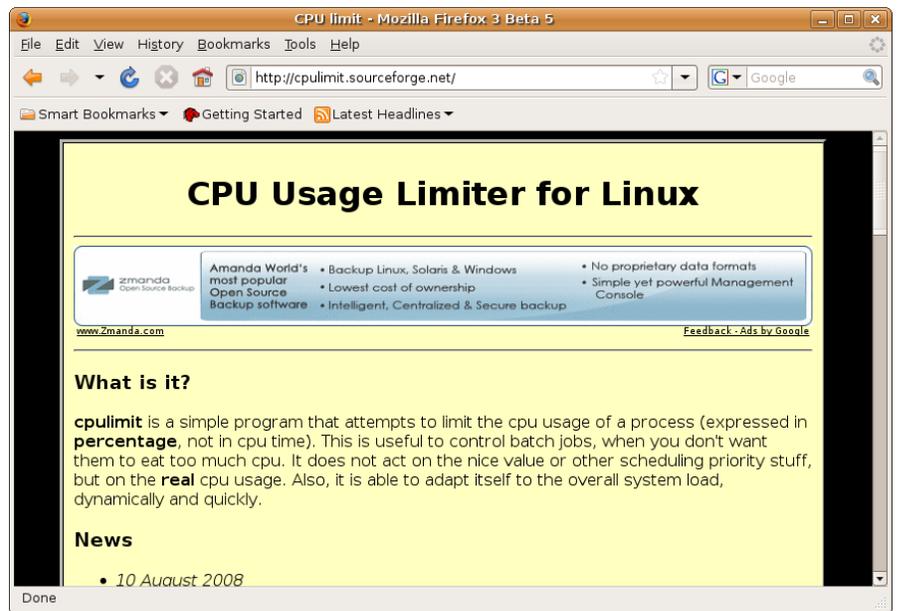
Click the *Control* button to control how much CPU limiting will be used. I've set mine to reduce CPU usage by 50%.

If you are running multiple firewalls, you will want to limit each one. This program may also limit other processes running on your Windows computer.



For **Linux**, use **cpulimit**. You may learn more about cpulimit at the following Web site:

<http://cpulimit.sf.net> or
<http://cpulimit.sourceforge.net>

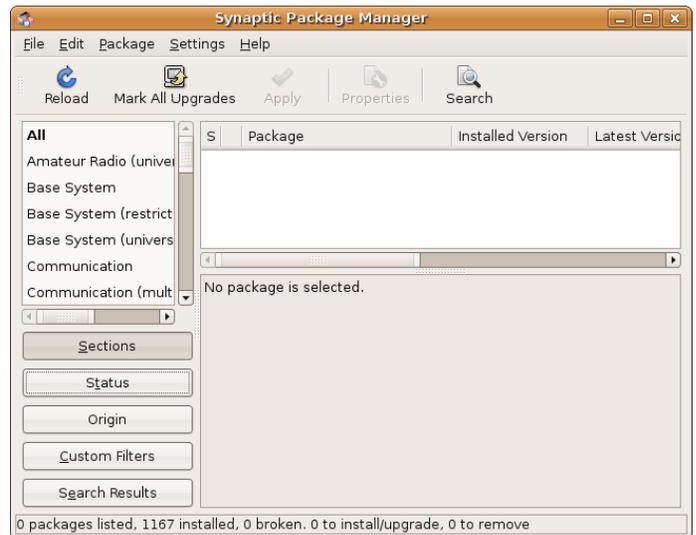
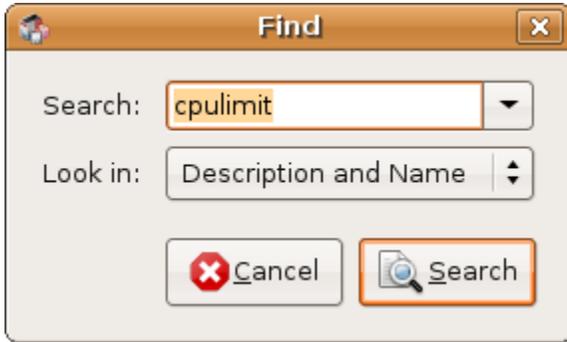


Synaptic Package Manager is tool in Linux that finds, installs, and removes software. Let's use it to find and install cpulimit.

Click on *Synaptic Package Manager* under *Administration* on the *System* menu.

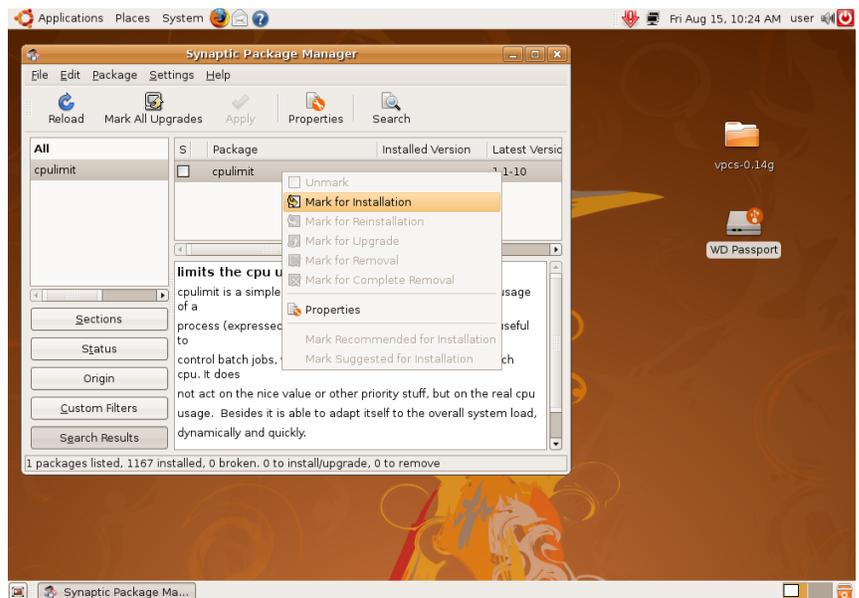
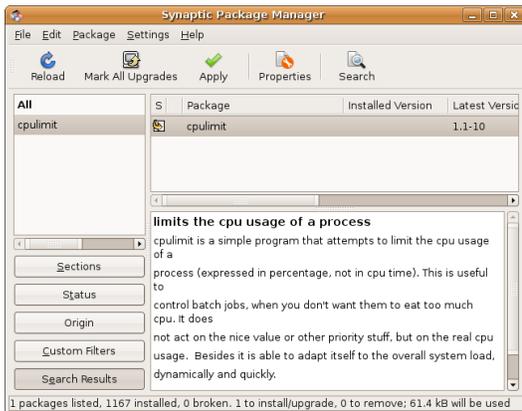


Click the *Search* button and type **cpulimit** in the *Search field* in the *Find* window.

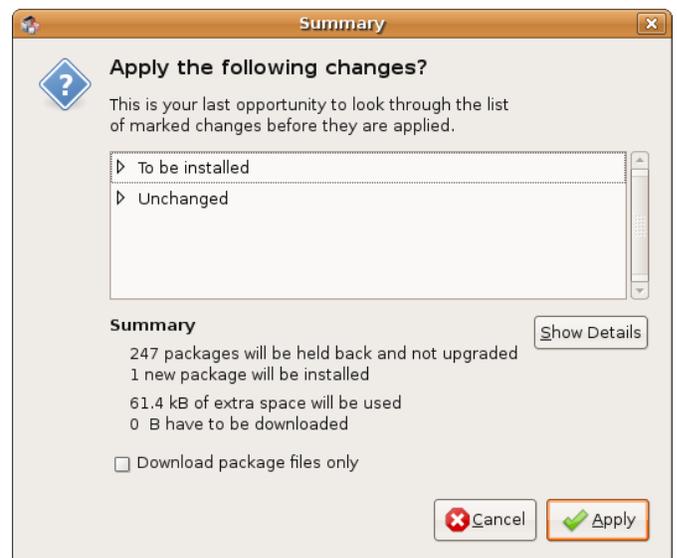


Right-click **cpulimit** and choose *Mark for Installation*.

Then click the *Apply* button in the toolbar.



Click the *Apply* button at the bottom of the Summary window. The changes are applied and the software is installed.

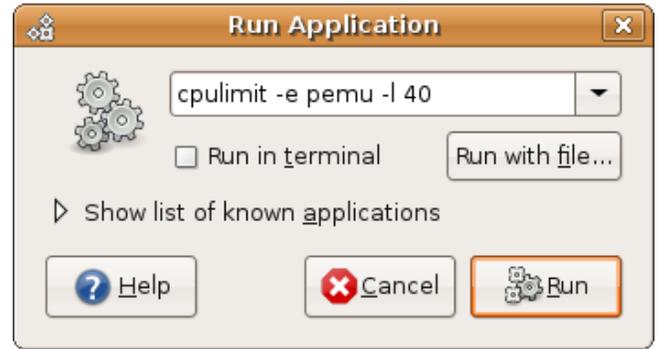


Click the *Close* button to finish the installation.

To run `cpulimit`, press F2 while holding the ALT key down (**ALT+F2**) in Linux to open a *Run Application* box. Type the following in the box:

`cpulimit -e pemu -l 40`

This will limit the application *pemu* to 40% CPU usage.



You may type **`cpulimit -h`** to see an explanation of the command syntax:

```
Usage: cpulimit TARGET [OPTIONS...]
TARGET must be exactly one of these:
  -p, --pid=N           pid of the process
  -e, --exe=FILE       name of the executable program file
  -P, --path=PATH      absolute path name of the executable program file
OPTIONS
  -l, --limit=N        percentage of cpu allowed from 0 to 100 (mandatory)
  -v, --verbose        show control statistics
  -z, --lazy           exit if there is no suitable target process, or if it dies
  -h, --help          display this help and exit
```

The following shows the result of running a PIX Firewall (*pemu*) in GNS3 without CPU control on the left, and then the CPU levels after using `cpulimit` at 40%:

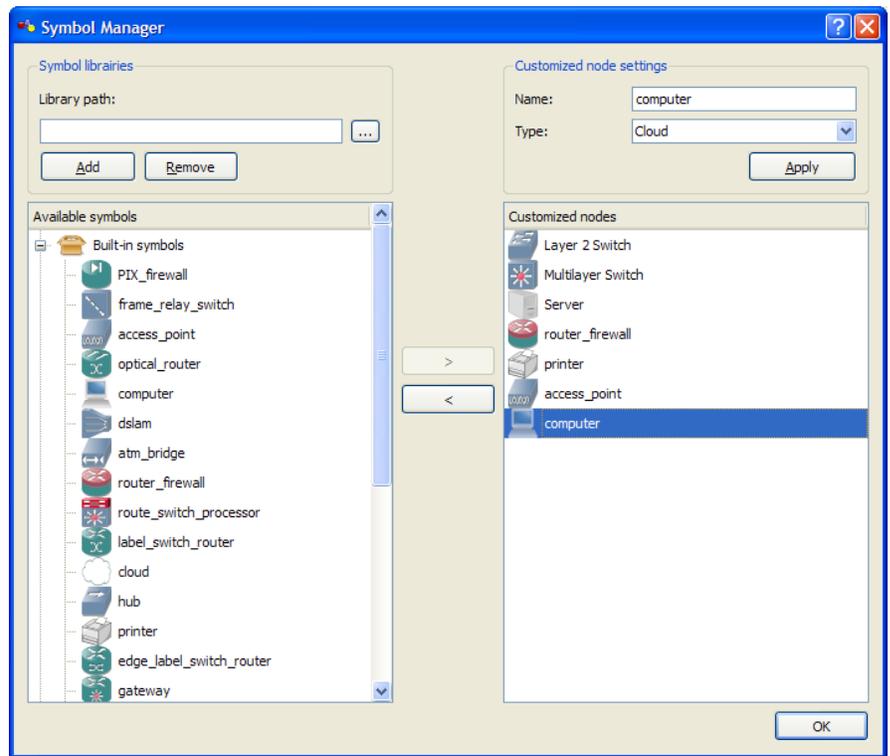
Process Name	Status	% CPU	Nice	ID	Memory
gvfsd-trash	Sleeping	0	0	5524	392.0 KiB
gvfs-fuse-daemon	Sleeping	0	0	5505	392.0 KiB
metacity	Sleeping	0	0	5444	4.7 MiB
mixer_applet2	Sleeping	0	0	5570	5.0 MiB
nautilus	Sleeping	0	0	5447	18.0 MiB
nm-applet	Sleeping	0	0	5498	3.8 MiB
notification-daemon	Sleeping	0	0	5669	5.8 MiB
pemu	Running	94	19	5707	153.6 MiB
pulseaudio	Sleeping	0	0	5395	5.6 MiB
python	Sleeping	0	0	5655	3.1 MiB
python	Sleeping	0	0	5651	14.0 MiB

Process Name	Status	% CPU	Nice	ID	Memory
gvfsd-trash	Sleeping	0	0	5524	392.0 KiB
gvfs-fuse-daemon	Sleeping	0	0	5505	392.0 KiB
metacity	Sleeping	0	0	5444	4.7 MiB
mixer_applet2	Sleeping	0	0	5570	5.0 MiB
nautilus	Sleeping	0	0	5447	18.0 MiB
nm-applet	Sleeping	0	0	5498	3.8 MiB
notification-daemon	Sleeping	0	0	5669	5.8 MiB
pemu	Running	40	19	5707	153.7 MiB
pulseaudio	Sleeping	0	0	5395	5.6 MiB
python	Sleeping	0	0	5655	3.1 MiB
python	Sleeping	0	0	5651	13.9 MiB

Symbol Library

GNS3 provides a variety of symbols, or icons, which may be used in creating topologies. We see some of them in the *Nodes Types* pane on the left of the main interface. If you choose *Symbol Manager* on the *Edit* menu, you'll see some additional symbols in the *Available symbols* pane.

To add one of these symbols, select it in the *Available symbols* pane on the left, and click the arrow button in the middle. This will transfer a copy of the symbol to the *Customized nodes* pane on the right. You may then type a new name for the symbol in the *Name* field at the top. In addition, you may specify the type of symbol by using the drop-down arrow next to *Type*. For example, I've added a computer as a cloud in the example.



What if you'd like to add some symbols of your own? First, you must create your own **Symbol Library**. Then simply specify the path to your Symbol Library and click the *Add* button.

To create your custom-made symbols library, gather together all of the symbols you'd like to include in your library. All symbols must be converted to scalable vector graphics (svg). If you have images in formats such as jpg or bmp, you'll need to convert them. An open source product you may download and install for free to accomplish this is Inkscape. You'll find it at the following Web site:



<http://www.inkscape.org/>

Download Inkscape and install it. Open Inkscape and then open your jpg or bmp file. Then use *Save As* on the *File* menu. Give your filename an extension of svg and use the drop-down arrow to choose *Plain SVG (*.svg)*. Convert all of your symbols to svg files before you continue. By the way, I would size your images to around 70x70 so they fit in size-wise with the other symbols.

As an example, I am going to add a firewall, IP Phone, and laptop as new symbols in a custom symbols library. I've used Inkscape to convert my jpg files to svg files.

Next, create an XML file with the extension **qrc**. Every entry has an alias that is the name of the symbol as it will appear in GNS3. I will use the aliases "Firewall", "IP Phone", and "Laptop". The path on my computer where I have placed these images is d:\symbols. You may use the full path or relative path. Here is the file that I will call mike.qrc:

```
<!DOCTYPE RCC><RCC version="1.0">
<qresource>
<file alias='Firewall.svg'>d:\symbols\firewall.svg</file>
<file alias='IP Phone.svg'>d:\symbols\iphone.svg</file>
<file alias='Laptop.svg'>d:\symbols\laptop.svg</file>
</qresource>
</RCC>
```

Note that my aliases are enclosed in quotes, and that it is acceptable to use spaces. You may create this file in any text editor, such as Notepad. Save it with a **qrc** extension (be sure there isn't a hidden txt extension at the end). A *qrc* file is a *resource collection file*. My file will be called *mike.qrc*.

Now you need to compile your library using the **Qt Resource Compiler (rcc)**. **RCC** is included in the Qt application framework that you may download from the Internet. Or you may download the Windows version from GNS3 by pointing your browser to:

<http://www.gns3.net/files/rcc.exe>

Rcc.exe will also need **mingwm10.dll** to work. If you install Qt, this file will be included. If you just download rcc.exe from GNS3, then you'll need to grab a copy of mingwm10.dll from the Internet. One source to download the file from is:

<http://www.dll-files.com/dllindex/dll-files.shtml?mingwm10>

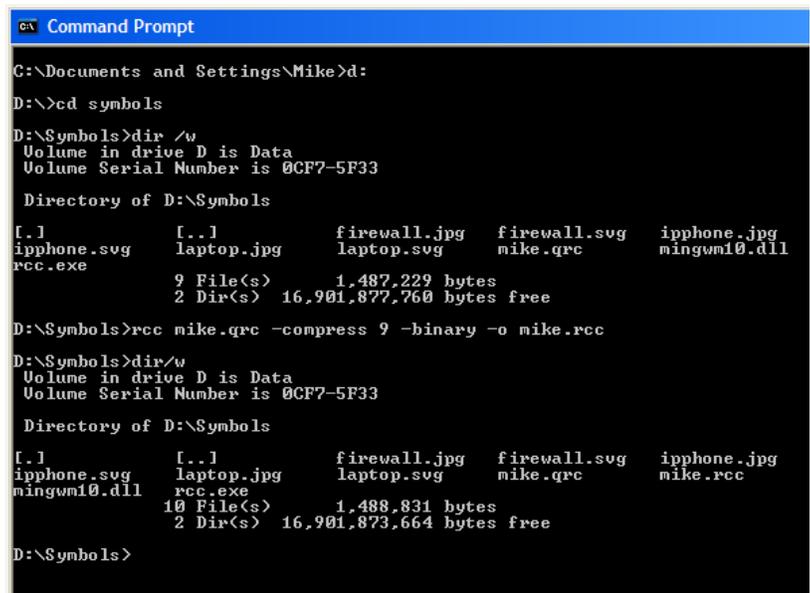
Copy rcc.exe and mingwm10.dll to the same directory as your qrc file created above. Then open a command prompt or terminal window and traverse to your symbols directory.

Now it's time to compile your custom symbols library for use in GNS3. Use the following command, substituting your filenames as necessary:

```
rcc mike.qrc -compress 9 -binary -o mike.rcc
```

Now you should have your custom symbols library called mike.rcc (in our example).

The difficult part is finished!



```
C:\Documents and Settings\Mike>d:
D:\>cd symbols
D:\Symbols>dir /w
Volume in drive D is Data
Volume Serial Number is 0CF7-5F33

Directory of D:\Symbols

[.]          [..]          firewall.jpg  firewall.svg  ipphone.jpg
ipphone.svg  laptop.jpg    laptop.svg    mike.qrc      mingwm10.dll
rcc.exe
             9 File(s)    1,487,229 bytes
             2 Dir(s)   16,901,877,760 bytes free

D:\Symbols>rcc mike.qrc -compress 9 -binary -o mike.rcc
D:\Symbols>dir /w
Volume in drive D is Data
Volume Serial Number is 0CF7-5F33

Directory of D:\Symbols

[.]          [..]          firewall.jpg  firewall.svg  ipphone.jpg
ipphone.svg  laptop.jpg    laptop.svg    mike.qrc      mingwm10.dll
rcc.exe
             10 File(s)   1,488,831 bytes
             2 Dir(s)   16,901,873,664 bytes free

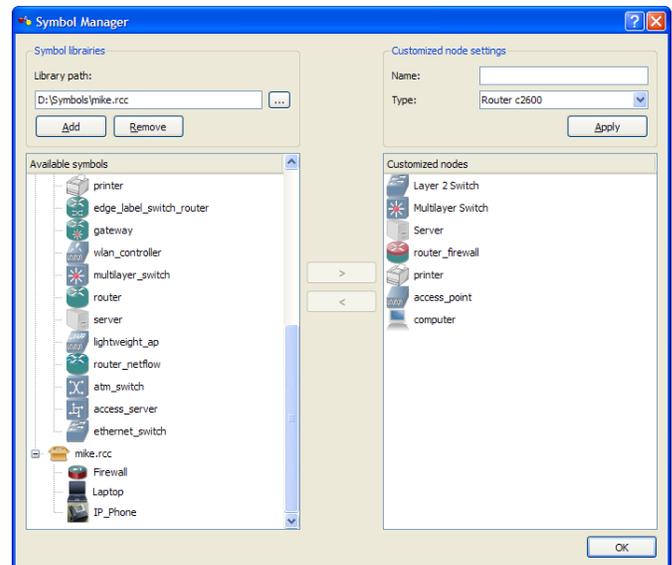
D:\Symbols>
```

Return to GNS3. Choose *Symbol Manger* under the *Edit* menu.

Click  next to library path and choose your new custom symbol library (mike.rcc in our example).

Then click the *Add* button.

Your library is now added and available.



Resources

I hope this documentation is helpful. But don't stop here. I

highly recommend that you visit the GNS3 Web site at www.gns3.net where video demonstrations are available. Also, one of the most useful sites as you prepare for certifications is the Dynamips forum at <http://7200emu.hacki.at>.