## Contents

1. **Introduction**  
   1.1 Introduction  

2. **Client-side installation**  
   2.1 Network issues  

3. **The Dyn@NG virtual laboratory interface**  
   3.1 Architecture  
   3.2 Accessing the server  
   3.3 User Interface  

4. **Simulating your first topology**  

5. **IOS command line configuration tips**  
   5.1 Configuration modes  
   5.2 Command shortening and online help  
   5.3 Console timeout  
   5.4 Connecting a router to a switch  

6. **Troubleshooting**  
   6.1 Physical links seeming not to be working  

7. **Useful links**  

8. **Acknowledgments**
1 Introduction

This tutorial aims at providing an overview of the functionalities of the Dyn@NG virtual networking laboratory. It will also present how to access the software functionalities and it will introduce users to the the main features of the system. Server-side installation and some more details on the Dyn@NG internals are available in separate documents enclosed in the source pack.

From the end-user perspective, the main component is the Dyn@NG web interface (the graphical network simulator), which allows the simulation of complex networks based on selected Cisco devices. It is a frontend to Dynamips, Dynagen and Qemu and can emulate the behavior of some selected Cisco routers using ad-hoc virtual machines. Some of its features, mainly the ability to capture packets on every established link, make it an ideal instrument to learn how to deal with some issues of the “real life” devices without actually having access to them.

Dyn@NG is a software that allows the simulation to run on a remote machine (provided with a Dynamips installation with a Cisco IOS image, the so-called Dynamips “hypervisor mode”), leveraging the user from setting up and configuring such infrastructure. Moreover, with Dyn@NG you can set up a single, powerful server to be used by many users concurrently, each one simulating its own virtual network; users do not interfere with each other and do not have to own an extremely powerful computer to run their simulations on.

2 Client-side installation

Dyn@NG is a web-based application that requires no additional application to be installed on the client machine (except of course a web browser). All the installation is done only once, server-side.

However, you may want to install Wireshark to analyze capture files.

2.1 Network issues

Dyn@NG requires the client to be able to connect to the TCP port on which the web server listens to new connections; typically 80 or 8080 for HTTP, 443 for HTTPS.

All the forwarding to the console ports spawned to drive virtual routers is done server-side, with Apache rewriting rules and mod_proxy. It is not yet clear if HTTP proxies might interfere with such flows.

1Please remember that server-side installation instructions are available in a separate document, that is enclosed in the source pack.
3 The Dyn@NG virtual laboratory interface

3.1 Architecture

Dyn@NG allows many users to simulate their own virtual network without interfering with each other. The software backend interfaces with Dynamips and spawns different communication ports for each virtual router and user. All these operations are then presented to the user through a unified web interface, that therefore wraps all the connections (that usually would require access to arbitrary TCP/UDP ports) over HTTP.

3.2 Accessing the server

The Dyn@NG interface is available at the following web site:

http://dynng.ipv6.polito.it

Registration is free, provided that your email address belongs to a set of selected academic domains. The administrator can edit this list.
3.3 User Interface

The main Dyn@NG page is shown in Figure 1. Its main features are described here.

- On top of the web page there is a **menu** to access some common operations: create a new topology or save/load it, or start/stop the network operations.
- On the left, the **device library** displays a collection of all available routers and switches. They can be dragged and dropped in the middle panel.
- The middle panel is used to draw the **network topology**. Devices can be dragged and dropped from the left panel, whereas links can be created by selecting the source device with a left click and then the destination one with a CTRL-left click.
  
  You can change the properties of devices and links by right-clicking on them.
- The right panel lists all the available **links** in the current topology. The link called "network" is actually a virtual link that aggregates all the packets flowing on all links. You can create custom aggregated links by clicking on the “aggregate captures” button above, dragging the desired links on the right of the new window that popped up, then choosing any name you like.
  
  If the network is already up and running (*remember that network is started trough the menu at the top*), you can begin a capture on a single or aggregated link with the green arrow at the side of the desired link. The other buttons let you stop the capture, bring up a preview, download the capture file or just delete the link.
- The bottom panel lets you access the router **consoles**. If the network is already up and running (*remember that network is started trough the menu at the top*), you can click on each icon to bring up the console for that router: you can then drag the console window around.
- You can logoff using the button at the top right of the screen.

A more complicated screenshot is portrayed in Figure 2: you can see a couple of terminals running aside the network topology.

4 Simulating your first topology

- Access the *Dyn@NG* web interface and log in.
- Create a simple network topology:
  - drag and drop the router icon onto the middle panel, thereby creating router R0;
  - drag and drop it again to create router R1;
– link the routers by left-clicking on R0, then CTRL-left-clicking on R1; select
slot 0 of R0’s first linecard to be connected to slot 0 of R1’s first linecard.
• Start the network operations from the Network menu at the top of the screen.
The routers will boot and you will see the progress in a pop-up window.
• Click on R0 and R1 console icons at the bottom. A couple of windows will open
inside the browser page to show the terminals.
Select them, one at a time, and press the Enter key on your keyboard a couple of
times in each of them; this is a known problem, as sometimes the router prompt
does not appear if you do not press “Enter”. If everything is ok, after some time
you should see the following prompt on both consoles:
Would you like to enter the initial configuration dialog? [yes/no]
• Answer “no” to the request. You will configure the machines manually. Wait until
the Router> prompt appears in both consoles. You are going to:
  – Enter into the privileged-mode of the routers;
  – Enter into the configuration mode to configure the router settings;
Enter into the *interface configuration mode* to configure the interfaces;

- Actually configure the interfaces, setting their IP address and then enabling them;
- Finish the configuration.

Details on the meaning of the commands will be provided in the next section. This is what you have to do:

- On R0 console, type the following:
  
  ```
  enable
  configure terminal
  interface FastEthernet0/0
  ip address 192.168.0.1 255.255.255.0
  no shutdown
  end
  ```

- On R1 console, type the following (please note that the IP address is **different**):
  
  ```
  enable
  configure terminal
  interface FastEthernet0/0
  ip address 192.168.0.2 255.255.255.0
  no shutdown
  end
  ```

You have now configured the interfaces on the link.

- You may want to start the packet capture before going further. Find the L0 link in the right panel and start the capture by left-clicking onto the green arrow at its side. Alternatively, you might right-click onto the link itself in the topology and start the capture from the contextual menu.

- Now make the routers ping each other:
  
  - On R0’s console type: `ping 192.168.0.2`
  - On R1’s console type: `ping 192.168.0.1`

You should see a similar text appearing on each console:

- **Sending 5, 100-byte ICMP Echos to 192.168.0.1, timeout is 2 seconds: .!!!!
  Success rate is 80 percent (4/5), round-trip min/avg/max = 4/4/4 ms**

- Stop the capture from the right panel by clicking on the red square button, or, alternatively, by right-clicking on the link itself.
• Download the capture to your hard disk by using the appropriate button in the right panel and open it in Wireshark.

You can see there how loquacious Cisco devices are. Among the other things, you can see the ARP exchange generated by your ping and the following ICMP echo request and reply packets.

Congratulations! You have completed this tutorial. You are now able to create a simple topology, start it, configure its devices, capture exchanged packets and analyze them in Wireshark. Before going further with the other tutorials, you should read the other sections of this manual, especially Section 5 called *IOS command line configuration tips*. They will help you to learn how to make the system work as you want.

## 5 IOS command line configuration tips

### 5.1 Configuration modes

The Cisco IOS command line interface has several configuration modes. The ones you will mostly use are listed in Table 1.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EXEC-mode</strong></td>
<td>In this mode you are allowed to use some of the available commands. Also, you are not allowed to change the configuration. This is the default mode in which you enter after connecting to the router console.</td>
</tr>
<tr>
<td><strong>Privileged mode</strong></td>
<td>This is the privileged, “administration” mode. You are allowed to execute all the commands that do not change the configuration. You enter this mode by typing <code>enable</code> in the exec-mode.</td>
</tr>
<tr>
<td><strong>Global configuration mode</strong></td>
<td>In this mode you are allowed to change the global configuration. Changes are applied immediately. You enter this mode by typing <code>configure terminal</code> in the privileged mode.</td>
</tr>
<tr>
<td><strong>Interface conf. mode</strong></td>
<td>In this mode you can change the configuration of a specific interface. You enter this mode by typing, for example, <code>interface FastEthernetX/X</code>, or <code>interface Vlan1000</code> in the global configuration mode.</td>
</tr>
</tbody>
</table>

Table 1: Useful Cisco IOS commands.

You can go back to the privileged mode from the global or interface configuration modes by typing `end`. You can also type `exit` to jump back to the global configuration mode from
the interface configuration mode, or from the global configuration mode to the privileged mode. If you type `exit` in the EXEC or privileged mode, you will be logged off the console (not a big deal, just press RETURN to get back in).

### 5.2 Command shortening and online help

When there is no ambiguity you can shorten the commands by only typing their first letters. For example, the basic IP configuration of an interface can be typed as:

```
en
conf t
  in fa0/0
    ip addr 192.168.0.1 255.255.255.0
    no shut
end
```

If you are not sure whether you can shorten a command or not, press TAB after the first letters. If the command self-completes, you can use just those letters instead of the full command; otherwise you have to provide a longer hint. If TAB does not complete your command, press “?” (a question mark) to have a list of alternatives. Also, if you press “?” after a space following a command, you will receive some help about the immediately following accepted parameter.

### 5.3 Console timeout

If a router console is inactive, after some time you will be logged out. You can then press RETURN to get back in, and you will be brought back to the EXEC prompt. If you want to avoid this annoyance, you can disable the timeout by typing:

```
configure terminal
  line console 0
    exec-timeout 0 0
end
```

### 5.4 Connecting a router to a switch

If you connect a routed interface of one router (FastEthernet0/X) to a switched interface of another router (FastEthernet1/X), you will get some CDP warning messages when turning up the routed interface (switched interfaces are up by default). The interfaces will fail to negotiate a common speed and duplex setting; this seems to be a bug in the
simulator. To solve this problem, you need to disable the auto-negotiation in the routed interface and set up speed and duplex mode manually:

```
configure terminal
  interface FastEthernet0/X
    shutdown
    speed 100
    duplex full
    no shutdown
end
```

It is important that the changes are made when the interface is down.

## 6 Troubleshooting

### 6.1 Physical links seeming not to be working

It may sometimes happen that not all the links are working in the topology. To check for this problem, you may launch the following command in the privileged mode:

```
show cdp neighbors
```

CDP is a Cisco proprietary protocol used, among other things, to discover neighboring Cisco devices. Use it to check for connectivity between routers linked to each other. On a router connected to four other machines on the interfaces Fa1/0 - Fa1/3, for example, you should obtain:

<table>
<thead>
<tr>
<th>Device ID</th>
<th>Local Intrfce</th>
<th>Holdtme</th>
<th>Capability</th>
<th>Platform</th>
<th>Port ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router</td>
<td>Fas 1/3</td>
<td>174</td>
<td>R S I</td>
<td>2691</td>
<td>Fas 1/0</td>
</tr>
<tr>
<td>Router</td>
<td>Fas 1/1</td>
<td>179</td>
<td>R S I</td>
<td>2691</td>
<td>Fas 0/0</td>
</tr>
<tr>
<td>Router</td>
<td>Fas 1/0</td>
<td>175</td>
<td>R S I</td>
<td>2691</td>
<td>Fas 0/0</td>
</tr>
<tr>
<td>Router</td>
<td>Fas 1/2</td>
<td>172</td>
<td>R S I</td>
<td>2691</td>
<td>Fas 1/0</td>
</tr>
</tbody>
</table>

If you find persistent anomalies, you can try to restart the simulation.
7 Useful links

- **http://dynagen.org/tutorial.htm**
  Dynagen tutorial. You may want to check the *Working with the Management Console* section for some hints on how to use the Dynagen console.

- **http://www.ipflow.utc.fr/blog/**
  Dynamips blog.

- **http://7200emu.hacki.at/**
  Forum of Dynamips and Dynagen users. A lot of good information, especially about router configurations.

8 Acknowledgments

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