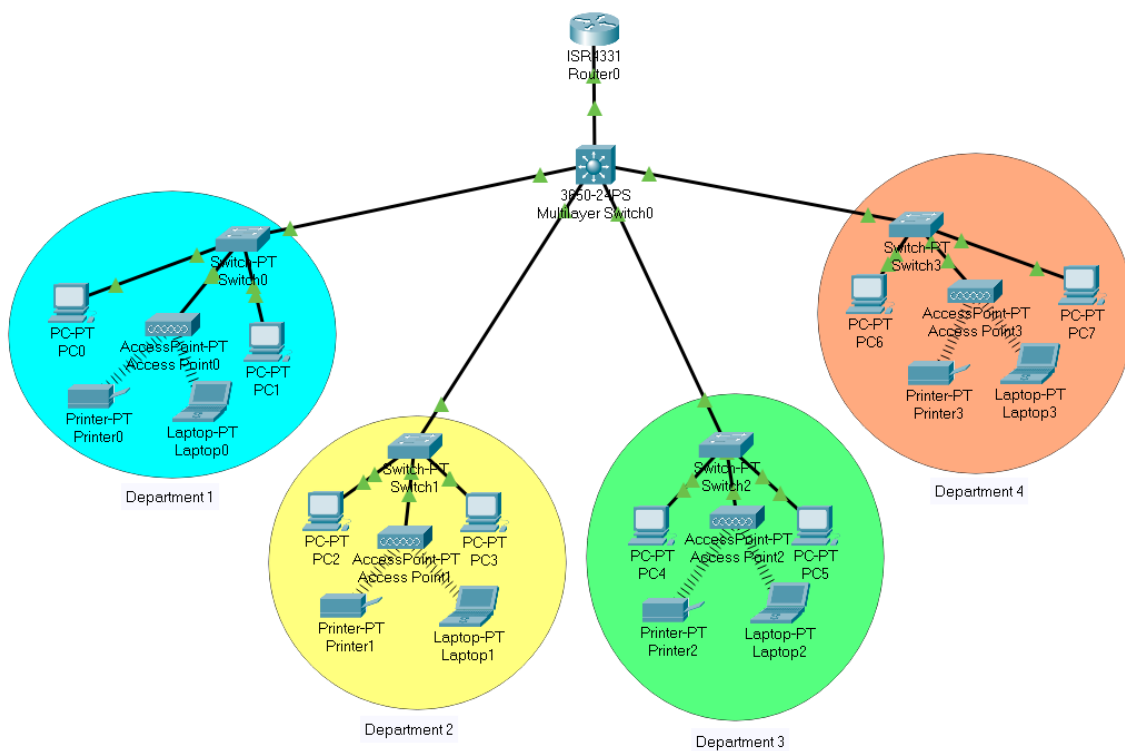


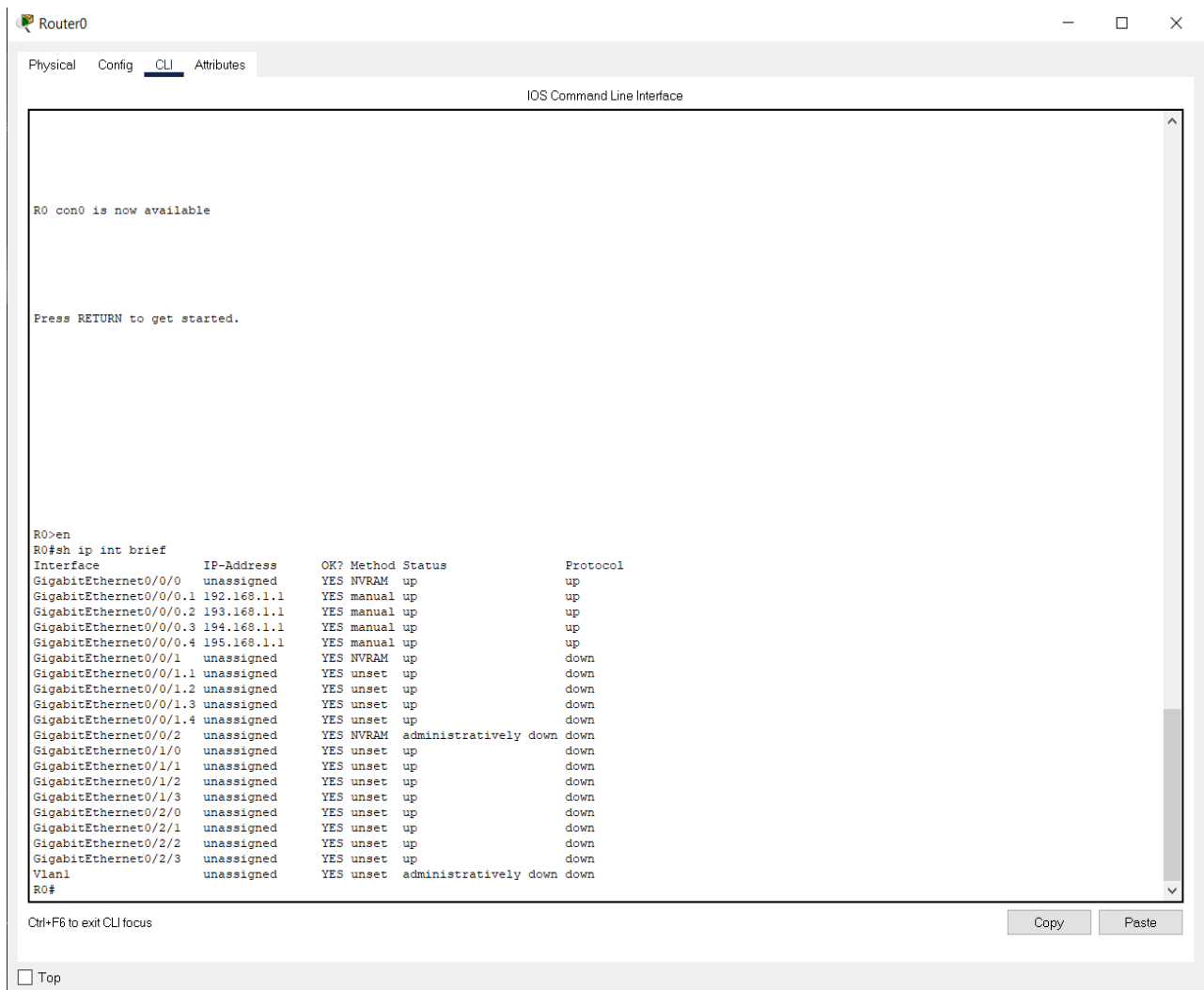
## **2-Tier Collapsed-Core SOHO Network**

*Designed by Sam Rajan*

The following diagram below depicts the 2-Tier Collapsed Core SOHO (Small Office/Home Office) network created using Cisco's Packet Tracer software. The network features 4 departments which each have their own assigned DHCP pools. Each department features a PT switch, two desktop PCs, a wireless AP, a printer, and a laptop. The wireless AP allows the printer and laptop to wirelessly connect to the department VLAN and use the network to communicate to other departments. Each department's wireless AP uses WPA-2K authentication and has a separate password used for connecting to each VLAN. The multilayer switch conducts the switching between departments and comprises the condensed distribution and core layer. The interface between the multilayer switch is split into 4 sub-interfaces to facilitate the router-on-a-stick configuration. Each sub-interface corresponds to a distinct VLAN and DHCP group respective to each department.



## Router Configurations:



```
Router0
Physical Config CLI Attributes
IOS Command Line Interface

R0 con0 is now available

Press RETURN to get started.

R0>en
R0#sh ip int brief
Interface                IP-Address      OK? Method Status          Protocol
GigabitEthernet0/0/0      unassigned      YES NVRAM    up              up
GigabitEthernet0/0/0.1    192.168.1.1     YES manual    up              up
GigabitEthernet0/0/0.2    193.168.1.1     YES manual    up              up
GigabitEthernet0/0/0.3    194.168.1.1     YES manual    up              up
GigabitEthernet0/0/0.4    195.168.1.1     YES manual    up              up
GigabitEthernet0/0/1      unassigned      YES NVRAM    up              down
GigabitEthernet0/0/1.1    unassigned      YES unset    up              down
GigabitEthernet0/0/1.2    unassigned      YES unset    up              down
GigabitEthernet0/0/1.3    unassigned      YES unset    up              down
GigabitEthernet0/0/1.4    unassigned      YES unset    up              down
GigabitEthernet0/0/2      unassigned      YES NVRAM    administratively down down
GigabitEthernet0/1/0      unassigned      YES unset    up              down
GigabitEthernet0/1/1      unassigned      YES unset    up              down
GigabitEthernet0/1/2      unassigned      YES unset    up              down
GigabitEthernet0/1/3      unassigned      YES unset    up              down
GigabitEthernet0/2/0      unassigned      YES unset    up              down
GigabitEthernet0/2/1      unassigned      YES unset    up              down
GigabitEthernet0/2/2      unassigned      YES unset    up              down
GigabitEthernet0/2/3      unassigned      YES unset    up              down
Vlan1                     unassigned      YES unset    administratively down down
R0#
```

Ctrl+F6 to exit CLI focus

Copy Paste

☐ Top

As can be seen in the image above, the GigabitEthernet0/0/0 interface has been divided into 4 sub-interfaces. Each sub-interface is assigned the default gateway for each respective department network and will be used in the assignment of the DHCP pools. GigabitEthernet0/0/0.1 corresponds to the 192.168.1.0/24 network, GigabitEthernet0/0/0.2 corresponds to the 193.168.1.0/24 network, GigabitEthernet0/0/0.3 corresponds to the 194.168.1.0/24 network, and GigabitEthernet0/0/0.4 corresponds to the 195.168.1.0/24 network.

The screenshot shows a Cisco Router CLI window titled "Router0" with tabs for "Physical", "Config", "CLI", and "Attributes". The "CLI" tab is active, displaying the "IOS Command Line Interface". The command "R0#sh ip dhcp pool" has been entered, resulting in the following output:

```
R0#sh ip dhcp pool

Pool vlan10 :
  Utilization mark (high/low) : 100 / 0
  Subnet size (first/next) : 0 / 0
  Total addresses : 254
  Leased addresses : 0
  Excluded addresses : 0
  Pending event : none

  1 subnet is currently in the pool
  Current index      IP address range      Leased/Excluded/Total
  192.168.1.1        192.168.1.1 - 192.168.1.254  0 / 0 / 254

Pool vlan20 :
  Utilization mark (high/low) : 100 / 0
  Subnet size (first/next) : 0 / 0
  Total addresses : 254
  Leased addresses : 0
  Excluded addresses : 0
  Pending event : none

  1 subnet is currently in the pool
  Current index      IP address range      Leased/Excluded/Total
  193.168.1.1        193.168.1.1 - 193.168.1.254  0 / 0 / 254

Pool vlan30 :
  Utilization mark (high/low) : 100 / 0
  Subnet size (first/next) : 0 / 0
  Total addresses : 254
  Leased addresses : 0
  Excluded addresses : 0
  Pending event : none

  1 subnet is currently in the pool
  Current index      IP address range      Leased/Excluded/Total
  194.168.1.1        194.168.1.1 - 194.168.1.254  0 / 0 / 254

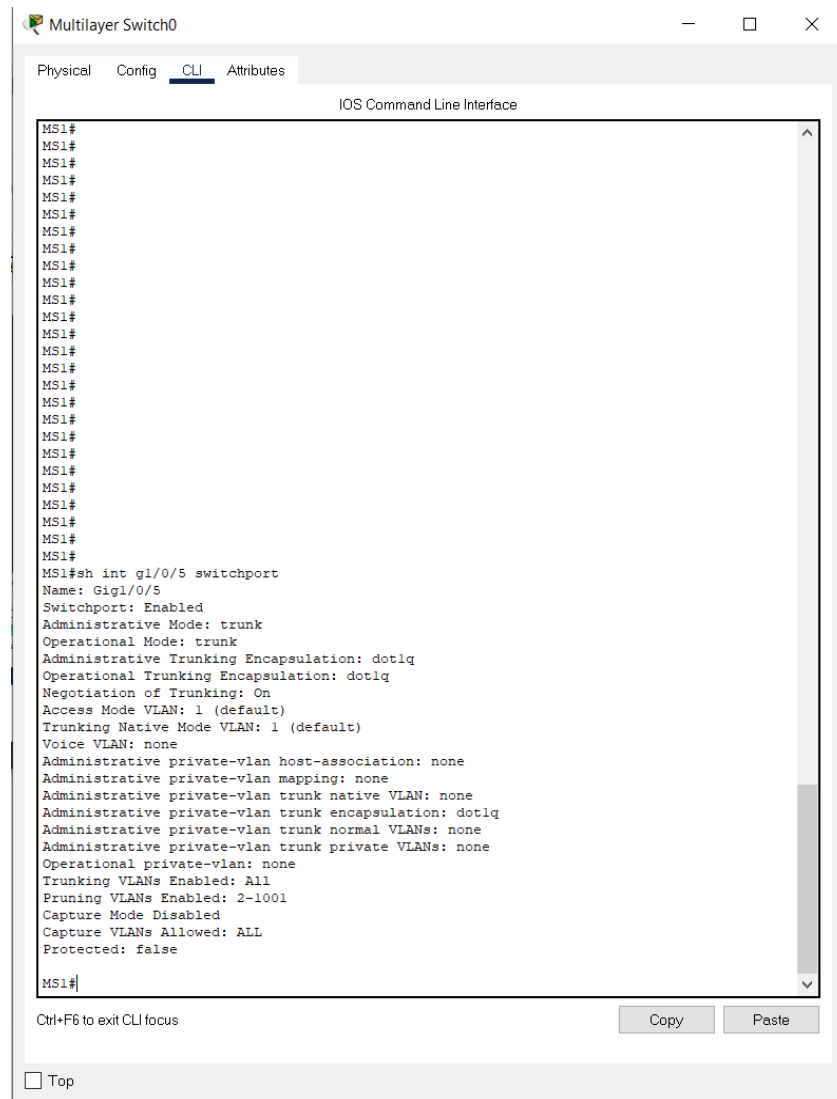
Pool vlan40 :
  Utilization mark (high/low) : 100 / 0
  Subnet size (first/next) : 0 / 0
  Total addresses : 254
  Leased addresses : 0
  Excluded addresses : 0
  Pending event : none

  1 subnet is currently in the pool
  Current index      IP address range      Leased/Excluded/Total
  195.168.1.1        195.168.1.1 - 195.168.1.254  0 / 0 / 254
R0#
```

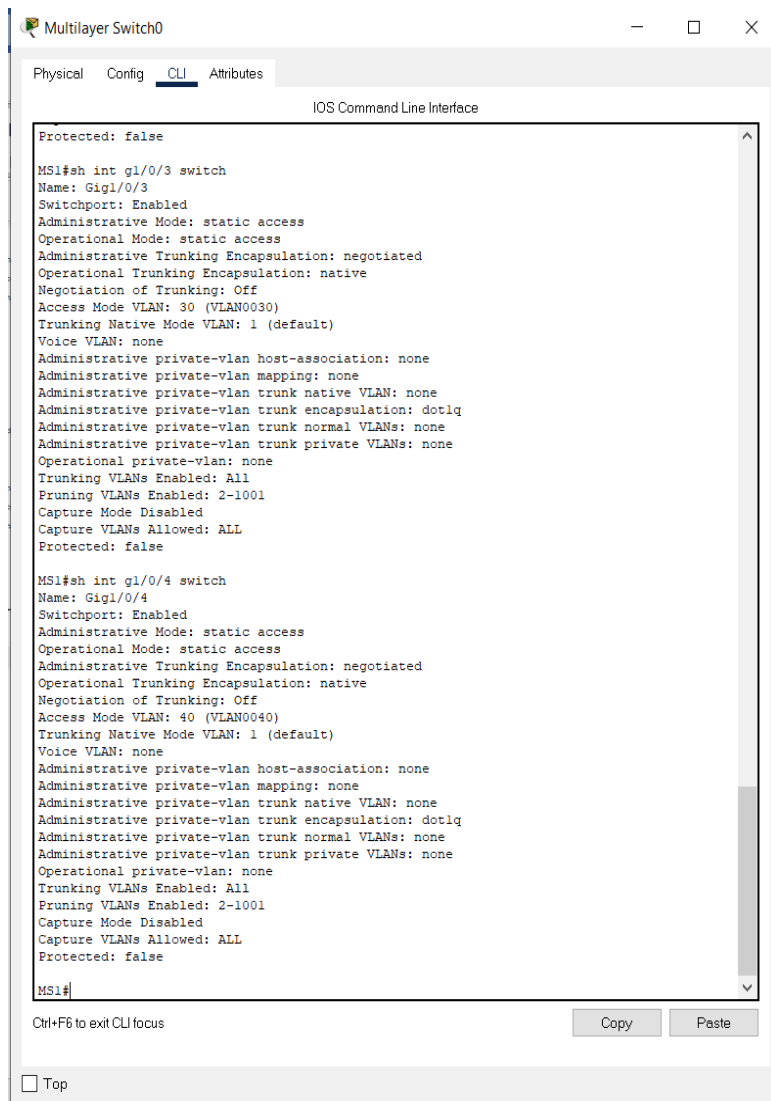
At the bottom of the CLI window, there is a status bar with "Ctrl+F6 to exit CLI focus" and buttons for "Copy" and "Paste". A "Top" button is also visible in the bottom left corner of the window frame.

This image shows the DHCP pool configurations on the router as per the respective VLANs that will be assigned to each department. VLAN 10 corresponds to Department 1, VLAN 20 corresponds to Department 2, VLAN 30 corresponds to Department 3, and VLAN 40 corresponds to Department 4. The vlan10 pool corresponds to the 192.168.1.1 – 192.168.1.254 address range, the vlan20 pool corresponds to the 193.168.1.1 – 193.168.1.254 address range, the vlan30 pool corresponds to the 194.168.1.1 – 194.168.1.254 address range, and the vlan40 pool corresponds to the 195.168.1.1 – 195.168.1.254 address range.

### Multilayer Switch Configurations:



The multilayer switch comprises the entire condensed core/distribution layer. The GigabitEthernet1/0/5 interface (which connects the switch to the router and has been split into sub-interfaces) has been configured to be in trunking mode and uses 802.1q encapsulation.



The interfaces GigabitEthernet1/0/1 – GigabitEthernet1/0/4 are all configured to be access ports for the respective department VLANs. GigabitEthernet1/0/1 is used to access VLAN10, GigabitEthernet1/0/2 is used to access VLAN20, GigabitEthernet1/0/3 is used to access VLAN30, and GigabitEthernet1/0/4 is used to access VLAN40.

The image displays four screenshots of Cisco Packet Tracer, each showing the CLI of a different switch (Switch0, Switch1, Switch2, and Switch3) in the 'IOS Command Line Interface' mode. The switches are configured with the following settings:

- Switch0:**
  - Hostname: SW0#
  - IP Address: 192.168.1.1
  - VLANs: 10 (vlan10), 20 (vlan20)
  - Trunking: Native Mode VLAN: 1 (default), Voice VLAN: none
  - Operational private-vlan: none
  - Trunking VLANs Enabled: All
  - Pruning VLANs Enabled: 2-1001
  - Capture Mode Disabled
  - Capture VLANs Allowed: ALL
  - Protected: false
- Switch1:**
  - Hostname: SW1#
  - IP Address: 192.168.1.2
  - VLANs: 10 (vlan10), 20 (vlan20)
  - Trunking: Native Mode VLAN: 1 (default), Voice VLAN: none
  - Operational private-vlan: none
  - Trunking VLANs Enabled: All
  - Pruning VLANs Enabled: 2-1001
  - Capture Mode Disabled
  - Capture VLANs Allowed: ALL
  - Protected: false
- Switch2:**
  - Hostname: SW2#
  - IP Address: 192.168.1.3
  - VLANs: 10 (vlan10), 20 (vlan20)
  - Trunking: Native Mode VLAN: 1 (default), Voice VLAN: none
  - Operational private-vlan: none
  - Trunking VLANs Enabled: All
  - Pruning VLANs Enabled: 2-1001
  - Capture Mode Disabled
  - Capture VLANs Allowed: ALL
  - Protected: false
- Switch3:**
  - Hostname: SW3#
  - IP Address: 192.168.1.4
  - VLANs: 10 (vlan10), 20 (vlan20)
  - Trunking: Native Mode VLAN: 1 (default), Voice VLAN: none
  - Operational private-vlan: none
  - Trunking VLANs Enabled: All
  - Pruning VLANs Enabled: 2-1001
  - Capture Mode Disabled
  - Capture VLANs Allowed: ALL
  - Protected: false

Each screenshot shows the 'CLI' tab selected, with the 'IOS Command Line Interface' title bar. The 'Physical' and 'Attributes' tabs are also visible. The 'CLI' tab shows the configuration commands and their output, including the 'Press RETURN to get started!' prompt. The 'Physical' tab shows the switch's physical interface configuration, including the 'FastEthernet' interfaces. The 'Attributes' tab shows the switch's attributes, including the 'Switchport' status and 'Operational Mode'.

## Wireless AP Configurations:

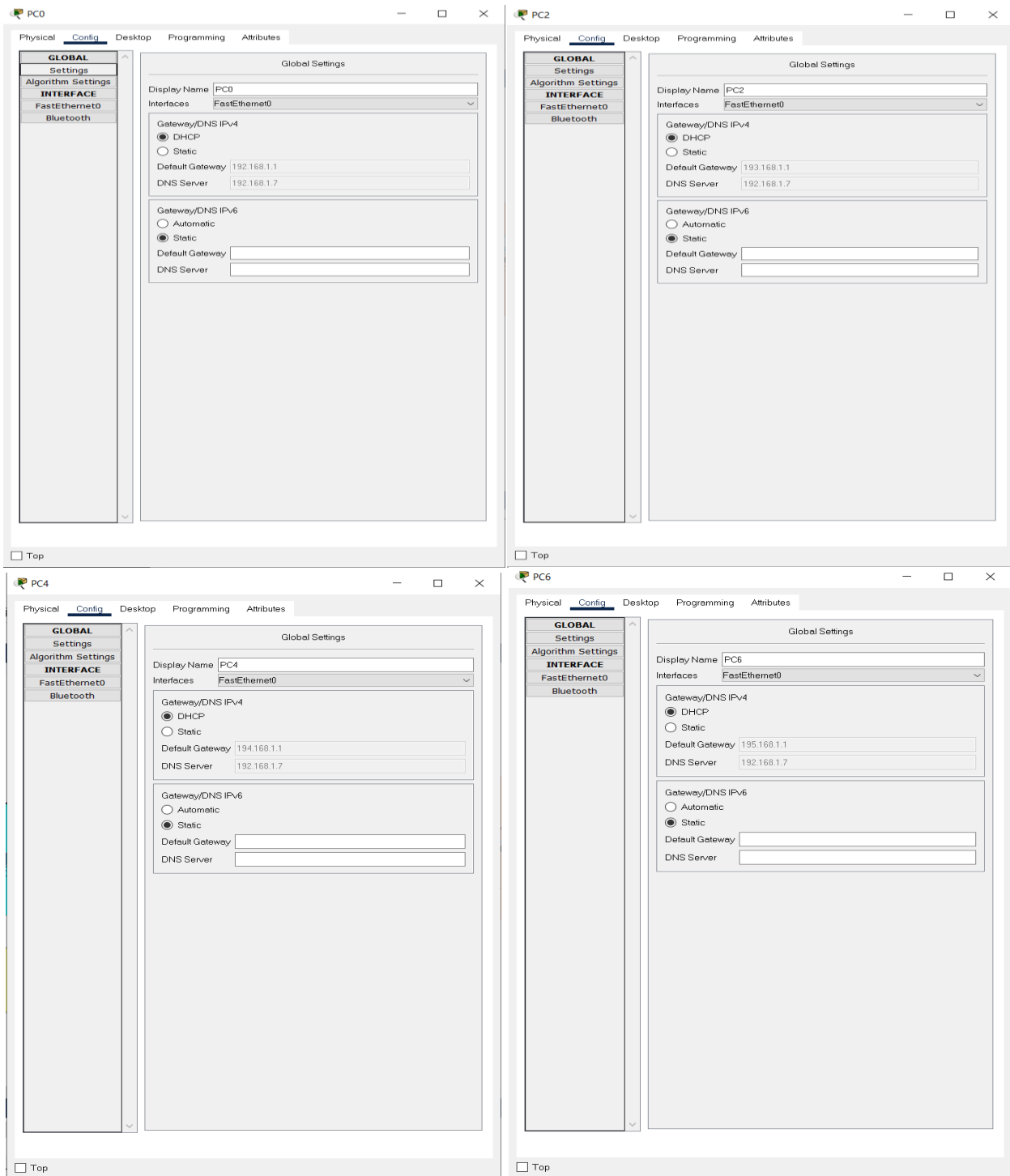
The image displays four screenshots of wireless AP configuration windows, each for a different access point (AP0, AP1, AP2, AP3). Each window has tabs for Physical, Config, and Attributes. The Config tab is active, showing settings for Port 1. The settings include Port Status (On), SSID (Default), 2.4 GHz Channel (6), Coverage Range (meters) (140.00), Authentication (WPA2-PSK), PSK Pass Phrase, User ID, Password, and Encryption Type (AES).

Access Point	Port Status	SSID	2.4 GHz Channel	Coverage Range (meters)	Authentication	PSK Pass Phrase	User ID	Password	Encryption Type
Access Point0	On	Default	6	140.00	WPA2-PSK	p4ssw0rd1			AES
Access Point1	On	Default	6	140.00	WPA2-PSK	p4ssw0rd2			AES
Access Point2	On	Default	6	140.00	WPA2-PSK	p4ssw0rd3			AES
Access Point3	On	Default	6	140.00	WPA2-PSK	p4ssw0rd4			AES

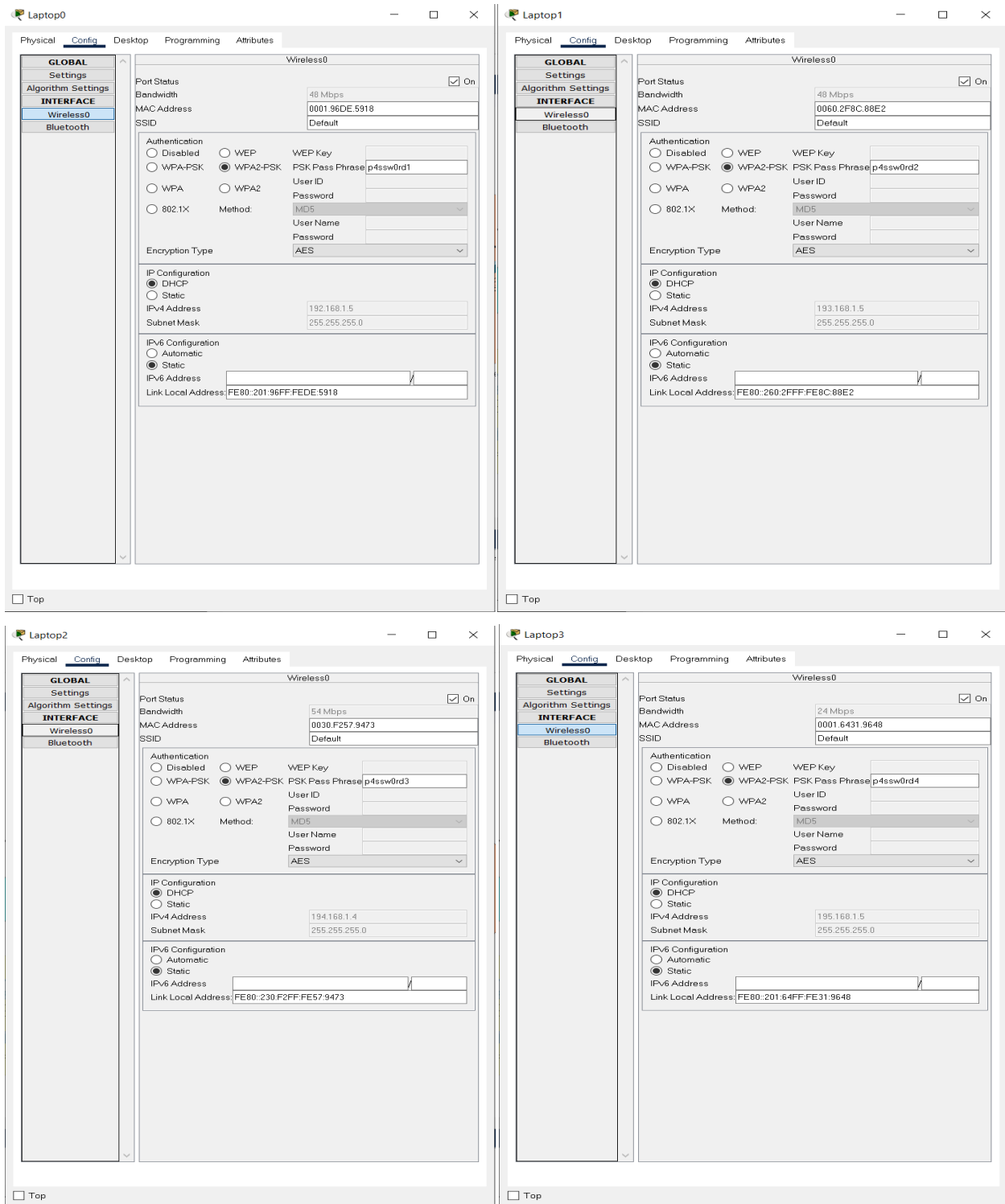
The wireless APs for each department use WPA2-PSK authentication and all have separate passwords. AP 0 corresponds to department 1, AP 1 corresponds to department 2, AP 2 corresponds to department 3, and AP 4 corresponds to department 4.



## Host Configurations:



These PCs have been configured to use DHCP to receive an IP address. They will receive an IP address based on the department VLAN they belong to. Note that this difference between them can be observed via the distinct default gateways for each PCs. This same setting has been configured for all PCs throughout the network.



The wireless hosts (laptops) have been configured to connect to the AP using their respective passwords. The encryption type used for the connection is AES. All wireless hosts have also been configured to use DHCP to allocate IP addresses to them. These same settings are also used to configure the wireless printers in the network.

### Sample connectivity tests:

These tests will showcase the functionality of the network in the most comprehensive way. The tests will involve each of the laptops pinging the laptops in the other departments successfully.

The IPs for each of the department laptops are:

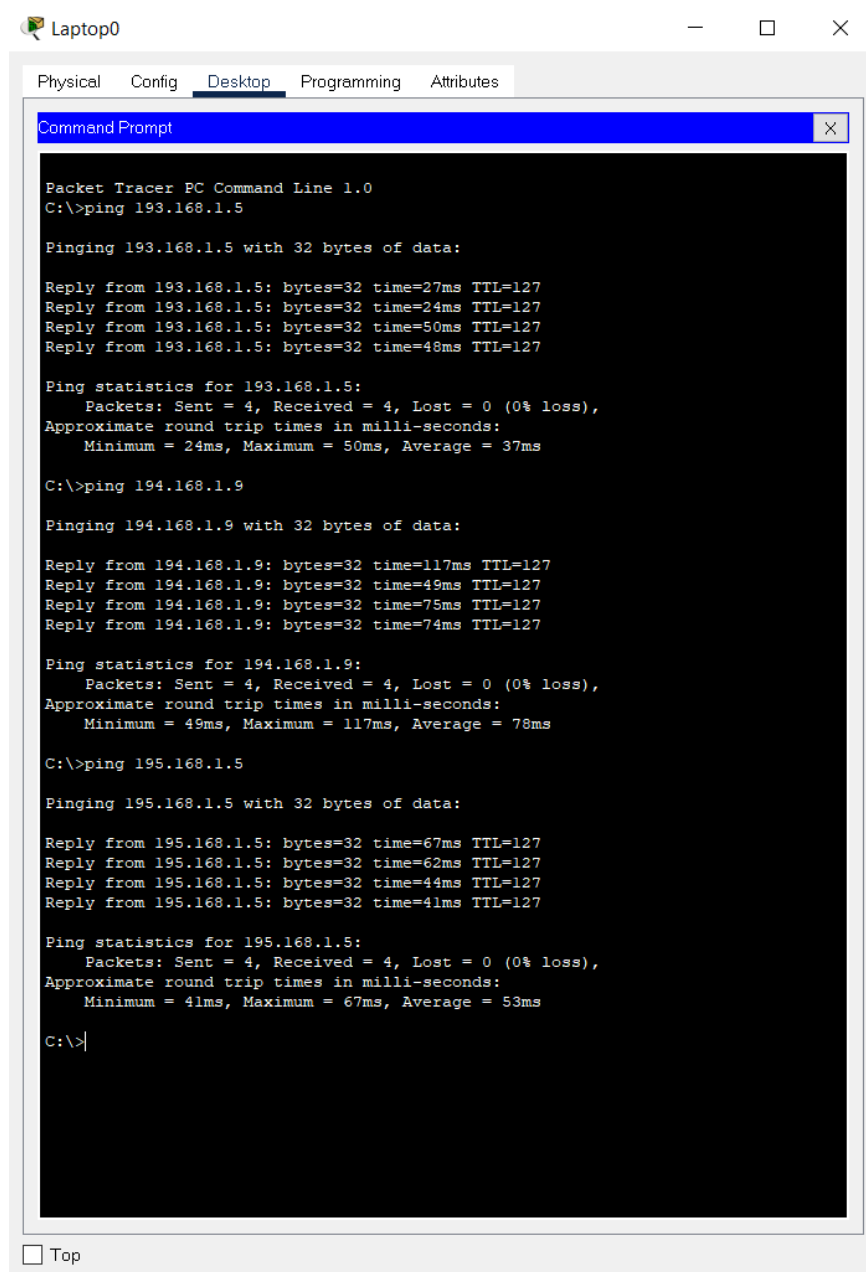
Department 1 (Laptop 0): 192.168.1.3/24

Department 2 (Laptop 1): 193.168.1.5/24

Department 3 (Laptop 2): 194.168.1.9/24

Department 4 (Laptop 3): 195.168.1.5/24

*Department 1 (Laptop 0) Pings:*



```
Packet Tracer PC Command Line 1.0
C:\>ping 193.168.1.5

Pinging 193.168.1.5 with 32 bytes of data:

Reply from 193.168.1.5: bytes=32 time=27ms TTL=127
Reply from 193.168.1.5: bytes=32 time=24ms TTL=127
Reply from 193.168.1.5: bytes=32 time=50ms TTL=127
Reply from 193.168.1.5: bytes=32 time=48ms TTL=127

Ping statistics for 193.168.1.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 24ms, Maximum = 50ms, Average = 37ms

C:\>ping 194.168.1.9

Pinging 194.168.1.9 with 32 bytes of data:

Reply from 194.168.1.9: bytes=32 time=117ms TTL=127
Reply from 194.168.1.9: bytes=32 time=49ms TTL=127
Reply from 194.168.1.9: bytes=32 time=75ms TTL=127
Reply from 194.168.1.9: bytes=32 time=74ms TTL=127

Ping statistics for 194.168.1.9:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 49ms, Maximum = 117ms, Average = 78ms

C:\>ping 195.168.1.5

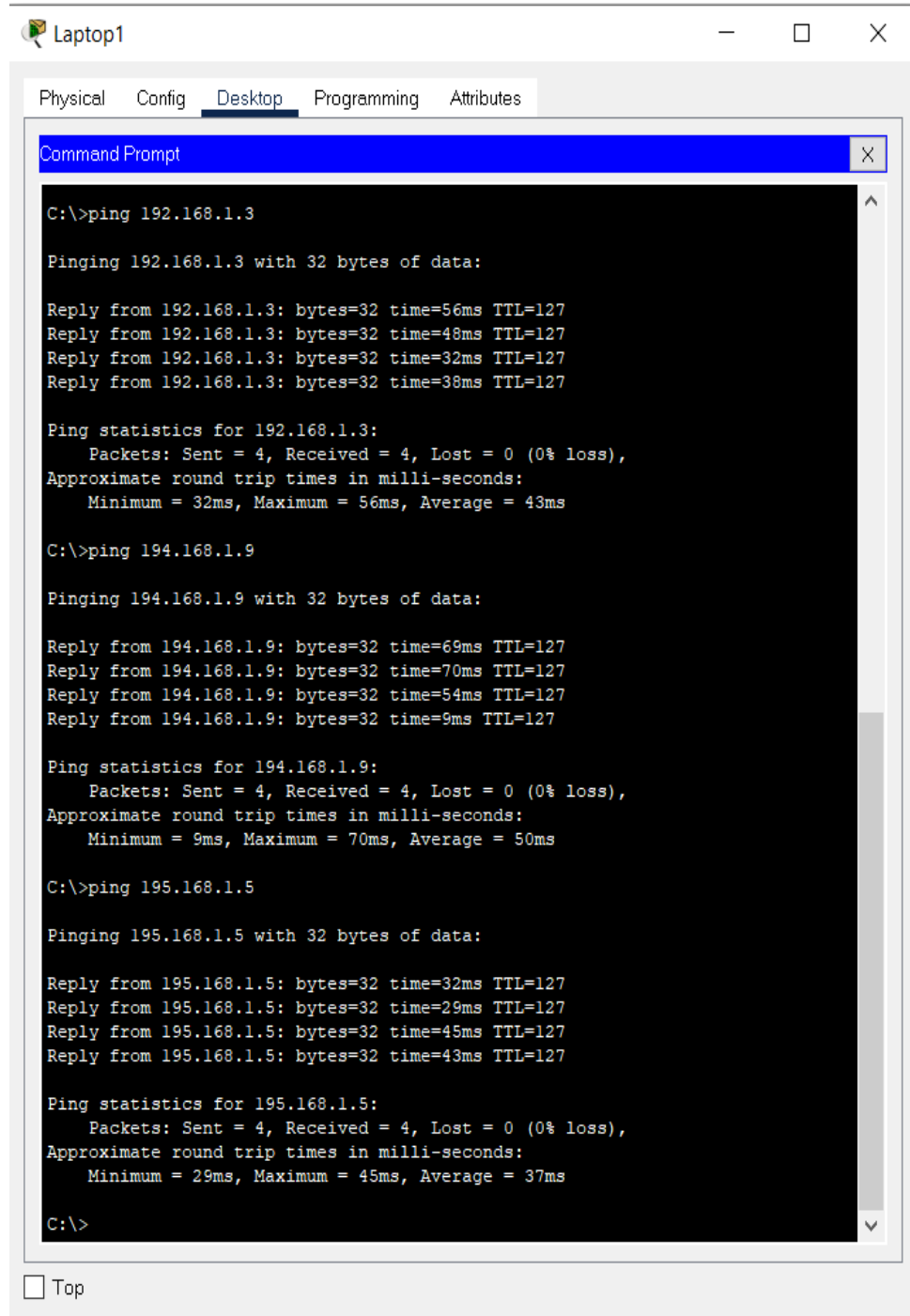
Pinging 195.168.1.5 with 32 bytes of data:

Reply from 195.168.1.5: bytes=32 time=67ms TTL=127
Reply from 195.168.1.5: bytes=32 time=62ms TTL=127
Reply from 195.168.1.5: bytes=32 time=44ms TTL=127
Reply from 195.168.1.5: bytes=32 time=41ms TTL=127

Ping statistics for 195.168.1.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 41ms, Maximum = 67ms, Average = 53ms

C:\>
```

## Department 2 (Laptop 1) Pings:



```
C:\>ping 192.168.1.3

Pinging 192.168.1.3 with 32 bytes of data:

Reply from 192.168.1.3: bytes=32 time=56ms TTL=127
Reply from 192.168.1.3: bytes=32 time=48ms TTL=127
Reply from 192.168.1.3: bytes=32 time=32ms TTL=127
Reply from 192.168.1.3: bytes=32 time=38ms TTL=127

Ping statistics for 192.168.1.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 32ms, Maximum = 56ms, Average = 43ms

C:\>ping 194.168.1.9

Pinging 194.168.1.9 with 32 bytes of data:

Reply from 194.168.1.9: bytes=32 time=69ms TTL=127
Reply from 194.168.1.9: bytes=32 time=70ms TTL=127
Reply from 194.168.1.9: bytes=32 time=54ms TTL=127
Reply from 194.168.1.9: bytes=32 time=9ms TTL=127

Ping statistics for 194.168.1.9:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 9ms, Maximum = 70ms, Average = 50ms

C:\>ping 195.168.1.5

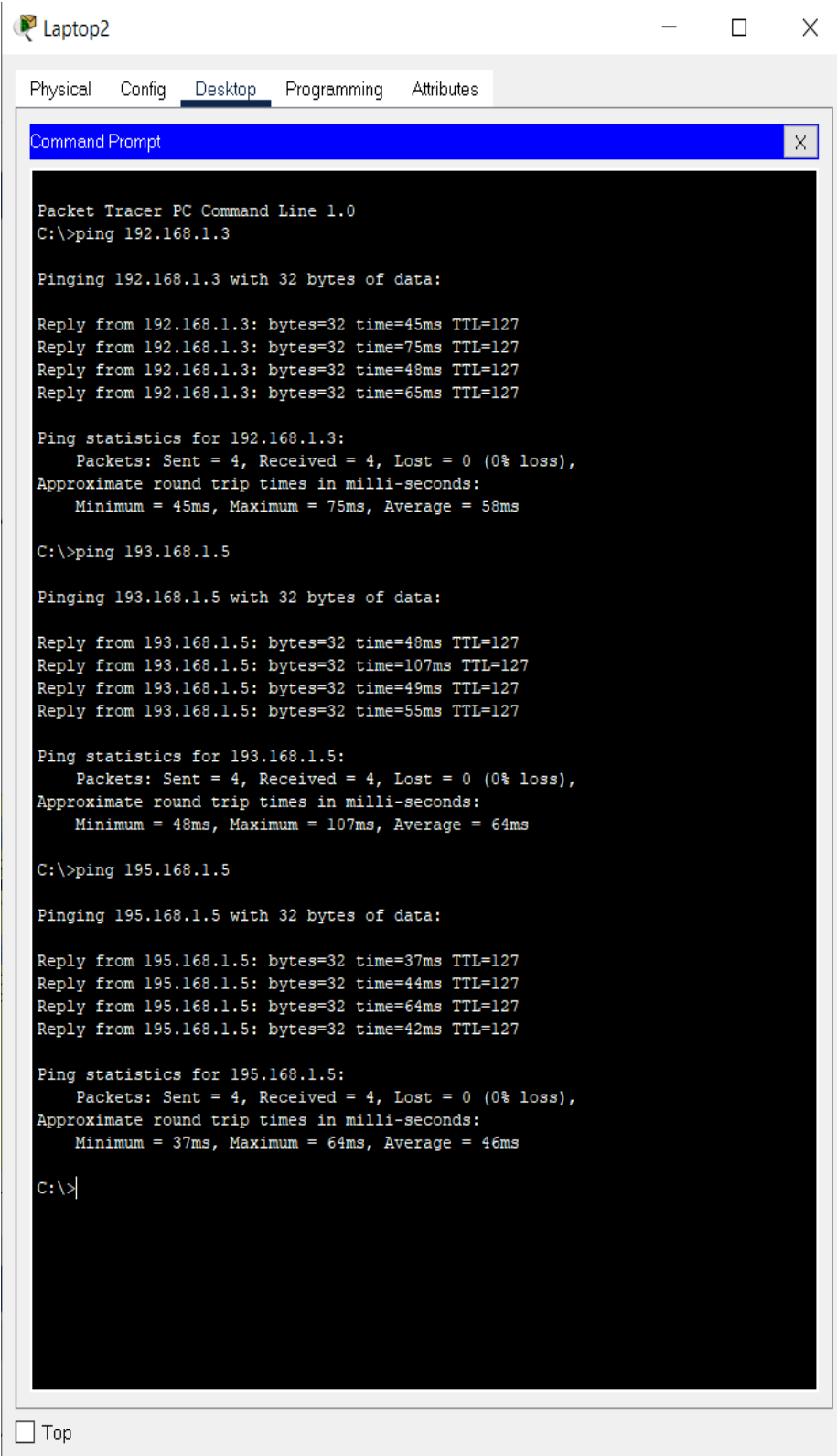
Pinging 195.168.1.5 with 32 bytes of data:

Reply from 195.168.1.5: bytes=32 time=32ms TTL=127
Reply from 195.168.1.5: bytes=32 time=29ms TTL=127
Reply from 195.168.1.5: bytes=32 time=45ms TTL=127
Reply from 195.168.1.5: bytes=32 time=43ms TTL=127

Ping statistics for 195.168.1.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 29ms, Maximum = 45ms, Average = 37ms

C:\>
```

### Department 3 (Laptop 2) Pings:



The screenshot shows a Packet Tracer interface with a window titled "Laptop2". The window has tabs for "Physical", "Config", "Desktop", "Programming", and "Attributes". The "Desktop" tab is active, displaying a "Command Prompt" window. The Command Prompt shows the output of three ping commands executed from the C:\ prompt.

```
Packet Tracer PC Command Line 1.0
C:\>ping 192.168.1.3

Pinging 192.168.1.3 with 32 bytes of data:

Reply from 192.168.1.3: bytes=32 time=45ms TTL=127
Reply from 192.168.1.3: bytes=32 time=75ms TTL=127
Reply from 192.168.1.3: bytes=32 time=48ms TTL=127
Reply from 192.168.1.3: bytes=32 time=65ms TTL=127

Ping statistics for 192.168.1.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 45ms, Maximum = 75ms, Average = 58ms

C:\>ping 193.168.1.5

Pinging 193.168.1.5 with 32 bytes of data:

Reply from 193.168.1.5: bytes=32 time=48ms TTL=127
Reply from 193.168.1.5: bytes=32 time=107ms TTL=127
Reply from 193.168.1.5: bytes=32 time=49ms TTL=127
Reply from 193.168.1.5: bytes=32 time=55ms TTL=127

Ping statistics for 193.168.1.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 48ms, Maximum = 107ms, Average = 64ms

C:\>ping 195.168.1.5

Pinging 195.168.1.5 with 32 bytes of data:

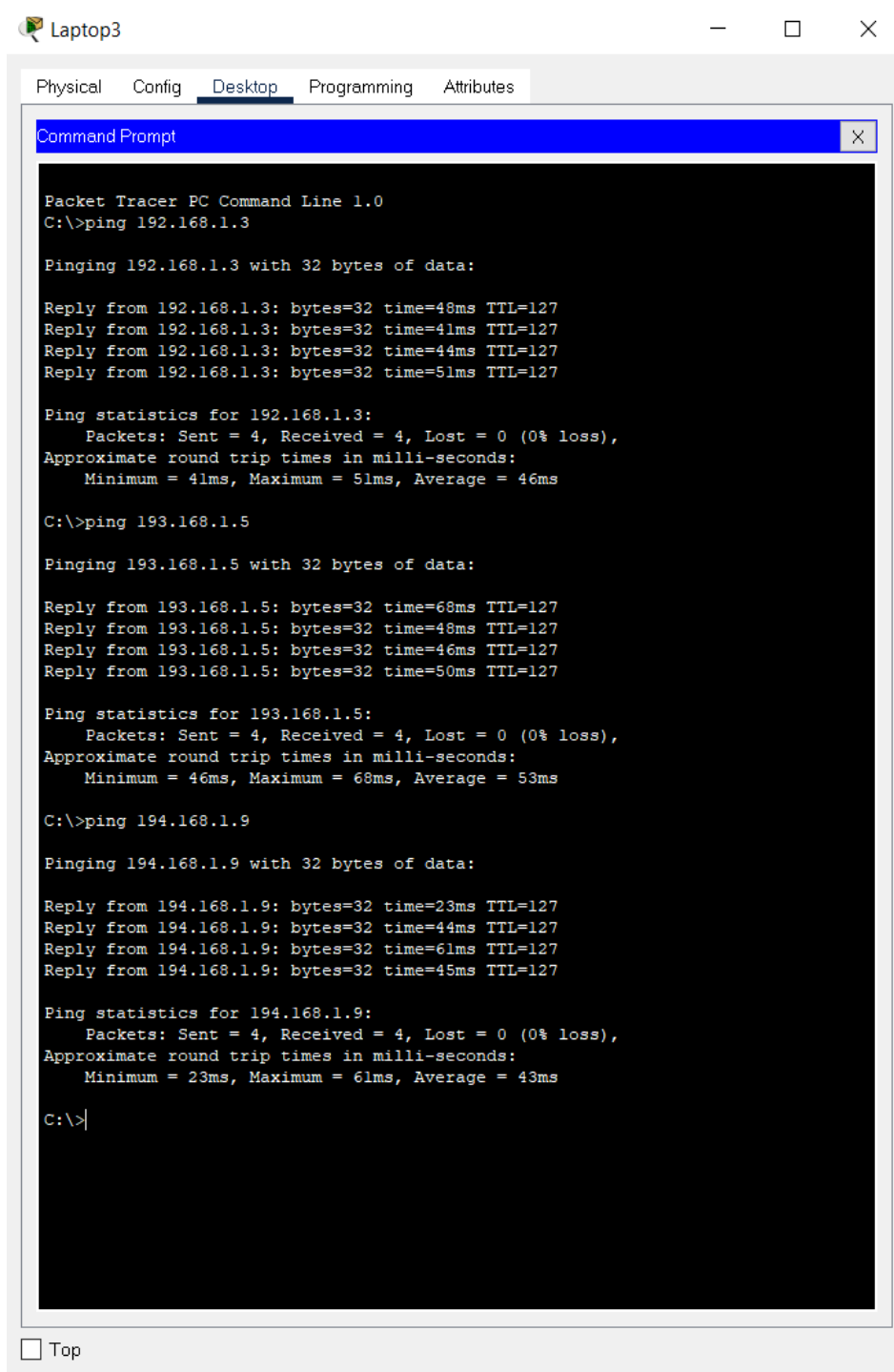
Reply from 195.168.1.5: bytes=32 time=37ms TTL=127
Reply from 195.168.1.5: bytes=32 time=44ms TTL=127
Reply from 195.168.1.5: bytes=32 time=64ms TTL=127
Reply from 195.168.1.5: bytes=32 time=42ms TTL=127

Ping statistics for 195.168.1.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 37ms, Maximum = 64ms, Average = 46ms

C:\>|
```

At the bottom left of the Command Prompt window, there is a checkbox labeled "Top".

#### Department 4 (Laptop 3) Pings:



The screenshot shows a Packet Tracer interface for a laptop named 'Laptop3'. The 'Desktop' tab is active, displaying a 'Command Prompt' window. The command prompt shows the results of three ping commands executed from the laptop. Each command is followed by four replies and a summary of statistics.

```
Packet Tracer PC Command Line 1.0
C:\>ping 192.168.1.3

Pinging 192.168.1.3 with 32 bytes of data:

Reply from 192.168.1.3: bytes=32 time=48ms TTL=127
Reply from 192.168.1.3: bytes=32 time=41ms TTL=127
Reply from 192.168.1.3: bytes=32 time=44ms TTL=127
Reply from 192.168.1.3: bytes=32 time=51ms TTL=127

Ping statistics for 192.168.1.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 41ms, Maximum = 51ms, Average = 46ms

C:\>ping 193.168.1.5

Pinging 193.168.1.5 with 32 bytes of data:

Reply from 193.168.1.5: bytes=32 time=68ms TTL=127
Reply from 193.168.1.5: bytes=32 time=48ms TTL=127
Reply from 193.168.1.5: bytes=32 time=46ms TTL=127
Reply from 193.168.1.5: bytes=32 time=50ms TTL=127

Ping statistics for 193.168.1.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 46ms, Maximum = 68ms, Average = 53ms

C:\>ping 194.168.1.9

Pinging 194.168.1.9 with 32 bytes of data:

Reply from 194.168.1.9: bytes=32 time=23ms TTL=127
Reply from 194.168.1.9: bytes=32 time=44ms TTL=127
Reply from 194.168.1.9: bytes=32 time=61ms TTL=127
Reply from 194.168.1.9: bytes=32 time=45ms TTL=127

Ping statistics for 194.168.1.9:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 23ms, Maximum = 61ms, Average = 43ms

C:\>|
```

At the bottom of the Command Prompt window, there is a 'Top' button.