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LAB 3 [REPORT]

SWITCHING

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1.0 Introduction

End systems are connected together by a network of communication links and packet switches that carry out packet switching. The two prominent types of packet switches are routers and link layer switches [4]. Network switching is used to connect computers in the same local area network (LAN) and at the same time, limit collision domain for packet frame transmission. There are namely two categories of switching; connectionless and connection-oriented switching [5]. In connectionless switching also known as packet switching, data is forwarded on behalf of tables and no prior handshaking is required. Connection-oriented switching also known as circuit switching, the circuit along which the data will be transferred is pre-established and the circuit can be kept for future use or discarded.

To carry out the switching process, a switch is used. In a network, a switch is a device that filters and then forwards packets of data from one networking device to another within a LAN to send incoming message frames by looking at the MAC addresses of each port [7]. Overall, the purpose of a switch in a network is the following; connection of multiple hosts, forwarding data packets to a specific host, managing ingoing and outgoing traffic, keeping the electrical signal undistorted, and increasing the bandwidth of the LAN.

For this laboratory experiment, the network simulation, emulation and hardware implementation of a star-topology network configuration was carried out. The simulation and emulation stages of the laboratory experiment, it was done on GNS3 using the GNS3 Ethernet switch and LISA emulator respectively. For the hardware implementation of the experiment, the LISA NA-810C hardware appliance was used.

2.0 Objectives

- Familiarisation with network switching techniques
- Simulation and emulation of a switching connection on GNS3 and with LISA
- Implementation of a simple real-world switching connection

3.0 List of Equipment

No.	Equipment	Quantity
1	GNS3 software	1
2	VirtualBox software	1
3	Wireshark software	1
4	Linux Switch Application (LISA) Image	1
5	Linux Switch Hardware Appliance [NA-810C - 1U Rackmount Network Appliance Platform]	1
6	Desktop computer	5

4.0 Procedures

1) Simulation of LAN connection on GNS3

- i. A star topology configuration was constructed on GNS3 using the existing Ethernet switch as shown in Figure 1 below with straight-through cables connecting the VPCS (Virtual PC Simulator) with the switch.

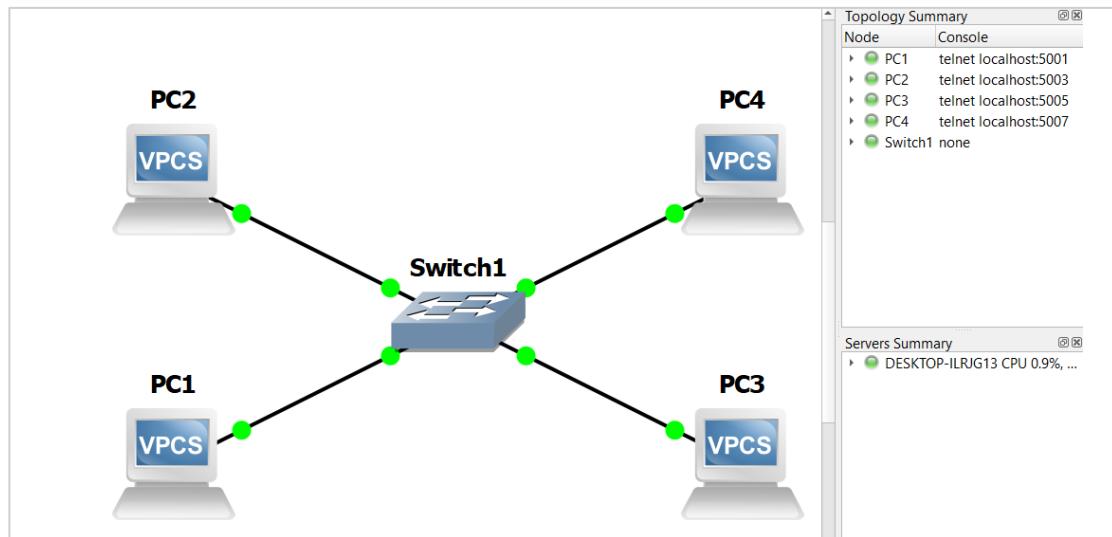


Figure 1: Star-topology configuration using GNS3 Ethernet switch for LAN simulation

- ii. The simulation was run and the console was opened. Each connection was also made to capture the packet transfer on Wireshark.
- iii. The ping command was carried out between all the PCs with each other to verify the LAN connection.

2) Emulation of LAN connection using LISA on GNS3

- i. A star topology configuration was constructed on GNS3 using the LISA emulator as shown in Figure 2 below with straight-through cables connecting the VPCS (Virtual PC Simulator) with the switch.

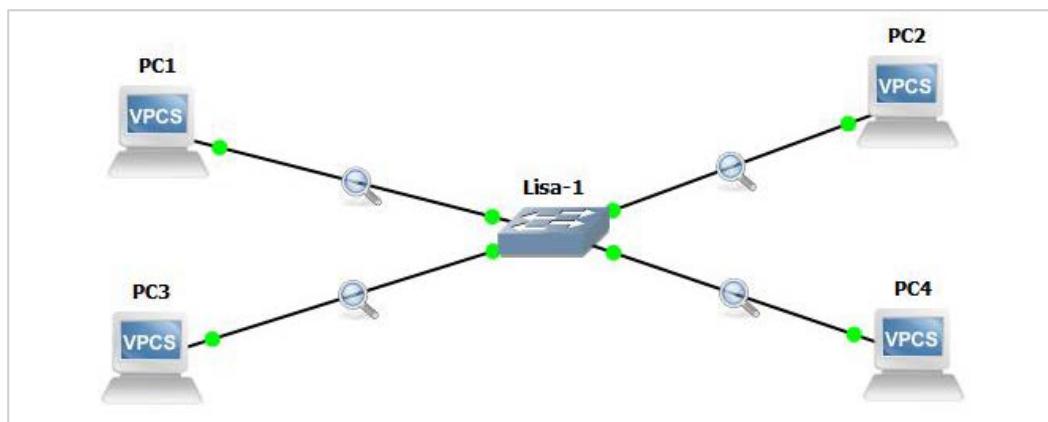


Figure 2: Star-topology configuration using LISA appliance for LAN emulation

- ii. The simulation was run and the console was opened and the LISA switch emulator was configured as shown in Figure 3 below.

```

localhost.localdomain login: root
Password:
Last login: Mon Nov 19 22:44:13 on ttys0
[root@localhost ~]# swcli
localhost.localdomain#enable
localhost.localdomain#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
localhost.localdomain(config)#interface ethernet 0 ← Port Connection 1
localhost.localdomain(config-if)#switchport mode access
localhost.localdomain(config-if)#exit
localhost.localdomain(config)#
localhost.localdomain(config)#interface ethernet 1 ← Port Connection 2
localhost.localdomain(config-if)#switchport mode access
localhost.localdomain(config-if)#exit
localhost.localdomain(config)#
localhost.localdomain(config)#interface ethernet 2 ← Port Connection 3
localhost.localdomain(config-if)#switchport mode access
localhost.localdomain(config-if)#exit
localhost.localdomain(config)#
localhost.localdomain(config)#interface ethernet 3 ← Port Connection 3
localhost.localdomain(config-if)#switchport mode access
localhost.localdomain(config-if)#exit
localhost.localdomain(config)^Z
localhost.localdomain#

```

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Figure 3: Configuration of LISA switch on GNS3 console with 3 port connections set up

- iii. Each connection was made to capture the packet transfer on Wireshark.
 iv. The ping command was carried out between all the PCs with each other to verify the LAN connection.

3) Real-world LAN connection using LISA hardware appliance

- i. Before setting up the NA-810C LISA hardware appliance, the PCs used needed to be set up. Firstly, the PCs were disconnected from any Internet connections and the firewall was turned off as shown in Figure 4 below.

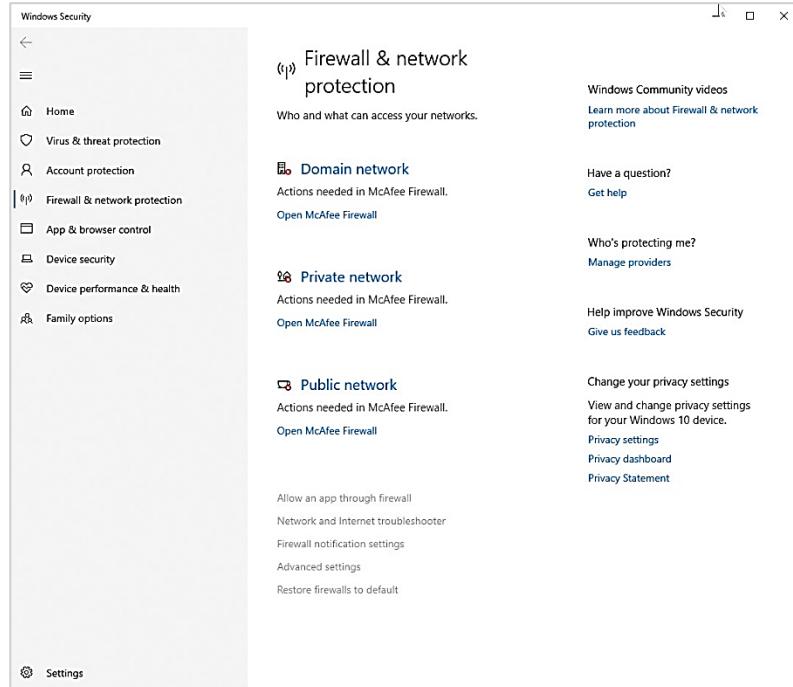


Figure 4: Firewall turned off on each individual PC

- ii. A monitor was connected to the LISA appliance along with a mouse and keyboard. Then, straight-through cables were then used to connect each PC to the ports of the LISA appliance.
- iii. On each PC, the following steps were taken to change the IPv4 addresses of each PC: Control Panel > Network and Sharing Center > Change adapter settings > Ethernet (Select LISA appliance connection) > Properties > Double click Internet Protocol Version 4 > Change IP addresses. This is shown in Figure 5 and Figure 6 below.

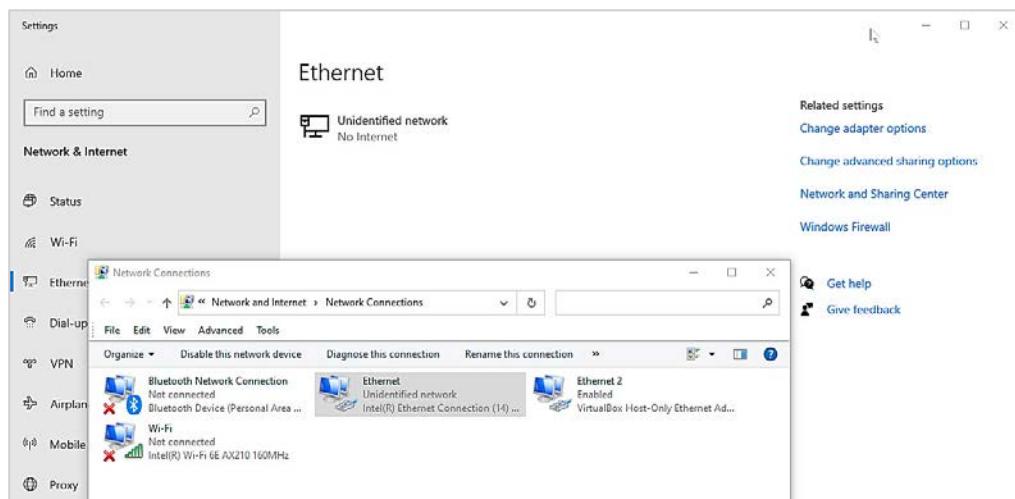


Figure 5: Adapter settings with Ethernet connection to LISA appliance selected

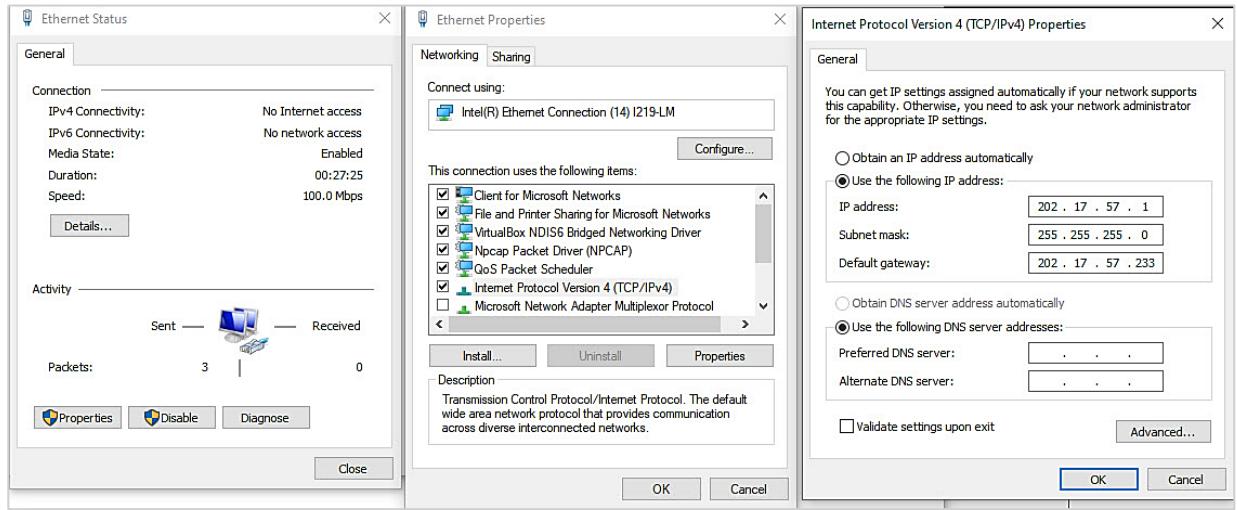


Figure 6: Process of changing the IP address of the PCs

- iv. After the IP addresses were set for each PC, the LISA appliance was configured on the Terminal using the following lines shown in Figure 7 below:

```

81 [SR14@SR14 ~]$ su
82 Password:
83 su: incorrect password
84 [SR14@SR14 ~]$ su
85 Password:
86 [root@SR14 SR14]# swcli
87 SR14#enable
103 SR14#config terminal
104 Enter configuration commands, one per line. End with CNTL/Z.
105 SR14(config)#interface ethernet0
106 SR14(config-if)#switchport mode access
107 SR14(config-if)#interface ethernet1
108 SR14(config-if)#switchport mode access
109 SR14(config-if)#interface ethernet1
110 SR14(config-if)#switchport mode access
111 SR14(config-if)#interface ethernet2
112 SR14(config-if)#switchport mode access
113 SR14(config-if)#interface ethernet3
114 SR14(config-if)#switchport mode access
115 SR14(config-if)^Z

```

Figure 7: Configuration of the LISA appliance on the Terminal

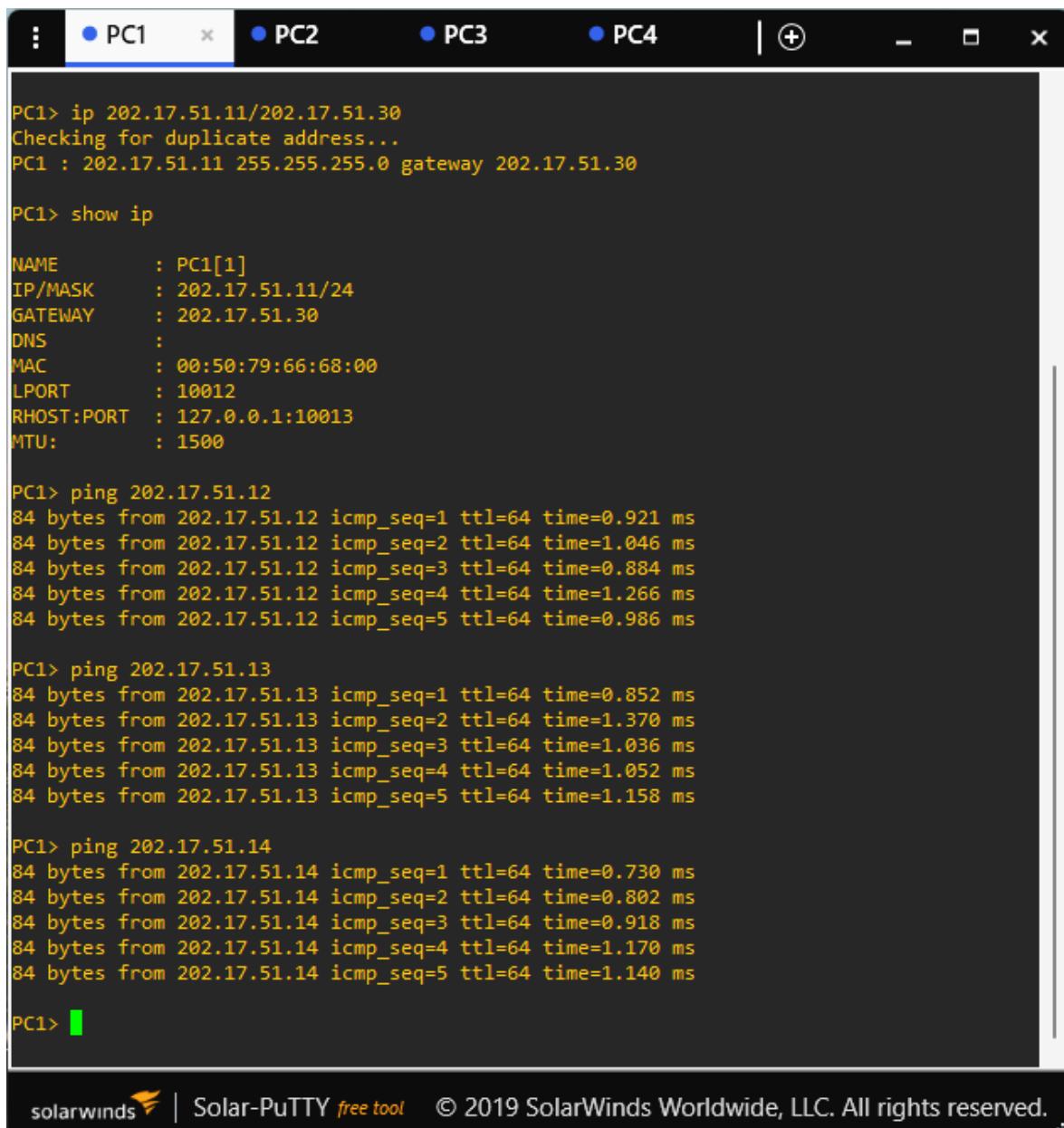
- v. The command prompt was opened on all PCs along with Wireshark. The ping command was carried out among all PCs for each individual PC and the packet transfer was observed on Wireshark.

5.0 Results and Observations

1) *Simulation of LAN connection on GNS3*

Figure 8, Figure 10, Figure 12 and Figure 14 below show the screengrabs of the console window of the network simulation of the star-topology configuration on GNS3 whereby the VPCSSs were configured to each have static LAN addresses for PC1, PC2, PC3 and PC4 respectively.

Figure 9, Figure 11, Figure 13 and Figure 15 below show the captured packets on Wireshark for PC1, PC2, PC3 and PC4 respectively. Lastly, a summary of the LAN address configurations for the GNS3 simulation is shown in Table 1 below.



The screenshot shows a Solar-PuTTY terminal window with four tabs at the top: PC1 (selected), PC2, PC3, and PC4. The PC1 tab displays the following command-line session:

```
PC1> ip 202.17.51.11/202.17.51.30
Checking for duplicate address...
PC1 : 202.17.51.11 255.255.255.0 gateway 202.17.51.30

PC1> show ip

NAME      : PC1[1]
IP/MASK   : 202.17.51.11/24
GATEWAY   : 202.17.51.30
DNS       :
MAC       : 00:50:79:66:68:00
LPORT     : 10012
RHOST:PORT : 127.0.0.1:10013
MTU:      : 1500

PC1> ping 202.17.51.12
84 bytes from 202.17.51.12 icmp_seq=1 ttl=64 time=0.921 ms
84 bytes from 202.17.51.12 icmp_seq=2 ttl=64 time=1.046 ms
84 bytes from 202.17.51.12 icmp_seq=3 ttl=64 time=0.884 ms
84 bytes from 202.17.51.12 icmp_seq=4 ttl=64 time=1.266 ms
84 bytes from 202.17.51.12 icmp_seq=5 ttl=64 time=0.986 ms

PC1> ping 202.17.51.13
84 bytes from 202.17.51.13 icmp_seq=1 ttl=64 time=0.852 ms
84 bytes from 202.17.51.13 icmp_seq=2 ttl=64 time=1.370 ms
84 bytes from 202.17.51.13 icmp_seq=3 ttl=64 time=1.036 ms
84 bytes from 202.17.51.13 icmp_seq=4 ttl=64 time=1.052 ms
84 bytes from 202.17.51.13 icmp_seq=5 ttl=64 time=1.158 ms

PC1> ping 202.17.51.14
84 bytes from 202.17.51.14 icmp_seq=1 ttl=64 time=0.730 ms
84 bytes from 202.17.51.14 icmp_seq=2 ttl=64 time=0.802 ms
84 bytes from 202.17.51.14 icmp_seq=3 ttl=64 time=0.918 ms
84 bytes from 202.17.51.14 icmp_seq=4 ttl=64 time=1.170 ms
84 bytes from 202.17.51.14 icmp_seq=5 ttl=64 time=1.140 ms

PC1>
```

At the bottom of the window, it says "solarwinds | Solar-PuTTY free tool © 2019 SolarWinds Worldwide, LLC. All rights reserved."

Figure 8: Setting up static IP address and execution of ping command for PC1 on GNS3 simulation using switch.

No.	Time	Source	Destination	Protocol	Length	Info
1 0.000000	Private_66:68:03	Broadcast	ARP	64 Who has 202.17.51.11? Tell 202.17.51.14		
2 0.001044	Private_66:68:00	Private_66:68:03	ARP	64 202.17.51.11 is at 00:50:79:66:68:00		
3 0.015666	202.17.51.14	202.17.51.11	ICMP	98 Echo (ping) request id=0x3031, seq=1/256, ttl=64 (reply in 4)		
4 0.016800	202.17.51.11	202.17.51.14	ICMP	98 Echo (ping) reply id=0x3031, seq=1/256, ttl=64 (request in 3)		
5 1.037663	202.17.51.14	202.17.51.11	ICMP	98 Echo (ping) request id=0x3131, seq=2/512, ttl=64 (reply in 6)		
6 1.038703	202.17.51.11	202.17.51.14	ICMP	98 Echo (ping) reply id=0x3131, seq=2/512, ttl=64 (request in 5)		
7 2.058019	202.17.51.14	202.17.51.11	ICMP	98 Echo (ping) request id=0x3231, seq=3/768, ttl=64 (reply in 8)		
8 2.059055	202.17.51.11	202.17.51.14	ICMP	98 Echo (ping) reply id=0x3231, seq=3/768, ttl=64 (request in 7)		
9 3.077994	202.17.51.14	202.17.51.11	ICMP	98 Echo (ping) request id=0x3331, seq=4/1024, ttl=64 (reply in 10)		
10 3.078993	202.17.51.11	202.17.51.14	ICMP	98 Echo (ping) reply id=0x3331, seq=4/1024, ttl=64 (request in 9)		
11 4.102348	202.17.51.14	202.17.51.11	ICMP	98 Echo (ping) request id=0x3431, seq=5/1280, ttl=64 (reply in 12)		
12 4.103413	202.17.51.11	202.17.51.14	ICMP	98 Echo (ping) reply id=0x3431, seq=5/1280, ttl=64 (request in 11)		
13 7.442924	Private_66:68:03	Broadcast	ARP	64 Who has 202.17.51.12? Tell 202.17.51.14		
14 20.180833	Private_66:68:03	Broadcast	ARP	64 Who has 202.17.51.13? Tell 202.17.51.14		
15 35.627264	Private_66:68:02	Broadcast	ARP	64 Who has 202.17.51.11? Tell 202.17.51.13		
16 35.627264	Private_66:68:00	Private_66:68:02	ARP	64 202.17.51.11 is at 00:50:79:66:68:00		
17 35.642397	202.17.51.13	202.17.51.11	ICMP	98 Echo (ping) request id=0x5331, seq=1/256, ttl=64 (reply in 18)		
18 35.642397	202.17.51.11	202.17.51.13	ICMP	98 Echo (ping) reply id=0x5331, seq=1/256, ttl=64 (request in 17)		
19 36.661053	202.17.51.13	202.17.51.11	ICMP	98 Echo (ping) request id=0x5431, seq=2/512, ttl=64 (reply in 20)		
20 36.661053	202.17.51.11	202.17.51.13	ICMP	98 Echo (ping) reply id=0x5431, seq=2/512, ttl=64 (request in 19)		
21 37.682565	202.17.51.13	202.17.51.11	ICMP	98 Echo (ping) request id=0x5531, seq=3/768, ttl=64 (reply in 22)		
22 37.683599	202.17.51.11	202.17.51.13	ICMP	98 Echo (ping) reply id=0x5531, seq=3/768, ttl=64 (request in 21)		
23 38.702597	202.17.51.13	202.17.51.11	ICMP	98 Echo (ping) request id=0x5631, seq=4/1024, ttl=64 (reply in 24)		
24 38.702597	202.17.51.11	202.17.51.13	ICMP	98 Echo (ping) reply id=0x5631, seq=4/1024, ttl=64 (request in 23)		
25 39.724653	202.17.51.13	202.17.51.11	ICMP	98 Echo (ping) request id=0x5731, seq=5/1280, ttl=64 (reply in 26)		
26 39.724653	202.17.51.11	202.17.51.13	ICMP	98 Echo (ping) reply id=0x5731, seq=5/1280, ttl=64 (request in 25)		
27 43.033512	Private_66:68:02	Broadcast	ARP	64 Who has 202.17.51.12? Tell 202.17.51.13		
28 68.736303	Private_66:68:01	Broadcast	ARP	64 Who has 202.17.51.11? Tell 202.17.51.12		
29 68.737340	Private_66:68:00	Private_66:68:01	ARP	64 202.17.51.11 is at 00:50:79:66:68:00		
30 68.751955	202.17.51.12	202.17.51.11	ICMP	98 Echo (ping) request id=0x7531, seq=1/256, ttl=64 (reply in 31)		
31 68.752991	202.17.51.11	202.17.51.12	ICMP	98 Echo (ping) reply id=0x7531, seq=1/256, ttl=64 (request in 30)		
32 69.778831	202.17.51.12	202.17.51.11	ICMP	98 Echo (ping) request id=0x7631, seq=2/512, ttl=64 (reply in 33)		
33 69.778831	202.17.51.11	202.17.51.12	ICMP	98 Echo (ping) reply id=0x7631, seq=2/512, ttl=64 (request in 32)		
34 70.801589	202.17.51.12	202.17.51.11	ICMP	98 Echo (ping) request id=0x7731, seq=3/768, ttl=64 (reply in 35)		
35 70.801589	202.17.51.11	202.17.51.12	ICMP	98 Echo (ping) reply id=0x7731, seq=3/768, ttl=64 (request in 34)		
36 71.819623	202.17.51.12	202.17.51.11	ICMP	98 Echo (ping) request id=0x7831, seq=4/1024, ttl=64 (reply in 37)		
37 71.820665	202.17.51.11	202.17.51.12	ICMP	98 Echo (ping) reply id=0x7831, seq=4/1024, ttl=64 (request in 36)		
38 72.841555	202.17.51.12	202.17.51.11	ICMP	98 Echo (ping) request id=0x7931, seq=5/1280, ttl=64 (reply in 39)		
39 72.841555	202.17.51.11	202.17.51.12	ICMP	98 Echo (ping) reply id=0x7931, seq=5/1280, ttl=64 (request in 38)		
40 98.267405	202.17.51.11	202.17.51.12	ICMP	98 Echo (ping) request id=0x9231, seq=1/256, ttl=64 (reply in 41)		
41 98.268515	202.17.51.12	202.17.51.11	ICMP	98 Echo (ping) reply id=0x9231, seq=1/256, ttl=64 (request in 40)		
42 99.293164	202.17.51.11	202.17.51.12	ICMP	98 Echo (ping) request id=0x9331, seq=2/512, ttl=64 (reply in 43)		
43 99.294663	202.17.51.12	202.17.51.11	ICMP	98 Echo (ping) reply id=0x9331, seq=2/512, ttl=64 (request in 42)		
44 100.312303	202.17.51.11	202.17.51.12	ICMP	98 Echo (ping) request id=0x9431, seq=3/768, ttl=64 (reply in 45)		
45 100.312303	202.17.51.12	202.17.51.11	ICMP	98 Echo (ping) reply id=0x9431, seq=3/768, ttl=64 (request in 44)		
46 101.333468	202.17.51.11	202.17.51.12	ICMP	98 Echo (ping) request id=0x9531, seq=4/1024, ttl=64 (reply in 47)		
47 101.334807	202.17.51.12	202.17.51.11	ICMP	98 Echo (ping) reply id=0x9531, seq=4/1024, ttl=64 (request in 46)		
48 102.353817	202.17.51.11	202.17.51.12	ICMP	98 Echo (ping) request id=0x9631, seq=5/1280, ttl=64 (reply in 49)		
49 102.353817	202.17.51.12	202.17.51.11	ICMP	98 Echo (ping) reply id=0x9631, seq=5/1280, ttl=64 (request in 48)		
50 106.229106	202.17.51.11	202.17.51.13	ICMP	98 Echo (ping) request id=0x9a31, seq=1/256, ttl=64 (reply in 51)		
51 106.230103	202.17.51.13	202.17.51.11	ICMP	98 Echo (ping) reply id=0x9a31, seq=1/256, ttl=64 (request in 50)		
52 107.253884	202.17.51.11	202.17.51.13	ICMP	98 Echo (ping) request id=0x9b31, seq=2/512, ttl=64 (reply in 53)		
53 107.254885	202.17.51.13	202.17.51.11	ICMP	98 Echo (ping) reply id=0x9b31, seq=2/512, ttl=64 (request in 52)		
54 108.270465	202.17.51.11	202.17.51.13	ICMP	98 Echo (ping) request id=0x9c31, seq=3/768, ttl=64 (reply in 55)		
55 108.271410	202.17.51.13	202.17.51.11	ICMP	98 Echo (ping) reply id=0x9c31, seq=3/768, ttl=64 (request in 54)		
56 109.294851	202.17.51.11	202.17.51.13	ICMP	98 Echo (ping) request id=0x9d31, seq=4/1024, ttl=64 (reply in 57)		
57 109.295737	202.17.51.13	202.17.51.11	ICMP	98 Echo (ping) reply id=0x9d31, seq=4/1024, ttl=64 (request in 56)		
58 110.325091	202.17.51.11	202.17.51.13	ICMP	98 Echo (ping) request id=0x9e31, seq=5/1280, ttl=64 (reply in 59)		
59 110.326100	202.17.51.13	202.17.51.11	ICMP	98 Echo (ping) reply id=0x9e31, seq=5/1280, ttl=64 (request in 58)		
60 114.204600	202.17.51.11	202.17.51.14	ICMP	98 Echo (ping) request id=0xa231, seq=1/256, ttl=64 (reply in 61)		
61 114.204600	202.17.51.14	202.17.51.11	ICMP	98 Echo (ping) reply id=0xa231, seq=1/256, ttl=64 (request in 60)		
62 115.221812	202.17.51.11	202.17.51.14	ICMP	98 Echo (ping) request id=0xa331, seq=2/512, ttl=64 (reply in 63)		
63 115.221812	202.17.51.14	202.17.51.11	ICMP	98 Echo (ping) reply id=0xa331, seq=2/512, ttl=64 (request in 62)		
64 116.237445	202.17.51.11	202.17.51.14	ICMP	98 Echo (ping) request id=0xa431, seq=3/768, ttl=64 (reply in 65)		
65 116.237445	202.17.51.14	202.17.51.11	ICMP	98 Echo (ping) reply id=0xa431, seq=3/768, ttl=64 (request in 64)		
66 117.256974	202.17.51.11	202.17.51.14	ICMP	98 Echo (ping) request id=0xa531, seq=4/1024, ttl=64 (reply in 67)		
67 117.256974	202.17.51.14	202.17.51.11	ICMP	98 Echo (ping) reply id=0xa531, seq=4/1024, ttl=64 (request in 66)		
68 118.275947	202.17.51.11	202.17.51.14	ICMP	98 Echo (ping) request id=0xa631, seq=5/1280, ttl=64 (reply in 69)		
69 118.276950	202.17.51.14	202.17.51.11	ICMP	98 Echo (ping) reply id=0xa631, seq=5/1280, ttl=64 (request in 68)		

Figure 9: Packet capture on Wireshark for PC1 for GNS3 simulation

```
PC2> ip 202.17.51.12/202.17.51.30
Checking for duplicate address...
PC1 : 202.17.51.12 255.255.255.0 gateway 202.17.51.30

PC2> show ip

NAME      : PC2[1]
IP/MASK   : 202.17.51.12/24
GATEWAY   : 202.17.51.30
DNS       :
MAC       : 00:50:79:66:68:01
LPORT     : 10010
RHOST:PORT : 127.0.0.1:10011
MTU:      : 1500

PC2> ping 202.17.51.11
84 bytes from 202.17.51.11 icmp_seq=1 ttl=64 time=1.224 ms
84 bytes from 202.17.51.11 icmp_seq=2 ttl=64 time=1.014 ms
84 bytes from 202.17.51.11 icmp_seq=3 ttl=64 time=1.039 ms
84 bytes from 202.17.51.11 icmp_seq=4 ttl=64 time=1.292 ms
84 bytes from 202.17.51.11 icmp_seq=5 ttl=64 time=1.305 ms

PC2> ping 202.17.51.13
84 bytes from 202.17.51.13 icmp_seq=1 ttl=64 time=1.048 ms
84 bytes from 202.17.51.13 icmp_seq=2 ttl=64 time=1.326 ms
84 bytes from 202.17.51.13 icmp_seq=3 ttl=64 time=0.767 ms
84 bytes from 202.17.51.13 icmp_seq=4 ttl=64 time=0.909 ms
84 bytes from 202.17.51.13 icmp_seq=5 ttl=64 time=0.873 ms

PC2> ping 202.17.51.14
84 bytes from 202.17.51.14 icmp_seq=1 ttl=64 time=1.266 ms
84 bytes from 202.17.51.14 icmp_seq=2 ttl=64 time=1.554 ms
84 bytes from 202.17.51.14 icmp_seq=3 ttl=64 time=1.068 ms
84 bytes from 202.17.51.14 icmp_seq=4 ttl=64 time=1.300 ms
84 bytes from 202.17.51.14 icmp_seq=5 ttl=64 time=0.681 ms

PC2> 
```

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Figure 10: Setting up static IP address and execution of ping command for PC2 on GNS3 simulation using switch.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	Private_66:68:03	Broadcast	ARP	64	Who has 202.17.51.1? Tell 202.17.51.14
2	7.441880	Private_66:68:03	Broadcast	ARP	64	Who has 202.17.51.1? Tell 202.17.51.14
3	7.442880	Private_66:68:01	Private_66:68:03	ARP	64	202.17.51.12 is at 00:50:79:66:68:01
4	7.456174	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) request id=0x3731, seq=1/256, ttl=64 (reply in 5)
5	7.457183	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3731, seq=1/256, ttl=64 (request in 4)
6	8.474539	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) request id=0x3831, seq=2/512, ttl=64 (reply in 7)
7	8.474539	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3831, seq=2/512, ttl=64 (request in 6)
8	9.494751	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) request id=0x3931, seq=3/768, ttl=64 (reply in 9)
9	9.495662	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3931, seq=3/768, ttl=64 (request in 8)
10	10.513832	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) request id=0x3a31, seq=4/1024, ttl=64 (reply in 11)
11	10.514875	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3a31, seq=4/1024, ttl=64 (request in 10)
12	11.538224	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) request id=0x3b31, seq=5/1280, ttl=64 (reply in 13)
13	11.538224	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3b31, seq=5/1280, ttl=64 (request in 12)
14	10.179789	Private_66:68:03	Broadcast	ARP	64	Who has 202.17.51.13? Tell 202.17.51.14
15	35.626220	Private_66:68:02	Broadcast	ARP	64	Who has 202.17.51.11? Tell 202.17.51.13
16	43.032468	Private_66:68:02	Broadcast	ARP	64	Who has 202.17.51.12? Tell 202.17.51.13
17	43.033467	Private_66:68:01	Private_66:68:02	ARP	64	202.17.51.12 is at 00:50:79:66:68:01
18	43.047369	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) request id=0x5b31, seq=1/256, ttl=64 (reply in 19)
19	43.047369	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5b31, seq=1/256, ttl=64 (request in 18)
20	44.068189	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) request id=0x5c31, seq=2/512, ttl=64 (reply in 21)
21	44.068189	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5c31, seq=2/512, ttl=64 (request in 20)
22	45.091350	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) request id=0x5d31, seq=3/768, ttl=64 (reply in 23)
23	45.092297	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5d31, seq=3/768, ttl=64 (request in 22)
24	46.110688	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) request id=0x5e31, seq=4/1024, ttl=64 (reply in 25)
25	46.110688	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5e31, seq=4/1024, ttl=64 (request in 24)
26	47.130012	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) request id=0x5f31, seq=5/1280, ttl=64 (reply in 27)
27	47.131045	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5f31, seq=5/1280, ttl=64 (request in 26)
28	68.735259	Private_66:68:01	Broadcast	ARP	64	Who has 202.17.51.11? Tell 202.17.51.12
29	68.736296	Private_66:68:00	Private_66:68:01	ARP	64	202.17.51.11 is at 00:50:79:66:68:00
30	68.750911	202.17.51.12	202.17.51.11	ICMP	98	Echo (ping) request id=0x7531, seq=1/256, ttl=64 (reply in 31)
31	68.751947	202.17.51.11	202.17.51.12	ICMP	98	Echo (ping) reply id=0x7531, seq=1/256, ttl=64 (request in 30)
32	69.777787	202.17.51.12	202.17.51.11	ICMP	98	Echo (ping) request id=0x7631, seq=2/512, ttl=64 (reply in 33)
33	69.777787	202.17.51.11	202.17.51.12	ICMP	98	Echo (ping) reply id=0x7631, seq=2/512, ttl=64 (request in 32)
34	70.800545	202.17.51.12	202.17.51.11	ICMP	98	Echo (ping) request id=0x7731, seq=3/768, ttl=64 (reply in 35)
35	70.800545	202.17.51.11	202.17.51.12	ICMP	98	Echo (ping) reply id=0x7731, seq=3/768, ttl=64 (request in 34)
36	71.818579	202.17.51.12	202.17.51.11	ICMP	98	Echo (ping) request id=0x7831, seq=4/1024, ttl=64 (reply in 37)
37	71.819621	202.17.51.11	202.17.51.12	ICMP	98	Echo (ping) reply id=0x7831, seq=4/1024, ttl=64 (request in 36)
38	72.840511	202.17.51.12	202.17.51.11	ICMP	98	Echo (ping) request id=0x7931, seq=5/1280, ttl=64 (reply in 39)
39	72.840511	202.17.51.11	202.17.51.12	ICMP	98	Echo (ping) reply id=0x7931, seq=5/1280, ttl=64 (request in 38)
40	77.846127	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) request id=0x7e31, seq=1/256, ttl=64 (reply in 41)
41	77.846127	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) reply id=0x7e31, seq=1/256, ttl=64 (request in 40)
42	78.870878	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) request id=0x7f31, seq=2/512, ttl=64 (reply in 43)
43	78.872014	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) reply id=0x7f31, seq=2/512, ttl=64 (request in 42)
44	79.895165	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) request id=0x8031, seq=3/768, ttl=64 (reply in 45)
45	79.896160	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8031, seq=3/768, ttl=64 (request in 44)
46	80.915168	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) request id=0x8131, seq=4/1024, ttl=64 (reply in 47)
47	80.915168	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8131, seq=4/1024, ttl=64 (request in 46)
48	81.937632	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) request id=0x8231, seq=5/1280, ttl=64 (reply in 49)
49	81.937632	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8231, seq=5/1280, ttl=64 (request in 48)
50	85.895960	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) request id=0x8631, seq=1/256, ttl=64 (reply in 51)
51	85.896962	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8631, seq=1/256, ttl=64 (request in 50)
52	86.914173	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) request id=0x8731, seq=2/512, ttl=64 (reply in 53)
53	86.915198	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8731, seq=2/512, ttl=64 (request in 52)
54	87.931968	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) request id=0x8831, seq=3/768, ttl=64 (reply in 55)
55	87.931968	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8831, seq=3/768, ttl=64 (request in 54)
56	88.948777	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) request id=0x8931, seq=4/1024, ttl=64 (reply in 57)
57	88.949818	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8931, seq=4/1024, ttl=64 (request in 56)
58	89.969293	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) request id=0x8a31, seq=5/1280, ttl=64 (reply in 59)
59	89.969293	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8a31, seq=5/1280, ttl=64 (request in 58)
60	98.266361	202.17.51.11	202.17.51.12	ICMP	98	Echo (ping) request id=0x9231, seq=1/256, ttl=64 (reply in 61)
61	98.267471	202.17.51.12	202.17.51.11	ICMP	98	Echo (ping) reply id=0x9231, seq=1/256, ttl=64 (request in 60)
62	99.292120	202.17.51.11	202.17.51.12	ICMP	98	Echo (ping) request id=0x9331, seq=2/512, ttl=64 (reply in 63)
63	99.293619	202.17.51.12	202.17.51.11	ICMP	98	Echo (ping) reply id=0x9331, seq=2/512, ttl=64 (request in 62)
64	100.311259	202.17.51.11	202.17.51.12	ICMP	98	Echo (ping) request id=0x9431, seq=3/768, ttl=64 (reply in 65)
65	100.311259	202.17.51.12	202.17.51.11	ICMP	98	Echo (ping) reply id=0x9431, seq=3/768, ttl=64 (request in 64)
66	101.332424	202.17.51.11	202.17.51.12	ICMP	98	Echo (ping) request id=0x9531, seq=4/1024, ttl=64 (reply in 67)
67	101.333763	202.17.51.12	202.17.51.11	ICMP	98	Echo (ping) reply id=0x9531, seq=4/1024, ttl=64 (request in 66)
68	102.352773	202.17.51.11	202.17.51.12	ICMP	98	Echo (ping) request id=0x9631, seq=5/1280, ttl=64 (reply in 69)
69	102.352773	202.17.51.12	202.17.51.11	ICMP	98	Echo (ping) reply id=0x9631, seq=5/1280, ttl=64 (request in 68)

Figure 11: Packet capture on Wireshark for PC2 for GNS3 simulation

The screenshot shows a Solar-PuTTY window with four tabs at the top: PC1, PC2, PC3 (selected), and PC4. The PC3 tab displays the following terminal session:

```
PC3> ip 202.17.51.13/202.17.51.30
Checking for duplicate address...
PC1 : 202.17.51.13 255.255.255.0 gateway 202.17.51.30

PC3> show ip

NAME      : PC3[1]
IP/MASK   : 202.17.51.13/24
GATEWAY   : 202.17.51.30
DNS       :
MAC       : 00:50:79:66:68:02
LPORT     : 10008
RHOST:PORT : 127.0.0.1:10009
MTU:      : 1500

PC3> ping 202.17.51.11
84 bytes from 202.17.51.11 icmp_seq=1 ttl=64 time=1.179 ms
84 bytes from 202.17.51.11 icmp_seq=2 ttl=64 time=1.712 ms
84 bytes from 202.17.51.11 icmp_seq=3 ttl=64 time=1.120 ms
84 bytes from 202.17.51.11 icmp_seq=4 ttl=64 time=1.205 ms
84 bytes from 202.17.51.11 icmp_seq=5 ttl=64 time=1.003 ms

PC3> ping 202.17.51.12
84 bytes from 202.17.51.12 icmp_seq=1 ttl=64 time=1.635 ms
84 bytes from 202.17.51.12 icmp_seq=2 ttl=64 time=3.110 ms
84 bytes from 202.17.51.12 icmp_seq=3 ttl=64 time=0.933 ms
84 bytes from 202.17.51.12 icmp_seq=4 ttl=64 time=0.962 ms
84 bytes from 202.17.51.12 icmp_seq=5 ttl=64 time=1.227 ms

PC3>
PC3> ping 202.17.51.14
84 bytes from 202.17.51.14 icmp_seq=1 ttl=64 time=1.130 ms
84 bytes from 202.17.51.14 icmp_seq=2 ttl=64 time=0.555 ms
84 bytes from 202.17.51.14 icmp_seq=3 ttl=64 time=1.112 ms
84 bytes from 202.17.51.14 icmp_seq=4 ttl=64 time=0.827 ms
84 bytes from 202.17.51.14 icmp_seq=5 ttl=64 time=1.015 ms

PC3>
```

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Figure 12: Setting up static IP address and execution of ping command for PC3 on GNS3 simulation using switch.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	Private_66:68:03	Broadcast	ARP	64	Who has 202.17.51.11? Tell 202.17.51.14
2	7.441880	Private_66:68:03	Broadcast	ARP	64	Who has 202.17.51.12? Tell 202.17.51.14
3	20.179789	Private_66:68:03	Broadcast	ARP	64	Who has 202.17.51.13? Tell 202.17.51.14
4	20.179789	Private_66:68:02	Private_66:68:03	ARP	64	202.17.51.13 is at 00:50:79:66:68:02
5	20.194731	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) request id=0x4431, seq=1/256, ttl=64 (reply in 6)
6	20.194731	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) reply id=0x4431, seq=1/256, ttl=64 (request in 5)
7	21.210383	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) request id=0x4531, seq=2/512, ttl=64 (reply in 8)
8	21.211843	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) reply id=0x4531, seq=2/512, ttl=64 (request in 7)
9	22.230736	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) request id=0x4631, seq=3/768, ttl=64 (reply in 10)
10	22.230736	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) reply id=0x4631, seq=3/768, ttl=64 (request in 9)
11	23.254946	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) request id=0x4731, seq=4/1024, ttl=64 (reply in 12)
12	23.254946	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) reply id=0x4731, seq=4/1024, ttl=64 (request in 11)
13	24.275458	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) request id=0x4831, seq=5/1280, ttl=64 (reply in 14)
14	24.275458	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) reply id=0x4831, seq=5/1280, ttl=64 (request in 13)
15	35.625189	Private_66:68:02	Broadcast	ARP	64	Who has 202.17.51.11? Tell 202.17.51.13
16	35.626220	Private_66:68:00	Private_66:68:02	ARP	64	202.17.51.11 is at 00:50:79:66:68:00
17	35.641353	202.17.51.13	202.17.51.11	ICMP	98	Echo (ping) request id=0x5331, seq=1/256, ttl=64 (reply in 18)
18	35.641353	202.17.51.11	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5331, seq=1/256, ttl=64 (request in 17)
19	36.659001	202.17.51.13	202.17.51.11	ICMP	98	Echo (ping) request id=0x5431, seq=2/512, ttl=64 (reply in 20)
20	36.660009	202.17.51.11	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5431, seq=2/512, ttl=64 (request in 19)
21	37.681521	202.17.51.13	202.17.51.11	ICMP	98	Echo (ping) request id=0x5531, seq=3/768, ttl=64 (reply in 22)
22	37.682555	202.17.51.11	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5531, seq=3/768, ttl=64 (request in 21)
23	38.701553	202.17.51.13	202.17.51.11	ICMP	98	Echo (ping) request id=0x5631, seq=4/1024, ttl=64 (reply in 24)
24	38.701553	202.17.51.11	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5631, seq=4/1024, ttl=64 (request in 23)
25	39.722573	202.17.51.13	202.17.51.11	ICMP	98	Echo (ping) request id=0x5731, seq=5/1280, ttl=64 (reply in 26)
26	39.723609	202.17.51.11	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5731, seq=5/1280, ttl=64 (request in 25)
27	43.032468	Private_66:68:02	Broadcast	ARP	64	Who has 202.17.51.12? Tell 202.17.51.13
28	43.033467	Private_66:68:01	Private_66:68:02	ARP	64	202.17.51.12 is at 00:50:79:66:68:01
29	43.047369	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) request id=0x5b31, seq=1/256, ttl=64 (reply in 30)
30	43.047369	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5b31, seq=1/256, ttl=64 (request in 29)
31	44.068189	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) request id=0x5c31, seq=2/512, ttl=64 (reply in 32)
32	44.068189	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5c31, seq=2/512, ttl=64 (request in 31)
33	45.091350	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) request id=0x5d31, seq=3/768, ttl=64 (reply in 34)
34	45.092297	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5d31, seq=3/768, ttl=64 (request in 33)
35	46.110688	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) request id=0x5e31, seq=4/1024, ttl=64 (reply in 36)
36	46.110688	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5e31, seq=4/1024, ttl=64 (request in 35)
37	47.130012	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) request id=0x5f31, seq=5/1280, ttl=64 (reply in 38)
38	47.131045	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) reply id=0x5f31, seq=5/1280, ttl=64 (request in 37)
39	59.862003	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) request id=0x6c31, seq=1/256, ttl=64 (reply in 40)
40	59.863006	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) reply id=0x6c31, seq=1/256, ttl=64 (request in 39)
41	60.883389	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) request id=0x6d31, seq=2/512, ttl=64 (reply in 42)
42	60.883389	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) reply id=0x6d31, seq=2/512, ttl=64 (request in 41)
43	61.905511	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) request id=0x6e31, seq=3/768, ttl=64 (reply in 44)
44	61.905511	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) reply id=0x6e31, seq=3/768, ttl=64 (request in 43)
45	62.924953	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) request id=0x6f31, seq=4/1024, ttl=64 (reply in 46)
46	62.924953	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) reply id=0x6f31, seq=4/1024, ttl=64 (request in 45)
47	63.944576	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) request id=0x7031, seq=5/1280, ttl=64 (reply in 48)
48	63.944576	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) reply id=0x7031, seq=5/1280, ttl=64 (request in 47)
49	68.736296	Private_66:68:01	Broadcast	ARP	64	Who has 202.17.51.11? Tell 202.17.51.12
50	77.846127	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) request id=0x7e31, seq=1/256, ttl=64 (reply in 51)
51	77.846127	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) reply id=0x7e31, seq=1/256, ttl=64 (request in 50)
52	78.870878	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) request id=0x7f31, seq=2/512, ttl=64 (reply in 53)
53	78.872014	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) reply id=0x7f31, seq=2/512, ttl=64 (request in 52)
54	79.895165	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) request id=0x8031, seq=3/768, ttl=64 (reply in 55)
55	79.896160	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8031, seq=3/768, ttl=64 (request in 54)
56	80.915168	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) request id=0x8131, seq=4/1024, ttl=64 (reply in 57)
57	80.915168	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8131, seq=4/1024, ttl=64 (request in 56)
58	81.937632	202.17.51.12	202.17.51.13	ICMP	98	Echo (ping) request id=0x8231, seq=5/1280, ttl=64 (reply in 59)
59	81.937632	202.17.51.13	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8231, seq=5/1280, ttl=64 (request in 58)
60	106.229059	202.17.51.11	202.17.51.13	ICMP	98	Echo (ping) request id=0x9a31, seq=1/256, ttl=64 (reply in 61)
61	106.229059	202.17.51.13	202.17.51.11	ICMP	98	Echo (ping) reply id=0x9a31, seq=1/256, ttl=64 (request in 60)
62	107.252840	202.17.51.11	202.17.51.13	ICMP	98	Echo (ping) request id=0x9b31, seq=2/512, ttl=64 (reply in 63)
63	107.253841	202.17.51.13	202.17.51.11	ICMP	98	Echo (ping) reply id=0x9b31, seq=2/512, ttl=64 (request in 62)
64	108.269421	202.17.51.11	202.17.51.13	ICMP	98	Echo (ping) request id=0x9c31, seq=3/768, ttl=64 (reply in 65)
65	108.270366	202.17.51.13	202.17.51.11	ICMP	98	Echo (ping) reply id=0x9c31, seq=3/768, ttl=64 (request in 64)
66	109.294693	202.17.51.11	202.17.51.13	ICMP	98	Echo (ping) request id=0x9d31, seq=4/1024, ttl=64 (reply in 66)
67	109.294693	202.17.51.13	202.17.51.11	ICMP	98	Echo (ping) reply id=0x9d31, seq=4/1024, ttl=64 (request in 66)
68	110.325056	202.17.51.11	202.17.51.13	ICMP	98	Echo (ping) request id=0x9e31, seq=5/1280, ttl=64 (reply in 69)
69	110.325056	202.17.51.13	202.17.51.11	ICMP	98	Echo (ping) reply id=0x9e31, seq=5/1280, ttl=64 (request in 68)

Figure 13: Packet capture on Wireshark for PC3 for GNS3 simulation

```
PC4> ip 202.17.51.14/202.17.51.30
Checking for duplicate address...
PC1 : 202.17.51.14 255.255.255.0 gateway 202.17.51.30

PC4> show ip

NAME      : PC4[1]
IP/MASK   : 202.17.51.14/24
GATEWAY   : 202.17.51.30
DNS       :
MAC       : 00:50:79:66:68:03
LPORT     : 10014
RHOST:PORT : 127.0.0.1:10015
MTU:      : 1500

PC4> ping 202.17.51.11
84 bytes from 202.17.51.11 icmp_seq=1 ttl=64 time=1.492 ms
84 bytes from 202.17.51.11 icmp_seq=2 ttl=64 time=1.140 ms
84 bytes from 202.17.51.11 icmp_seq=3 ttl=64 time=1.430 ms
84 bytes from 202.17.51.11 icmp_seq=4 ttl=64 time=2.024 ms
84 bytes from 202.17.51.11 icmp_seq=5 ttl=64 time=1.534 ms

PC4> ping 202.17.51.12
84 bytes from 202.17.51.12 icmp_seq=1 ttl=64 time=1.583 ms
84 bytes from 202.17.51.12 icmp_seq=2 ttl=64 time=0.809 ms
84 bytes from 202.17.51.12 icmp_seq=3 ttl=64 time=0.988 ms
84 bytes from 202.17.51.12 icmp_seq=4 ttl=64 time=1.310 ms
84 bytes from 202.17.51.12 icmp_seq=5 ttl=64 time=1.032 ms

PC4> ping 202.17.51.13
84 bytes from 202.17.51.13 icmp_seq=1 ttl=64 time=1.604 ms
84 bytes from 202.17.51.13 icmp_seq=2 ttl=64 time=1.883 ms
84 bytes from 202.17.51.13 icmp_seq=3 ttl=64 time=1.048 ms
84 bytes from 202.17.51.13 icmp_seq=4 ttl=64 time=0.871 ms
84 bytes from 202.17.51.13 icmp_seq=5 ttl=64 time=1.183 ms

PC4>
```

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Figure 14: Setting up static IP address and execution of ping command for PC4 on GNS3 simulation using switch.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	Private_66:68:03	Broadcast	ARP	64	Who has 202.17.51.11? Tell 202.17.51.14
2	0.001044	Private_66:68:00	Private_66:68:03	ARP	64	202.17.51.11 is at 00:50:79:66:68:00
3	0.015666	202.17.51.14	202.17.51.11	ICMP	98	Echo (ping) request id=0x3031, seq=1/256, ttl=64 (reply in 4)
4	0.016800	202.17.51.11	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3031, seq=1/256, ttl=64 (request in 3)
5	1.037663	202.17.51.14	202.17.51.11	ICMP	98	Echo (ping) request id=0x3131, seq=2/512, ttl=64 (reply in 6)
6	1.038703	202.17.51.11	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3131, seq=2/512, ttl=64 (request in 5)
7	2.058019	202.17.51.14	202.17.51.11	ICMP	98	Echo (ping) request id=0x3231, seq=3/768, ttl=64 (reply in 8)
8	2.059055	202.17.51.11	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3231, seq=3/768, ttl=64 (request in 7)
9	3.077994	202.17.51.14	202.17.51.11	ICMP	98	Echo (ping) request id=0x3331, seq=4/1024, ttl=64 (reply in 10)
10	3.078993	202.17.51.11	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3331, seq=4/1024, ttl=64 (request in 9)
11	4.102348	202.17.51.14	202.17.51.11	ICMP	98	Echo (ping) request id=0x3431, seq=5/1280, ttl=64 (reply in 12)
12	4.103413	202.17.51.11	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3431, seq=5/1280, ttl=64 (request in 11)
13	7.442924	Private_66:68:03	Broadcast	ARP	64	Who has 202.17.51.12? Tell 202.17.51.14
14	7.443924	Private_66:68:01	Private_66:68:03	ARP	64	202.17.51.12 is at 00:50:79:66:68:01
15	7.457218	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) request id=0x3731, seq=1/256, ttl=64 (reply in 16)
16	7.458227	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3731, seq=1/256, ttl=64 (request in 15)
17	8.475583	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) request id=0x3831, seq=2/512, ttl=64 (reply in 18)
18	8.476577	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3831, seq=2/512, ttl=64 (request in 17)
19	9.495795	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) request id=0x3931, seq=3/768, ttl=64 (reply in 20)
20	9.496706	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3931, seq=3/768, ttl=64 (request in 19)
21	10.514876	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) request id=0x3a31, seq=4/1024, ttl=64 (reply in 22)
22	10.515919	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3a31, seq=4/1024, ttl=64 (request in 21)
23	11.538049	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) request id=0x3b31, seq=5/1280, ttl=64 (reply in 24)
24	11.539268	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) reply id=0x3b31, seq=5/1280, ttl=64 (request in 23)
25	20.179920	Private_66:68:03	Broadcast	ARP	64	Who has 202.17.51.13? Tell 202.17.51.14
26	20.188833	Private_66:68:02	Private_66:68:03	ARP	64	202.17.51.13 is at 00:50:79:66:68:02
27	20.195775	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) request id=0x4431, seq=1/256, ttl=64 (reply in 28)
28	20.195775	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) reply id=0x4431, seq=1/256, ttl=64 (request in 27)
29	21.211427	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) request id=0x4531, seq=2/512, ttl=64 (reply in 30)
30	21.212887	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) reply id=0x4531, seq=2/512, ttl=64 (request in 29)
31	22.231780	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) request id=0x4631, seq=3/768, ttl=64 (reply in 32)
32	22.231780	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) reply id=0x4631, seq=3/768, ttl=64 (request in 31)
33	23.255990	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) request id=0x4731, seq=4/1024, ttl=64 (reply in 34)
34	23.255990	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) reply id=0x4731, seq=4/1024, ttl=64 (request in 33)
35	24.276502	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) request id=0x4831, seq=5/1280, ttl=64 (reply in 36)
36	24.276502	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) reply id=0x4831, seq=5/1280, ttl=64 (request in 35)
37	35.627264	Private_66:68:02	Broadcast	ARP	64	Who has 202.17.51.11? Tell 202.17.51.13
38	43.033512	Private_66:68:02	Broadcast	ARP	64	Who has 202.17.51.12? Tell 202.17.51.13
39	59.863047	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) request id=0x6c31, seq=1/256, ttl=64 (reply in 40)
40	59.864050	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) reply id=0x6c31, seq=1/256, ttl=64 (request in 39)
41	60.884433	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) request id=0x6d31, seq=2/512, ttl=64 (reply in 42)
42	60.884433	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) reply id=0x6d31, seq=2/512, ttl=64 (request in 41)
43	61.906555	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) request id=0x6e31, seq=3/768, ttl=64 (reply in 44)
44	61.906555	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) reply id=0x6e31, seq=3/768, ttl=64 (request in 43)
45	62.925997	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) request id=0x6f31, seq=4/1024, ttl=64 (reply in 46)
46	62.925997	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) reply id=0x6f31, seq=4/1024, ttl=64 (request in 45)
47	63.945620	202.17.51.13	202.17.51.14	ICMP	98	Echo (ping) request id=0x7031, seq=5/1280, ttl=64 (reply in 48)
48	63.945620	202.17.51.14	202.17.51.13	ICMP	98	Echo (ping) reply id=0x7031, seq=5/1280, ttl=64 (request in 47)
49	68.736303	Private_66:68:01	Broadcast	ARP	64	Who has 202.17.51.11? Tell 202.17.51.12
50	85.897004	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) request id=0x8631, seq=1/256, ttl=64 (reply in 51)
51	85.898006	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8631, seq=1/256, ttl=64 (request in 50)
52	86.915217	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) request id=0x8731, seq=2/512, ttl=64 (reply in 53)
53	86.916242	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8731, seq=2/512, ttl=64 (request in 52)
54	87.933012	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) request id=0x8831, seq=3/768, ttl=64 (reply in 55)
55	87.933012	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8831, seq=3/768, ttl=64 (request in 54)
56	88.949821	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) request id=0x8931, seq=4/1024, ttl=64 (reply in 57)
57	88.950862	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8931, seq=4/1024, ttl=64 (request in 56)
58	89.970337	202.17.51.12	202.17.51.14	ICMP	98	Echo (ping) request id=0x8a31, seq=5/1280, ttl=64 (reply in 59)
59	89.970337	202.17.51.14	202.17.51.12	ICMP	98	Echo (ping) reply id=0x8a31, seq=5/1280, ttl=64 (request in 58)
60	114.204600	202.17.51.11	202.17.51.14	ICMP	98	Echo (ping) request id=0xa231, seq=1/256, ttl=64 (reply in 61)
61	114.204600	202.17.51.14	202.17.51.11	ICMP	98	Echo (ping) reply id=0xa231, seq=1/256, ttl=64 (request in 60)
62	115.221812	202.17.51.11	202.17.51.14	ICMP	98	Echo (ping) request id=0xa331, seq=2/512, ttl=64 (reply in 63)
63	115.221812	202.17.51.14	202.17.51.11	ICMP	98	Echo (ping) reply id=0xa331, seq=2/512, ttl=64 (request in 62)
64	116.237445	202.17.51.11	202.17.51.14	ICMP	98	Echo (ping) request id=0xa431, seq=3/768, ttl=64 (reply in 65)
65	116.237445	202.17.51.14	202.17.51.11	ICMP	98	Echo (ping) reply id=0xa431, seq=3/768, ttl=64 (request in 64)
66	117.256974	202.17.51.11	202.17.51.14	ICMP	98	Echo (ping) request id=0xa531, seq=4/1024, ttl=64 (reply in 67)
67	117.256974	202.17.51.14	202.17.51.11	ICMP	98	Echo (ping) reply id=0xa531, seq=4/1024, ttl=64 (request in 66)
68	118.275947	202.17.51.11	202.17.51.14	ICMP	98	Echo (ping) request id=0xa631, seq=5/1280, ttl=64 (reply in 69)
69	118.276950	202.17.51.14	202.17.51.11	ICMP	98	Echo (ping) reply id=0xa631, seq=5/1280, ttl=64 (request in 68)

Figure 15: Packet capture on Wireshark for PC4 for GNS3 simulation

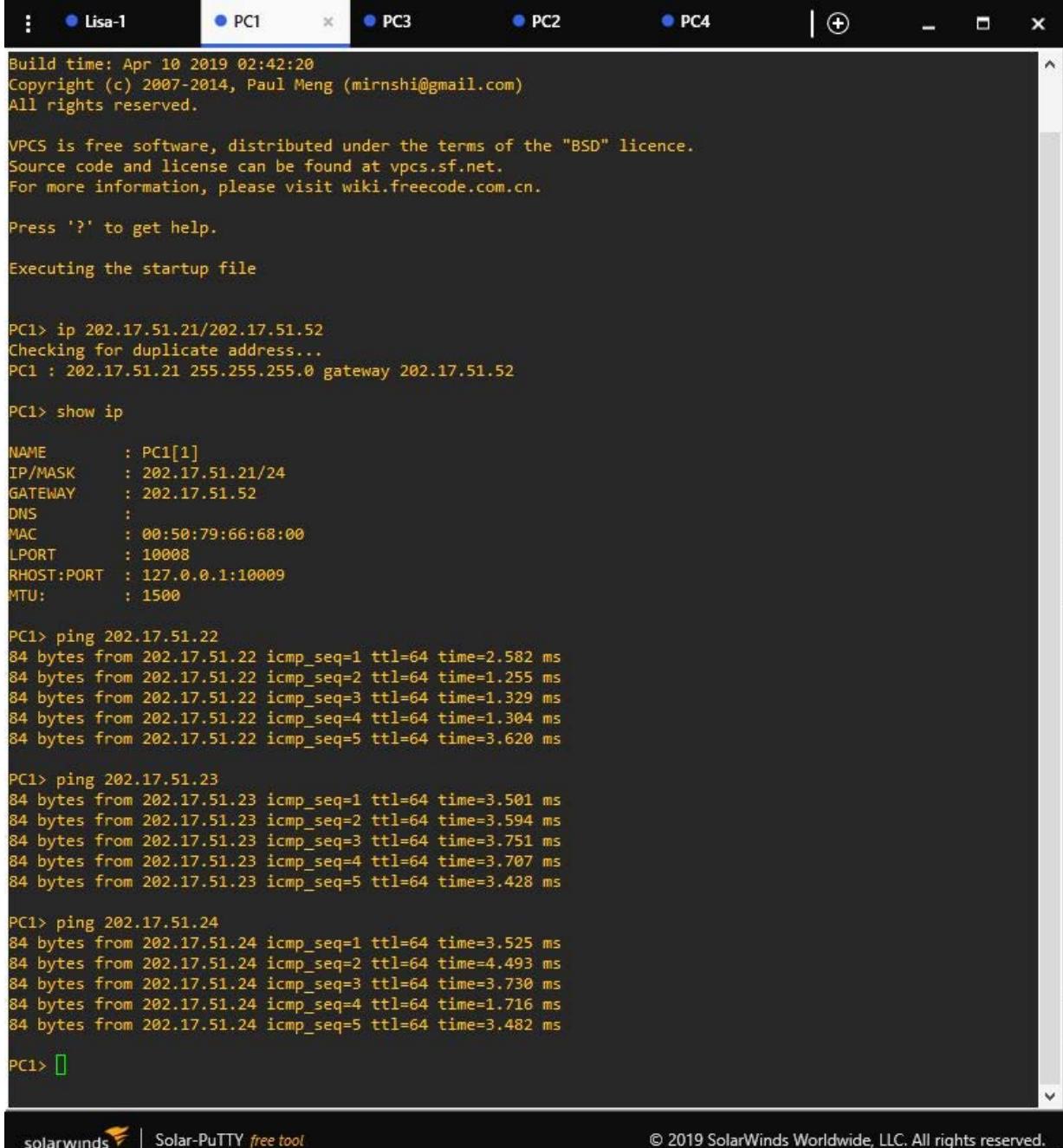
Table 1: LAN address configuration for simulation on GNS3

Computer	IP Address	Gateway Address	Netmask Address
PC1	202.17.51.11	202.17.51.30	255.255.255.0
PC2	202.17.51.12	202.17.51.30	255.255.255.0
PC3	202.17.51.13	202.17.51.30	255.255.255.0
PC4	202.17.51.14	202.17.51.30	255.255.255.0

2) Emulation of LAN connection using LISA on GNS3

Figure 16, Figure 18, Figure 20 and Figure 22 below show the screengrabs of the console window of the network emulation of the star-topology configuration on GNS3 using LISA whereby the VPCs were configured to each have static LAN addresses for PC1, PC2, PC3 and PC4 respectively.

Figure 17, Figure 19, Figure 21 and Figure 23 below show the captured packets on Wireshark for PC1, PC2, PC3 and PC4 respectively. Lastly, a summary of the LAN address configurations for the GNS3 emulation using LISA is shown in Table 2 below.



The screenshot shows a Solar-PuTTY terminal window titled "Lisa-1". The tabs at the top are "Lisa-1", "PC1", "PC3", "PC2", and "PC4". The "PC1" tab is selected. The terminal output is as follows:

```
Build time: Apr 10 2019 02:42:20
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Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC1> ip 202.17.51.21/202.17.51.52
Checking for duplicate address...
PC1 : 202.17.51.21 255.255.255.0 gateway 202.17.51.52

PC1> show ip

NAME      : PC1[1]
IP/MASK   : 202.17.51.21/24
GATEWAY   : 202.17.51.52
DNS       :
MAC       : 00:50:79:66:68:00
LPORT     : 10008
RHOST:PORT : 127.0.0.1:10009
MTU:      : 1500

PC1> ping 202.17.51.22
84 bytes from 202.17.51.22 icmp_seq=1 ttl=64 time=2.582 ms
84 bytes from 202.17.51.22 icmp_seq=2 ttl=64 time=1.255 ms
84 bytes from 202.17.51.22 icmp_seq=3 ttl=64 time=1.329 ms
84 bytes from 202.17.51.22 icmp_seq=4 ttl=64 time=1.304 ms
84 bytes from 202.17.51.22 icmp_seq=5 ttl=64 time=3.620 ms

PC1> ping 202.17.51.23
84 bytes from 202.17.51.23 icmp_seq=1 ttl=64 time=3.501 ms
84 bytes from 202.17.51.23 icmp_seq=2 ttl=64 time=3.594 ms
84 bytes from 202.17.51.23 icmp_seq=3 ttl=64 time=3.751 ms
84 bytes from 202.17.51.23 icmp_seq=4 ttl=64 time=3.707 ms
84 bytes from 202.17.51.23 icmp_seq=5 ttl=64 time=3.428 ms

PC1> ping 202.17.51.24
84 bytes from 202.17.51.24 icmp_seq=1 ttl=64 time=3.525 ms
84 bytes from 202.17.51.24 icmp_seq=2 ttl=64 time=4.493 ms
84 bytes from 202.17.51.24 icmp_seq=3 ttl=64 time=3.730 ms
84 bytes from 202.17.51.24 icmp_seq=4 ttl=64 time=1.716 ms
84 bytes from 202.17.51.24 icmp_seq=5 ttl=64 time=3.482 ms

PC1>
```

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Figure 16: Setting up static IP address and execution of ping command for PC1 on GNS3 emulation using LISA.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	::	ff02::16	ICMPv6	110	Multicast Listener Report Message v2
22	163.929010	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) request id=0x08b8, seq=1/256, ttl=64 (reply in 23)
23	163.931207	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) reply id=0x08b8, seq=1/256, ttl=64 (request in 22)
24	164.933455	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) request id=0x09b8, seq=2/512, ttl=64 (reply in 25)
25	164.934486	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) reply id=0x09b8, seq=2/512, ttl=64 (request in 24)
26	165.935904	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) request id=0x0ab8, seq=3/768, ttl=64 (reply in 27)
27	165.936965	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) reply id=0x0ab8, seq=3/768, ttl=64 (request in 26)
28	166.937782	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) request id=0x0bb8, seq=4/1024, ttl=64 (reply in 29)
29	166.938807	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) reply id=0x0bb8, seq=4/1024, ttl=64 (request in 28)
30	167.940181	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) request id=0x0cb8, seq=5/1280, ttl=64 (reply in 31)
31	167.943134	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) reply id=0x0cb8, seq=5/1280, ttl=64 (request in 30)
32	181.277088	Private_66:68:00	Broadcast	ARP	64	Who has 202.17.51.23? Tell 202.17.51.21
33	181.280069	Private_66:68:02	Private_66:68:00	ARP	64	202.17.51.23 is at 0:05:08:79:66:68:02
34	181.282769	202.17.51.21	202.17.51.23	ICMP	98	Echo (ping) request id=0x19b8, seq=1/256, ttl=64 (reply in 35)
35	181.285625	202.17.51.23	202.17.51.21	ICMP	98	Echo (ping) reply id=0x19b8, seq=1/256, ttl=64 (request in 34)
36	182.286568	202.17.51.21	202.17.51.23	ICMP	98	Echo (ping) request id=0x1ab8, seq=2/512, ttl=64 (reply in 37)
37	182.289459	202.17.51.23	202.17.51.21	ICMP	98	Echo (ping) reply id=0x1ab8, seq=2/512, ttl=64 (request in 36)
38	183.290987	202.17.51.21	202.17.51.23	ICMP	98	Echo (ping) request id=0x1bb8, seq=3/768, ttl=64 (reply in 39)
39	183.293974	202.17.51.23	202.17.51.21	ICMP	98	Echo (ping) reply id=0x1bb8, seq=3/768, ttl=64 (request in 38)
40	184.295649	202.17.51.21	202.17.51.23	ICMP	98	Echo (ping) request id=0x1cb8, seq=4/1024, ttl=64 (reply in 41)
41	184.298625	202.17.51.23	202.17.51.21	ICMP	98	Echo (ping) reply id=0x1cb8, seq=4/1024, ttl=64 (request in 40)
42	184.973268	PcsCompu_7a:83:48	CDP/VTP/DTP/PagP/UD...	CDP	185	Device ID: localhost.localdomain Port ID: eth0
43	185.301028	202.17.51.21	202.17.51.23	ICMP	98	Echo (ping) request id=0x1db8, seq=5/1280, ttl=64 (reply in 44)
44	185.303838	202.17.51.23	202.17.51.21	ICMP	98	Echo (ping) reply id=0x1db8, seq=5/1280, ttl=64 (request in 43)
45	189.236234	Private_66:68:00	Broadcast	ARP	64	Who has 202.17.51.24? Tell 202.17.51.21
46	189.239538	Private_66:68:03	Private_66:68:00	ARP	64	202.17.51.24 is at 0:05:08:79:66:68:03
47	189.241716	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) request id=0x21b8, seq=1/256, ttl=64 (reply in 48)
48	189.244659	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) reply id=0x21b8, seq=1/256, ttl=64 (request in 47)
49	190.247863	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) request id=0x22b8, seq=2/512, ttl=64 (reply in 50)
50	190.250829	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) reply id=0x22b8, seq=2/512, ttl=64 (request in 49)
51	191.252729	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) request id=0x23b8, seq=3/768, ttl=64 (reply in 52)
52	191.255800	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) reply id=0x23b8, seq=3/768, ttl=64 (request in 51)
53	192.257000	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) request id=0x24b8, seq=4/1024, ttl=64 (reply in 54)
54	192.258401	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) reply id=0x24b8, seq=4/1024, ttl=64 (request in 53)
55	193.260678	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) request id=0x25b8, seq=5/1280, ttl=64 (reply in 56)
56	193.263522	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) reply id=0x25b8, seq=5/1280, ttl=64 (request in 55)
57	204.735354	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) request id=0x31b8, seq=1/256, ttl=64 (reply in 58)
58	204.735971	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) reply id=0x31b8, seq=1/256, ttl=64 (request in 57)
59	205.739229	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) request id=0x32b8, seq=2/512, ttl=64 (reply in 60)
60	205.739867	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) reply id=0x32b8, seq=2/512, ttl=64 (request in 59)
61	206.743431	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) request id=0x33b8, seq=3/768, ttl=64 (reply in 62)
62	206.744036	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) reply id=0x33b8, seq=3/768, ttl=64 (request in 61)
63	207.747576	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) request id=0x34b8, seq=4/1024, ttl=64 (reply in 64)
64	207.748074	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) reply id=0x34b8, seq=4/1024, ttl=64 (request in 63)
65	208.752622	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) request id=0x35b8, seq=5/1280, ttl=64 (reply in 66)
66	208.753211	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) reply id=0x35b8, seq=5/1280, ttl=64 (request in 65)
67	222.133629	Private_66:68:01	Broadcast	ARP	64	Who has 202.17.51.23? Tell 202.17.51.22
68	231.763849	Private_66:68:01	Broadcast	ARP	64	Who has 202.17.51.24? Tell 202.17.51.22
69	241.422756	202.17.51.23	202.17.51.21	ICMP	98	Echo (ping) request id=0x56b8, seq=1/256, ttl=64 (reply in 70)
70	241.423386	202.17.51.21	202.17.51.23	ICMP	98	Echo (ping) reply id=0x56b8, seq=1/256, ttl=64 (request in 69)
71	242.428184	202.17.51.23	202.17.51.21	ICMP	98	Echo (ping) request id=0x57b8, seq=2/512, ttl=64 (reply in 72)
72	242.428775	202.17.51.21	202.17.51.23	ICMP	98	Echo (ping) reply id=0x57b8, seq=2/512, ttl=64 (request in 71)
73	243.431237	202.17.51.23	202.17.51.21	ICMP	98	Echo (ping) request id=0x58b8, seq=3/768, ttl=64 (reply in 74)
74	243.431503	202.17.51.21	202.17.51.23	ICMP	98	Echo (ping) reply id=0x58b8, seq=3/768, ttl=64 (request in 73)
75	244.433973	202.17.51.23	202.17.51.21	ICMP	98	Echo (ping) request id=0x59b8, seq=4/1024, ttl=64 (reply in 76)
76	244.434770	202.17.51.21	202.17.51.23	ICMP	98	Echo (ping) reply id=0x59b8, seq=4/1024, ttl=64 (request in 75)
77	244.974061	PcsCompu_7a:83:48	CDP/VTP/DTP/PagP/UD...	CDP	185	Device ID: localhost.localdomain Port ID: eth0
78	245.438930	202.17.51.23	202.17.51.21	ICMP	98	Echo (ping) request id=0x5ab8, seq=5/1280, ttl=64 (reply in 79)
79	245.439508	202.17.51.21	202.17.51.23	ICMP	98	Echo (ping) reply id=0x5ab8, seq=5/1280, ttl=64 (request in 78)
80	261.425259	Private_66:68:02	Broadcast	ARP	64	Who has 202.17.51.24? Tell 202.17.51.23
81	274.861988	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) request id=0x77b8, seq=1/256, ttl=64 (reply in 82)
82	274.862584	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) reply id=0x77b8, seq=1/256, ttl=64 (request in 81)
83	275.868179	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) request id=0x78b8, seq=2/512, ttl=64 (reply in 84)
84	275.868788	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) reply id=0x78b8, seq=2/512, ttl=64 (request in 83)
85	276.872837	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) request id=0x79b8, seq=3/768, ttl=64 (reply in 86)
86	276.873443	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) reply id=0x79b8, seq=3/768, ttl=64 (request in 85)
87	277.876869	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) request id=0x7ab8, seq=4/1024, ttl=64 (reply in 88)
88	277.877473	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) reply id=0x7ab8, seq=4/1024, ttl=64 (request in 87)
89	278.880848	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) request id=0x7bb8, seq=5/1280, ttl=64 (reply in 90)
90	278.881514	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) reply id=0x7bb8, seq=5/1280, ttl=64 (request in 89)
91	304.975103	PcsCompu_7a:83:48	CDP/VTP/DTP/PagP/UD...	CDP	185	Device ID: localhost.localdomain Port ID: eth0

Figure 17: Packet capture on Wireshark for PC1 for emulation using LISA

```
Build time: Apr 10 2019 02:42:20
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Press '?' to get help.

Executing the startup file

PC2> ip 202.17.51.22/202.17.51.52
Checking for duplicate address...
PC1 : 202.17.51.22 255.255.255.0 gateway 202.17.51.52

PC2> show ip

NAME      : PC2[1]
IP/MASK   : 202.17.51.22/24
GATEWAY   : 202.17.51.52
DNS       :
MAC       : 00:50:79:66:68:01
LPORT     : 10010
RHOST:PORT : 127.0.0.1:10011
MTU:      : 1500

PC2> ping 202.17.51.21
84 bytes from 202.17.51.21 icmp_seq=1 ttl=64 time=3.461 ms
84 bytes from 202.17.51.21 icmp_seq=2 ttl=64 time=3.678 ms
84 bytes from 202.17.51.21 icmp_seq=3 ttl=64 time=3.842 ms
84 bytes from 202.17.51.21 icmp_seq=4 ttl=64 time=2.734 ms
84 bytes from 202.17.51.21 icmp_seq=5 ttl=64 time=3.557 ms

PC2> ping 202.17.51.23
84 bytes from 202.17.51.23 icmp_seq=1 ttl=64 time=4.910 ms
84 bytes from 202.17.51.23 icmp_seq=2 ttl=64 time=4.561 ms
84 bytes from 202.17.51.23 icmp_seq=3 ttl=64 time=3.604 ms
84 bytes from 202.17.51.23 icmp_seq=4 ttl=64 time=1.206 ms
84 bytes from 202.17.51.23 icmp_seq=5 ttl=64 time=1.167 ms

PC2> ping 202.17.51.24
84 bytes from 202.17.51.24 icmp_seq=1 ttl=64 time=0.977 ms
84 bytes from 202.17.51.24 icmp_seq=2 ttl=64 time=3.894 ms
84 bytes from 202.17.51.24 icmp_seq=3 ttl=64 time=2.429 ms
84 bytes from 202.17.51.24 icmp_seq=4 ttl=64 time=3.600 ms
84 bytes from 202.17.51.24 icmp_seq=5 ttl=64 time=3.653 ms

PC2>
```

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Figure 18: Setting up static IP address and execution of ping command for PC2 on GNS3 emulation using LISA.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	::	ff02::16	ICMPv6	110	Multicast Listener Report Message v2
21	149.742005	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) request id=0x0bb8, seq=1/256, ttl=64 (reply in 22)
22	149.742588	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) reply id=0x0bb8, seq=1/256, ttl=64 (request in 21)
23	150.745817	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) request id=0x0bb8, seq=2/512, ttl=64 (reply in 24)
24	150.746067	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) reply id=0x0bb8, seq=2/512, ttl=64 (request in 23) PING
25	151.748260	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) request id=0x0bb8, seq=3/768, ttl=64 (reply in 26)
26	151.748483	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) reply id=0x0bb8, seq=3/768, ttl=64 (request in 25) FROM
27	152.750118	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) request id=0x0bb8, seq=4/1024, ttl=64 (reply in 28) PC1
28	152.750358	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) reply id=0x0bb8, seq=4/1024, ttl=64 (request in 27)
29	153.753267	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) request id=0x0cb8, seq=5/1280, ttl=64 (reply in 30)
30	153.753889	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) reply id=0x0cb8, seq=5/1280, ttl=64 (request in 29)
31	167.090219	Private_66:68:00	Broadcast	ARP	64	Who has 202.17.51.23? Tell 202.17.51.21
32	170.785362	PcsCompu_36:2d:62	CDP/VT/P/DTP/PAgP/UD...	CDP	185	Device ID: localhost.localdomain Port ID: eth1
33	170.049462	Private_66:68:00	Broadcast	ARP	64	Who has 202.17.51.24? Tell 202.17.51.21
34	190.546079	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) request id=0x31b8, seq=1/256, ttl=64 (reply in 35)
35	190.548880	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) reply id=0x31b8, seq=1/256, ttl=64 (request in 34)
36	191.549907	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) request id=0x32b8, seq=2/512, ttl=64 (reply in 37)
37	191.552920	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) reply id=0x32b8, seq=2/512, ttl=64 (request in 36) PING
38	192.554087	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) request id=0x33b8, seq=3/768, ttl=64 (reply in 39) TO
39	192.557129	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) reply id=0x33b8, seq=3/768, ttl=64 (request in 38) PC1
40	193.558566	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) request id=0x34b8, seq=4/1024, ttl=64 (reply in 41)
41	193.560081	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) reply id=0x34b8, seq=4/1024, ttl=64 (request in 40)
42	194.563316	202.17.51.22	202.17.51.21	ICMP	98	Echo (ping) request id=0x35b8, seq=5/1280, ttl=64 (reply in 43)
43	194.566226	202.17.51.21	202.17.51.22	ICMP	98	Echo (ping) reply id=0x35b8, seq=5/1280, ttl=64 (request in 42)
44	207.943992	Private_66:68:01	Broadcast	ARP	64	Who has 202.17.51.23? Tell 202.17.51.22
45	207.947305	Private_66:68:02	Private_66:68:01	ARP	64	202.17.51.23 is at 00:50:79:66:68:02
46	207.949511	202.17.51.22	202.17.51.23	ICMP	98	Echo (ping) request id=0x42b8, seq=1/256, ttl=64 (reply in 47)
47	207.953771	202.17.51.23	202.17.51.22	ICMP	98	Echo (ping) reply id=0x42b8, seq=1/256, ttl=64 (request in 46)
48	208.955907	202.17.51.22	202.17.51.23	ICMP	98	Echo (ping) request id=0x43b8, seq=2/512, ttl=64 (reply in 49)
49	208.959322	202.17.51.23	202.17.51.22	ICMP	98	Echo (ping) reply id=0x43b8, seq=2/512, ttl=64 (request in 48)
50	209.961380	202.17.51.22	202.17.51.23	ICMP	98	Echo (ping) request id=0x44b8, seq=3/768, ttl=64 (reply in 51) PC3
51	209.964353	202.17.51.23	202.17.51.22	ICMP	98	Echo (ping) reply id=0x44b8, seq=3/768, ttl=64 (request in 50) TO
52	210.965237	202.17.51.22	202.17.51.23	ICMP	98	Echo (ping) request id=0x45b8, seq=4/1024, ttl=64 (reply in 53)
53	210.966199	202.17.51.23	202.17.51.22	ICMP	98	Echo (ping) reply id=0x45b8, seq=4/1024, ttl=64 (request in 52)
54	211.967549	202.17.51.22	202.17.51.23	ICMP	98	Echo (ping) request id=0x46b8, seq=5/1280, ttl=64 (reply in 55)
55	211.968510	202.17.51.23	202.17.51.22	ICMP	98	Echo (ping) reply id=0x46b8, seq=5/1280, ttl=64 (request in 54)
56	217.575305	Private_66:68:01	Broadcast	ARP	64	Who has 202.17.51.24? Tell 202.17.51.22
57	217.576116	Private_66:68:03	Private_66:68:01	ARP	64	202.17.51.24 is at 00:50:79:66:68:03
58	217.577198	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) request id=0x4cb8, seq=1/256, ttl=64 (reply in 59)
59	217.577994	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) reply id=0x4cb8, seq=1/256, ttl=64 (request in 58)
60	218.579995	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) request id=0x4db8, seq=2/512, ttl=64 (reply in 61)
61	218.583206	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) reply id=0x4db8, seq=2/512, ttl=64 (request in 60) PING
62	219.585261	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) request id=0x4eb8, seq=3/768, ttl=64 (reply in 63) TO
63	219.587228	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) reply id=0x4eb8, seq=3/768, ttl=64 (request in 62)
64	220.588274	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) request id=0x4fb8, seq=4/1024, ttl=64 (reply in 65) PC4
65	220.591201	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) reply id=0x4fb8, seq=4/1024, ttl=64 (request in 64)
66	221.593869	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) request id=0x50b8, seq=5/1280, ttl=64 (reply in 67)
67	221.596870	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) reply id=0x50b8, seq=5/1280, ttl=64 (request in 66)
68	230.786013	PcsCompu_36:2d:62	CDP/VT/P/DTP/PAgP/UD...	CDP	185	Device ID: localhost.localdomain Port ID: eth1
69	236.315669	202.17.51.23	202.17.51.22	ICMP	98	Echo (ping) request id=0x5fb8, seq=1/256, ttl=64 (reply in 70)
70	236.316324	202.17.51.22	202.17.51.23	ICMP	98	Echo (ping) reply id=0x5fb8, seq=1/256, ttl=64 (request in 69)
71	237.319702	202.17.51.23	202.17.51.22	ICMP	98	Echo (ping) request id=0x60b8, seq=2/512, ttl=64 (reply in 72)
72	237.320311	202.17.51.22	202.17.51.23	ICMP	98	Echo (ping) reply id=0x60b8, seq=2/512, ttl=64 (request in 71)
73	238.323801	202.17.51.23	202.17.51.22	ICMP	98	Echo (ping) request id=0x61b8, seq=3/768, ttl=64 (reply in 74) FROM
74	238.324479	202.17.51.22	202.17.51.23	ICMP	98	Echo (ping) reply id=0x61b8, seq=3/768, ttl=64 (request in 73) PC3
75	239.328415	202.17.51.23	202.17.51.22	ICMP	98	Echo (ping) request id=0x62b8, seq=4/1024, ttl=64 (reply in 76)
76	239.329232	202.17.51.22	202.17.51.23	ICMP	98	Echo (ping) reply id=0x62b8, seq=4/1024, ttl=64 (request in 75)
77	240.333354	202.17.51.23	202.17.51.22	ICMP	98	Echo (ping) request id=0x63b8, seq=5/1280, ttl=64 (reply in 78)
78	240.333949	202.17.51.22	202.17.51.23	ICMP	98	Echo (ping) reply id=0x63b8, seq=5/1280, ttl=64 (request in 77)
79	247.237335	Private_66:68:02	Broadcast	ARP	64	Who has 202.17.51.24? Tell 202.17.51.23
80	289.258342	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) request id=0x94b8, seq=1/256, ttl=64 (reply in 81)
81	289.259066	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) reply id=0x94b8, seq=1/256, ttl=64 (request in 80)
82	290.263174	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) request id=0x95b8, seq=2/512, ttl=64 (reply in 83)
83	290.263840	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) reply id=0x95b8, seq=2/512, ttl=64 (request in 82) PING
84	290.287040	PcsCompu_36:2d:62	CDP/VT/P/DTP/PAgP/UD...	CDP	185	Device ID: localhost.localdomain Port ID: eth1 FROM
85	291.268513	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) request id=0x96b8, seq=3/768, ttl=64 (reply in 86) PC4
86	291.269169	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) reply id=0x96b8, seq=3/768, ttl=64 (request in 85)
87	292.273340	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) request id=0x97b8, seq=4/1024, ttl=64 (reply in 88)
88	292.273943	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) reply id=0x97b8, seq=4/1024, ttl=64 (request in 87)
89	293.277056	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) request id=0x98b8, seq=5/1280, ttl=64 (reply in 90)
90	293.277672	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) reply id=0x98b8, seq=5/1280, ttl=64 (request in 89)
91	350.787259	PcsCompu_36:2d:62	CDP/VT/P/DTP/PAgP/UD...	CDP	185	Device ID: localhost.localdomain Port ID: eth1
92	410.787409	PcsCompu_36:2d:62	CDP/VT/P/DTP/PAgP/UD...	CDP	185	Device ID: localhost.localdomain Port ID: eth1
93	470.788747	PcsCompu_36:2d:62	CDP/VT/P/DTP/PAgP/UD...	CDP	185	Device ID: localhost.localdomain Port ID: eth1

Figure 19: Packet capture on Wireshark for PC2 for emulation using LISA

```
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Press '?' to get help.

Executing the startup file

PC3> ip 202.17.51.23/202.17.51.52
Checking for duplicate address...
PC1 : 202.17.51.23 255.255.255.0 gateway 202.17.51.52

PC3> show ip

NAME      : PC3[1]
IP/MASK   : 202.17.51.23/24
GATEWAY   : 202.17.51.52
DNS       :
MAC       : 00:50:79:66:68:02
LPORT     : 10014
RHOST:PORT : 127.0.0.1:10015
MTU:      : 1500

PC3> ping 202.17.51.21
84 bytes from 202.17.51.21 icmp_seq=1 ttl=64 time=3.599 ms
84 bytes from 202.17.51.21 icmp_seq=2 ttl=64 time=3.673 ms
84 bytes from 202.17.51.21 icmp_seq=3 ttl=64 time=1.507 ms
84 bytes from 202.17.51.21 icmp_seq=4 ttl=64 time=3.786 ms
84 bytes from 202.17.51.21 icmp_seq=5 ttl=64 time=3.286 ms

PC3> ping 202.17.51.22
84 bytes from 202.17.51.22 icmp_seq=1 ttl=64 time=3.730 ms

84 bytes from 202.17.51.22 icmp_seq=2 ttl=64 time=3.602 ms
84 bytes from 202.17.51.22 icmp_seq=3 ttl=64 time=3.652 ms
84 bytes from 202.17.51.22 icmp_seq=4 ttl=64 time=3.822 ms
84 bytes from 202.17.51.22 icmp_seq=5 ttl=64 time=3.603 ms

PC3>
PC3> ping 202.17.51.24
84 bytes from 202.17.51.24 icmp_seq=1 ttl=64 time=3.505 ms
84 bytes from 202.17.51.24 icmp_seq=2 ttl=64 time=2.821 ms
84 bytes from 202.17.51.24 icmp_seq=3 ttl=64 time=3.048 ms
84 bytes from 202.17.51.24 icmp_seq=4 ttl=64 time=3.487 ms
84 bytes from 202.17.51.24 icmp_seq=5 ttl=64 time=3.609 ms

PC3>
```

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Figure 20: Setting up static IP address and execution of ping command for PC3 on GNS3 emulation using LISA.

No.	Time	Source	Destination	Protocol	Length Info
1	0.000000	::	ff02::16	ICMPv6	110 Multicast Listener Report Message v2
22	158.959831	202.17.51.21	202.17.51.23	ICMP	98 Echo (ping) request id=0x19b8, seq=1/256, ttl=64 (reply in 23)
23	158.960491	202.17.51.23	202.17.51.21	ICMP	98 Echo (ping) reply id=0x19b8, seq=1/256, ttl=64 (request in 22)
24	159.963752	202.17.51.21	202.17.51.23	ICMP	98 Echo (ping) request id=0x1ab8, seq=2/512, ttl=64 (reply in 25)
25	159.964403	202.17.51.23	202.17.51.21	ICMP	98 Echo (ping) reply id=0x1ab8, seq=2/512, ttl=64 (request in 24)
26	160.968164	202.17.51.21	202.17.51.23	ICMP	98 Echo (ping) request id=0x1bb8, seq=3/768, ttl=64 (reply in 27)
27	160.968795	202.17.51.23	202.17.51.21	ICMP	98 Echo (ping) reply id=0x1bb8, seq=3/768, ttl=64 (request in 26)
28	161.972749	202.17.51.21	202.17.51.23	ICMP	98 Echo (ping) request id=0x1cb8, seq=4/1024, ttl=64 (reply in 29)
29	161.973417	202.17.51.23	202.17.51.21	ICMP	98 Echo (ping) reply id=0x1cb8, seq=4/1024, ttl=64 (request in 28)
30	162.649538	PcsCompu_54:2b:cf	CDP/FTP/DTP/PAgP/UD.. CDP		185 Device ID: localhost.localdomain Port ID: eth2
31	162.978125	202.17.51.21	202.17.51.23	ICMP	98 Echo (ping) request id=0x1db8, seq=5/1280, ttl=64 (reply in 32)
32	162.978720	202.17.51.23	202.17.51.21	ICMP	98 Echo (ping) reply id=0x1db8, seq=5/1280, ttl=64 (request in 31)
33	166.913593	Private_66:68:00	Broadcast	ARP	64 Who has 202.17.51.21? Tell 202.17.51.21
34	199.809587	Private_66:68:01	Broadcast	ARP	64 Who has 202.17.51.23? Tell 202.17.51.22
35	199.810218	Private_66:68:02	Private_66:68:01	ARP	64 202.17.51.23 is at 00:50:79:66:68:02
36	199.814654	202.17.51.22	202.17.51.23	ICMP	98 Echo (ping) request id=0x42b8, seq=1/256, ttl=64 (reply in 37)
37	199.815265	202.17.51.23	202.17.51.22	ICMP	98 Echo (ping) reply id=0x42b8, seq=1/256, ttl=64 (request in 36)
38	200.821401	202.17.51.22	202.17.51.23	ICMP	98 Echo (ping) request id=0x43b8, seq=2/512, ttl=64 (reply in 39)
39	200.822005	202.17.51.23	202.17.51.22	ICMP	98 Echo (ping) reply id=0x43b8, seq=2/512, ttl=64 (request in 38)
40	201.826624	202.17.51.22	202.17.51.23	ICMP	98 Echo (ping) request id=0x44b8, seq=3/768, ttl=64 (reply in 41)
41	201.827244	202.17.51.23	202.17.51.22	ICMP	98 Echo (ping) reply id=0x44b8, seq=3/768, ttl=64 (request in 40)
42	202.829690	202.17.51.22	202.17.51.23	ICMP	98 Echo (ping) request id=0x45b8, seq=4/1024, ttl=64 (reply in 43)
43	202.829892	202.17.51.23	202.17.51.22	ICMP	98 Echo (ping) reply id=0x45b8, seq=4/1024, ttl=64 (request in 42)
44	203.831962	202.17.51.22	202.17.51.23	ICMP	98 Echo (ping) request id=0x46b8, seq=5/1280, ttl=64 (reply in 45)
45	203.832178	202.17.51.23	202.17.51.22	ICMP	98 Echo (ping) reply id=0x46b8, seq=5/1280, ttl=64 (request in 44)
46	209.439765	Private_66:68:01	Broadcast	ARP	64 Who has 202.17.51.24? Tell 202.17.51.22
47	219.097432	202.17.51.23	202.17.51.21	ICMP	98 Echo (ping) request id=0x56b8, seq=1/256, ttl=64 (reply in 48)
48	219.100353	202.17.51.21	202.17.51.23	ICMP	98 Echo (ping) reply id=0x56b8, seq=1/256, ttl=64 (request in 47)
49	220.102792	202.17.51.23	202.17.51.21	ICMP	98 Echo (ping) request id=0x57b8, seq=2/512, ttl=64 (reply in 50)
50	220.105778	202.17.51.21	202.17.51.23	ICMP	98 Echo (ping) reply id=0x57b8, seq=2/512, ttl=64 (request in 49)
51	221.106662	202.17.51.23	202.17.51.21	ICMP	98 Echo (ping) request id=0x58b8, seq=3/768, ttl=64 (reply in 52)
52	221.107867	202.17.51.21	202.17.51.23	ICMP	98 Echo (ping) reply id=0x58b8, seq=3/768, ttl=64 (request in 51)
53	222.108639	202.17.51.23	202.17.51.21	ICMP	98 Echo (ping) request id=0x59b8, seq=4/1024, ttl=64 (reply in 54)
54	222.111745	202.17.51.21	202.17.51.23	ICMP	98 Echo (ping) reply id=0x59b8, seq=4/1024, ttl=64 (request in 53)
55	222.650121	PcsCompu_54:2b:cf	CDP/FTP/DTP/PAgP/UD.. CDP		185 Device ID: localhost.localdomain Port ID: eth2
56	223.113758	202.17.51.23	202.17.51.21	ICMP	98 Echo (ping) request id=0x5ab8, seq=5/1280, ttl=64 (reply in 57)
57	223.116402	202.17.51.21	202.17.51.23	ICMP	98 Echo (ping) reply id=0x5ab8, seq=5/1280, ttl=64 (request in 56)
58	228.178476	202.17.51.23	202.17.51.22	ICMP	98 Echo (ping) request id=0x5fb8, seq=1/256, ttl=64 (reply in 59)
59	228.181400	202.17.51.22	202.17.51.23	ICMP	98 Echo (ping) reply id=0x5fb8, seq=1/256, ttl=64 (request in 58)
60	229.182506	202.17.51.23	202.17.51.22	ICMP	98 Echo (ping) request id=0x60b8, seq=2/512, ttl=64 (reply in 61)
61	229.185471	202.17.51.22	202.17.51.23	ICMP	98 Echo (ping) reply id=0x60b8, seq=2/512, ttl=64 (request in 60)
62	230.186578	202.17.51.23	202.17.51.22	ICMP	98 Echo (ping) request id=0x61b8, seq=3/768, ttl=64 (reply in 63)
63	230.189588	202.17.51.22	202.17.51.23	ICMP	98 Echo (ping) reply id=0x61b8, seq=3/768, ttl=64 (request in 62)
64	231.191222	202.17.51.23	202.17.51.22	ICMP	98 Echo (ping) request id=0x62b8, seq=4/1024, ttl=64 (reply in 65)
65	231.194336	202.17.51.22	202.17.51.23	ICMP	98 Echo (ping) reply id=0x62b8, seq=4/1024, ttl=64 (request in 64)
66	232.196147	202.17.51.23	202.17.51.22	ICMP	98 Echo (ping) request id=0x63b8, seq=5/1280, ttl=64 (reply in 67)
67	232.199098	202.17.51.22	202.17.51.23	ICMP	98 Echo (ping) reply id=0x63b8, seq=5/1280, ttl=64 (request in 66)
68	239.099881	Private_66:68:02	Broadcast	ARP	64 Who has 202.17.51.24? Tell 202.17.51.23
69	239.103136	Private_66:68:03	Private_66:68:02	ARP	64 202.17.51.24 is at 00:50:79:66:68:03
70	239.104344	202.17.51.23	202.17.51.24	ICMP	98 Echo (ping) request id=0x6ab8, seq=1/256, ttl=64 (reply in 71)
71	239.107265	202.17.51.24	202.17.51.23	ICMP	98 Echo (ping) reply id=0x6ab8, seq=1/256, ttl=64 (request in 70)
72	240.108347	202.17.51.23	202.17.51.24	ICMP	98 Echo (ping) request id=0x6bb8, seq=2/512, ttl=64 (reply in 73)
73	240.110682	202.17.51.24	202.17.51.23	ICMP	98 Echo (ping) reply id=0x6bb8, seq=2/512, ttl=64 (request in 72)
74	241.112681	202.17.51.23	202.17.51.24	ICMP	98 Echo (ping) request id=0x6cb8, seq=3/768, ttl=64 (reply in 75)
75	241.115143	202.17.51.24	202.17.51.23	ICMP	98 Echo (ping) reply id=0x6cb8, seq=3/768, ttl=64 (request in 74)
76	242.116758	202.17.51.23	202.17.51.24	ICMP	98 Echo (ping) request id=0x6db8, seq=4/1024, ttl=64 (reply in 77)
77	242.119638	202.17.51.24	202.17.51.23	ICMP	98 Echo (ping) reply id=0x6db8, seq=4/1024, ttl=64 (request in 76)
78	243.120755	202.17.51.23	202.17.51.24	ICMP	98 Echo (ping) request id=0x6eb8, seq=5/1280, ttl=64 (reply in 79)
79	243.123695	202.17.51.24	202.17.51.23	ICMP	98 Echo (ping) reply id=0x6eb8, seq=5/1280, ttl=64 (request in 78)
80	282.651095	PcsCompu_54:2b:cf	CDP/FTP/DTP/PAgP/UD.. CDP		185 Device ID: localhost.localdomain Port ID: eth2
81	290.230880	202.17.51.24	202.17.51.23	ICMP	98 Echo (ping) request id=0x9db8, seq=1/256, ttl=64 (reply in 82)
82	290.231530	202.17.51.23	202.17.51.24	ICMP	98 Echo (ping) reply id=0x9db8, seq=1/256, ttl=64 (request in 81)
83	291.236678	202.17.51.24	202.17.51.23	ICMP	98 Echo (ping) request id=0x9eb8, seq=2/512, ttl=64 (reply in 84)
84	291.237350	202.17.51.23	202.17.51.24	ICMP	98 Echo (ping) reply id=0x9eb8, seq=2/512, ttl=64 (request in 83)
85	292.240910	202.17.51.24	202.17.51.23	ICMP	98 Echo (ping) request id=0x9fb8, seq=3/768, ttl=64 (reply in 86)
86	292.241585	202.17.51.23	202.17.51.24	ICMP	98 Echo (ping) reply id=0x9fb8, seq=3/768, ttl=64 (request in 85)
87	293.245596	202.17.51.24	202.17.51.23	ICMP	98 Echo (ping) request id=0xa0b8, seq=4/1024, ttl=64 (reply in 88)
88	293.246155	202.17.51.23	202.17.51.24	ICMP	98 Echo (ping) reply id=0xa0b8, seq=4/1024, ttl=64 (request in 87)
89	294.249489	202.17.51.24	202.17.51.23	ICMP	98 Echo (ping) request id=0x1b8, seq=5/1280, ttl=64 (reply in 90)
90	294.250060	202.17.51.23	202.17.51.24	ICMP	98 Echo (ping) reply id=0x1b8, seq=5/1280, ttl=64 (request in 89)

Figure 21: Packet capture on Wireshark for PC3 for emulation using LISA

```

Lisa-1   PC1   PC3   PC2   PC4   | + - x
Build time: Apr 10 2019 02:42:20
Copyright (c) 2007-2014, Paul Meng (mirnshi@gmail.com)
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VPCS is free software, distributed under the terms of the "BSD" licence.
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC4> ip 202.17.51.24/202.17.51.52
Checking for duplicate address...
PC1 : 202.17.51.24 255.255.255.0 gateway 202.17.51.52

PC4> show ip

NAME      : PC4[1]
IP/MASK   : 202.17.51.24/24
GATEWAY   : 202.17.51.52
DNS       :
MAC       : 00:50:79:66:68:03
LPORT     : 10016
RHOST:PORT: 127.0.0.1:10017
MTU:      : 1500

PC4> ping 202.17.51.21
84 bytes from 202.17.51.21 icmp_seq=1 ttl=64 time=3.848 ms
84 bytes from 202.17.51.21 icmp_seq=2 ttl=64 time=3.582 ms
84 bytes from 202.17.51.21 icmp_seq=3 ttl=64 time=3.536 ms
84 bytes from 202.17.51.21 icmp_seq=4 ttl=64 time=3.457 ms
84 bytes from 202.17.51.21 icmp_seq=5 ttl=64 time=3.671 ms

PC4> ping 202.17.51.22
84 bytes from 202.17.51.22 icmp_seq=1 ttl=64 time=4.124 ms
84 bytes from 202.17.51.22 icmp_seq=2 ttl=64 time=3.724 ms
84 bytes from 202.17.51.22 icmp_seq=3 ttl=64 time=3.721 ms
84 bytes from 202.17.51.22 icmp_seq=4 ttl=64 time=3.625 ms
84 bytes from 202.17.51.22 icmp_seq=5 ttl=64 time=3.660 ms

PC4> ping 202.17.51.23
84 bytes from 202.17.51.23 icmp_seq=1 ttl=64 time=3.948 ms
84 bytes from 202.17.51.23 icmp_seq=2 ttl=64 time=3.655 ms
84 bytes from 202.17.51.23 icmp_seq=3 ttl=64 time=3.634 ms
84 bytes from 202.17.51.23 icmp_seq=4 ttl=64 time=3.724 ms
84 bytes from 202.17.51.23 icmp_seq=5 ttl=64 time=3.564 ms

PC4>

```

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Figure 22: Setting up static IP address and execution of ping command for PC4 on GNS3 emulation using LISA.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	::	ff02::16	ICMPv6	110	Multicast Listener Report Message v2
24	159.373834	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) request id=0x21b8, seq=1/256, ttl=64 (reply in 25)
25	159.374442	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) reply id=0x21b8, seq=1/256, ttl=64 (request in 24)
26	160.380007	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) request id=0x22b8, seq=2/512, ttl=64 (reply in 27)
27	160.380655	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) reply id=0x22b8, seq=2/512, ttl=64 (request in 26)
28	161.384908	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) request id=0x23b8, seq=3/768, ttl=64 (reply in 29)
29	161.385524	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) reply id=0x23b8, seq=3/768, ttl=64 (request in 28)
30	162.388455	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) request id=0x24b8, seq=4/1024, ttl=64 (reply in 31)
31	162.388776	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) reply id=0x24b8, seq=4/1024, ttl=64 (request in 30)
32	163.392786	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) request id=0x25b8, seq=5/1280, ttl=64 (reply in 33)
33	163.393402	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) reply id=0x25b8, seq=5/1280, ttl=64 (request in 32)
34	192.264735	Private_66:68:01	Broadcast	ARP	64	Who has 202.17.51.23? Tell 202.17.51.22
35	201.894755	Private_66:68:01	Broadcast	ARP	64	Who has 202.17.51.24? Tell 202.17.51.22
36	201.894874	Private_66:68:03	Private_66:68:01	ARP	64	202.17.51.24 is at 00:50:79:66:68:03
37	201.896506	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) request id=0x4cb8, seq=1/256, ttl=64 (reply in 38)
38	201.896679	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) reply id=0x4cb8, seq=1/256, ttl=64 (request in 37)
39	202.900235	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) request id=0x4db8, seq=2/512, ttl=64 (reply in 40)
40	202.901058	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) reply id=0x4db8, seq=2/512, ttl=64 (request in 39)
41	203.905119	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) request id=0x4eb8, seq=3/768, ttl=64 (reply in 42)
42	203.905531	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) reply id=0x4eb8, seq=3/768, ttl=64 (request in 41)
43	204.908493	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) request id=0x4fb8, seq=4/1024, ttl=64 (reply in 44)
44	204.909084	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) reply id=0x50b8, seq=4/1024, ttl=64 (request in 43)
45	205.914113	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) request id=0x50b8, seq=5/1280, ttl=64 (reply in 46)
46	205.914765	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) reply id=0x50b8, seq=5/1280, ttl=64 (request in 45)
47	215.105139	PcsCompu_c1:ef:9d	CDP/VTP/DTP/PAgP/UD...	CDP	185	Device ID: localhost.localdomain Port ID: eth3
48	231.556357	Private_66:68:02	Broadcast	ARP	64	Who has 202.17.51.24? Tell 202.17.51.23
49	231.557024	Private_66:68:02	Private_66:68:02	ARP	64	202.17.51.24 is at 00:50:79:66:68:03
50	231.560510	202.17.51.23	202.17.51.24	ICMP	98	Echo (ping) request id=0x6ab8, seq=1/256, ttl=64 (reply in 51)
51	231.561160	202.17.51.24	202.17.51.23	ICMP	98	Echo (ping) reply id=0x6ab8, seq=1/256, ttl=64 (request in 50)
52	232.564341	202.17.51.23	202.17.51.24	ICMP	98	Echo (ping) request id=0x6bb8, seq=2/512, ttl=64 (reply in 53)
53	232.564813	202.17.51.24	202.17.51.23	ICMP	98	Echo (ping) reply id=0x6bb8, seq=2/512, ttl=64 (request in 52)
54	233.568628	202.17.51.23	202.17.51.24	ICMP	98	Echo (ping) request id=0x6cb8, seq=3/768, ttl=64 (reply in 55)
55	233.569112	202.17.51.24	202.17.51.23	ICMP	98	Echo (ping) reply id=0x6cb8, seq=3/768, ttl=64 (request in 54)
56	234.572950	202.17.51.23	202.17.51.24	ICMP	98	Echo (ping) request id=0x6db8, seq=4/1024, ttl=64 (reply in 57)
57	234.573571	202.17.51.24	202.17.51.23	ICMP	98	Echo (ping) reply id=0x6db8, seq=4/1024, ttl=64 (request in 56)
58	235.576975	202.17.51.23	202.17.51.24	ICMP	98	Echo (ping) request id=0x6eb8, seq=5/1280, ttl=64 (reply in 59)
59	235.577544	202.17.51.24	202.17.51.23	ICMP	98	Echo (ping) reply id=0x6eb8, seq=5/1280, ttl=64 (request in 58)
60	244.991523	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) request id=0x77b8, seq=1/256, ttl=64 (reply in 61)
61	244.994626	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) reply id=0x77b8, seq=1/256, ttl=64 (request in 60)
62	245.997859	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) request id=0x78b8, seq=2/512, ttl=64 (reply in 63)
63	246.000790	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) reply id=0x78b8, seq=2/512, ttl=64 (request in 62)
64	247.002547	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) request id=0x79b8, seq=3/768, ttl=64 (reply in 65)
65	247.005429	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) reply id=0x79b8, seq=3/768, ttl=64 (request in 64)
66	248.006573	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) request id=0x7ab8, seq=4/1024, ttl=64 (reply in 67)
67	248.009425	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) reply id=0x7ab8, seq=4/1024, ttl=64 (request in 66)
68	249.010490	202.17.51.24	202.17.51.21	ICMP	98	Echo (ping) request id=0x7bb8, seq=5/1280, ttl=64 (reply in 69)
69	249.013518	202.17.51.21	202.17.51.24	ICMP	98	Echo (ping) reply id=0x7bb8, seq=5/1280, ttl=64 (request in 68)
70	273.575823	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) request id=0x94b8, seq=1/256, ttl=64 (reply in 71)
71	273.579165	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) reply id=0x94b8, seq=1/256, ttl=64 (request in 70)
72	274.580915	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) request id=0x95b8, seq=2/512, ttl=64 (reply in 73)
73	274.583990	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) reply id=0x95b8, seq=2/512, ttl=64 (request in 72)
74	275.106042	PcsCompu_c1:ef:9d	CDP/VTP/DTP/PAgP/UD...	CDP	185	Device ID: localhost.localdomain Port ID: eth3
75	275.586271	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) request id=0x96b8, seq=3/768, ttl=64 (reply in 76)
76	275.589274	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) reply id=0x96b8, seq=3/768, ttl=64 (request in 75)
77	276.591131	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) request id=0x97b8, seq=4/1024, ttl=64 (reply in 78)
78	276.594062	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) reply id=0x97b8, seq=4/1024, ttl=64 (request in 77)
79	277.594843	202.17.51.24	202.17.51.22	ICMP	98	Echo (ping) request id=0x98b8, seq=5/1280, ttl=64 (reply in 80)
80	277.597873	202.17.51.22	202.17.51.24	ICMP	98	Echo (ping) reply id=0x98b8, seq=5/1280, ttl=64 (request in 79)
81	282.684392	202.17.51.24	202.17.51.23	ICMP	98	Echo (ping) request id=0x9db8, seq=1/256, ttl=64 (reply in 82)
82	282.687643	202.17.51.23	202.17.51.24	ICMP	98	Echo (ping) reply id=0x9db8, seq=1/256, ttl=64 (request in 81)
83	283.690426	202.17.51.24	202.17.51.23	ICMP	98	Echo (ping) request id=0x9eb8, seq=2/512, ttl=64 (reply in 84)
84	283.693432	202.17.51.23	202.17.51.24	ICMP	98	Echo (ping) reply id=0x9eb8, seq=2/512, ttl=64 (request in 83)
85	284.694635	202.17.51.24	202.17.51.23	ICMP	98	Echo (ping) request id=0x9fb8, seq=3/768, ttl=64 (reply in 86)
86	284.697661	202.17.51.23	202.17.51.24	ICMP	98	Echo (ping) reply id=0x9fb8, seq=3/768, ttl=64 (request in 85)
87	285.699306	202.17.51.24	202.17.51.23	ICMP	98	Echo (ping) request id=0xa0b8, seq=4/1024, ttl=64 (reply in 88)
88	285.702285	202.17.51.23	202.17.51.24	ICMP	98	Echo (ping) reply id=0xa0b8, seq=4/1024, ttl=64 (request in 87)
89	286.703227	202.17.51.24	202.17.51.23	ICMP	98	Echo (ping) request id=0xa1b8, seq=5/1280, ttl=64 (reply in 90)
90	286.706158	202.17.51.23	202.17.51.24	ICMP	98	Echo (ping) reply id=0xa1b8, seq=5/1280, ttl=64 (request in 89)

Figure 23: Packet capture on Wireshark for PC4 for emulation using LISA

Table 2: LAN address configuration for emulation on GNS3 using LISA emulator

Computer	IP Address	Gateway Address	Netmask Address
PC1	202.17.51.21	202.17.51.52	255.255.255.0
PC2	202.17.51.22	202.17.51.52	255.255.255.0
PC3	202.17.51.23	202.17.51.52	255.255.255.0
PC4	202.17.51.24	202.17.51.52	255.255.255.0

3) Real world LAN connection using LISA hardware appliance

```

Windows IP Configuration

Ethernet adapter Ethernet 2:

  Connection-specific DNS Suffix  . :
  Link-local IPv6 Address . . . . . : fe80::783:94d0:d159:b75d%17
  IPv4 Address. . . . . : 192.168.56.1
  Subnet Mask . . . . . : 255.255.255.0
  Default Gateway . . . . . :

Wireless LAN adapter Local Area Connection* 1:

  Media State . . . . . : Media disconnected
  Connection-specific DNS Suffix  . :

Wireless LAN adapter Local Area Connection* 2:

  Media State . . . . . : Media disconnected
  Connection-specific DNS Suffix  . :

Ethernet adapter Ethernet:

  Connection-specific DNS Suffix  . :
  Link-local IPv6 Address . . . . . : fe80::8871:754c:2438:76bb%3
  IPv4 Address. . . . . : 202.17.57.1
  Subnet Mask . . . . . : 255.255.255.0
  Default Gateway . . . . . : 202.17.57.233

Wireless LAN adapter Wi-Fi:

  Media State . . . . . : Media disconnected
  Connection-specific DNS Suffix  . : upm.edu.my

Ethernet adapter Bluetooth Network Connection:

  Media State . . . . . : Media disconnected
  Connection-specific DNS Suffix  . :

C:\Users\Dell>

```

Figure 24: IP configuration summary of PC1 on hardware

A summary of the LAN address configurations for the GNS3 simulation is shown in Table 3 below. Figure 24 above shows the ipconfig command being carried out on PC1 which shows the IP configuration of the particular device. Figure 25 to Figure 27 shows the ping commands that were executed from PC1, PC2 and PC3 respectively. Finally, Figure 28 shows the process of setting the IP address of PC4. Finally, Figure 29 to Figure 32 show the captured packets on Wireshark for PC1, PC2, PC3 and PC4 respectively.

Table 3: LAN address configuration for hardware

Computer	IP Address	Gateway Address	Netmask Address
PC1	202.17.57.1	202.17.57.233	255.255.255.0
PC2	202.17.57.2	202.17.57.233	255.255.255.0
PC3	202.17.57.3	202.17.57.233	255.255.255.0
PC4	202.17.57.4	202.17.57.233	255.255.255.0

C:\ Command Prompt

C:\Users\Dell>ping 202.17.57.3 ← PING PC1 TO PC3

```
Pinging 202.17.57.3 with 32 bytes of data:  
Reply from 202.17.57.3: bytes=32 time<1ms TTL=128  
Reply from 202.17.57.3: bytes=32 time=1ms TTL=128  
Reply from 202.17.57.3: bytes=32 time=1ms TTL=128  
Reply from 202.17.57.3: bytes=32 time=1ms TTL=128
```

```
Ping statistics for 202.17.57.3:  
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),  
Approximate round trip times in milli-seconds:  
Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

C:\Users\Dell>ping 202.17.57.4 ← PING PC1 TO PC4

```
Pinging 202.17.57.4 with 32 bytes of data:  
Reply from 202.17.57.4: bytes=32 time=1ms TTL=128  
Reply from 202.17.57.4: bytes=32 time=1ms TTL=128  
Reply from 202.17.57.4: bytes=32 time=1ms TTL=128  
Reply from 202.17.57.4: bytes=32 time=1ms TTL=128
```

```
Ping statistics for 202.17.57.4:  
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),  
Approximate round trip times in milli-seconds:  
Minimum = 1ms, Maximum = 1ms, Average = 1ms
```

C:\Users\Dell>ping 202.17.57.2 ← PING PC1 TO PC2

```
Pinging 202.17.57.2 with 32 bytes of data:  
Reply from 202.17.57.2: bytes=32 time=1ms TTL=128  
Reply from 202.17.57.2: bytes=32 time=2ms TTL=128  
Reply from 202.17.57.2: bytes=32 time=2ms TTL=128  
Reply from 202.17.57.2: bytes=32 time=2ms TTL=128
```

```
Ping statistics for 202.17.57.2:  
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),  
Approximate round trip times in milli-seconds:  
Minimum = 1ms, Maximum = 2ms, Average = 1ms
```

C:\Users\Dell>

Figure 25: Ping commands executed from PC1 on hardware to the other PCs

```

C:\ Command Prompt
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\Users\g3>ping 202.17.57.1 ← PING PC2 TO PC1

Pinging 202.17.57.1 with 32 bytes of data:
Reply from 202.17.57.1: bytes=32 time=2ms TTL=128
Reply from 202.17.57.1: bytes=32 time=2ms TTL=128
Reply from 202.17.57.1: bytes=32 time=1ms TTL=128
Reply from 202.17.57.1: bytes=32 time=2ms TTL=128

Ping statistics for 202.17.57.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 2ms, Average = 1ms

C:\Users\g3>ping 202.17.57.3 ← PING PC2 TO PC3

Pinging 202.17.57.3 with 32 bytes of data:
Reply from 202.17.57.3: bytes=32 time=1ms TTL=128

Ping statistics for 202.17.57.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms

C:\Users\g3>ping 202.17.57.4 ← PING PC2 TO PC4

Pinging 202.17.57.4 with 32 bytes of data:
Reply from 202.17.57.4: bytes=32 time=2ms TTL=128
Reply from 202.17.57.4: bytes=32 time=1ms TTL=128
Reply from 202.17.57.4: bytes=32 time=1ms TTL=128
Reply from 202.17.57.4: bytes=32 time=1ms TTL=128

Ping statistics for 202.17.57.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 2ms, Average = 1ms

```

C:\Users\g3>
Figure 26: Ping commands executed from PC2 on hardware to the other PCs

```
C:\Users\ASUS>ping 202.17.57.1 ← PING PC3 TO PC1
Pinging 202.17.57.1 with 32 bytes of data:
Reply from 202.17.57.1: bytes=32 time=1ms TTL=128

Ping statistics for 202.17.57.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 1ms, Average = 1ms

C:\Users\ASUS>ping 202.17.57.2 ← PING PC3 TO PC2
Pinging 202.17.57.2 with 32 bytes of data:
Reply from 202.17.57.2: bytes=32 time=1ms TTL=128

Ping statistics for 202.17.57.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 1ms, Average = 1ms

C:\Users\ASUS>ping 202.17.57.4 ← PING PC3 TO PC4
Pinging 202.17.57.4 with 32 bytes of data:
Reply from 202.17.57.4: bytes=32 time<1ms TTL=128
Reply from 202.17.57.4: bytes=32 time=1ms TTL=128
Reply from 202.17.57.4: bytes=32 time=1ms TTL=128
Reply from 202.17.57.4: bytes=32 time=1ms TTL=128

Ping statistics for 202.17.57.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

Figure 27: Ping commands executed from PC3 on hardware to the other PCs

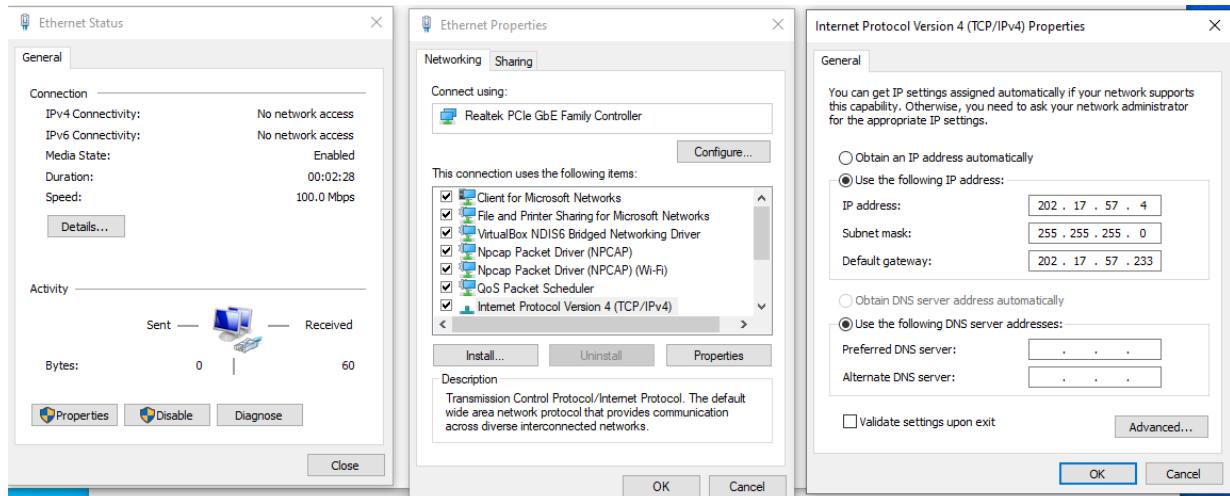


Figure 28: Process of changing the IP address of PC4

No.	Time	Source	Destination	Protocol	Length	Info
243	34.602404	fe80::cb5b:e828:706...	ff02:::c	SSDP	181	M-SEARCH * HTTP/1.1
244	34.602587	202.17.57.2	239.255.255.250	SSDP	167	M-SEARCH * HTTP/1.1
245	34.633770	fe80::cb5b:e828:706...	ff02:::c	SSDP	183	M-SEARCH * HTTP/1.1
246	34.634124	202.17.57.2	239.255.255.250	SSDP	169	M-SEARCH * HTTP/1.1
247	34.665800	202.17.57.2	239.255.255.250	SSDP	179	M-SEARCH * HTTP/1.1
248	34.888499	202.17.57.2	239.255.255.250	SSDP	179	M-SEARCH * HTTP/1.1
249	35.044426	202.17.57.1	202.17.57.3	ICMP	74	Echo (ping) request id=0x0001, seq=7511/22301, ttl=128 (reply in 250)
250	35.045448	202.17.57.3	202.17.57.1	ICMP	74	Echo (ping) reply id=0x0001, seq=7511/22301, ttl=128 (request in 249)
251	35.098049	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233?
252	35.224304	202.17.57.2	224.0.0.251	MDNS	82	Standard query 0x0000 PTR _googlecast._tcp.local, "QM" question
253	35.224304	fe80::cb5b:e828:706...	ff02:::fb	MDNS	102	Standard query 0x0000 PTR _googlecast._tcp.local, "QM" question
254	35.224304	202.17.57.2	224.0.0.251	MDNS	82	Standard query 0x0000 PTR _googlecast._tcp.local, "QM" question
255	35.224871	fe80::cb5b:e828:706...	ff02:::fb	MDNS	102	Standard query 0x0000 PTR _googlecast._tcp.local, "QM" question
256	35.252341	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
257	35.487904	Dell_42:7d:2e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.1
258	35.865003	202.17.57.2	239.255.255.250	SSDP	179	M-SEARCH * HTTP/1.1
259	36.007992	Dell_42:7d:2e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.1
260	36.055497	202.17.57.1	202.17.57.3	ICMP	74	Echo (ping) request id=0x0001, seq=7512/22557, ttl=128 (reply in 261)
261	36.056519	202.17.57.3	202.17.57.1	ICMP	74	Echo (ping) reply id=0x0001, seq=7512/22557, ttl=128 (request in 260)
262	36.088452	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
263	36.362581	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
264	36.436807	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
265	37.000175	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
266	37.012365	Dell_42:7d:2e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.1
267	37.075389	202.17.57.1	202.17.57.3	ICMP	74	Echo (ping) request id=0x0001, seq=7513/22813, ttl=128 (reply in 268)
268	37.076434	202.17.57.3	202.17.57.1	ICMP	74	Echo (ping) reply id=0x0001, seq=7513/22813, ttl=128 (request in 267)
269	37.078428	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
270	37.138381	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
350	47.512131	Dell_42:7d:2e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.1
351	47.586777	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
352	47.753285	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
353	47.937674	192.168.0.10	192.168.0.10	SNMP	154	trap iso.3.6.1.4.1.3183.1.1.1.3.6.1.4.1.3183.1.1.1
354	48.753415	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
355	48.990836	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
356	49.188372	202.17.57.1	202.17.57.4	ICMP	74	Echo (ping) request id=0x0001, seq=7514/23069, ttl=128 (reply in 357)
357	49.189373	202.17.57.4	202.17.57.1	ICMP	74	Echo (ping) reply id=0x0001, seq=7514/23069, ttl=128 (request in 356)
358	49.584896	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
359	49.753580	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
360	50.203800	202.17.57.1	202.17.57.4	ICMP	74	Echo (ping) request id=0x0001, seq=7515/23325, ttl=128 (reply in 361)
361	50.204668	202.17.57.1	202.17.57.1	ICMP	74	Echo (ping) reply id=0x0001, seq=7515/23325, ttl=128 (request in 360)
362	50.593208	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
363	50.753262	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
364	51.022303	Dell_42:7d:2e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.1
365	51.221274	202.17.57.1	202.17.57.4	ICMP	74	Echo (ping) request id=0x0001, seq=7516/23581, ttl=128 (reply in 366)
366	51.222346	202.17.57.4	202.17.57.1	ICMP	74	Echo (ping) reply id=0x0001, seq=7516/23581, ttl=128 (request in 365)
367	51.591614	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
368	52.006177	Dell_42:7d:2e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.1
369	52.241804	202.17.57.1	202.17.57.4	ICMP	74	Echo (ping) request id=0x0001, seq=7517/23837, ttl=128 (reply in 370)
370	52.242599	202.17.57.4	202.17.57.1	ICMP	74	Echo (ping) reply id=0x0001, seq=7517/23837, ttl=128 (request in 369)
371	52.591569	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
372	53.002629	Dell_42:7d:2e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.1
373	53.220804	202.17.57.4	202.17.57.255	UDP	82	51350 + 1947 Len=40
374	53.589211	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
375	54.004364	Dell_42:7d:2e	WistronI_9b:4c:d4	ARP	42	Who has 202.17.57.4? Tell 202.17.57.1
376	54.005123	WistronI_9b:4c:d4	Dell_42:7d:2e	ARP	60	202.17.57.4 is at 98:ee:cb:9b:4c:d4
377	54.044234	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
378	54.142525	WistronI_9b:4c:d4	Dell_42:7d:2e	ARP	60	Who has 202.17.57.1? Tell 202.17.57.4
379	54.142550	Dell_42:7d:2e	WistronI_9b:4c:d4	ARP	42	202.17.57.1 is at a0:29:19:42:7d:2e
380	54.673143	202.17.57.1	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=7518/24093, ttl=128 (reply in 381)
381	54.674276	202.17.57.2	202.17.57.1	ICMP	74	Echo (ping) reply id=0x0001, seq=7518/24093, ttl=128 (request in 380)
382	54.753358	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
383	54.832958	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
384	54.846250	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
385	54.990057	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
386	55.484196	fe80::cb5b:e828:706...	ff02:::1:2	DHCPv6	157	Solicit XID: 0xbcbc445 CID: 0001000126c7ddcd002b67faa194
387	55.592289	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
388	55.642582	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
389	55.679896	202.17.57.1	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=7519/24349, ttl=128 (reply in 390)
390	55.680933	202.17.57.2	202.17.57.1	ICMP	74	Echo (ping) reply id=0x0001, seq=7519/24349, ttl=128 (request in 389)
391	55.753550	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
392	56.185525	Dell_42:7d:2e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.1
393	56.579796	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
394	56.642641	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
395	56.685026	202.17.57.1	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=7520/24605, ttl=128 (reply in 396)
396	56.686822	202.17.57.2	202.17.57.1	ICMP	74	Echo (ping) reply id=0x0001, seq=7520/24605, ttl=128 (request in 395)
397	57.014179	Dell_42:7d:2e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.1
398	57.701537	202.17.57.1	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=7521/24861, ttl=128 (reply in 399)
399	57.703195	202.17.57.2	202.17.57.1	ICMP	74	Echo (ping) reply id=0x0001, seq=7521/24861, ttl=128 (request in 398)
400	57.986109	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2

Figure 29: Packet capture on Wireshark for PCI for hardware LAN connection

No.	Time	Source	Destination	Protocol	Length	Info
90	17.694761	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
91	17.947919	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.1? Tell 202.17.57.2
92	17.949145	Dell_A2:7d:2e	LCFCHeFe_fa:a1:94	ARP	60	202.17.57.1 is at a0:29:19:42:7d:2e
93	17.949342	202.17.57.2	202.17.57.1	ICMP	74	Echo (ping) request id=0x0001, seq=138/35328, ttl=128 (reply in 94)
94	17.950006	202.17.57.1	202.17.57.2	ICMP	74	Echo (ping) reply id=0x0001, seq=138/35328, ttl=128 (request in 93)
95	18.011886	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
96	18.017457	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
97	18.111548	Dell_A2:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
98	18.697747	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
99	18.746418	202.17.57.1	202.17.57.255	BROWSER	243	Host Announcement DESKTOP-ILRIG13, Workstation, Server, NT Workstation
100	18.758155	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
101	18.859588	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
102	18.962339	202.17.57.2	202.17.57.1	ICMP	74	Echo (ping) request id=0x0001, seq=139/35584, ttl=128 (reply in 103)
103	18.964333	202.17.57.1	202.17.57.2	ICMP	74	Echo (ping) reply id=0x0001, seq=139/35584, ttl=128 (request in 102)
104	19.699503	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
105	19.741770	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
106	19.859750	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
107	19.983257	202.17.57.2	202.17.57.1	ICMP	74	Echo (ping) request id=0x0001, seq=140/35840, ttl=128 (reply in 108)
108	19.984576	202.17.57.1	202.17.57.2	ICMP	74	Echo (ping) reply id=0x0001, seq=140/35840, ttl=128 (request in 107)
109	20.046474	202.17.57.4	239.255.255.250	SSDP	179	M-SEARCH * HTTP/1.1
110	20.231656	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
111	20.579649	202.17.57.0.251	MDNS		163	Standard query 0x0000 PTR _http._tcp.local, "QM" question PTR _ni-rt._tcp.local, "Q
112	20.687364	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
113	20.742895	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
114	21.004973	202.17.57.2	202.17.57.1	ICMP	74	Echo (ping) request id=0x0001, seq=141/36096, ttl=128 (reply in 115)
115	21.006391	202.17.57.1	202.17.57.2	ICMP	74	Echo (ping) reply id=0x0001, seq=141/36096, ttl=128 (request in 114)
116	21.017625	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
148	28.243521	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
149	28.569744	202.17.57.3	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=101/25856, ttl=128 (reply in 152)
150	28.570200	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.3? Tell 202.17.57.2
151	28.570541	D-LinkIn_d2:1c:7e	LCFCHeFe_fa:a1:94	ARP	60	202.17.57.3 is at bc:0f:9a:d2:1c:7e
152	28.570603	202.17.57.2	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=101/25856, ttl=128 (request in 149)
153	28.621888	Dell_A2:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
154	28.651121	202.17.57.4	202.17.57.255	NBNS	92	Name query NB WORKGROUP<1c>
155	28.686779	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
156	29.058721	202.17.57.4	239.255.255.250	SSDP	179	M-SEARCH * HTTP/1.1
157	29.243719	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
158	29.415267	202.17.57.4	202.17.57.255	NBNS	92	Name query NB WORKGROUP<1c>
159	29.572727	202.17.57.3	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=102/26112, ttl=128 (reply in 160)
160	29.573077	202.17.57.2	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=102/26112, ttl=128 (request in 159)
161	29.696539	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
162	30.165746	202.17.57.4	202.17.57.255	NBNS	92	Name query NB WORKGROUP<1c>
163	30.200809	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
164	30.577793	202.17.57.3	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=103/26368, ttl=128 (reply in 165)
165	30.578190	202.17.57.2	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=103/26368, ttl=128 (request in 164)
166	30.859623	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
167	30.900717	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
168	31.582854	202.17.57.3	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=104/26624, ttl=128 (reply in 169)
169	31.583190	202.17.57.2	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=104/26624, ttl=128 (request in 168)
170	31.655995	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
265	49.334073	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
266	49.360059	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
267	49.602295	202.17.57.2	202.17.57.3	ICMP	74	Echo (ping) request id=0x0001, seq=148/37888, ttl=128 (reply in 268)
268	49.602994	202.17.57.3	202.17.57.2	ICMP	74	Echo (ping) reply id=0x0001, seq=148/37888, ttl=128 (request in 267)
269	49.695544	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
270	50.240135	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
271	50.359423	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
272	50.616538	202.17.57.2	202.17.57.3	ICMP	74	Echo (ping) request id=0x0001, seq=149/38144, ttl=128 (reply in 273)
273	50.617330	202.17.57.3	202.17.57.2	ICMP	74	Echo (ping) reply id=0x0001, seq=149/38144, ttl=128 (request in 272)
274	51.029189	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
275	51.240239	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
276	51.691535	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
277	52.240024	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
308	61.360463	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.4? Tell 202.17.57.2
309	61.360976	WistronI_9b:4c:d4	LCFCHeFe_fa:a1:94	ARP	60	202.17.57.4 is at 98:ee:cb:9b:4c:d4
310	61.361027	202.17.57.2	202.17.57.4	ICMP	74	Echo (ping) request id=0x0001, seq=150/38400, ttl=128 (reply in 311)
311	61.362092	202.17.57.4	202.17.57.2	ICMP	74	Echo (ping) reply id=0x0001, seq=150/38400, ttl=128 (request in 310)
312	61.860623	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
313	62.035642	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
314	62.367952	202.17.57.2	202.17.57.4	ICMP	74	Echo (ping) request id=0x0001, seq=151/38656, ttl=128 (reply in 315)
315	62.369254	202.17.57.4	202.17.57.2	ICMP	74	Echo (ping) reply id=0x0001, seq=151/38656, ttl=128 (request in 314)
316	62.696550	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
317	62.762846	Dell_A2:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
318	62.771569	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
319	62.860045	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
320	63.384798	202.17.57.2	202.17.57.4	ICMP	74	Echo (ping) request id=0x0001, seq=152/38912, ttl=128 (reply in 321)
321	63.385979	202.17.57.4	202.17.57.2	ICMP	74	Echo (ping) reply id=0x0001, seq=152/38912, ttl=128 (request in 320)
322	63.620440	Dell_A2:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
323	63.666512	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
324	63.697992	LCFCHeFe_fa:a1:94	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.2
325	63.739930	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
326	64.404765	202.17.57.2	202.17.57.4	ICMP	74	Echo (ping) request id=0x0001, seq=153/39168, ttl=128 (reply in 327)
327	64.406046	202.17.57.4	202.17.57.2	ICMP	74	Echo (ping) reply id=0x0001, seq=153/39168, ttl=128 (request in 326)
328	64.612797	Dell_A2:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1

Figure 30: Packet capture on Wireshark for PC2 for hardware LAN connection

No.	Time	Source	Destination	Protocol	Length	Info
87	21.802766	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
88	22.037768	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
89	22.162382	D-LinkIn_d2:1c:7e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.3
90	22.341450	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
91	22.415841	202.17.57.3	202.17.57.1	ICMP	74	Echo (ping) request id=0x0001, seq=109/27904, ttl=128 (reply in 92)
92	22.416755	202.17.57.1	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=109/27904, ttl=128 (request in 91)
93	22.420696	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
94	22.991319	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
95	23.162265	D-LinkIn_d2:1c:7e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.3
96	23.318679	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
97	23.416103	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
98	23.418099	202.17.57.3	202.17.57.1	ICMP	74	Echo (ping) request id=0x0001, seq=110/28160, ttl=128 (reply in 99)
99	23.419500	202.17.57.1	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=110/28160, ttl=128 (request in 98)
100	23.996681	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
101	24.052941	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
102	24.421349	202.17.57.3	202.17.57.1	ICMP	74	Echo (ping) request id=0x0001, seq=111/28416, ttl=128 (reply in 103)
103	24.422882	202.17.57.1	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=111/28416, ttl=128 (request in 102)
104	25.052711	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
105	25.361212	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
106	25.379179	D-LinkIn_d2:1c:7e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.3
107	25.425407	202.17.57.3	202.17.57.1	ICMP	74	Echo (ping) request id=0x0001, seq=112/28672, ttl=128 (reply in 108)
108	25.426386	202.17.57.1	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=112/28672, ttl=128 (request in 107)
109	25.825864	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
110	25.998980	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
111	26.162311	D-LinkIn_d2:1c:7e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.3
112	26.299510	202.17.57.3	239.255.255.250	SSDP	217	M-SEARCH * HTTP/1.1
113	26.315419	202.17.57.3	239.255.255.250	SSDP	216	M-SEARCH * HTTP/1.1
114	26.415104	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
115	26.915045	Dell_42:7d:2e	D-LinkIn_d2:1c:7e	ARP	60	Who has 202.17.57.3?
116	26.915088	D-LinkIn_d2:1c:7e	Dell_42:7d:2e	ARP	42	202.17.57.3 is at bc:0f:9a:d2:1c:7e
117	26.989283	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
118	27.162136	D-LinkIn_d2:1c:7e	Dell_42:7d:2e	ARP	42	Who has 202.17.57.1?
119	27.162178	D-LinkIn_d2:1c:7e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.3
120	27.162759	Dell_42:7d:2e	D-LinkIn_d2:1c:7e	ARP	60	202.17.57.1 is at a0:29:19:42:7d:2e
121	27.252778	202.17.57.3	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=113/28928, ttl=128 (reply in 122)
122	27.253570	202.17.57.2	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=113/28928, ttl=128 (request in 121)
123	27.306545	202.17.57.3	239.255.255.250	SSDP	217	M-SEARCH * HTTP/1.1
124	27.322164	202.17.57.3	239.255.255.250	SSDP	216	M-SEARCH * HTTP/1.1
125	27.415001	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
126	28.162109	D-LinkIn_d2:1c:7e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.3
127	28.255393	202.17.57.3	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=114/29184, ttl=128 (reply in 128)
128	28.256312	202.17.57.2	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=114/29184, ttl=128 (request in 127)
129	28.314296	202.17.57.3	239.255.255.250	SSDP	217	M-SEARCH * HTTP/1.1
130	28.329899	202.17.57.3	239.255.255.250	SSDP	216	M-SEARCH * HTTP/1.1
131	28.345276	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
132	28.417409	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
133	28.999735	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
134	29.162189	D-LinkIn_d2:1c:7e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.3
135	29.260430	202.17.57.3	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=115/29440, ttl=128 (reply in 136)
136	29.261298	202.17.57.2	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=115/29440, ttl=128 (request in 135)
137	29.322268	202.17.57.3	239.255.255.250	SSDP	217	M-SEARCH * HTTP/1.1
138	29.337985	202.17.57.3	239.255.255.250	SSDP	216	M-SEARCH * HTTP/1.1
139	29.349424	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
140	29.417642	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
141	29.996408	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
142	30.052216	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
143	30.162492	D-LinkIn_d2:1c:7e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.3
144	30.265619	202.17.57.3	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=116/29696, ttl=128 (reply in 145)
145	30.266911	202.17.57.2	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=116/29696, ttl=128 (request in 144)
146	30.358718	192.168.0.10	192.168.0.10	SNMP	154	trap iso.3.6.1.4.1.3183.1.1.3.6.1.4.1.3183.1.1.1
147	30.998409	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
148	31.051663	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
149	31.996416	LCFCHeFe_fa:a1:94	D-LinkIn_d2:1c:7e	ARP	60	Who has 202.17.57.3?
150	31.996453	D-LinkIn_d2:1c:7e	LCFCHeFe_fa:a1:94	ARP	42	202.17.57.3 is at bc:0f:9a:d2:1c:7e
151	31.996509	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
152	32.162372	D-LinkIn_d2:1c:7e	LCFCHeFe_fa:a1:94	ARP	42	Who has 202.17.57.233? Tell 202.17.57.3
153	32.162914	LCFCHeFe_fa:a1:94	D-LinkIn_d2:1c:7e	ARP	60	202.17.57.2 is at 00:2b:67:fa:a1:94
154	32.287761	202.17.57.3	202.17.57.4	ICMP	74	Echo (ping) request id=0x0001, seq=117/29952, ttl=128 (reply in 155)
155	32.288577	202.17.57.4	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=117/29952, ttl=128 (request in 154)
156	32.998609	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
157	33.147478	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
158	33.291123	202.17.57.3	202.17.57.4	ICMP	74	Echo (ping) request id=0x0001, seq=118/30208, ttl=128 (reply in 159)
159	33.291693	202.17.57.4	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=118/30208, ttl=128 (request in 158)
160	33.354083	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
161	33.379115	D-LinkIn_d2:1c:7e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.3
162	33.829780	202.17.57.3	202.17.57.255	BROWSER	243	Host Announcement LAPTOP-03M7UR09, Workstation, Server, NT Workstation
163	33.925691	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
164	34.037924	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
165	34.162048	D-LinkIn_d2:1c:7e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.3
166	34.296618	202.17.57.3	202.17.57.4	ICMP	74	Echo (ping) request id=0x0001, seq=119/30464, ttl=128 (reply in 167)
167	34.297155	202.17.57.4	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=119/30464, ttl=128 (request in 166)
168	34.346860	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
169	34.351165	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
170	34.915482	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
171	35.001873	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
172	35.039550	WistronI_9b:4c:d4	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.4
173	35.161968	D-LinkIn_d2:1c:7e	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.3
174	35.300340	202.17.57.3	202.17.57.4	ICMP	74	Echo (ping) request id=0x0001, seq=120/30720, ttl=128 (reply in 175)
175	35.301102	202.17.57.4	202.17.57.3	ICMP	74	Echo (ping) reply id=0x0001, seq=120/30720, ttl=128 (request in 174)
176	35.360915	LCFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
177	35.470259	202.17.57.1	202.17.57.255	DB-LSP...	175	Dropbox LAN sync Discover Protocol, JavaScript Object Notation

Figure 31: Packet capture on Wireshark for PC3 for hardware LAN connection

No.	Time	Source	Destination	Protocol	Length	Info
172	19.265925	Dell_42:7d:2e	WistronI_9b:4c:d4	ARP	60	202.17.57.1 is at a0:29:19:42:7d:2e
173	19.265971	202.17.57.4	202.17.57.1	ICMP	74	Echo (ping) request id=0x0001, seq=1/256, ttl=128 (reply in 174)
174	19.267417	202.17.57.1	202.17.57.4	ICMP	74	Echo (ping) reply id=0x0001, seq=1/256, ttl=128 (request in 173)
175	19.513149	202.17.57.4	239.255.255.250	UDP	694	49666 → 3702 Len=652
176	19.517456	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
177	19.638092	fe80::7151:e83b:ed4...	ff02::c	UDP	714	49667 → 3702 Len=652
178	19.784595	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
179	19.852650	LFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
180	19.903275	WistronI_9b:4c:d4	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.4
181	20.106613	202.17.57.4	239.255.255.250	UDP	698	49666 → 3702 Len=656
182	20.278519	202.17.57.4	202.17.57.1	ICMP	74	Echo (ping) request id=0x0001, seq=2/512, ttl=128 (reply in 184)
183	20.278548	fe80::7151:e83b:ed4...	ff02::c	UDP	718	49667 → 3702 Len=656
184	20.280177	202.17.57.1	202.17.57.4	ICMP	74	Echo (ping) reply id=0x0001, seq=2/512, ttl=128 (request in 182)
185	20.622222	fe80::7151:e83b:ed4...	ff02::c	UDP	714	49667 → 3702 Len=652
186	20.715991	202.17.57.4	239.255.255.250	UDP	698	49666 → 3702 Len=656
187	20.761426	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
188	20.851243	LFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
189	20.903025	WistronI_9b:4c:d4	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.4
190	20.934641	fe80::7151:e83b:ed4...	ff02::c	UDP	718	49667 → 3702 Len=656
191	21.121987	202.17.57.4	239.255.255.250	UDP	694	49666 → 3702 Len=652
192	21.293925	202.17.57.4	202.17.57.1	ICMP	74	Echo (ping) request id=0x0001, seq=3/768, ttl=128 (reply in 193)
193	21.295283	202.17.57.1	202.17.57.4	ICMP	74	Echo (ping) reply id=0x0001, seq=3/768, ttl=128 (request in 192)
194	21.517752	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
195	21.528309	202.17.57.4	239.255.255.250	UDP	694	49666 → 3702 Len=652
196	21.653227	fe80::7151:e83b:ed4...	ff02::c	UDP	714	49667 → 3702 Len=652
197	21.965609	WistronI_9b:4c:d4	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.4
198	22.040199	LFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
199	22.121748	202.17.57.4	239.255.255.250	UDP	698	49666 → 3702 Len=656
200	22.293823	fe80::7151:e83b:ed4...	ff02::c	UDP	718	49667 → 3702 Len=656
201	22.309202	202.17.57.4	202.17.57.1	ICMP	74	Echo (ping) request id=0x0001, seq=4/1024, ttl=128 (reply in 202)
202	22.310492	202.17.57.1	202.17.57.4	ICMP	74	Echo (ping) reply id=0x0001, seq=4/1024, ttl=128 (request in 201)
203	22.517087	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
220	24.136973	202.17.57.4	239.255.255.250	UDP	698	49666 → 3702 Len=656
221	24.308832	fe80::7151:e83b:ed4...	ff02::c	UDP	718	49667 → 3702 Len=656
222	24.454396	WistronI_9b:4c:d4	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.4
223	24.455091	LFCHeFe_fa:a1:94	WistronI_9b:4c:d4	ARP	60	202.17.57.2 is at 00:2b:67:fa:a1:94
224	24.455104	202.17.57.4	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=5/1280, ttl=128 (reply in 225)
225	24.455736	202.17.57.2	202.17.57.4	ICMP	74	Echo (ping) reply id=0x0001, seq=5/1280, ttl=128 (request in 224)
226	24.516703	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
227	24.652597	fe80::7151:e83b:ed4...	ff02::c	UDP	714	49667 → 3702 Len=652
228	24.789651	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
229	24.902440	WistronI_9b:4c:d4	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.4
230	25.466265	202.17.57.4	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=6/1536, ttl=128 (reply in 231)
231	25.467245	202.17.57.2	202.17.57.4	ICMP	74	Echo (ping) reply id=0x0001, seq=6/1536, ttl=128 (request in 230)
232	25.511295	LFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
233	25.981393	202.17.57.1	202.17.57.255	DB-LSP...	175	Dropbox LAN sync Discovery Protocol, JavaScript Object Notation
234	26.184652	WistronI_9b:4c:d4	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.4
235	26.350797	LFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
236	26.481675	202.17.57.4	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=7/1792, ttl=128 (reply in 237)
237	26.482742	202.17.57.2	202.17.57.4	ICMP	74	Echo (ping) reply id=0x0001, seq=7/1792, ttl=128 (request in 236)
238	26.903234	WistronI_9b:4c:d4	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.4
239	27.362364	LFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
240	27.497388	202.17.57.4	202.17.57.2	ICMP	74	Echo (ping) request id=0x0001, seq=8/2048, ttl=128 (reply in 241)
241	27.498466	202.17.57.2	202.17.57.4	ICMP	74	Echo (ping) reply id=0x0001, seq=8/2048, ttl=128 (request in 240)
242	27.903343	WistronI_9b:4c:d4	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.4
243	28.254151	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
265	30.127599	WistronI_9b:4c:d4	Broadcast	ARP	42	Who has 202.17.57.3? Tell 202.17.57.4
266	30.128407	D-LinkIn_d2:1c:7e	WistronI_9b:4c:d4	ARP	60	202.17.57.3 is at bc:0f:9a:d2:1c:7e
267	30.128419	202.17.57.4	202.17.57.3	ICMP	74	Echo (ping) request id=0x0001, seq=9/2304, ttl=128 (reply in 268)
268	30.129088	202.17.57.3	202.17.57.4	ICMP	74	Echo (ping) reply id=0x0001, seq=9/2304, ttl=128 (request in 267)
269	30.393274	202.17.57.2	202.17.57.255	NBNS	92	Name query NB WPAD<0>
270	30.644965	202.17.57.2	224.0.0.251	MDNS	70	Standard query 0x0000 AAAA wpad.local, "QM" question
271	30.645942	fe80::cb5b:e828:706...	ff02::fb	MDNS	70	Standard query 0x0000 AAAA wpad.local, "QM" question
272	30.646931	202.17.57.2	224.0.0.251	MDNS	70	Standard query 0x0000 A wpad.local, "QM" question
273	30.647962	fe80::cb5b:e828:706...	ff02::fb	MDNS	90	Standard query 0x0000 A wpad.local, "QM" question
274	30.695851	AxiomTec_4c:f8:ea	CDP/VTTP/DTTP/PAgP/UD...	CDP	168	Device ID: SR14 Port ID: eth0
275	30.861884	LFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
276	30.905057	WistronI_9b:4c:d4	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.4
277	31.139576	202.17.57.4	202.17.57.3	ICMP	74	Echo (ping) request id=0x0001, seq=10/2560, ttl=128 (reply in 278)
278	31.140594	202.17.57.3	202.17.57.4	ICMP	74	Echo (ping) reply id=0x0001, seq=10/2560, ttl=128 (request in 277)
279	31.156613	202.17.57.2	202.17.57.255	NBNS	92	Name query NB WPAD<0>
280	31.984888	WistronI_9b:4c:d4	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.4
281	32.061616	LFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
282	32.155899	202.17.57.4	202.17.57.3	ICMP	74	Echo (ping) request id=0x0001, seq=11/2816, ttl=128 (reply in 283)
283	32.156923	202.17.57.3	202.17.57.4	ICMP	74	Echo (ping) reply id=0x0001, seq=11/2816, ttl=128 (request in 282)
284	32.762006	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3
285	32.856828	LFCHeFe_fa:a1:94	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.2
286	32.905858	WistronI_9b:4c:d4	Broadcast	ARP	42	Who has 202.17.57.233? Tell 202.17.57.4
287	33.171478	202.17.57.4	202.17.57.3	ICMP	74	Echo (ping) request id=0x0001, seq=12/3072, ttl=128 (reply in 288)
288	33.172243	202.17.57.3	202.17.57.4	ICMP	74	Echo (ping) reply id=0x0001, seq=12/3072, ttl=128 (request in 287)
289	33.422507	Dell_42:7d:2e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.1
290	33.516844	D-LinkIn_d2:1c:7e	Broadcast	ARP	60	Who has 202.17.57.233? Tell 202.17.57.3

Figure 32: Packet capture on Wireshark for PC4 for hardware LAN connection

6.0 Discussion

a) What is the purpose of network switching?

Network switching is the process of forwarding incoming data packets from one port or the source, out to another port or the destination [5]. Link-layer switches forward data packets in an access network [4]. The functions of link-layer switching or Layer 2 switching are the following; address learning, forwarding and filtering, and loop avoidance [3].

Switches forward traffic based on MAC addresses. To be able to do this, switches learn which devices are on which segments of the network by looking at the source addresses of the frames it receives which is added to a table that is retained by the switch. The process of forwarding has been mentioned prior. Filtering is the process of dropping a frame when the source MAC address is the same as the destination MAC address. Lastly, loop avoidance which carried out by the Spanning Tree Protocol (STP) to stop network loops while permitting redundancy to prevent complete failure in a particular link. [3]

b) Which networking layer does the switch operate in?

Switches operate in the data link layer, which is Layer 2 of the TCP/IP Internet Protocol stack where the data packets are known as frames. Network protocols such as Ethernet and Wi-Fi are used in this layer [1]. The layers of the TCP/IP Internet Protocol stack are shown in Figure 33 below.

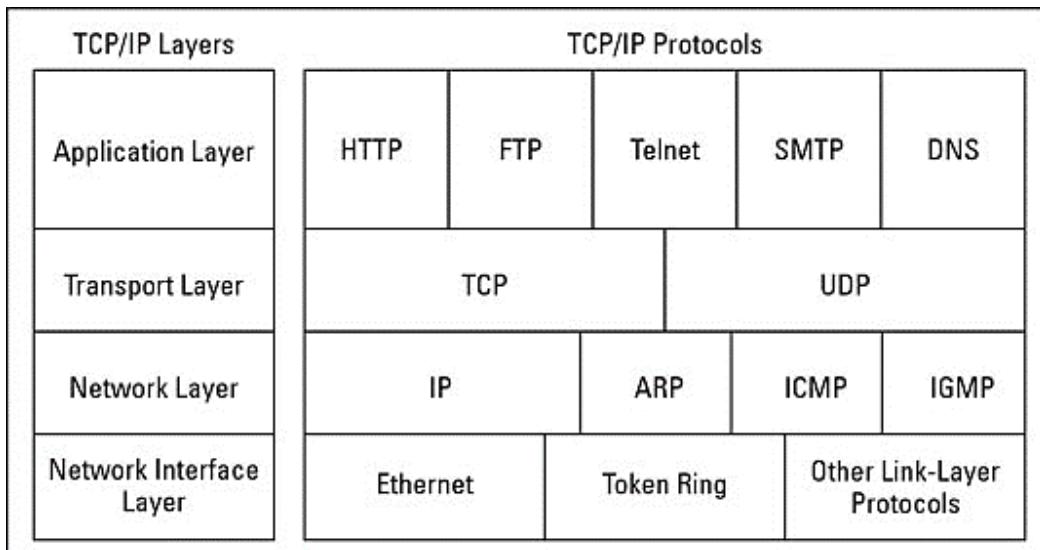


Figure 33: Layers of the TCP/IP Internet protocol stack [15]

c) What is the difference between bridging and switching?

Overall, a network bridge connects two LANs whereas a network switch connects multiple hosts to a network. They both operate on the data link layer and can filter data so that the correct host receives a transmission [2]. Table 4 below shows the differences between a switch and a bridge.

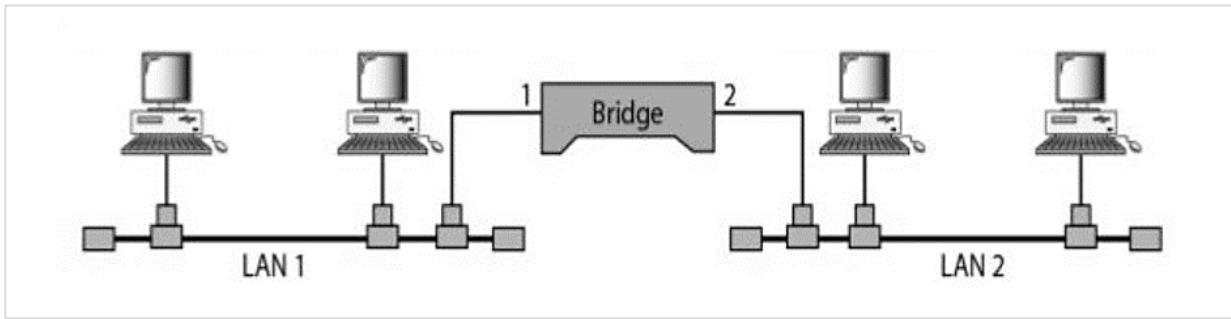


Figure 34: A two-port bridge linking two LANs [6]

Table 4: Differences between a bridge and a switch [2]

	Bridge	Switch
Packet forwarding	Performed using software	Performed using ASICs. Switches are hardware based.
Method of switching	Store and forward method	Store and forward, cut-through, and fragment-free methods.
Number of ports	2 ports only	Multiple ports
Function	Device that connects two LANs and controls data flow between them.	Networking device that learns hosts through port connections by their IP addresses.
Division of collision domain	Divides collision domain into two parts. Bridges can create collision domains but not broadcast domains.	Used to connect workstations or computer systems whereby a separate collision domain is created for each node that is connected to the switch. Switches can also create multiple broadcast domains.

d) **What is the difference between normal and managed switches?**

[8] [9] The main difference between normal or unmanaged switches versus managed switches is the control the user has over the settings. Unmanaged or normal switches have no settings that have to be configured and are designed to simply be plugged in and run. However, managed switches are fully configurable and customisable which makes them more suitable for larger networks and other critical network-supporting activities [9]. Table 5 below shows the key differences between normal and managed features.

Table 5: Differences between normal and managed switches [8][9]

	Normal Switch	Managed Switch
Performance	Can be plugged in and run immediately with a network	Channels can be prioritised ensuring optimal performance where needed.

Security	Only has basic security	Able to monitor and control the network to shut down active threats, protection for data, control, and managing plans
Cost	Relatively cheap and simple to operate	More expensive and require more expertise to run which adds to cost
Application	Used in smaller networks such as homes, single offices, and smaller businesses.	Used in larger networks such as in enterprise-sized businesses and data centres that require more control over traffic.

e) ***How many nodes are maximum/available for switching?***

A node is a connection point among network devices such as switches, routers, and printers which are able to send and receive data from one endpoint to another. Switches examine destination addresses and can carry out error checking during transmission [17]. Assuming a star-topology configuration as was conducted during the laboratory session, the maximum number of addressable nodes on a network is 1024 [16]. This particular number of nodes is the maximum number of attempts the network will try to transmit a packet before being reported as failed [17].

f) ***Discuss switching access mode.***

The command ‘switchport mode access’ is a command used both for the LISA emulator as well as the LISA hardware switching appliance to force a particular port on the switch to be an access port or in ‘access mode’ so that any device connected to it will be able to communicate with another device that is also connected to the same VLAN. The ‘access mode’ is typically used to connect terminating end devices such as PCs and laptops. [12]

g) ***What is the difference between network simulation and emulation?***

Simulators create an environment that contains all of the variables that would exist in the real environment. Typically, simulators are used for software testing scenarios [13]. Network simulators utilise mathematical formulas to create a purely theoretical and virtual model of a network and is typically used for research and educational purposes however they are crucial in network testing, design and development. The downside however is that simulators are unable to anticipate certain events that may occur in a physical network [14].

Emulators attempt to mimic the actual environment which could consist of both hardware and software configurations. They are suitable for testing how software interacts with the underlying hardware or a combination of both [13]. Network emulators are used to test the performance of an actual network. They allow testing, performance validation and trouble shooting and are available as both hardware or software solutions. A network emulator is able to accurately replicate a client-server connection without the need for an actual device such

as a router or modem. ‘Problems’ like packet loss, delay and jitter can also be modelled [14] to account for the issues faced in networking in the real world.

h) What is the difference between network emulation and real-world implementation?

As mentioned prior, network emulation is an attempt to mimic the actual environment of a network using configurations for either software or hardware or both in order to test the actual performance of a network. Often emulation is used as a testing method before the real-world implementation of a network to eradicate as many issues as possible to prevent ‘costly accidents’. Of course, the real-world implementation of a network provides the actual environment so there may be some unforeseen or unexpected occurrences that were not considered during emulation.

i) Explain about the Linux Switching Appliance (LISA).

LISA or Linux Switching Appliance is a multilayer emulation switching device that runs on PC hardware architecture running Linux. LISA is able to perform Layer 2 and Layer 3 packet switching. It is also able to run dynamic routing protocols such as OSPF and BGP [11].

There are 2 major components to running LISA; Linux multilayer Switch which is a Linux kernel module that performs Layer 2 switching and implements virtual interfaces for inter-VLAN routing and a command line interface is used to configure and control the switching process.

j) Provide TWO other open-source switching software apart from LISA that can be run on Linux.

An open-source switching software or VM is PicOS-V which is distributed by Pica8 [19]. It is available for various platforms; ONIE, VMware, ESXi, GNS3 and VirtualBox. Another virtual switch is Open vSwitch which is licensed under the open-source Apache 2.0 [20]. Both the mentioned switching software; PicOS-V and Open vSwitch are compatible with the Linux operating system.

k) Discuss your achievements and problems encountered during the laboratory session.

All the intended objectives of the laboratory session were accomplished successfully. Switching was carried out in the star-topology in three stages; simulation, emulation, and real-world implementation. There were no major problems encountered during any of the stages as the ping commands were carried out between the VPCS or PCs successfully.

The first experiment involved the simulation of a star-topology connection using the GNS3 Ethernet switch. The ping command was carried out between all the VPCS and resulted successfully. The console windows and Wireshark captures are shown above from Figure 8 to Figure 15. The second experiment involved the software emulation of the same start-topology configuration using the LISA emulator. A similar process was carried out as the simulation and also gave a successful outcome. The console windows and Wireshark captures are shown above from Figure 16 to Figure 23.

There was a minor setback while carrying out the last experiment which was the hardware implementation of LISA. There was an instance where the ping command was not successful with PC3 and showed the following on the command line interface as shown in Figure 35 below. This issue however was quickly resolved by turning off the firewall on PC3 which blocked all ‘incoming connections’. It was ensured that the firewall was turned off for all PCs to prevent this from occurring again. The successful hardware results are shown above from Figure 25 to Figure 32.

```
C:\ Select Command Prompt
Reply from 202.17.57.2: Destination host unreachable.
Reply from 202.17.57.2: Destination host unreachable.

Ping statistics for 202.17.57.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

C:\Users\g3>ping 202.17.57.3

Pinging 202.17.57.3 with 32 bytes of data:
Reply from 202.17.57.2: Destination host unreachable.

Ping statistics for 202.17.57.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

C:\Users\g3>ping 202.17.57.3

Pinging 202.17.57.3 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 202.17.57.3:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Figure 35: PC3 found to be unreachable when ping command was carried out

7.0 Conclusion

The objectives of the laboratory session were fulfilled successfully as the desired results were obtained. The simulation and emulation of the star-topology network were carried out without any issues and the ping command was executed between the VPCS. For the hardware implementation of the network using the LISA appliance, there were no major issues and the ping command was also executed without problems. It was ensured that the configuration of the devices was done correctly. For all three laboratory experiments, the transferred packets during the execution of the ping command were monitored using Wireshark. Figure 36 below shows the setup of hardware implementation in the laboratory.

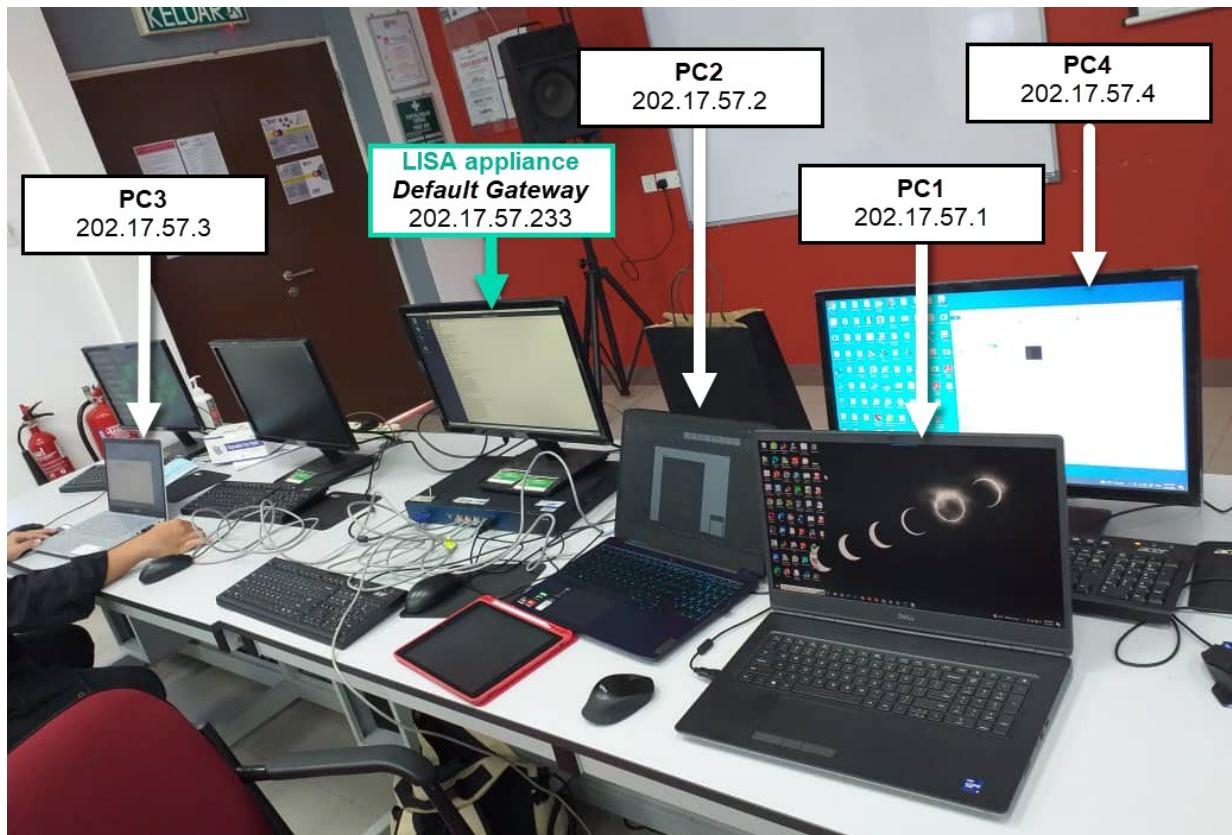


Figure 36: Setup of PCs and LISA appliance in the laboratory

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