

SAND PMA

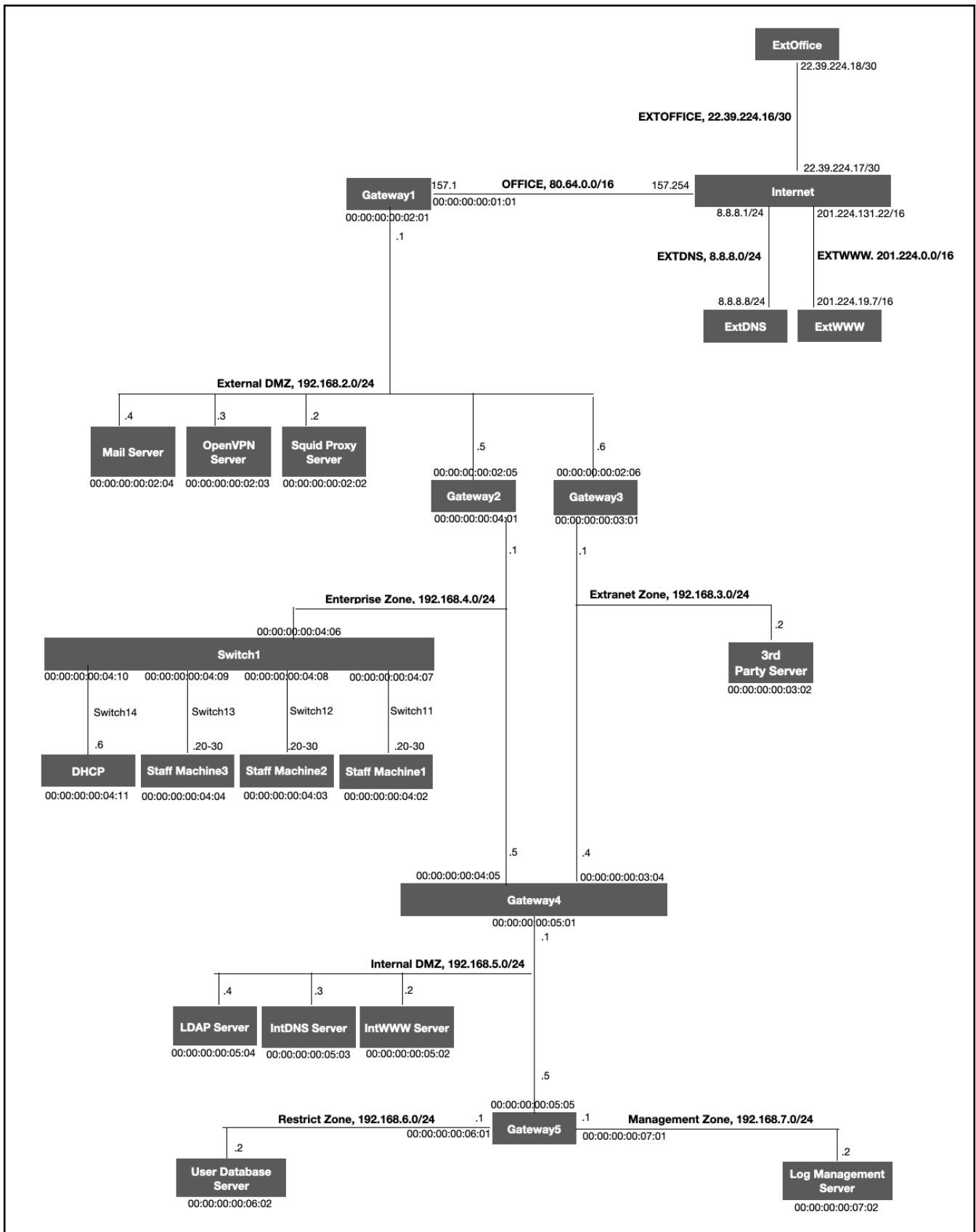
Student ID or IDs for group work	2126529
Module Date	7th - 11th November 2022

Date set	10 th Nov 2022
Submission date (excluding extensions)	12 th Dec 2022
Submission guidance	Several files of several types to be submitted via tabula (See Assignment Specification supplied separately) Also viva / demo
Marks return date (excluding extensions)	18 th Jan 2023
Late submission policy	If work is submitted late, penalties will be applied at the rate of 5 marks per University working day after the due date, up to a maximum of 10 working days late. After this period the mark for the work will be reduced to 0 (which is the maximum penalty). “Late” means after the submission deadline time as well as the date – work submitted after the given time even on the same day is counted as 1 day late. For Postgraduate students only, who started their current course before 1 August 2019 , the daily penalty is 3 marks rather than 5.
Resubmission policy	If you fail this assignment or module, please be aware that the University allows students to remedy such failure (within certain limits). Decisions to authorise such resubmissions are made by Exam Boards. Normally these will be issued at specific times of the year, depending on your programme of study. More information can be found from your programme office if you are concerned.

Module title & code	ES94P-15 Security Architecture and Network Defence (SAND)
Module owner	Peter Norris
Module tutor	Peter Norris
Module marker	Peter Norris
Assessment type	Technical securing of organisation’s assets (design, implement, test) in emulated environment, evaluation of proposal, with demo/viva. All to be consistent with each other.
Weighting of mark	100%

Phase1:

1.1 Clearly represent the zones of trust, the network topology and ip addressing used in the network diagram in the pdf[1]



1.2 Define and implement credible zones of trust and re-organised IP addressing[1]

- Internet Zone (No Trust):

	IP Address	Mac Address
ExtOffice	22.39.224.18/30	X
ExtDNS	8.8.8.8/24	X
ExtWWW	201.224.19.7/16	X

- External DMZ (Low Trust):

	IP Address	Mac Address
Squid Proxy Server	192.168.2.2/24	00:00:00:00:02:02
OpenVPN Server	192.168.2.3/24	00:00:00:00:02:03
Mail Server	192.168.2.4/24	00:00:00:00:02:04

- Enterprise Zone (Medium Trust):

	IP Address	Mac Address
Staff Machine1	192.168.4.20-30/24	00:00:00:00:04:02
Staff Machine2	192.168.4.20-30/24	00:00:00:00:04:03
Staff Machine3	192.168.4.20-30/24	00:00:00:00:04:04

- Extranet Zone (Medium Trust):

	IP Address	Mac Address
3rd Party Server	192.168.3.2/24	00:00:00:00:03:02

- Internal DMZ (High Trust):

	IP Address	Mac Address
IntWWW Server	192.168.5.2/24	00:00:00:00:05:02
IntDNS Server	192.168.5.3/24	00:00:00:00:05:03
LDAP Server	192.168.5.4/24	00:00:00:00:05:04

- Restrict Zone (Highest Trust):

	IP Address	Mac Address
User Database Server	192.168.6.2/24	00:00:00:00:06:02

- Management Zone (Highest Trust):

	IP Address	Mac Address
Log Management Server	192.168.7.2/24	00:00:00:00:07:02

1.3 Define and implement filters between zones of trust (All use TCP protocol)

- External DMZ (Low Trust) - Enterprise Zone (Medium Trust)

	IP Address:Port	IP Address:Port
Squid Server → All Staff	192.168.2.2/24:Any	192.168.4.0/24:5000
OpenVPN Server → All Staff	192.168.2.3/24:Any	192.168.4.0/24:5000
Mail Server → All Staff	192.168.2.4/24:Any	192.168.4.0/24:5000

- Enterprise Zone (Medium Trust) - Extranet Zone (Medium Trust)

	IP Address:Port	IP Address:Port
All Staff → 3rd Party Server	192.168.4.0/24:Any	192.168.3.2/24:6000
3rd Party Server → All Staff	192.168.3.2/24:Any	192.168.4.0/24:5000

- Enterprise Zone (Medium Trust) - Internal DMZ (High Trust)

	IP Address:Port	IP Address:Port
All Staff → IntWWW Server	192.168.4.0/24:Any	192.168.5.2/24:8080
All Staff → IntDNS Server	192.168.4.0/24:Any	192.168.5.3/24:53
All Staff → LDAP Server	192.168.4.0/24:Any	192.168.5.4/24:389

- Internal DMZ (High Trust) - Restrict Zone (Highest Trust)

	IP Address:Port	IP Address:Port
IntWWW Server → User DB Server	192.168.5.2/24:Any	192.168.6.2/24:1433
LDAP Server → User DB Server	192.168.5.4/24:Any	192.168.6.2/24:1433

- Management Zone (Highest Trust) - All Zone

	IP Address:Port	IP Address:Port
Log Management → External DMZ	192.168.7.2/24:Any	192.168.2.0/24:Any
Log Management → Enterprise Zone	192.168.7.2/24:Any	192.168.3.0/24:Any
Log Management → Extranet Zone	192.168.7.2/24:Any	192.168.4.0/24:Any
Log Management → Internal DMZ	192.168.7.2/24:Any	192.168.5.0/24:Any
Log Management → Restrict Zone	192.168.7.2/24:Any	192.168.6.0/24:Any

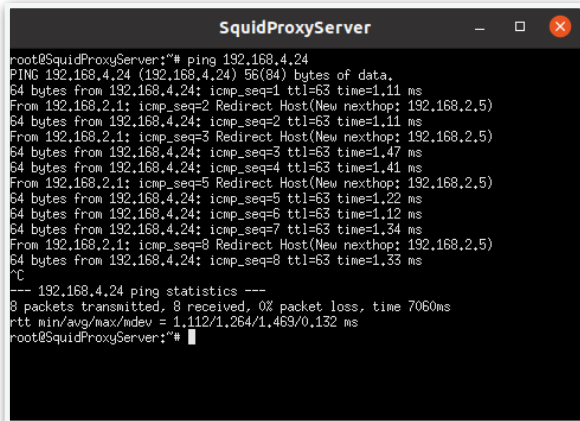
1.4 Partially verify that connectivity is achieved / prevented as appropriate between clients and services

1.4.1 Ping(ICMP) devices between zones to ensure the ip routes we set are correct

To simplify, we select one machine in each zone to ensure ip routes we set are achieved below

External DMZ (Low Trust) - Enterprise Zone (Medium Trust)

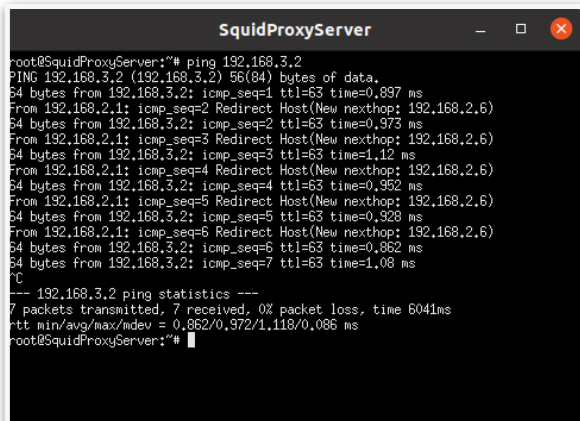
- Squid Server - Staff Machine1 (/hostlab/shared/1_4_1_1.pcap)



```
root@SquidProxyServer:~# ping 192.168.4.24
PING 192.168.4.24 (192.168.4.24) 56(84) bytes of data:
64 bytes from 192.168.4.24: icmp_seq=1 ttl=63 time=1.11 ms
From 192.168.2.1: icmp_seq=2 Redirect Host(New nexthop: 192.168.2.5)
64 bytes from 192.168.4.24: icmp_seq=2 ttl=63 time=1.11 ms
From 192.168.2.1: icmp_seq=3 Redirect Host(New nexthop: 192.168.2.5)
64 bytes from 192.168.4.24: icmp_seq=3 ttl=63 time=1.47 ms
64 bytes from 192.168.4.24: icmp_seq=4 ttl=63 time=1.41 ms
From 192.168.2.1: icmp_seq=5 Redirect Host(New nexthop: 192.168.2.5)
64 bytes from 192.168.4.24: icmp_seq=5 ttl=63 time=1.22 ms
64 bytes from 192.168.4.24: icmp_seq=6 ttl=63 time=1.12 ms
64 bytes from 192.168.4.24: icmp_seq=7 ttl=63 time=1.34 ms
From 192.168.2.1: icmp_seq=8 Redirect Host(New nexthop: 192.168.2.5)
64 bytes from 192.168.4.24: icmp_seq=8 ttl=63 time=1.33 ms
^C
--- 192.168.4.24 ping statistics ---
8 packets transmitted, 8 received, 0% packet loss, time 7060ms
rtt min/avg/max/mdev = 1.112/1.264/1.463/0.132 ms
root@SquidProxyServer:~#
```

• External DMZ (Low Trust) - Extranet Zone (Medium Trust)

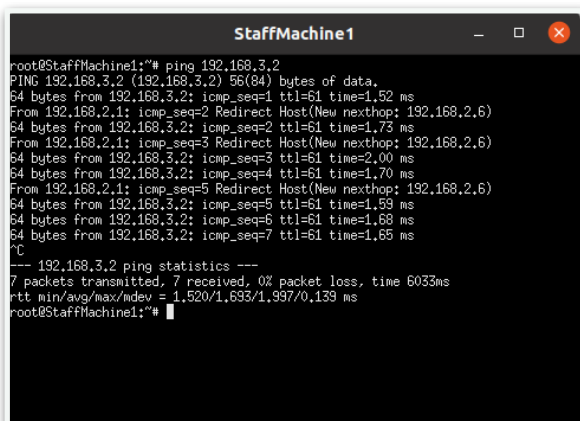
- Squid Server - 3rd Party Server (/hostlab/shared/1_4_1_2.pcap)



```
root@SquidProxyServer:~# ping 192.168.3.2
PING 192.168.3.2 (192.168.3.2) 56(84) bytes of data:
64 bytes from 192.168.3.2: icmp_seq=1 ttl=63 time=0.897 ms
From 192.168.2.1: icmp_seq=2 Redirect Host(New nexthop: 192.168.2.6)
64 bytes from 192.168.3.2: icmp_seq=2 ttl=63 time=0.973 ms
From 192.168.2.1: icmp_seq=3 Redirect Host(New nexthop: 192.168.2.6)
64 bytes from 192.168.3.2: icmp_seq=3 ttl=63 time=1.12 ms
From 192.168.2.1: icmp_seq=4 Redirect Host(New nexthop: 192.168.2.6)
64 bytes from 192.168.3.2: icmp_seq=4 ttl=63 time=0.952 ms
From 192.168.2.1: icmp_seq=5 Redirect Host(New nexthop: 192.168.2.6)
64 bytes from 192.168.3.2: icmp_seq=5 ttl=63 time=0.928 ms
From 192.168.2.1: icmp_seq=6 Redirect Host(New nexthop: 192.168.2.6)
64 bytes from 192.168.3.2: icmp_seq=6 ttl=63 time=0.862 ms
64 bytes from 192.168.3.2: icmp_seq=7 ttl=63 time=1.08 ms
^C
--- 192.168.3.2 ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6041ms
rtt min/avg/max/mdev = 0.862/0.972/1.118/0.086 ms
root@SquidProxyServer:~#
```

• Enterprise Zone (Medium Trust) - Extranet Zone (Medium Trust)

- Staff Machine1 - 3rd Party Server (/hostlab/shared/1_4_1_3.pcap)



```
root@StaffMachine1:~# ping 192.168.3.2
PING 192.168.3.2 (192.168.3.2) 56(84) bytes of data:
64 bytes from 192.168.3.2: icmp_seq=1 ttl=61 time=1.52 ms
From 192.168.2.1: icmp_seq=2 Redirect Host(New nexthop: 192.168.2.6)
64 bytes from 192.168.3.2: icmp_seq=2 ttl=61 time=1.73 ms
From 192.168.2.1: icmp_seq=3 Redirect Host(New nexthop: 192.168.2.6)
64 bytes from 192.168.3.2: icmp_seq=3 ttl=61 time=2.00 ms
64 bytes from 192.168.3.2: icmp_seq=4 ttl=61 time=1.70 ms
From 192.168.2.1: icmp_seq=5 Redirect Host(New nexthop: 192.168.2.6)
64 bytes from 192.168.3.2: icmp_seq=5 ttl=61 time=1.59 ms
64 bytes from 192.168.3.2: icmp_seq=6 ttl=61 time=1.68 ms
64 bytes from 192.168.3.2: icmp_seq=7 ttl=61 time=1.65 ms
^C
--- 192.168.3.2 ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6033ms
rtt min/avg/max/mdev = 1.520/1.693/1.997/0.139 ms
root@StaffMachine1:~#
```

- Enterprise Zone (Medium Trust) - Internal DMZ (High Trust)
- Staff Machine1 - IntWWW Server (/hostlab/shared/1_4_1_4.pcap)

```

StaffMachine1
root@StaffMachine1:~# ping 192.168.5.2
PING 192.168.5.2 (192.168.5.2) 56(84) bytes of data.
From 192.168.4.1: icmp_seq=1 Redirect Host(New nexthop: 192.168.4.5)
64 bytes from 192.168.5.2: icmp_seq=1 ttl=63 time=2.17 ms
From 192.168.4.1: icmp_seq=2 Redirect Host(New nexthop: 192.168.4.5)
64 bytes from 192.168.5.2: icmp_seq=2 ttl=63 time=1.09 ms
From 192.168.4.1: icmp_seq=3 Redirect Host(New nexthop: 192.168.4.5)
64 bytes from 192.168.5.2: icmp_seq=3 ttl=63 time=1.54 ms
From 192.168.4.1: icmp_seq=4 Redirect Host(New nexthop: 192.168.4.5)
64 bytes from 192.168.5.2: icmp_seq=4 ttl=63 time=1.19 ms
From 192.168.4.1: icmp_seq=5 Redirect Host(New nexthop: 192.168.4.5)
64 bytes from 192.168.5.2: icmp_seq=5 ttl=63 time=1.09 ms
From 192.168.4.1: icmp_seq=6 Redirect Host(New nexthop: 192.168.4.5)
64 bytes from 192.168.5.2: icmp_seq=6 ttl=63 time=0.995 ms
^C
--- 192.168.5.2 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5049ms
rtt min/avg/max/mdev = 0.995/1.344/2.165/0.406 ms
root@StaffMachine1:~#

```

- Extranet Zone (Medium Trust) - Internal DMZ (High Trust)
- 3rd Party Server - IntWWW Server (/hostlab/shared/1_4_1_5.pcap)

```

3rdParty
root@3rdParty:~# ping 192.168.5.2
PING 192.168.5.2 (192.168.5.2) 56(84) bytes of data.
From 192.168.3.1: icmp_seq=1 Redirect Host(New nexthop: 192.168.3.4)
64 bytes from 192.168.5.2: icmp_seq=1 ttl=63 time=1.29 ms
From 192.168.3.1: icmp_seq=2 Redirect Host(New nexthop: 192.168.3.4)
64 bytes from 192.168.5.2: icmp_seq=2 ttl=63 time=0.885 ms
From 192.168.3.1: icmp_seq=3 Redirect Host(New nexthop: 192.168.3.4)
64 bytes from 192.168.5.2: icmp_seq=3 ttl=63 time=0.935 ms
From 192.168.3.1: icmp_seq=4 Redirect Host(New nexthop: 192.168.3.4)
64 bytes from 192.168.5.2: icmp_seq=4 ttl=63 time=1.03 ms
From 192.168.3.1: icmp_seq=5 Redirect Host(New nexthop: 192.168.3.4)
64 bytes from 192.168.5.2: icmp_seq=5 ttl=63 time=0.865 ms
From 192.168.3.1: icmp_seq=6 Redirect Host(New nexthop: 192.168.3.4)
64 bytes from 192.168.5.2: icmp_seq=6 ttl=63 time=0.949 ms
^C
--- 192.168.5.2 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5063ms
rtt min/avg/max/mdev = 0.865/1.645/34.872/34.984 ms
root@3rdParty:~#

```

- Internal DMZ (High Trust) - Restrict Zone (Highest Trust)
- IntWWW Server - User DB Server (/hostlab/shared/1_4_1_6.pcap)

```

IntWWWServer
root@IntWWWServer:~# ping 192.168.6.2
PING 192.168.6.2 (192.168.6.2) 56(84) bytes of data.
From 192.168.5.1: icmp_seq=1 Redirect Host(New nexthop: 192.168.5.5)
64 bytes from 192.168.6.2: icmp_seq=1 ttl=63 time=1.37 ms
From 192.168.5.1: icmp_seq=2 Redirect Host(New nexthop: 192.168.5.5)
64 bytes from 192.168.6.2: icmp_seq=2 ttl=63 time=1.04 ms
From 192.168.5.1: icmp_seq=3 Redirect Host(New nexthop: 192.168.5.5)
64 bytes from 192.168.6.2: icmp_seq=3 ttl=63 time=0.890 ms
From 192.168.5.1: icmp_seq=4 Redirect Host(New nexthop: 192.168.5.5)
64 bytes from 192.168.6.2: icmp_seq=4 ttl=63 time=0.952 ms
From 192.168.5.1: icmp_seq=5 Redirect Host(New nexthop: 192.168.5.5)
64 bytes from 192.168.6.2: icmp_seq=5 ttl=63 time=0.824 ms
From 192.168.5.1: icmp_seq=6 Redirect Host(New nexthop: 192.168.5.5)
64 bytes from 192.168.6.2: icmp_seq=6 ttl=63 time=1.14 ms
^C
--- 192.168.6.2 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5018ms
rtt min/avg/max/mdev = 0.824/1.034/1.366/0.179 ms
root@IntWWWServer:~#

```

- Management Zone (Highest Trust) - All Zone
- Log Management Server - Squid Server (/hostlab/shared/1_4_1_7.pcap)

```

LogmanagementServer
root@LogmanagementServer:~# ping 192.168.2.2
PING 192.168.2.2 (192.168.2.2) 56(84) bytes of data.
64 bytes from 192.168.2.2: icmp_seq=1 ttl=60 time=1.89 ms
64 bytes from 192.168.2.2: icmp_seq=2 ttl=60 time=1.436 ms
64 bytes from 192.168.2.2: icmp_seq=3 ttl=60 time=1.36 ms
64 bytes from 192.168.2.2: icmp_seq=4 ttl=60 time=1.28 ms
64 bytes from 192.168.2.2: icmp_seq=5 ttl=60 time=1.50 ms
64 bytes from 192.168.2.2: icmp_seq=6 ttl=60 time=1.46 ms
64 bytes from 192.168.2.2: icmp_seq=7 ttl=60 time=1.15 ms
^C
--- 192.168.2.2 ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6030ms
rtt min/avg/max/mdev = 1.147/63.479/435.706/151.961 ms
root@LogmanagementServer:~#

```

- Log Management Server- Staff Machine1 (/hostlab/shared/1_4_1_8.pcap)

```

LogmanagementServer
root@LogmanagementServer:~# ping 192.168.4.24
PING 192.168.4.24 (192.168.4.24) 56(84) bytes of data.
64 bytes from 192.168.4.24: icmp_seq=1 ttl=61 time=1.51 ms
64 bytes from 192.168.4.24: icmp_seq=2 ttl=61 time=1.37 ms
64 bytes from 192.168.4.24: icmp_seq=3 ttl=61 time=1.36 ms
64 bytes from 192.168.4.24: icmp_seq=4 ttl=61 time=1.26 ms
64 bytes from 192.168.4.24: icmp_seq=5 ttl=61 time=1.32 ms
64 bytes from 192.168.4.24: icmp_seq=6 ttl=61 time=1.33 ms
^C
--- 192.168.4.24 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5024ms
rtt min/avg/max/mdev = 1.262/1.356/1.512/0.077 ms
root@LogmanagementServer:~#

```

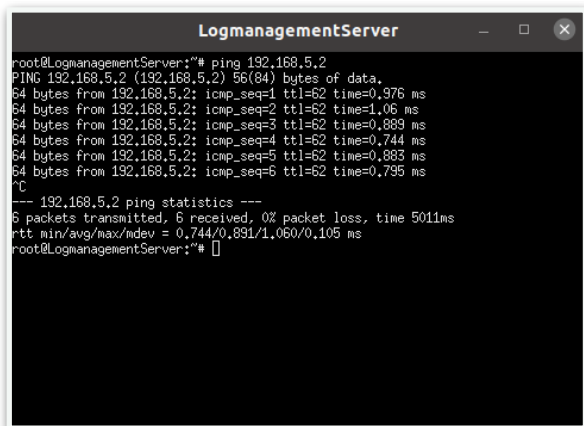
- Log Management Server - 3rd Party Server (/hostlab/shared/1_4_1_9.pcap)

```

LogmanagementServer
root@LogmanagementServer:~# ping 192.168.3.2
PING 192.168.3.2 (192.168.3.2) 56(84) bytes of data.
64 bytes from 192.168.3.2: icmp_seq=1 ttl=61 time=1.07 ms
64 bytes from 192.168.3.2: icmp_seq=2 ttl=61 time=1.20 ms
64 bytes from 192.168.3.2: icmp_seq=3 ttl=61 time=1.04 ms
64 bytes from 192.168.3.2: icmp_seq=4 ttl=61 time=1.15 ms
64 bytes from 192.168.3.2: icmp_seq=5 ttl=61 time=1.00 ms
64 bytes from 192.168.3.2: icmp_seq=6 ttl=61 time=0.856 ms
64 bytes from 192.168.3.2: icmp_seq=7 ttl=61 time=1.03 ms
^C
--- 192.168.3.2 ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6018ms
rtt min/avg/max/mdev = 0.856/1.048/1.202/0.103 ms
root@LogmanagementServer:~#

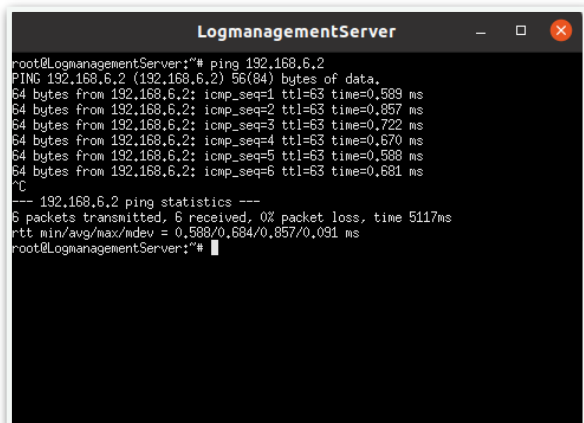
```

- Log Management Server - IntWWW Server (/hostlab/shared/1_4_1_10.pcap)



```
root@LogmanagementServer:~# ping 192.168.5.2
PING 192.168.5.2 (192.168.5.2) 56(84) bytes of data:
64 bytes from 192.168.5.2: icmp_seq=1 ttl=62 time=0.976 ms
64 bytes from 192.168.5.2: icmp_seq=2 ttl=62 time=1.06 ms
64 bytes from 192.168.5.2: icmp_seq=3 ttl=62 time=0.889 ms
64 bytes from 192.168.5.2: icmp_seq=4 ttl=62 time=0.744 ms
64 bytes from 192.168.5.2: icmp_seq=5 ttl=62 time=0.883 ms
64 bytes from 192.168.5.2: icmp_seq=6 ttl=62 time=0.795 ms
^C
--- 192.168.5.2 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5011ms
rtt min/avg/max/mdev = 0.744/0.891/1.060/0.105 ms
root@LogmanagementServer:~#
```

- Log Management Server - User DB Server (/hostlab/shared/1_4_1_11.pcap)

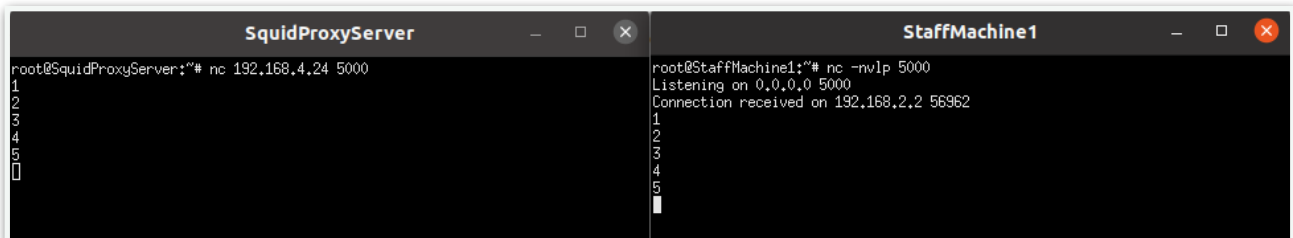


```
root@LogmanagementServer:~# ping 192.168.6.2
PING 192.168.6.2 (192.168.6.2) 56(84) bytes of data:
64 bytes from 192.168.6.2: icmp_seq=1 ttl=63 time=0.589 ms
64 bytes from 192.168.6.2: icmp_seq=2 ttl=63 time=0.857 ms
64 bytes from 192.168.6.2: icmp_seq=3 ttl=63 time=0.722 ms
64 bytes from 192.168.6.2: icmp_seq=4 ttl=63 time=0.670 ms
64 bytes from 192.168.6.2: icmp_seq=5 ttl=63 time=0.588 ms
64 bytes from 192.168.6.2: icmp_seq=6 ttl=63 time=0.681 ms
^C
--- 192.168.6.2 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5117ms
rtt min/avg/max/mdev = 0.588/0.684/0.857/0.091 ms
root@LogmanagementServer:~#
```

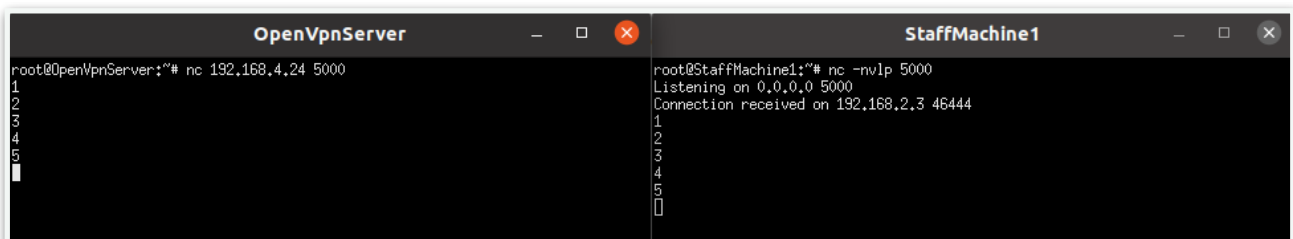

1.4.2 Netcat ports of devices that we set in the iptables filter

We verify connectivity is prevented by setting default input/forward/output DROP in all firewalls
In the following, we verify that the connectivity we set in the iptables filter is achieved

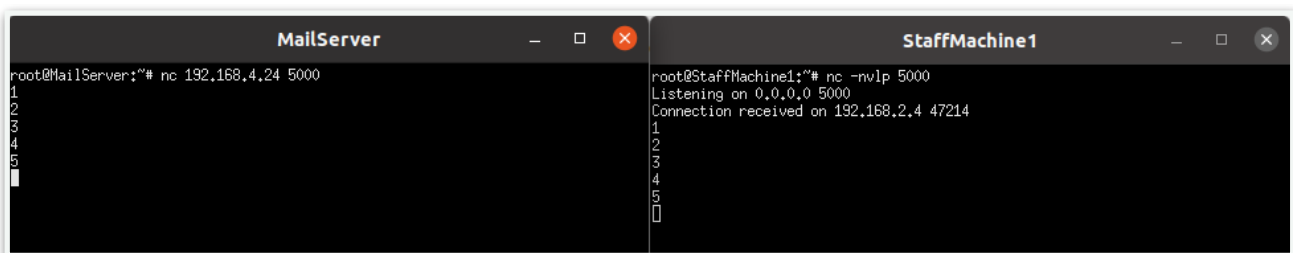
- External DMZ (Low Trust) - Enterprise Zone (Medium Trust)
- Squid Server → Staff Machine1(5000) (/hostlab/shared/1_4_2_1.pcap)



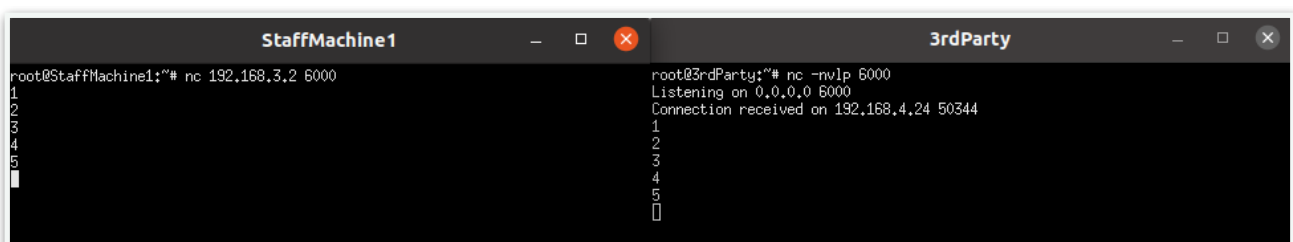
- OpenVPN Server → Staff Machine1(5000) (/hostlab/shared/1_4_2_2.pcap)



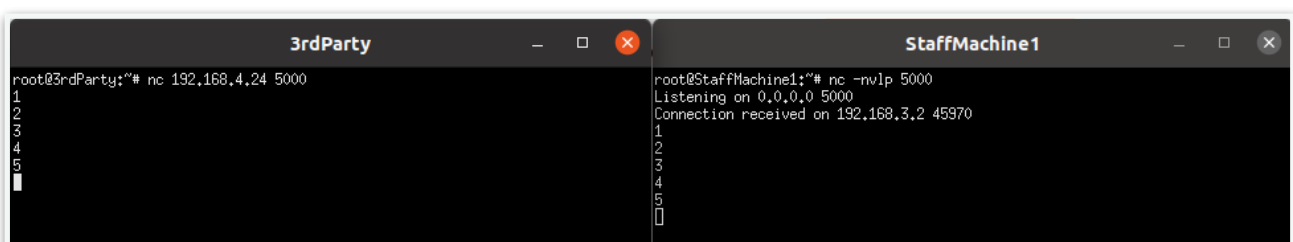
- Mail Server → Staff Machine1(5000) (/hostlab/shared/1_4_2_3.pcap)



- Enterprise Zone (Medium Trust) - Extranet Zone (Medium Trust)
- Staff Machine1 → 3rd Party Server(6000) (/hostlab/shared/1_4_2_4.pcap)



- 3rd Party Server → Staff Machine1(5000) (/hostlab/shared/1_4_2_5.pcap)



- Enterprise Zone (Medium Trust) - Internal DMZ (High Trust)
- Staff Machine1 → IntWWW Server(8080) (/hostlab/shared/1_4_2_6.pcap)

The screenshot shows two terminal windows side-by-side. The left window is titled 'StaffMachine1' and shows the command 'root@StaffMachine1:~# nc 192.168.5.2 8080' followed by a list of numbers 1 through 5. The right window is titled 'IntWWWServer' and shows the command 'root@IntWWWServer:~# nc -nvlp 8080', followed by 'Listening on 0.0.0.0 8080', 'Connection received on 192.168.4.24 49668', and a list of numbers 1 through 5.

- Staff Machine1 → IntDNS Server(53) (/hostlab/shared/1_4_2_7.pcap)

The screenshot shows two terminal windows side-by-side. The left window is titled 'StaffMachine1' and shows the command 'root@StaffMachine1:~# nc 192.168.5.3 53' followed by a list of numbers 1 through 5. The right window is titled 'IntDNSServer' and shows the command 'root@IntDNSServer:~# nc -nvlp 53', followed by 'Listening on 0.0.0.0 53', 'Connection received on 192.168.4.24 45814', and a list of numbers 1 through 5.

- Staff Machine1 → LDAP Server(389) (/hostlab/shared/1_4_2_8.pcap)

The screenshot shows two terminal windows side-by-side. The left window is titled 'StaffMachine1' and shows the command 'root@StaffMachine1:~# nc 192.168.5.4 389' followed by a list of numbers 1 through 5. The right window is titled 'LDAPServer' and shows the command 'root@LDAPServer:~# nc -nvlp 389', followed by 'Listening on 0.0.0.0 389', 'Connection received on 192.168.4.24 41238', and a list of numbers 1 through 5.

- Internal DMZ (High Trust) - Restrict Zone (Highest Trust)
- IntWWW Server → User DB Server(1433) (/hostlab/shared/1_4_2_9.pcap)

The screenshot shows two terminal windows side-by-side. The left window is titled 'IntWWWServer' and shows the command 'root@IntWWWServer:~# nc 192.168.6.2 1433' followed by a list of numbers 1 through 5. The right window is titled 'UserDBServer' and shows the command 'root@UserDBServer:~# nc -nvlp 1433', followed by 'Listening on 0.0.0.0 1433', 'Connection received on 192.168.5.2 35268', and a list of numbers 1 through 5.

- LDAP Server → User DB Server(1433) (/hostlab/shared/1_4_2_10.pcap)

The screenshot shows two terminal windows side-by-side. The left window is titled 'LDAPServer' and shows the command 'root@LDAPServer:~# nc 192.168.6.2 1433' followed by a list of numbers 1 through 5. The right window is titled 'UserDBServer' and shows the command 'root@UserDBServer:~# nc -nvlp 1433', followed by 'Listening on 0.0.0.0 1433', 'Connection received on 192.168.5.4 56484', and a list of numbers 1 through 5.

- Management Zone (Highest Trust) - All Zone
- Log Management → Squid Server(8080) (/hostlab/shared/1_4_2_11.pcap)

The screenshot shows two terminal windows side-by-side. The left window is titled 'LogmanagementServer' and shows the command 'root@LogmanagementServer:~# nc 192.168.2,2 8080'. The right window is titled 'SquidProxyServer' and shows the command 'root@SquidProxyServer:~# nc -nvlp 8080'. The output in the right window indicates it is listening on 0.0.0.0 8080 and has received a connection from 192.168.7,2 44850. A vertical list of numbers 1 through 5 is visible on the left side of the right window.

- Log Management → Staff Machine1(5000) (/hostlab/shared/1_4_2_12.pcap)

The screenshot shows two terminal windows side-by-side. The left window is titled 'LogmanagementServer' and shows the command 'root@LogmanagementServer:~# nc 192.168.4,24 5000'. The right window is titled 'StaffMachine1' and shows the command 'root@StaffMachine1:~# nc -nvlp 5000'. The output in the right window indicates it is listening on 0.0.0.0 5000 and has received a connection from 192.168.7,2 40110. A vertical list of numbers 1 through 5 is visible on the left side of the right window.

- Log Management → 3rd Party Server(6000) (/hostlab/shared/1_4_2_13.pcap)

The screenshot shows two terminal windows side-by-side. The left window is titled 'LogmanagementServer' and shows the command 'root@LogmanagementServer:~# nc 192.168.3,2 6000'. The right window is titled '3rdParty' and shows the command 'root@3rdParty:~# nc -nvlp 6000'. The output in the right window indicates it is listening on 0.0.0.0 6000 and has received a connection from 192.168.7,2 45142. A vertical list of numbers 1 through 5 is visible on the left side of the right window.

- Log Management → IntWWW Server(8080) (/hostlab/shared/1_4_2_14.pcap)

The screenshot shows two terminal windows side-by-side. The left window is titled 'LogmanagementServer' and shows the command 'root@LogmanagementServer:~# nc 192.168.5,2 8080'. The right window is titled 'IntWWWServer' and shows the command 'root@IntWWWServer:~# nc -nvlp 8080'. The output in the right window indicates it is listening on 0.0.0.0 8080 and has received a connection from 192.168.7,2 38548. A vertical list of numbers 1 through 5 is visible on the left side of the right window.

- Log Management → User DB Server(1433) (/hostlab/shared/1_4_2_15.pcap)

The screenshot shows two terminal windows side-by-side. The left window is titled 'LogmanagementServer' and shows the command 'root@LogmanagementServer:~# nc 192.168.6,2 1433'. The right window is titled 'UserDBServer' and shows the command 'root@UserDBServer:~# nc -nvlp 1433'. The output in the right window indicates it is listening on 0.0.0.0 1433 and has received a connection from 192.168.7,2 52634. A vertical list of numbers 1 through 5 is visible on the left side of the right window.

Phase2:

2.1 Fully implement NAT / port-forwarding(All use TCP protocol)

Internet Zone (No Trust) - External DMZ (Low Trust)

	IP Address:Port	IP Address:Port
Internet → Squid Server	80.64.157.1/16:Any	192.168.2.2/24:8080
Internet → OpenVPN Server	80.64.157.1/16:Any	192.168.2.3/24:487
Internet → Mail Server	80.64.157.1/16:Any	192.168.2.4/24:587
Squid Server → Internet	192.168.2.2/24:Any	80.64.157.254/16:Any
OpenVPN Server → Internet	192.168.2.3/24:Any	80.64.157.254/16:Any
Mail Server → Internet	192.168.2.4/24:Any	80.64.157.254/16:Any

2.2 Robustly verify that connectivity is achieved / prevented as appropriate between clients and services

In this part, we can combine Phase1.4 and will add the NAT part in the following Netcat ports of devices that we set in the iptables filter

- Internet Zone (No Trust) - External DMZ (Low Trust)
- Internet → Squid Server (8080) (/hostlab/shared/2_2_1.pcap)

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Internet                               SquidProxyServer
root@Internet:~# nc 80.64.157.1 8080
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- Squid Server → Internet (1234) (/hostlab/shared/2_2_4.pcap)

SquidProxyServer	Internet
root@SquidProxyServer:~# nc 80.64.157.254 1234	root@Internet:~# nc -nvlp 1234
1	Listening on 0.0.0.0 1234
2	Connection received on 80.64.157.1 60618
3	1
4	2
5	3
	4
	5

- OpenVPN Server → Internet (4321) (/hostlab/shared/2_2_5.pcap)

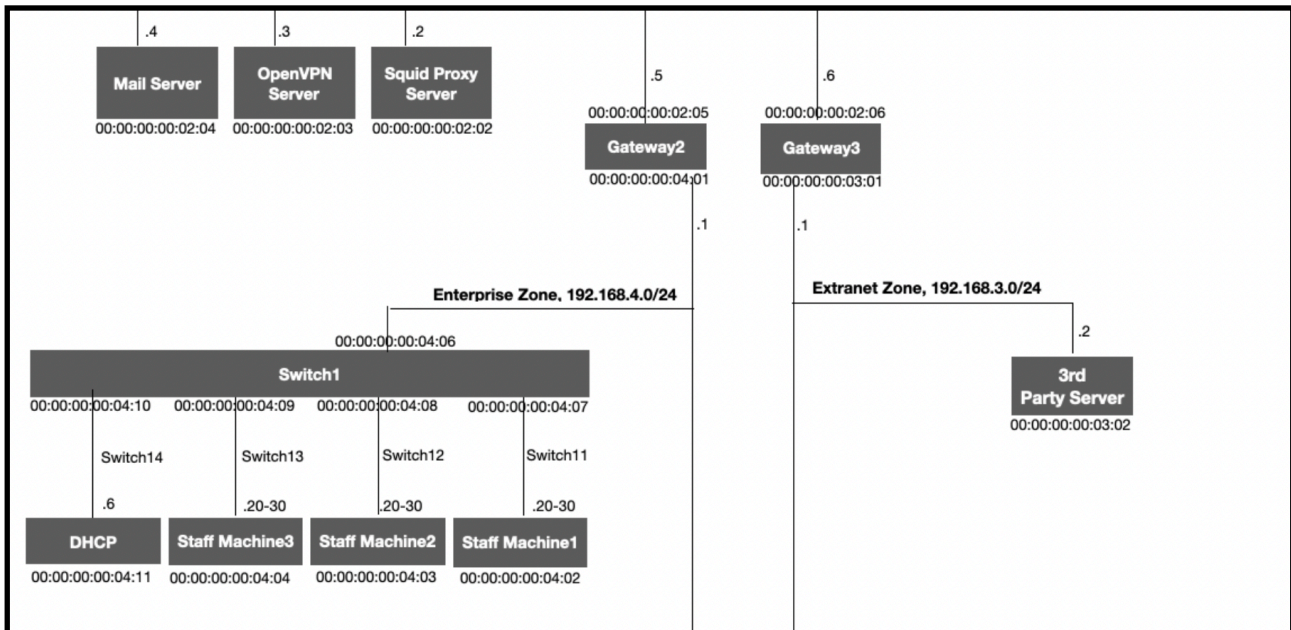
OpenVpnServer	Internet
root@OpenVpnServer:~# nc 80.64.157.254 4321	root@Internet:~# nc -nvlp 4321
1	Listening on 0.0.0.0 4321
2	Connection received on 80.64.157.1 42348
3	1
4	2
5	3
	4
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- Mail Server → Internet (1111) (/hostlab/shared/2_2_6.pcap)

MailServer	Internet
root@MailServer:~# nc 80.64.157.254 1111	root@Internet:~# nc -nvlp 1111
1	Listening on 0.0.0.0 1111
2	Connection received on 80.64.157.1 46324
3	1
4	2
5	3
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2.3 make a compelling case for your design and implementation of one augmented feature

- Load Balance: We divide the network traffic with 2 Gateways (Gateway2 and Gateway3) to avoid massive network traffic to Enterprise Zone



- DHCP: We can avoid manually setting IP addresses errors by using DHCP to enhance the security posture

```

StaffMachine1
netkit-phase1[1475]: --- Starting Netkit phase 1 init script ---
netkit-phase1[1475]: Mounting '/home/csc' on '/hosthome/'
netkit-phase1[1475]: Mounting '/home/csc/Desktop/PMA/Patrick_PMA' on '/hostlab/'
netkit-phase1[1475]: Configuring host name
netkit-phase1[1475]: Running 'resolvconf -u' to generate '/etc/resolv.conf'
netkit-phase1[1475]: Copying StaffMachine1-specific files from '/hostlab/StaffMa
chine1/'
netkit-phase1[1475]: --- Netkit phase 1 initialization terminated ---
netkit-phase2[1570]: --- Starting Netkit phase 2 init script ---
netkit-phase2[1570]: >>> Running StaffMachine1 specific startup script...
netkit-phase2[1588]: Internet Systems Consortium DHCP Client 4.4.1
netkit-phase2[1588]: Copyright 2004-2018 Internet Systems Consortium.
netkit-phase2[1588]: All rights reserved.
netkit-phase2[1588]: For info, please visit https://www.isc.org/software/dhcp/
netkit-phase2[1588]: Listening on LPF/eth0/00:00:00:00:04:02
netkit-phase2[1588]: Sending on LPF/eth0/00:00:00:00:04:02
netkit-phase2[1588]: Sending on Socket/fallback
netkit-phase2[1588]: Created duid "\000\001\000\001+(\375\030\000\000\000\000\00
4\002".
netkit-phase2[1588]: DHCPDISCOVER on eth0 to 255.255.255.255 port 67 interval 8
netkit-phase2[1588]: DHCPOFFER of 192.168.4.24 from 192.168.4.6
netkit-phase2[1588]: DHCPREQUEST for 192.168.4.24 on eth0 to 255.255.255.255 por
t 67
netkit-phase2[1588]: DHCPACK of 192.168.4.24 from 192.168.4.6
netkit-phase2[1588]: bound to 192.168.4.24 -- renewal in 12262 seconds.
netkit-phase2[1641]: KIMCILINK answers: file exists
netkit-phase2[1570]: >>> End of StaffMachine1 specific startup script.
netkit-phase2[1570]: *****
netkit-phase2[1570]: Lab directory: /home/csc/Desktop/PMA/Patrick_PMA
netkit-phase2[1570]: Version: "Phase1"
netkit-phase2[1570]: Author: "Peter Norris"
netkit-phase2[1570]: Email: "Patrickchou@warwick.ac.uk"
netkit-phase2[1570]: URL: <unknown>
netkit-phase2[1570]: Description:
netkit-phase2[1570]: "Patrick"
netkit-phase2[1570]: *****
netkit-phase2[1570]: --- Netkit phase 2 initialization terminated ---

Welcome to Netkit

StaffMachine1 login: root (automatic login)

Linux StaffMachine1 5.19.11 #1 Thu Sep 29 12:13:19 BST 2022 x86_64
Welcome to Netkit

Last login: Sun Dec 11 20:42:14 UTC 2022 on tty1
root@StaffMachine1:~#

```

3. Identifying the further work that is needed but that you were unable to realise

- Utilise VLANs to good effect
- Implement well-organised DNS using zone files

4. Reference

[1] Luciana Obregon. (2021) Infrastructure Security Architecture for Effective Security Monitoring