

# ITS 4750

# Final Project Documentation

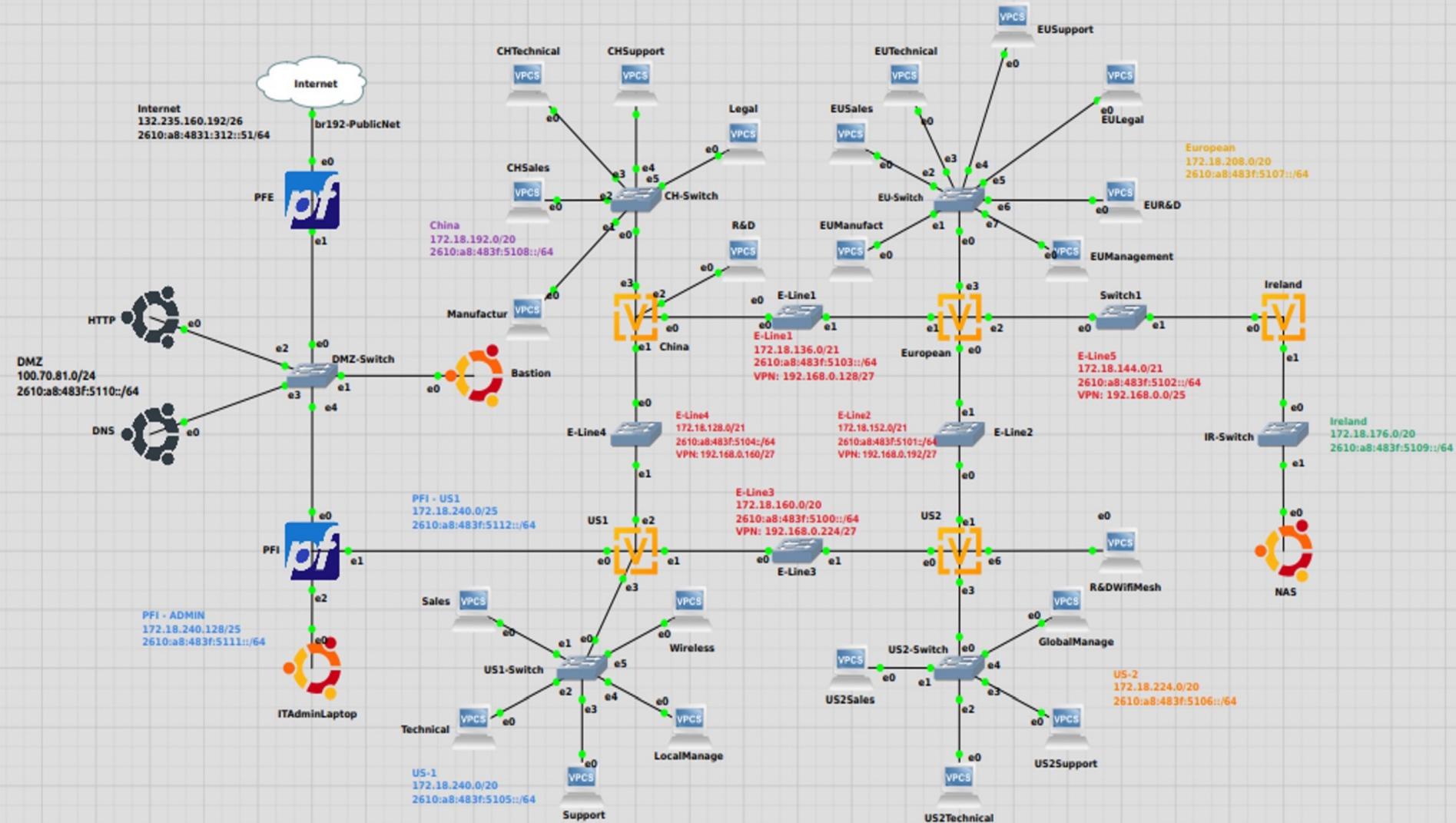
Nick Tipton

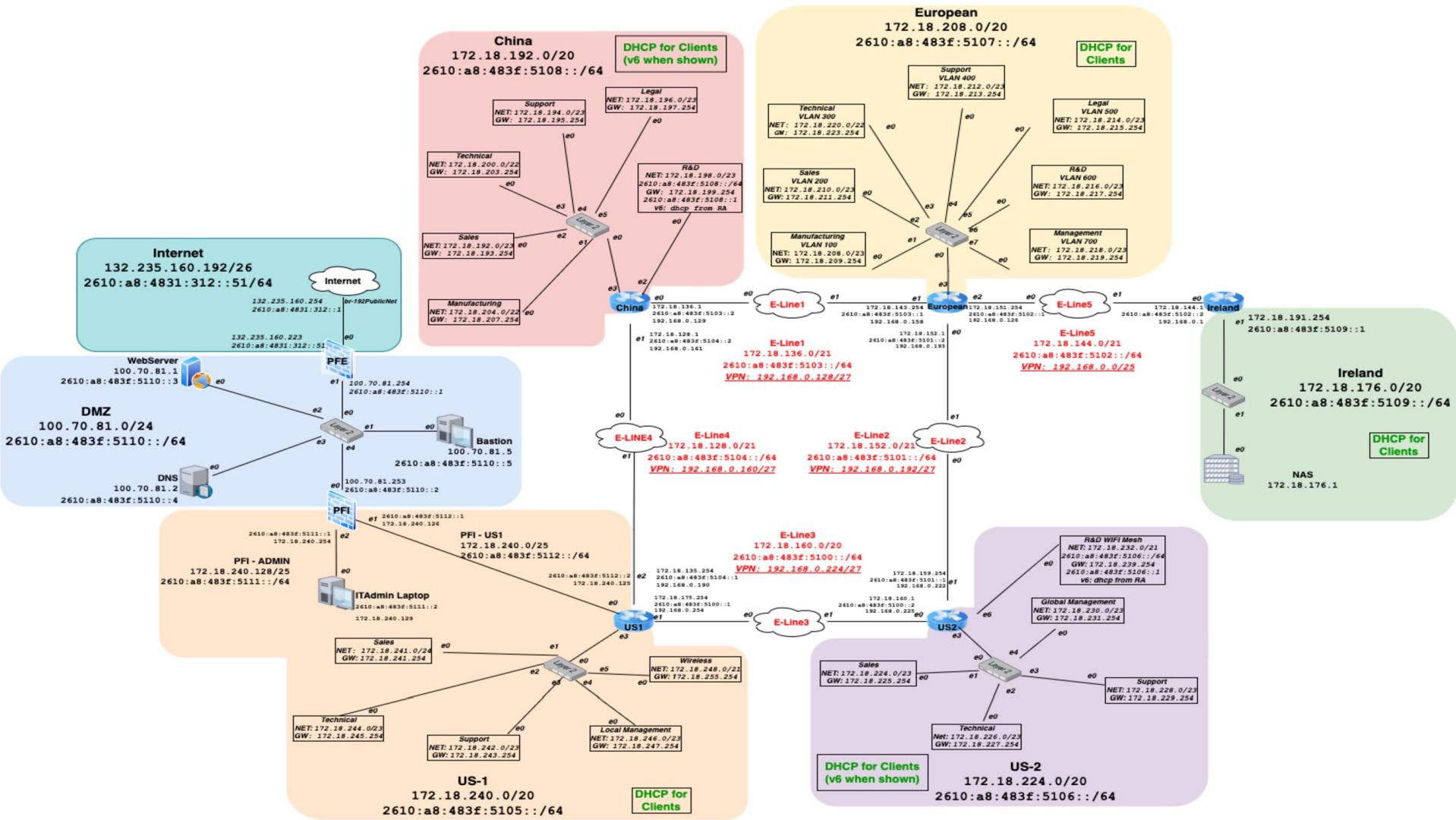
ITS Undergraduate

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# Additional Points

- 8. (15) - VLAN Trunks setup at sites for client connections
- 5. a. (20) - Distribute OSPF IPv4 routes for internal routed network
- 13. (25) - Site-to-Site connectivity is done via a third-party E-Line providers 192.168.X.X/Y for those links. Setup site-to-site VPNs for all E-Line links.





# Public Facing IPs

IPV4 Private Network Address	IPV6 Network Address	IPV4 Public Network Address	IPV4 WAN Network Address	IPV6 WAN Network Address		
172.18.128.0/17	2610:a8:483f:5100::/64	100.70.81.0/24	132.235.160.192/26	2610:a8:4831:312::51/64		
Location	Network Address IPv4	Useable IPv4 Range	Network Address IPv6			
Internet	132.235.160.192/26	132.235.160.193 - 132.235.160.254	2610:a8:4831:312::51/64	ethernet	IPv4 Address	IPv6 Address
Cloud				br192-PublicNet	132.235.160.254	2610:a8:4831:312::1
PFE				e0	132.235.160.223	2610:a8:4831:312::51
DMZ	100.70.81.0/24	100.70.81.1 - 100.70.81.254	2610:a8:483f:5110::/64			
	eth1 - PFE	100.70.81.254	2610:a8:483f:5110::1			
	WebServer	100.70.81.1	2610:a8:483f:5110::3			
	DNS	100.70.81.2	2610:a8:483f:5110::4			
	Bastion	100.70.81.5	2610:a8:483f:5110::5			
	eth0 - PFI	100.70.81.253	2610:a8:483f:5110::2			

# US1 & US2 Routers

<b>US1</b>	<b>172.18.240.0/20</b>	<b>172.18.240.1 – 172.18.255.254</b>	<b>2610:a8:483f:5105::/64</b>	<b>ethernet:VPN</b>	<b>IPv4 Address</b>	<b>IPv6 Address</b>
<i>US1 to US2</i>	172.18.160.0/20:192.168.0.224/27	172.18.160.1 – 172.18.175.254	2610:a8:483f:5100::/64	eth1: 192.168.0.254	172.18.175.254	2610:a8:483f:5100::1
<i>US1 to China</i>	172.18.128.0/21:192.168.0.160/27	172.18.128.1 – 172.18.135.254	2610:a8:483f:5104::/64	eth2: 192.168.0.190	172.18.135.254	2610:a8:483f:5104::1
<b>US1 Subdivisions</b>	<b>Network Address IPv4</b>	<b>Useable IPv4 Range</b>	<b>Network Address IPv6</b>	<b>ethernet</b>	<b>IPv4 Gateway</b>	<b>IPv6 Gateway</b>
<i>VLAN 100 - Sales</i>	172.18.241.0/24	172.18.241.1 – 172.18.241.254		eth3	172.18.241.254	
<i>VLAN 200 - Technical</i>	172.18.244.0/23	172.18.244.1 – 172.18.245.254		eth3	172.18.245.254	
<i>VLAN 300 - Support</i>	172.18.242.0/23	172.18.242.1 – 172.18.243.254	2610:a8:483f:5105::/64	eth3	172.18.243.254	2610:a8:483f:5105::1
<i>VLAN 400 - Local Management</i>	172.18.246.0/23	172.18.246.1 – 172.18.247.254		eth3	172.18.247.254	
<i>VLAN 500 - Wireless</i>	172.18.248.0/21	172.18.248.1 – 172.18.255.254		eth3	172.18.255.254	
<i>US1</i>	172.18.240.0/25	172.18.240.1 – 172.18.240.126	2610:a8:483f:5112::/64	eth0	172.18.240.125	2610:a8:483f:5112::2
<i>PFI</i>				eth1	172.18.240.126	2610:a8:483f:5112::1
<i>PFI</i>	172.18.240.128/25	172.18.240.129 – 172.18.240.254	2610:a8:483f:5111::/64	eth2	172.18.240.254	2610:a8:483f:5111::1
<i>IT ADMIN</i>				eth0	172.18.240.129	2610:a8:483f:5111::2
<b>Location</b>	<b>Network Address IPv4</b>	<b>Useable IPv4 Range</b>	<b>Network Address IPv6</b>			
<b>US2</b>	<b>172.18.224.0/20</b>	<b>172.18.224.1 – 172.18.239.254</b>	<b>2610:a8:483f:5106::/64</b>	<b>ethernet:VPN</b>	<b>IPv4 Address</b>	<b>IPv6 Address</b>
<i>US2 to US1</i>	172.18.160.0/20:192.168.0.224/27	172.18.160.1 – 172.18.175.254	2610:a8:483f:5100::/64	eth0: 192.168.0.225	172.18.160.1	2610:a8:483f:5100::2
<i>US2 to European</i>	172.18.152.0/21:192.168.0.192/27	172.18.152.1 – 172.18.159.254	2610:a8:483f:5101::/64	eth1: 192.168.0.222	172.18.159.254	2610:a8:483f:5101::1
<b>US2 Subdivisions</b>	<b>Network Address IPv4</b>	<b>Useable IPv4 Range</b>	<b>Network Address IPv6</b>	<b>ethernet</b>	<b>IPv4 Gateway</b>	<b>IPv6 Gateway</b>
<i>VLAN 100 - Sales</i>	172.18.224.0/23	172.18.224.1 – 172.18.225.254		eth3	172.18.225.254	
<i>VLAN 200 - Technical</i>	172.18.226.0/23	172.18.226.1 – 172.18.227.254		eth3	172.18.227.254	
<i>VLAN 300 - Support</i>	172.18.228.0/23	172.18.228.1 – 172.18.229.254	2610:a8:483f:5106::/64	eth3	172.18.229.254	2610:a8:483f:5106::1
<i>VLAN 400 - Global Management</i>	172.18.230.0/23	172.18.230.1 – 172.18.231.254		eth3	172.18.231.254	
<i>R&amp;D WiFi Mesh</i>	172.18.232.0/21	172.18.232.1 – 172.18.239.254		eth6	172.18.239.254	

# European & Ireland Routers

Location	Network Address IPv4	Useable IPv4 Range	Network Address IPv6			
<b>European</b>	<b>172.18.208.0/20</b>	<b>172.18.208.1 – 172.18.223.254</b>	<b>2610:a8:483f:5107::/64</b>			
<i>European to US2</i>	172.18.152.0/21:192.168.0.192/27	172.18.152.1 – 172.18.159.254	2610:a8:483f:5101::/64	eth0:192.168.0.193	172.18.152.1	2610:a8:483f:5101::2
<i>European to Ireland</i>	172.18.144.0/21:192.168.0.0/25	172.18.144.1 – 172.18.151.254	2610:a8:483f:5102::/64	eth2:192.168.0.126	172.18.151.254	2610:a8:483f:5102::1
<i>European to China</i>	172.18.136.0/21:192.168.0.128/27	172.18.136.1 – 172.18.143.254	2610:a8:483f:5103::/64	eth1:192.168.0.158	172.18.143.254	2610:a8:483f:5103::1
European Subdivisions	Network Address IPv4	Useable IPv4 Range	Network Address IPv6	ethernet	IPv4 Gateway	IPv6 Gateway
<i>VLAN 100 - Manufacturing</i>	172.18.208.0/23	172.18.208.1 – 172.18.209.254	2610:a8:483f:5107::/64	eth3	172.18.209.254	2610:a8:483f:5107::1
<i>VLAN 200 - Sales</i>	172.18.210.0/23	172.18.210.1 – 172.18.211.254		eth3	172.18.211.254	
<i>VLAN 300 - Technical</i>	172.18.220.0/22	172.18.220.1 – 172.18.223.254		eth3	172.18.223.254	
<i>VLAN 400 - Support</i>	172.18.212.0/23	172.18.212.1 – 172.18.213.254		eth3	172.18.213.254	
<i>VLAN 500 - Legal</i>	172.18.214.0/23	172.18.214.1 – 172.18.215.254		eth3	172.18.215.254	
<i>VLAN 600 - R&amp;D</i>	172.18.216.0/23	172.18.216.1 – 172.18.217.254		eth3	172.18.217.254	
<i>VLAN 700 - Management</i>	172.18.218.0/23	172.18.218.1 – 172.18.219.254		eth3	172.18.219.254	
Location	Network Address IPv4	Useable IPv4 Range	Network Address IPv6			
<b>Ireland</b>	<b>172.18.176.0/20</b>	<b>172.18.176.1 – 172.18.191.254</b>	<b>2610:a8:483f:5109::/64</b>			
<i>Ireland to European</i>	172.18.144.0/21:192.168.0.0/25	172.18.144.1 – 172.18.151.254	2610:a8:483f:5102::/64	eth0:192.168.0.1	172.18.144.1	2610:a8:483f:5102::2
Ireland Subdivisions	Network Address IPv4	Useable IPv4 Range	Network Address IPv6	ethernet	IPv4 Gateway	IPv6 Gateway
<i>VLAN 100 - NAS</i>	172.18.176.0/20	172.18.176.1 – 172.18.191.254	2610:a8:483f:5109::/64	eth0	172.18.191.254	2610:a8:483f:5109::1

# China Router

Location	Network Address IPv4	Useable IPv4 Range	Network Address IPv6			
China	172.18.192.0/20	172.18.192.1 - 172.18.207.254	2610:a8:483f:5108::/64	ethernet:VPN	IPv4 Address	IPv6 Address
China to European	172.18.136.0/21:192.168.0.128/27	172.18.136.1 - 172.18.143.254	2610:a8:483f:5103::/64	eth0:192.168.0.129	172.18.136.1	2610:a8:483f:5103::2
China to US1	172.18.128.0/21:192.168.0.160/27	172.18.128.1 - 172.18.135.254	2610:a8:483f:5104::/64	eth1:192.168.0.161	172.18.128.1	2610:a8:483f:5104::2
China Subdivisions	Network Address IPv4	Useable IPv4 Range	Network Address IPv6	ethernet	IPv4 Gateway	IPv6 Gateway
VLAN100-Manufacturing	172.18.204.0/22	172.18.204.1 - 172.18.207.254	2610:a8:483f:5108::/64	eth3	172.18.207.254	2610:a8:483f:5108::1
VLAN200-Sales	172.18.192.0/23	172.18.192.1 - 172.18.193.254		eth3	172.18.193.254	
VLAN300-Technical	172.18.200.0/22	172.18.200.1 - 172.18.203.254		eth3	172.18.203.254	
VLAN400-Support	172.18.194.0/23	172.18.194.1 - 172.18.195.254		eth3	172.18.195.254	
VLAN500-Legal	172.18.196.0/23	172.18.196.1 - 172.18.197.254		eth3	172.18.197.254	
R&D	172.18.198.0/23	172.18.198.1 - 172.18.199.254		eth2	172.18.199.254	

# Exterior Firewall Routes – PFE

Static Routes					
	Network	Gateway	Interface	Description	Actions
<input checked="" type="checkbox"/>	172.18.128.0/17	pfiUS1 - 100.70.81.253	LAN	aggregate	
<input checked="" type="checkbox"/>	2610:a8:483f:51::/64	Aggregate - 2610:00a8:483f:5110::2	LAN	aggregate6	
<input checked="" type="checkbox"/>	2610:a8:483f:5112::/64	Aggregate - 2610:00a8:483f:5110::2	LAN	PFIUS1	
<input checked="" type="checkbox"/>	2610:a8:483f:5111::/64	Aggregate - 2610:00a8:483f:5110::2	LAN	admin	
<input checked="" type="checkbox"/>	2610:a8:483f:5103::/64	Aggregate - 2610:00a8:483f:5110::2	LAN	US1	
<input checked="" type="checkbox"/>	2610:a8:483f:5100::/64	Aggregate - 2610:00a8:483f:5110::2	LAN	US1-US2	
<input checked="" type="checkbox"/>	2610:a8:483f:5106::/64	Aggregate - 2610:00a8:483f:5110::2	LAN	US2	
<input checked="" type="checkbox"/>	2610:a8:483f:5101::/64	Aggregate - 2610:00a8:483f:5110::2	LAN	US1-European	
<input checked="" type="checkbox"/>	2610:a8:483f:5107::/64	Aggregate - 2610:00a8:483f:5110::2	LAN	EU	
<input checked="" type="checkbox"/>	2610:a8:483f:5103::/64	Aggregate - 2610:00a8:483f:5110::2	LAN	EU-China	
<input checked="" type="checkbox"/>	2610:a8:483f:5108::/64	Aggregate - 2610:00a8:483f:5110::2	LAN	China	
<input checked="" type="checkbox"/>	2610:a8:483f:5104::/64	Aggregate - 2610:00a8:483f:5110::2	LAN	US1-China	
<input checked="" type="checkbox"/>	2610:a8:483f:5102::/64	Aggregate - 2610:00a8:483f:5110::2	LAN	EU-Ireland	
<input checked="" type="checkbox"/>	2610:a8:483f:5109::/64	Aggregate - 2610:00a8:483f:5110::2	LAN	Ireland	

Add

# Exterior Firewall Rules – PFE

FloatingWANLAN

**Rules (Drag to Change Order)**

States	Protocol	Source	Port	Destination	Port	Gateway	Queue	Schedule	Description	Actions
<input type="checkbox"/>	✓ 0/1021 B	IPv4	*	*	100.70.81.1	*	*	none	outside to web server	
<input type="checkbox"/>	✓ 0/0 B	IPv6	*	*	2610:a8:483f:5110::3	*	*	none	outside to web server v6	
<input type="checkbox"/>	✗ 0/792 KiB	IPv4+6	*	*	*	*	*	none	Deny ALL	

Add  Add  Delete  Save  Separator

# Exterior Firewall Rules – PFE

Floating   WAN   LAN

Rules (Drag to Change Order)											
	States	Protocol	Source	Port	Destination	Port	Gateway	Queue	Schedule	Description	Actions
<input checked="" type="checkbox"/>	✓ 19/392 KIB	*	*	*	LAN Address	80	*	*		Anti-Lockout Rule	   
<input type="checkbox"/>	✓ 0/2 KIB	IPv4+6 ICMP any	*	*	*	*	*	none		outgoing icmp	   
<input type="checkbox"/>	✓ 0/156 KIB	IPv4 TCP/UDP	100.70.81.2	*	*	53 (DNS)	*	none		dns from DNS server	   
<input type="checkbox"/>	✓ 40/354 KIB	IPv6 TCP/UDP	2610:a8:483f:5110::4	*	*	53 (DNS)	*	none		dns from DNS server v6	   
<input type="checkbox"/>	✓ 34/29.60 MIB	IPv4+6 TCP/UDP	*	*	*	80 (HTTP)	*	none		outgoing http traffic	   
<input type="checkbox"/>	✓ 23/2.25 MIB	IPv4+6 TCP/UDP	*	*	*	443 (HTTPS)	*	none		outgoing http traffic	   
<input type="checkbox"/>	✓ 0/0 B	IPv4 UDP	100.70.81.2	*	132.235.9.75	53 (DNS)	*	none		DNS to ..9.75	   
<input type="checkbox"/>	✓ 0/0 B	IPv6 UDP	2610:a8:483f:5110::4	*	2610:a8:483f:311::10	53 (DNS)	*	none		DNS to ....:10	   
<input type="checkbox"/>	✓ 0/0 B	IPv4 UDP	100.70.81.2	*	132.235.200.41	53 (DNS)	*	none		DNS to ..200.41	   
<input type="checkbox"/>	✓ 0/0 B	IPv6 UDP	2610:a8:483f:5110::4	*	2610:a8:483f:311::11	53 (DNS)	*	none		DNS to ....:11	   
<input type="checkbox"/>	✗ 0/957 KIB	IPv4 *	1172.18.128.0/17	*	*	*	*	none		Deny ALL	   
<input type="checkbox"/>	✗ 0/1.16 MIB	IPv4+6 *	*	*	*	*	*	none		Deny ALL	   

 Add  Add  Delete  Save  Separator

# Interior Firewall Routes – PFI

Gateways   Static Routes   Gateway Groups

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Static Routes					
	Network	Gateway	Interface	Description	Actions
<input checked="" type="checkbox"/>	172.18.128.0/17	v4 - 172.18.240.125	OPT1	v4 aggregate	
<input checked="" type="checkbox"/>	2610:a8:483f:51::/64	v6 - 2610:a8:483f:5112::2	OPT1	v6 aggregate	
<input checked="" type="checkbox"/>	2610:a8:483f:5105::/64	v6 - 2610:a8:483f:5112::2	OPT1	US1	
<input checked="" type="checkbox"/>	2610:a8:483f:5100::/64	v6 - 2610:a8:483f:5112::2	OPT1	US1-US2	
<input checked="" type="checkbox"/>	2610:a8:483f:5106::/64	v6 - 2610:a8:483f:5112::2	OPT1	US2	
<input checked="" type="checkbox"/>	2610:a8:483f:5101::/64	v6 - 2610:a8:483f:5112::2	OPT1	US2-EU	
<input checked="" type="checkbox"/>	2610:a8:483f:5107::/64	v6 - 2610:a8:483f:5112::2	OPT1	EU	
<input checked="" type="checkbox"/>	2610:a8:483f:5103::/64	v6 - 2610:a8:483f:5112::2	OPT1	EU-China	
<input checked="" type="checkbox"/>	2610:a8:483f:5108::/64	v6 - 2610:a8:483f:5112::2	OPT1	China	
<input checked="" type="checkbox"/>	2610:a8:483f:5102::/64	v6 - 2610:a8:483f:5112::2	OPT1	EU-Ireland	
<input checked="" type="checkbox"/>	2610:a8:483f:5109::/64	v6 - 2610:a8:483f:5112::2	OPT1	Ireland	

# Interior Firewall Routes – PFI

Floating   WAN   LAN   OPT1

Rules (Drag to Change Order)

	States	Protocol	Source	Port	Destination	Port	Gateway	Queue	Schedule	Description	Actions
<input type="checkbox"/>	<span style="color:red;">X</span> 0 /0 B	IPv4+6	*	*	*	*	none			Deny All	  

 Add  Add  Delete  Save  Separator

# Interior Firewall Routes – PFI

Rules (Drag to Change Order)											
□	States	Protocol	Source	Port	Destination	Port	Gateway	Queue	Schedule	Description	Actions
<input checked="" type="checkbox"/>	11 /737 KiB	*	*	*	LAN Address	80	*	*		Anti-Lockout Rule	
<input type="checkbox"/>	0 /120 B	IPv4 TCP/UDP	172.18.128.0/17	*	*	22 (SSH)	*	none		block ssh	
<input type="checkbox"/>	34 /7.80 MiB	IPv4+6	*	*	*	*	*	none		allow all out	
<input type="checkbox"/>	0/13 KiB	IPv4+6	*	*	*	*	*	none		Deny All	

# Interior Firewall Routes – PFI

Floating   WAN   LAN   OPT1

**Rules (Drag to Change Order)**

States	Protocol	Source	Port	Destination	Port	Gateway	Queue	Schedule	Description	Actions
<input type="checkbox"/>	✓ 0 / 0 B	IPv4 TCP/UDP	*	*	100.70.81.1	80 (HTTP)	*	none	allow http to web server	
<input type="checkbox"/>	✓ 0 / 0 B	IPv6 TCP/UDP	*	*	2610:a8:483f:5110::3	80 (HTTP)	*	none	allow http to web server v6	
<input type="checkbox"/>	✓ 0 / 0 B	IPv4 TCP/UDP	*	*	100.70.81.1	443 (HTTPS)	*	none	allow https to web server	
<input type="checkbox"/>	✓ 0 / 0 B	IPv6 TCP/UDP	*	*	2610:a8:483f:5110::3	443 (HTTPS)	*	none	allow https to web server v6	
<input type="checkbox"/>	✓ 0 / 71 KIB	IPv4 TCP/UDP	*	*	100.70.81.2	53 (DNS)	*	none	dns to DNS server	
<input type="checkbox"/>	✓ 0 / 0 B	IPv6 TCP/UDP	*	*	2610:a8:483f:5110::4	53 (DNS)	*	none	dns to DNS server v6	
<input type="checkbox"/>	✗ 0 / 240 B	IPv4 TCP/UDP	172.18.128.0/17	*	*	22 (SSH)	*	none	block ssh	
<input type="checkbox"/>	✓ 1 / 7.23 MiB	IPv4+6	*	*	*	*	*	none	allow all out	
<input type="checkbox"/>	✗ 0 / 13 KiB	IPv4+6	*	*	*	*	*	none	Deny All	

# DMZ Network Hosts

- Both GUI and CLIs received their configurations via static assignments.
- DNS CLI is the DNS server for all hosts in DMZ and all other objects.
- HTTP provides a web server that all hosts can connect to.
- Bastion provides the Web Configuration for the exterior firewall.

# GUIs outside of DMZ network

- The ITAdmin connected to PFI and NAS object in the Ireland network received their IP addresses via DHCP.
- ITAdmin provides the Web Configuration for the interior firewall.

# VPCS (VLANS)

- All PCs associated with the routers get their IPv4 addresses and IPv6 addresses (when required) automatically through DHCP.
- VLANS were setup on all routers to account for VPCS connected to a switch for the connections to the routers.
- SLAAC and VLAN had some interference I assume since the two v6 clients (R&Ds) are not connected to switch in the final phase of the network. When connected to a switch, they would only receive their SLAAC IPv6 address and not any IPv4 address, once removed from a switch they get IPv6 and IPv4 like normal.

# OSPF

- All routers generated their own routes around the network in IPv4.
- Small look at some of the US1 router OSPF generated routes for VPNs.

```
===== OSPF router routing table =====
R 192.168.0.1      [300] area: 0.0.0.0, ASBR
                           via 172.18.128.1, eth2
                           via 172.18.160.1, eth1
R 192.168.0.161    [100] area: 0.0.0.0, ASBR
                           via 172.18.128.1, eth2
                           via 172.18.160.1, eth1
R 192.168.0.193    [200] area: 0.0.0.0, ASBR
                           via 172.18.128.1, eth2
                           via 172.18.160.1, eth1
R 192.168.0.225    [100] area: 0.0.0.0, ASBR
                           via 172.18.160.1, eth1

===== OSPF external routing table =====
```

# IPv6 and VPN (E-Line VPNS)

- All of DMZ has IPv6 access.
- All routers have IPv6 connections to one another and to the Internet.
- All E-Lines have IPv6 connections that route IPv6 around the network.
- Even though not all clients behind the routers received IPv6, there is an IPv6 block assigned to the port clients WOULD access from if desired.
- All E-Lines (5) have VPN connections via the 192.168.0.0/24 network.
  - Each Router can reach the other side of their configured VPNs.
  - Wireshark captures show functioning VPN implementation.