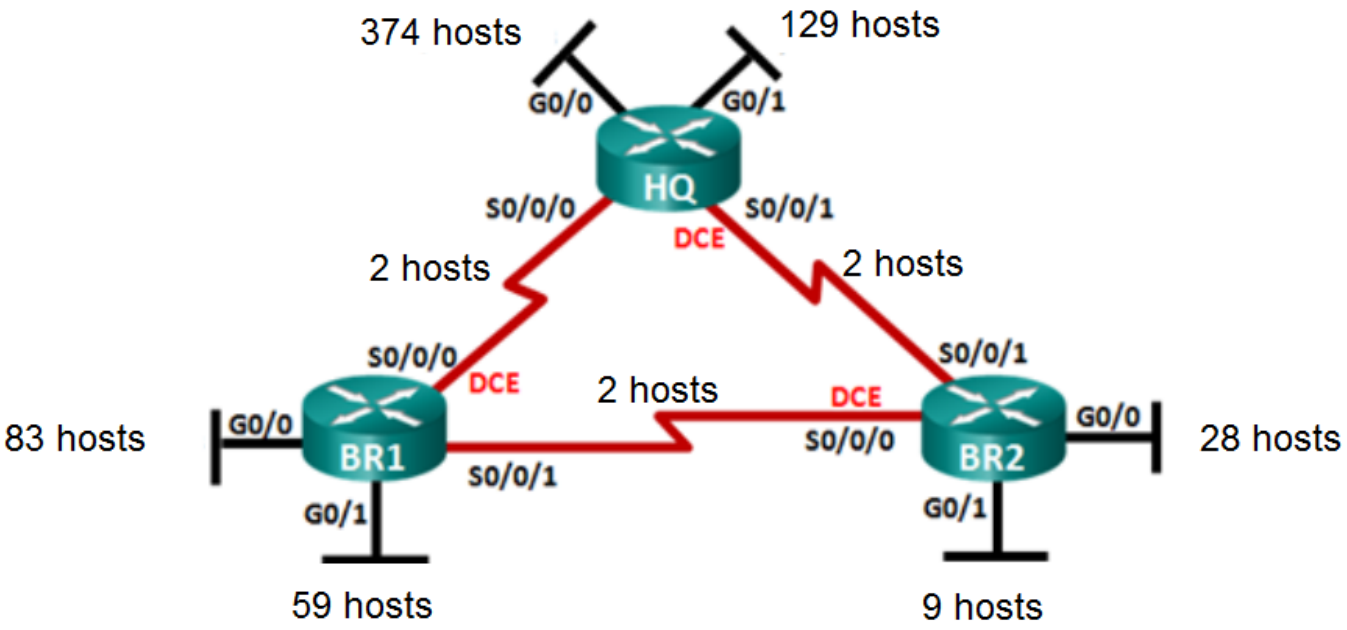
Activity 9.1– Walkthrough a VLSM Addressing Scheme

Topology



Objectives

Part 1: Examine Network Requirements

Part 2: Design the VLSM Address Scheme

Background / Scenario

Variable Length Subnet Mask (VLSM) was designed to avoid wasting IP addresses. With VLSM, a network is subnetted and then re-subnetted. This process can be repeated multiple times to create subnets of various sizes based on the number of hosts required in each subnet. Effective use of VLSM requires address planning.

In this lab, use the 172.16.4.0/22 network address to develop an address scheme for the network displayed in the topology diagram. Imagine that this network has been provided to you by your ISP. VLSM is used to meet the IPv4 addressing requirements. After you have designed the VLSM address scheme, you will configure the interfaces on the routers with the appropriate IP address information.

Note: Serial cables have two ends, one of which is called DCE and the other is called DTE. The DCE end will provide the clock and other control signals to the DTE end.

Part 1: Examine Network Requirements

In Part 1, you will examine the network requirements to develop a VLSM address scheme for the network displayed in the topology diagram using the 172.16.4.0/22 network address.

Step 1: Determine how many host addresses and subnets are available.

How many host addresses are available in a /22 network? 1022 (2^10 -2 = 1024 – 2)

How many networks are available in the 172.16.4.0/22 network if only the 3rd octet is used? 4

With a /22 prefix the subnet mask is: 11111111 . 11111111 . 11111100 . 00000000

The magic number is: 4

The starting network is: 172.16.4.0 The next network starts at: 172.16.8.0

This leaves the following 4 possible networks:

172.16.4.0 10101100 . 00010000 . 00000100 . 00000000

172.16.5.0 10101100 . 00010000 . 00000101 . 00000000

172.16.6.0 10101100 . 00010000 . 00000110 . 00000000

172.16.7.0 10101100 . 00010000 . 00000111 . 00000000

How many hosts can each of these networks support? 256

What is the total number of host addresses needed in the topology diagram? 688

HQ-G0/0: 374 +

HQ-G0/1: 129 +

BR1-G0/0: 83 +

BR1-G0/1: 59 +

BR2-G0/1: 9 +

BR2-G0/0: 28 +

HQ_To_BR1: 2 +

BR1_To_BR2: 2 +

BR2_To_HQ: 2

What is the minimum number of bits needed to support all the hosts? 10

Given that many host-bits, how many bits are left for the network and subnets? 22

What is the subnet mask for a /22 network? 255.255.252.0

What is the binary for the /22 subnet mask? 11111111 . 11111111 . 11111100 . 00000000

What is the binary for IP address 172.16.4.0: 10101100 . 00010000 . 00000100 . 00000000

How many subnets are needed in the network topology? 9

HQ-G0/0:

HQ-G0/1

BR1-G0/0

BR1-G0/1

BR2-G0/1

BR2-G0/0

HQ-S0/0/0_To_BR1_S/0/0/0

BR1-S0/0/1_To_BR2-S/0/0/0

BR2-S0/0/1_To_HQ-S0/0/1

Step 2: Determine the largest subnet.

What is the subnet name of the largest subnet? HQ-G0/0

How many IP addresses are required in the largest subnet? 374

How many bits are required to support that many hosts? 9 (2^9 = 512)

How many hosts can that many bits actually support? 510 (2^9 – 2)

What subnet mask can support that many host addresses? /23

```
/23       11111111 . 1111111 . 11111110 . 00000000
                                ^ (2^9 = 512)
```

How many actual host addresses can that subnet mask support? 510 (512 – 2)

Can you subnet the 172.16.4.0/22 network address to support this subnet? Yes

What are the two network addresses that would result from this subnetting?

Network address 1:

Decimal:	172.16.4.0/23
Binary:	10101100 . 00010000 . 00000100 . 00000000
Subnet mask:	11111111 . 11111111 . 11111110 . 00000000
First host address:	10101100 . 00010000 . 00000100 . 00000001
Decimal:	172.16.4.1
Last host address:	10101100 . 00010000 . 00000101 . 11111110
Decimal:	172.16.5.254
Broadcast address:	10101100 . 00010000 . 00000101 . 11111111
Decimal:	172.16.5.255

Network address 2:

Decimal:	172.16.6.0/23
Binary:	10101100 . 00010000 . 00000110 . 00000000
Subnet mask:	11111111 . 11111111 . 11111110 . 00000000
First host address:	10101100 . 00010000 . 00000110 . 00000001
Decimal:	172.16.6.1
Last host address:	10101100 . 00010000 . 00000111 . 11111110
Decimal:	172.16.7.254
Broadcast address:	10101100 . 00010000 . 00000111 . 11111111
Decimal:	172.16.7.255

Use the first network address (172.16.4.0/23) for this subnet. That leaves the second network (172.16.6.0/23) with up to 510 available IP addresses for further subnetting.

Step 3: Determine the second largest subnet.

What is the subnet name for the next largest subnet? HQ-G0/1

How many IP addresses are required in the next largest subnet? 129

How many bits are required to support that many hosts? 8 (2^8 = 256)

How many hosts can that many bits actually support? 254 (2^8 – 2)

What subnet mask can support that many host addresses? /24

```
/24        11111111 . 1111111 . 11111111 . 00000000
                                          ^ (2^8 = 256)
```

How many actual host addresses can that subnet mask support? 254 (256 – 2)

Can you subnet the remaining network from Step 2 (172.16.6.0/23) to support this subnet?

Yes, the remaining subnet (/23) can support 510 possible hosts. Splitting this in two gives us two further subnets with up to 254 hosts each.

What are the two network addresses that would result from this subnetting?

Network address 1:	Decimal:	172.16.6.0/24
	Binary:	10101100 . 00010000 . 00000110 . 00000000
	Subnet mask:	11111111 . 11111111 . 11111111 . 00000000
	First host address:	10101100 . 00010000 . 00000110 . 00000001
	Decimal:	172.16.6.1
	Last host address:	10101100 . 00010000 . 00000110 . 11111110
	Decimal:	172.16.6.254
	Broadcast address:	10101100 . 00010000 . 00000110 . 11111111
	Decimal:	172.16.6.255
Network address 2:	Decimal:	172.16.7.0/24
	Binary:	10101100 . 00010000 . 00000111 . 00000000
	Subnet mask:	11111111 . 11111111 . 11111111 . 00000000
	First host address:	10101100 . 00010000 . 00000111 . 00000001
	Decimal:	172.16.7.1
	Last host address:	10101100 . 00010000 . 00000111 . 11111110
	Decimal:	172.16.7.254
	Broadcast address:	10101100 . 00010000 . 00000111 . 11111111
	Decimal:	172.16.7.255

Use the first network address (172.16.6.0/24) for this subnet. That leaves the second network (172.16.7.0/24) with up to 510 available IP addresses for further subnetting.

Step 4: Determine the next (third) largest subnet.

What is the subnet name for the next largest subnet? BR1-G0/0

How many IP addresses are required in the next largest subnet? 83

How many bits are required to support that many hosts? 7 (2^7 = 128)

How many hosts can that many bits actually support? 126 (2^7 – 2)

What subnet mask can support that many host addresses? /25

```
/25       11111111 . 1111111 . 11111111 . 10000000
                                          ^ (2^7 = 128)
```

How many actual host addresses can that subnet mask support? 126 (128 – 2)

Can you subnet the remaining network from Step 3 (172.16.7.0/24) to support this subnet?

Yes, the remaining subnet (/24) can support 256 possible hosts. Splitting this in two gives us two further subnets with up to 126 hosts each.

What are the two network addresses that would result from this subnetting?

Network address 1:	Decimal:	172.16.7.0/25
	Binary:	10101100 . 00010000 . 00000111 . 00000000
	Subnet mask:	11111111 . 11111111 . 11111111 . 10000000
	First host address:	10101100 . 00010000 . 00000111 . 00000001
	Decimal:	172.16.7.1
	Last host address:	10101100 . 00010000 . 00000111 . 01111110
	Decimal:	172.16.7.126
	Broadcast address:	10101100 . 00010000 . 00000111 . 01111111
	Decimal:	172.16.7.127
Network address 2:	Decimal:	172.16.7.128/25
	Binary:	10101100 . 00010000 . 00000111 . 10000000
	Subnet mask:	11111111 . 11111111 . 11111111 . 10000000
	First host address:	10101100 . 00010000 . 00000111 . 10000001
	Decimal:	172.16.7.129
	Last host address:	10101100 . 00010000 . 00000111 . 11111110
	Decimal:	172.16.7.254
	Broadcast address:	10101100 . 00010000 . 00000111 . 11111111
	Decimal:	172.16.7.255

Use the first network address (172.16.7.0/25) for this subnet. That leaves the second network (172.16.7.128/25) with up to 128 available IP addresses for further subnetting.

Step 5: Determine the next (fourth) largest subnet.

What is the subnet name for the next largest subnet? BR1-G0/1

How many IP addresses are required in the next largest subnet? 59

How many bits are required to support that many hosts? 6 (2^6 = 64)

How many hosts can that many bits actually support? 62 (2^6 – 2)

What subnet mask can support that many host addresses? /26

```
/26       11111111 . 1111111 . 11111111 . 11000000
                                          ^ (2^6 = 64)
```

How many actual host addresses can that subnet mask support? 62 (64 – 2)

Can you subnet the remaining network from Step 4 (172.16.7.128/25) to support this subnet?

Yes, the remaining subnet (/25) can support 128 possible hosts. Splitting this in two gives us two further subnets with up to 64 hosts each.

What are the two network addresses that would result from this subnetting?

Network address 1:	Decimal:	172.16.7.128/26
	Binary:	10101100 . 00010000 . 00000111 . 10000000
	Subnet mask:	11111111 . 11111111 . 11111111 . 11000000
	First host address:	10101100 . 00010000 . 00000111 . 10000001
	Decimal:	172.16.7.129
	Last host address:	10101100 . 00010000 . 00000111 . 10111110
	Decimal:	172.16.7.190
	Broadcast address:	10101100 . 00010000 . 00000111 . 10111111
	Decimal:	172.16.7.191
Network address 2:	Decimal:	172.16.7.192/26
	Binary:	10101100 . 00010000 . 00000111 . 11000000
	Subnet mask:	11111111 . 11111111 . 11111111 . 11000000
	First host address:	10101100 . 00010000 . 00000111 . 11000001
	Decimal:	172.16.7.193
	Last host address:	10101100 . 00010000 . 00000111 . 11111110
	Decimal:	172.16.7.254
	Broadcast address:	10101100 . 00010000 . 00000111 . 11111111
	Decimal:	172.16.7.255

Use the first network address (172.16.7.128/26) for this subnet. That leaves the second network (172.16.7.192/26) with up to 64 available IP addresses for further subnetting.

Step 6: Determine the next (fifth) largest subnet.

What is the subnet name for the next largest subnet? BR2-G0/0

How many IP addresses are required in the next largest subnet? 28

How many bits are required to support that many hosts? 5 (2^5 = 32)

How many hosts can that many bits actually support? 30 (2^5 – 2)

What subnet mask can support that many host addresses? /27

```
/27       11111111 . 1111111 . 11111111 . 11100000
                                          ^ (2^5 = 32)
```

How many actual host addresses can that subnet mask support? 30 (32 – 2)

Can you subnet the remaining network from Step 5 (172.16.7.192/26) to support this subnet?

Yes, the remaining subnet (/26) can support 64 possible hosts. Splitting this in two gives us two further subnets with up to 32 hosts each.

What are the two network addresses that would result from this subnetting?

Network address 1:	Decimal:	172.16.7.192/27
	Binary:	10101100 . 00010000 . 00000111 . 11000000
	Subnet mask:	11111111 . 11111111 . 11111111 . 11100000
	First host address:	10101100 . 00010000 . 00000111 . 11000001
	Decimal:	172.16.7.193
	Last host address:	10101100 . 00010000 . 00000111 . 11011110
	Decimal:	172.16.7.222
	Broadcast address:	10101100 . 00010000 . 00000111 . 11011111
	Decimal:	172.16.7.223
Network address 2:	Decimal:	172.16.7.224/27
	Binary:	10101100 . 00010000 . 00000111 . 11100000
	Subnet mask:	11111111 . 11111111 . 11111111 . 11100000
	First host address:	10101100 . 00010000 . 00000111 . 11100001
	Decimal:	172.16.7.225
	Last host address:	10101100 . 00010000 . 00000111 . 11111110
	Decimal:	172.16.7.254
	Broadcast address:	10101100 . 00010000 . 00000111 . 11111111
	Decimal:	172.16.7.255

Use the first network address (172.16.7.192/27) for this subnet. That leaves the second network (172.16.7.224/27) with up to 32 available IP addresses for further subnetting.

Step 7: Determine the next (sixth) largest subnet.

What is the subnet name for the next largest subnet? BR2-G0/1

How many IP addresses are required in the next largest subnet? 9

How many bits are required to support that many hosts? 4 (2^4 = 16)

How many hosts can that many bits actually support? 14 (2^4 – 2)

What subnet mask can support that many host addresses? /28

```
/28       11111111 . 1111111 . 11111111 . 11110000
                                          ^ (2^4 = 16)
```

How many actual host addresses can that subnet mask support? 14 (16 – 2)

Can you subnet the remaining network from Step 5 (172.16.7.224/27) to support this subnet?

Yes, the remaining subnet (/27) can support 32 possible hosts. Splitting this in two gives us two further subnets with up to 16 hosts each.

What are the two network addresses that would result from this subnetting?

Network address 1:	Decimal:	172.16.7.224/28
	Binary:	10101100 . 00010000 . 00000111 . 11100000
	Subnet mask:	11111111 . 11111111 . 11111111 . 11110000
	First host address:	10101100 . 00010000 . 00000111 . 11100001
	Decimal:	172.16.7.224
	Last host address:	10101100 . 00010000 . 00000111 . 11101110
	Decimal:	172.16.7.238
	Broadcast address:	10101100 . 00010000 . 00000111 . 11101111
	Decimal:	172.16.7.239
Network address 2:	Decimal:	172.16.7.240/28
	Binary:	10101100 . 00010000 . 00000111 . 11110000
	Subnet mask:	11111111 . 11111111 . 11111111 . 11110000
	First host address:	10101100 . 00010000 . 00000111 . 11110001
	Decimal:	172.16.7.241
	Last host address:	10101100 . 00010000 . 00000111 . 11111110
	Decimal:	172.16.7.254
	Broadcast address:	10101100 . 00010000 . 00000111 . 11111111
	Decimal:	172.16.7.255

Use the first network address (172.16.7.224/28) for this subnet. That leaves the second network (172.16.7.240/28) with up to 16 available IP addresses for further subnetting.

Step 8: Determine the (three) subnets needed to support the serial links.

We will need to support three router to router networks (serial links). Each of these networks consists of 2 routers (actual hosts). What are the subnet names for the three remaining router to router networks?

HQ-S0/0/0_To_BR1_S/0/0/0

BR1-S0/0/1_To_BR2-S/0/0/0

BR2-S0/0/1_To_HQ-S0/0/1

How many IP addresses are required in each of these subnets? 2

How many bits are required to support that many hosts? 2 (2^2 = 4)

How many hosts can that many bits actually support? 2 (2^2 – 2)

What subnet mask can support that many host addresses? /30

/30 11111111 . 1111111 . 11111111 . 11111100

^ (2^2 = 4)

How many actual host addresses can that subnet mask support? 2 (4 – 2)

Can you subnet the remaining network from Step 5 (172.16.7.240/28) to support these three subnets?

Yes, the remaining subnet (/28) can support 16 possible hosts. We need 3 x 4 = 12 hosts to support the three router to router networks. The remaining /28 subnet could support up to 4 /30 subnets.

What are the four network addresses that would result from this subnetting?

Network address 1:	Decimal:	172.16.7.240/30
	Binary:	10101100 . 00010000 . 00000111 . 11111000
	Subnet mask:	11111111 . 11111111 . 11111111 . 11111100
	First host address:	10101100 . 00010000 . 00000111 . 11110001
	Decimal:	172.16.7.241
	Last host address:	10101100 . 00010000 . 00000111 . 11110010
	Decimal:	172.16.7.242
	Broadcast address:	10101100 . 00010000 . 00000111 . 11110011
	Decimal:	172.16.7.243
Network address 2:	Decimal:	172.16.7.244/30
	Binary:	10101100 . 00010000 . 00000111 . 11110100
	Subnet mask:	11111111 . 11111111 . 11111111 . 11111100
	First host address:	10101100 . 00010000 . 00000111 . 11110101
	Decimal:	172.16.7.245
	Last host address:	10101100 . 00010000 . 00000111 . 11110110
	Decimal:	172.16.7.246
	Broadcast address:	10101100 . 00010000 . 00000111 . 11110111
	Decimal:	172.16.7.247

Network address 3:	Decimal:	172.16.7.248/30
	Binary:	10101100 . 00010000 . 00000111 . 11111000
	Subnet mask:	11111111 . 11111111 . 11111111 . 11111100
	First host address:	10101100 . 00010000 . 00000111 . 11111001
	Decimal:	172.16.7.249
	Last host address:	10101100 . 00010000 . 00000111 . 11111010
	Decimal:	172.16.7.250
	Broadcast address:	10101100 . 00010000 . 00000111 . 11111011
	Decimal:	172.16.7.251
Network address 4:	Decimal:	172.16.7.252/30
	Binary:	10101100 . 00010000 . 00000111 . 11111100
	Subnet mask:	11111111 . 11111111 . 11111111 . 11111100
	First host address:	10101100 . 00010000 . 00000111 . 11111101
	Decimal:	172.16.7.253
	Last host address:	10101100 . 00010000 . 00000111 . 11111110
	Decimal:	172.16.7.254
	Broadcast address:	10101100 . 00010000 . 00000111 . 11111111
	Decimal:	172.16.7.255

8a. Use the first network address (172.16.7.240/30) for HQ-S0/0/0_To_BR1_S/0/0/0.

8b. Use the second network address (172.16.7.244/30) for BR2-S0/0/1_To_HQ-S0/0/1.

8c. Use the third network address (172.16.7.248/30) for BR1-S0/0/1_To_BR2-S/0/0/0.

8d. The remaining (fourth) network address (172.16.7.252/30) is unused for now.

Part 2: Design the VLSM Address Scheme

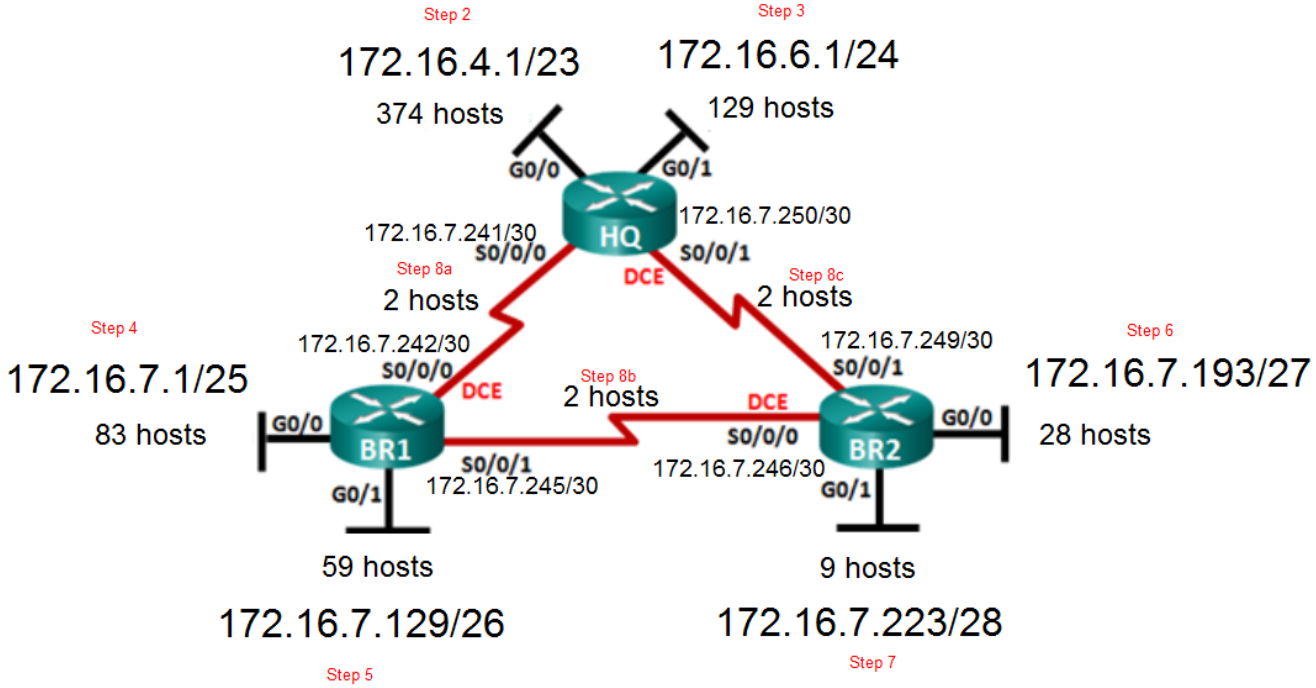
Step 1: Calculate the subnet information.

Subnet Description	Number of Hosts Needed	Subnet size	Network Address /CIDR	First Host Address	Last Host Address	Broadcast Address	Step #
HQ G0/0	374	512	172.16.4.0/23	172.16.4.1	172.16.5.254	172.16.5.255	2
HQ G0/1	129	256	172.16.6.0/24	172.16.6.1	172.16.6.254	172.16.6.255	3
BR1 G0/0	83	128	172.16.7.0/25	172.16.7.1	172.16.7.126	172.16.7.127	4
BR1 G0/1	59	64	172.16.7.128/26	172.16.7.129	172.16.7.190	172.16.7.191	5
BR2 G0/0	28	32	172.16.7.192/27	172.16.7.193	172.16.7.222	172.16.7.223	6
BR2 G0/1	9	16	172.16.7.224/28	172.16.7.225	172.16.7.238	172.16.7.239	7
HQ S0/0/0 – BR1 S0/0/0	2	4	172.16.7.240/30	172.16.7.241	172.16.7.242	172.16.7.243	8a
HQ S0/0/1 – BR2 S0/0/1	2	4	172.16.7.244/30	172.16.7.245	172.16.7.246	172.16.7.247	8b
BR1 S0/0/1 – BR2 S0/0/0	2	4	172.16.7.248/30	172.16.7.249	172.16.7.250	172.16.7.251	8c

Step 2: Complete the device interface address table.

Assign the first host address in the subnet to the Ethernet interfaces.

Device	Interface	IP Address	Prefix	Subnet mask	Connects to	Step #
HQ	G0/0	172.16.4.1	/23	255.255.254.0	374 Host LAN	2
	G0/1	172.16.6.1	/24	255.255.255.0	129 Host LAN	3
	S0/0/0	172.16.7.241	/30	255.255.255.252	BR1 S0/0/0	8a
	S0/0/1	172.16.7.250	/30	255.255.255.252	BR2 S0/0/1	8c
BR1	G0/0	172.16.7.1	/25	255.255.255.128	83 Host LAN	4
	G0/1	172.16.7.129	/26	255.255.255.192	59 Host LAN	5
	S0/0/0	172.16.7.242	/30	255.255.255.252	HQ S0/0/0	8a
	S0/0/1	172.16.7.245	/30	255.255.255.252	BR2 S0/0/0	8b
BR2	G0/0	172.16.193	/27	255.255.255.224	28 Host LAN	6
	G0/1	172.16.7.225	/28	255.255.255.240	9 Host LAN	7
	S0/0/0	172.16.7.246	/30	255.255.255.252	BR1 S0/0/1	8b
	S0/0/1	172.16.7.249	/30	255.255.255.252	HQ S0/0/1	8c



Subnet work allocation diagram: