Research Activity: Classless Subnetting

Given: 192.168.0.0/24

Topology Requirements:

- 40 hosts
- 30 hosts
- 20 hosts
- 10 hosts
- 2 point-to-point router links (2 hosts each)

Step 1: Arrange Networks by Size (Largest to Smallest)

When doing classless subnetting, always start with the largest subnet requirement first. This ensures you don't fragment your address space inefficiently.

Ordered Requirements:

1. 40 hosts
2. 30 hosts
3. 20 hosts
4. 10 hosts
5. 2 hosts (router link 1)
6. 2 hosts (router link 2)

Step 2: Find the Appropriate Subnet Mask for Each Network

You need to find the smallest subnet that can fit each requirement. Remember: Total hosts = 2^(host bits), and Usable hosts = Total hosts - 2 (subtract network and broadcast addresses).

Requirement	Smallest Subnet	Network Bits	Host Bits	Total Hosts	Usable Hosts	Subnet Mask
40 hosts	/26	26	6	$2^6 = 64$	62	255.255.255.192
30 hosts	/27	27	5	$2^5 = 32$	30	255.255.255.224
20 hosts	/28	28	4	$2^4 = 16$	14	❌ Too small!
20 hosts	/27	27	5	$2^5 = 32$	30	✅ 255.255.255.224
10 hosts	/28	28	4	$2^4 = 16$	14	255.255.255.240
2 hosts	/30	30	2	$2^2 = 4$	2	255.255.255.252
2 hosts	/30	30	2	$2^2 = 4$	2	255.255.255.252

Important Note: Even though 20 hosts might seem to fit in a /28 mathematically, /28 only gives 14 usable hosts (16 total - 2). You need /27 (30 usable hosts) to accommodate 20 devices.

Step 3: Complete Subnet Table

Now we assign actual IP addresses, working from the base network 192.168.0.0 and adding the block size each time.

Network	Prefix	Block Size	Total Hosts	Usable Hosts	Network Address	First Usable	Last Usable	Broadcast Address
40 hosts	/26	64	64	62	192.168.0.0	192.168.0.1	192.168.0.62	192.168.0.63
30 hosts	/27	32	32	30	192.168.0.64	192.168.0.65	192.168.0.94	192.168.0.95
20 hosts	/27	32	32	30	192.168.0.96	192.168.0.97	192.168.0.126	192.168.0.127
10 hosts	/28	16	16	14	192.168.0.128	192.168.0.129	192.168.0.142	192.168.0.143
Link 1	/30	4	4	2	192.168.0.144	192.168.0.145	192.168.0.146	192.168.0.147
Link 2	/30	4	4	2	192.168.0.148	192.168.0.149	192.168.0.150	192.168.0.151

Step 4: How the Calculations Work

For the 40-host network (/26):

- **Network Address:** Start at 192.168.0.0 (the base address)
- **Block Size:** /26 = 64 addresses (2^6 host bits)
- **Broadcast Address:** Network + Block Size - 1 = 0 + 64 - 1 = 192.168.0.63

- **First Usable:** Network + 1 = 192.168.0.1
- **Last Usable:** Broadcast - 1 = 192.168.0.62
- **Next Network:** Current Network + Block Size = 0 + 64 = **192.168.0.64**

For the 30-host network (/27):

- **Network Address:** 192.168.0.64 (from previous calculation)
- **Block Size:** /27 = 32 addresses
- **Broadcast Address:** 64 + 32 - 1 = 192.168.0.95
- **First Usable:** 192.168.0.65
- **Last Usable:** 192.168.0.94
- **Next Network:** 64 + 32 = **192.168.0.96**

For the 20-host network (/27):

- **Network Address:** 192.168.0.96
- **Block Size:** /27 = 32 addresses
- **Broadcast Address:** 96 + 32 - 1 = 192.168.0.127
- **First Usable:** 192.168.0.97
- **Last Usable:** 192.168.0.126
- **Next Network:** 96 + 32 = **192.168.0.128**

For the 10-host network (/28):

- **Network Address:** 192.168.0.128
- **Block Size:** /28 = 16 addresses
- **Broadcast Address:** 128 + 16 - 1 = 192.168.0.143
- **First Usable:** 192.168.0.129
- **Last Usable:** 192.168.0.142
- **Next Network:** 128 + 16 = **192.168.0.144**

For Router Link 1 (/30):

- **Network Address:** 192.168.0.144
- **Block Size:** /30 = 4 addresses

- **Broadcast Address:** 144 + 4 - 1 = 192.168.0.147
- **First Usable:** 192.168.0.145 (Router A interface)
- **Last Usable:** 192.168.0.146 (Router B interface)
- **Next Network:** 144 + 4 = **192.168.0.148**

For Router Link 2 (/30):

- **Network Address:** 192.168.0.148
- **Block Size:** /30 = 4 addresses
- **Broadcast Address:** 148 + 4 - 1 = 192.168.0.151
- **First Usable:** 192.168.0.149 (Router B interface)
- **Last Usable:** 192.168.0.150 (Router C interface)

Step 5: Address Efficiency Analysis

Classless Subnetting Efficiency:

Network	Required Hosts	Allocated Hosts	Wasted Addresses	Efficiency
40 hosts	40	62	22	64.5%
30 hosts	30	30	0	100%
20 hosts	20	30	10	66.7%
10 hosts	10	14	4	71.4%
Link 1	2	2	0	100%
Link 2	2	2	0	100%
TOTAL	**104 hosts**	**140 hosts**	**36 wasted**	**74.3% efficient**

Addresses Used: 0 to 151 = 152 addresses out of 256 available
Addresses Remaining: 192.168.0.152 to 192.168.0.255 = 104 addresses for future growth

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Comparison: Classful vs Classless Subnetting

If we used Classful Subnetting (all /26):

Network	Prefix	Usable Hosts	Required	Wasted
40 hosts	/26	62	40	22
30 hosts	/26	62	30	32

Network	Prefix	Usable Hosts	Required	Wasted
20 hosts	/26	62	20	42
10 hosts	/26	62	10	52
TOTAL		**248 hosts**	**100**	**148 wasted!**

Problem: We'd only be able to create 4 subnets (4 × 64 = 256 addresses), leaving **NO ROOM** for the two router links!

Conclusion: Classless subnetting is clearly superior for this scenario.

Visual Network Layout

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192.168.0.0/26   ──────► 40 hosts (192.168.0.1 - 192.168.0.62)
192.168.0.64/27  ──────► 30 hosts (192.168.0.65 - 192.168.0.94)
192.168.0.96/27  ──────► 20 hosts (192.168.0.97 - 192.168.0.126)
192.168.0.128/28 ──────► 10 hosts (192.168.0.129 - 192.168.0.142)
192.168.0.144/30 ──────► Router Link 1 (192.168.0.145 - 192.168.0.146)
192.168.0.148/30 ──────► Router Link 2 (192.168.0.149 - 192.168.0.150)
192.168.0.152-255 ─────► Available for future expansion (104 addresses)
```

Key Takeaways

1. **Always arrange subnets from largest to smallest** to avoid address space fragmentation
2. **Use the smallest subnet that fits** the requirement to maximize efficiency
3. **Remember the formula:** Usable hosts = 2^(host bits) - 2
4. **Network address** = First address (cannot be assigned to devices)
5. **Broadcast address** = Last address (cannot be assigned to devices)
6. **Next network address** = Current network + Block size
7. **Point-to-point links** always use /30 (2 usable addresses)
8. **Classless subnetting** is more efficient than classful subnetting in real-world scenarios

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Quick Reference: Common Subnet Sizes

Prefix	Subnet Mask	Block Size	Usable Hosts	Common Use
/24	255.255.255.0	256	254	Standard small network
/25	255.255.255.128	128	126	Large department
/26	255.255.255.192	64	62	Medium department
/27	255.255.255.224	32	30	Small department
/28	255.255.255.240	16	14	Small office
/29	255.255.255.248	8	6	Very small group
/30	255.255.255.252	4	2	Point-to-point links