Introduction to Networks

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Chapter 9

9.0 Introduction

9.1 Subnetting an IPv4 Network

9.2 Addressing Schemes

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Subnetting

Subnetting is the process of segmenting a larger network into multiple smaller networks called subnetworks or subnets.

Reasons for Subnetting:

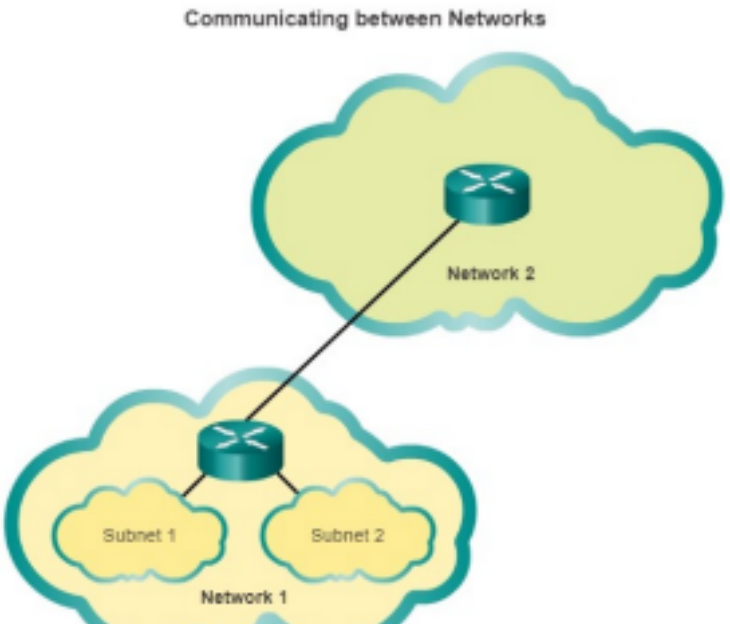
- Large networks must be segmented into smaller subnetworks, creating smaller groups of devices and services to:
  - Control traffic by containing broadcast traffic within each subnetwork.
  - Reduce overall network traffic and improve network performance.

Network Segmentation

Subnetting

Communication Between Subnets

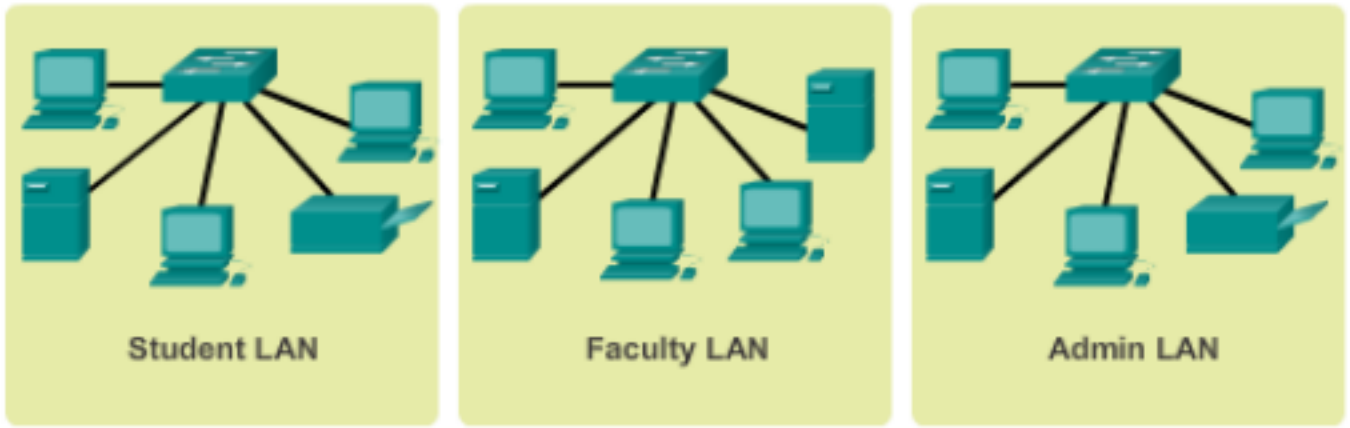
- A router is necessary for devices on different networks and subnets to communicate.
- Each router interface must have an



IPv4 host address that belongs to the network or subnet that the router interface is connected.

- Devices on a network and subnet use the router interface attached to their LAN as their default gateway.

The Plan



Planning requires decisions on each subnet in terms of size, the number of hosts per subnet, and how host addresses will be assigned.

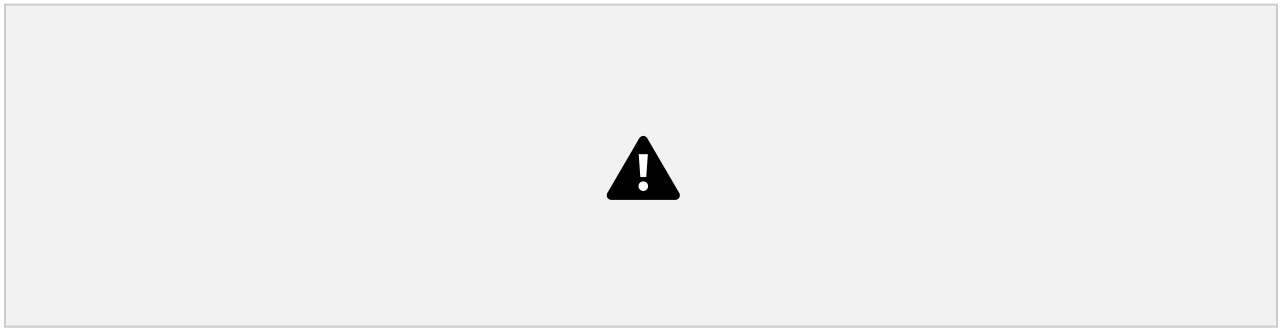
Planning the Network

Basic Subnetting

- Subnets are created by using one or more of the host bits as network bits.
- This is done by borrowing some of the bits from the host portion of the address.
- The more host bits borrowed, the more subnets can be created.
- For each bit borrowed, the number of subnetworks available is doubled.
- For example, if 1 bit is borrowed, 2 subnets can be created. If 2 bits, 4 subnets are created, if 3 bits are borrowed, 8 subnets are created, and so on (2^n; where n is the number of borrowed bits).
- However, with each bit borrowed, fewer host addresses are available per subnet.

Let's examine the example in Section 9.1.3.1.

Basic Subnetting



Original	192.	168.	1.	0	000 0000	Network 192.168.1.0/24
Mask	255.	255.	255.	0	000 0000	Mask: 255.255.255.0

Borrowing 1 Bit from the host portion creates 2 subnets with the same subnet mask

Subnet 0

Network

192.168.1.**0-127**/**25** Mask:

255.255.255.**128**

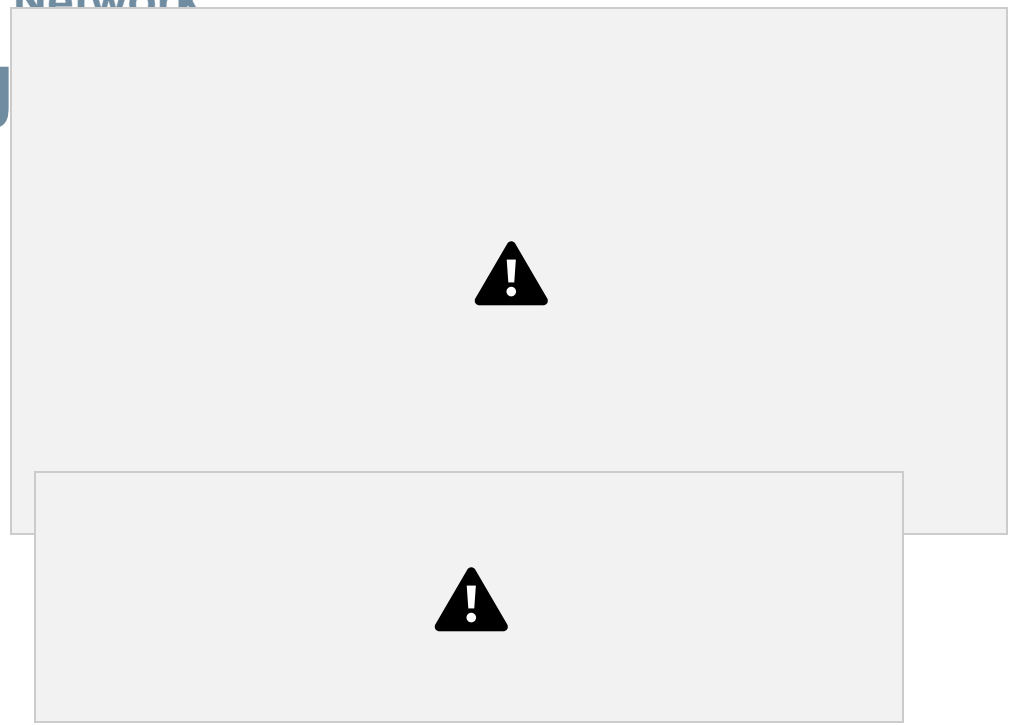
Subnet 1

Network

192.168.1.**128-255**/**25** Mask:

255.255.255.**128**

Subnetting



Calculate number of subnets

Calculate number

of hosts

2^7 = 128 addresses per subnet

2^7- 2 = 126 valid host addresses per subnet

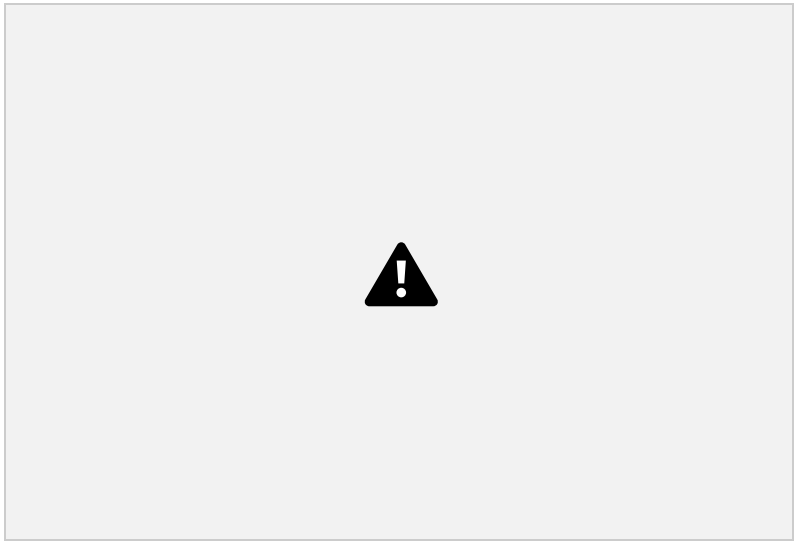
Subnetting an IPv4 Network

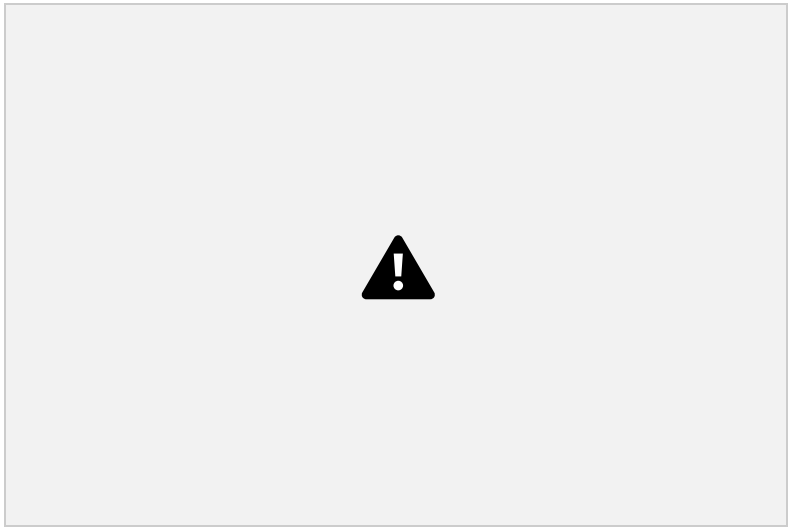
Subnets in Use

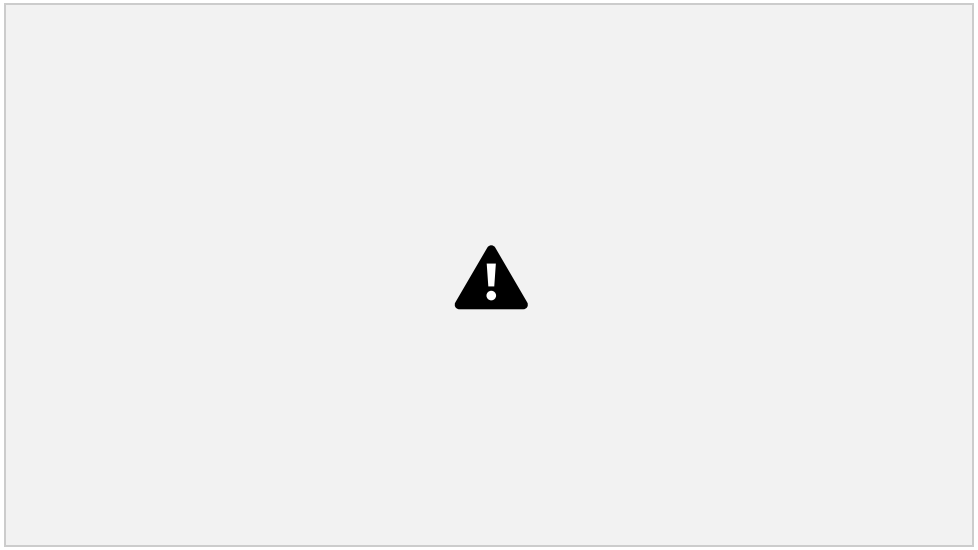
Subnets in Use

Subnet 0

Network 192.168.1.**0-127**/**25**







Subnet 1

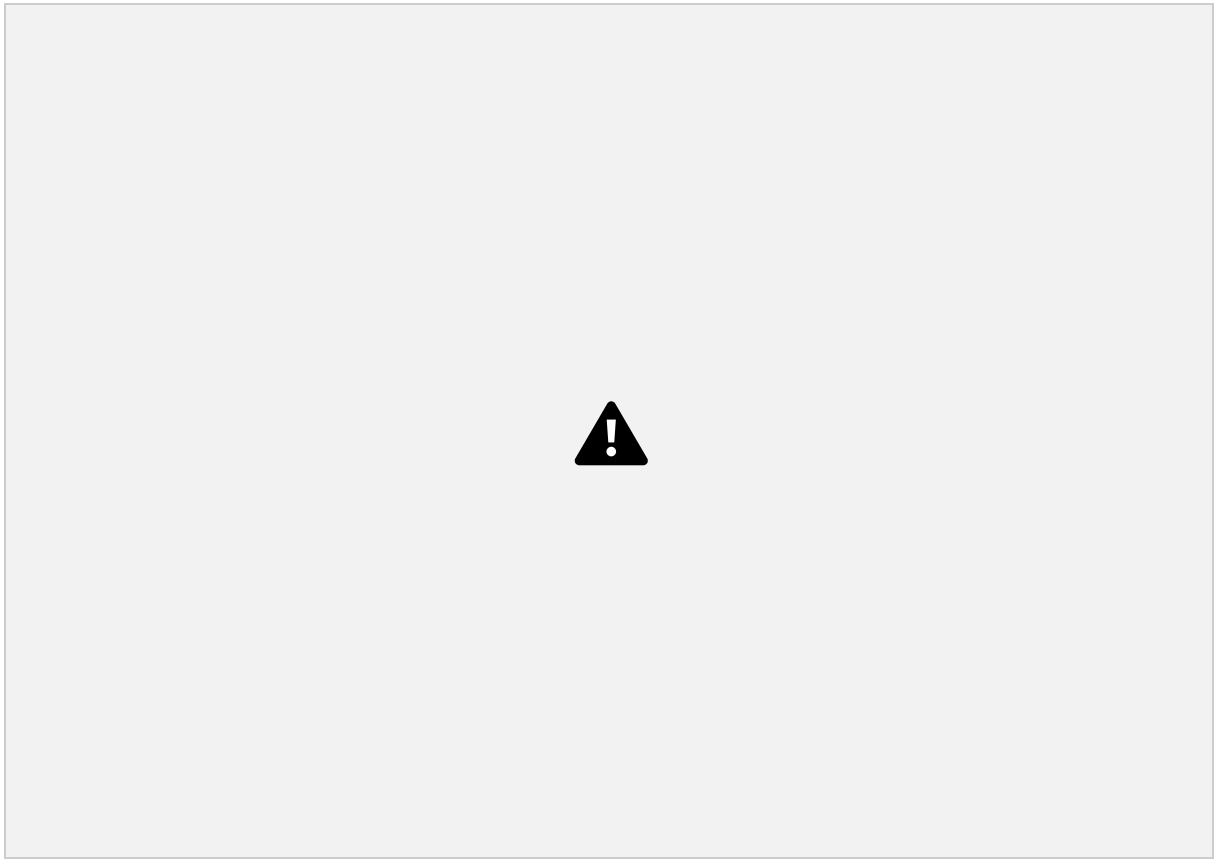
Network 192.168.1.**128-255**/**25**

Subnetting an IPv4 Network

Creating 4 Subnets

Borrowing 2 bits to create 4 subnets. **2^2 = 4 subnets**

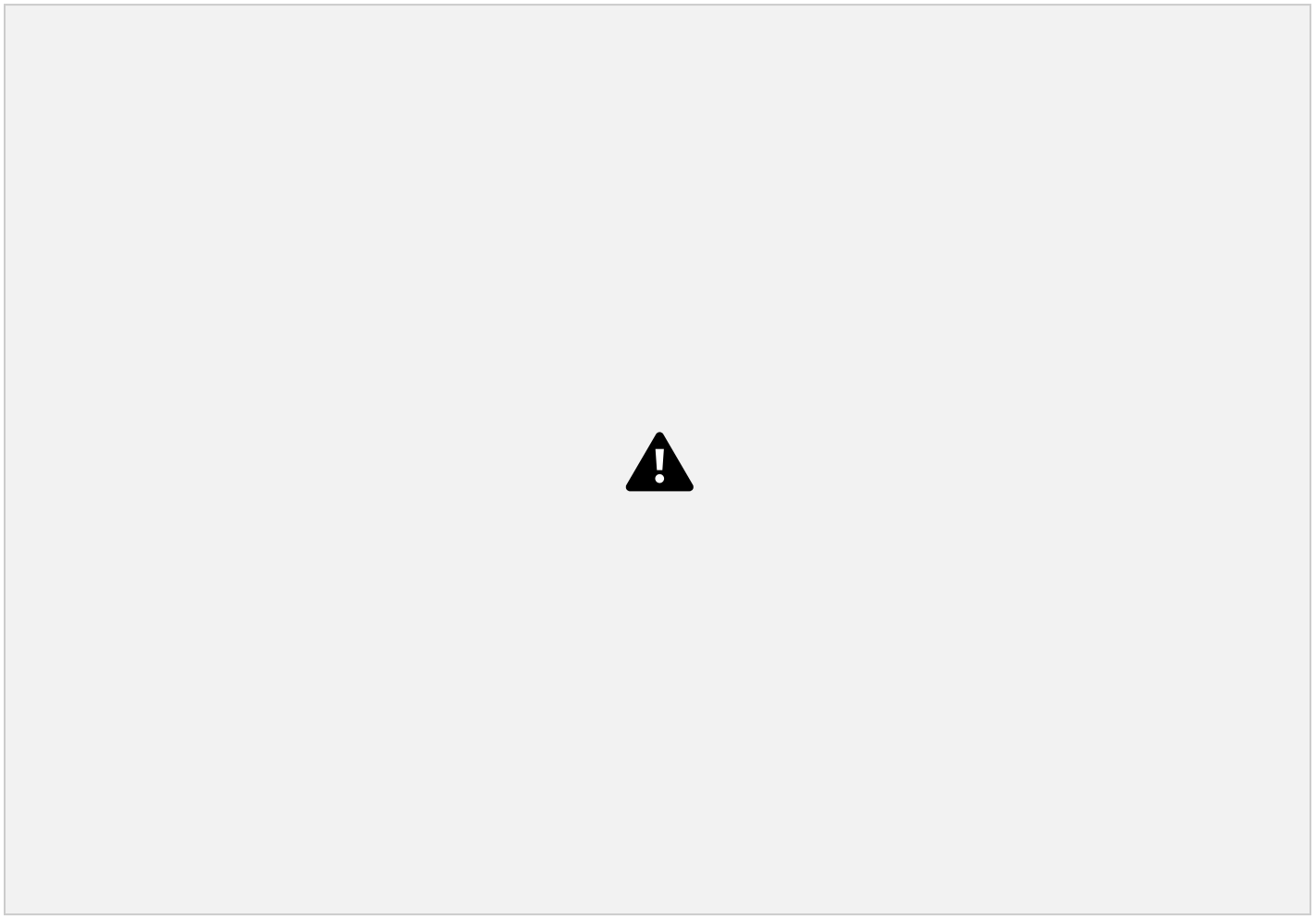
Creating 4 Subnets



Subnetting an IPv4 Network

Creating Eight Subnets

Borrowing 3 bits to **Create 8 Subnets**. **2^3 = 8 subnets**

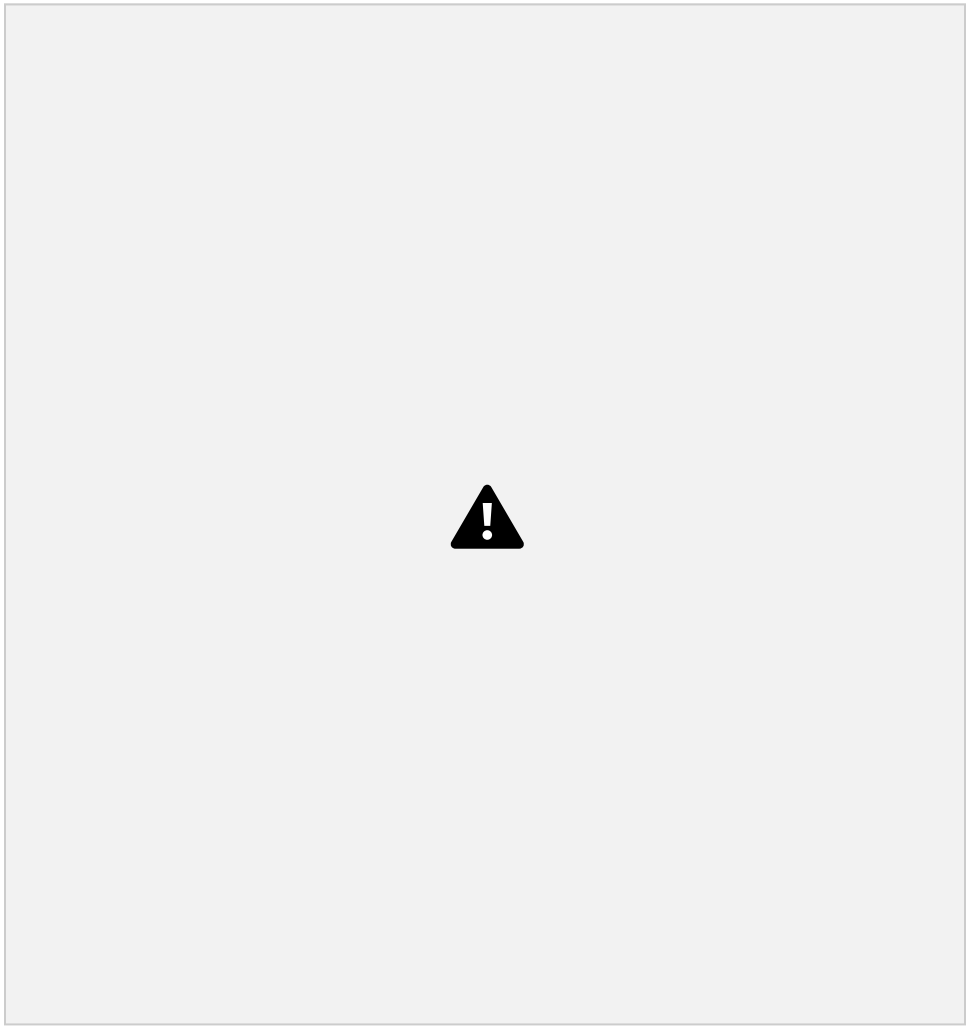


Subnetting an IPv4 Network

Creating Eight Subnets (Cont.)

Subnetting an IPv4 Network

Creating Eight Subnets (Cont.)



Determining the Subnet Mask

Subnetting Based on Host Requirements

Two considerations when planning subnets:

- Number of subnets required
- Number of host addresses required

Formula to determine number of usable hosts: 2^n-2

- 2^n(where *n* is the number of remaining host bits) is used to calculate the number of hosts.
- -2 (The subnetwork address and broadcast address cannot be used on each subnet.)

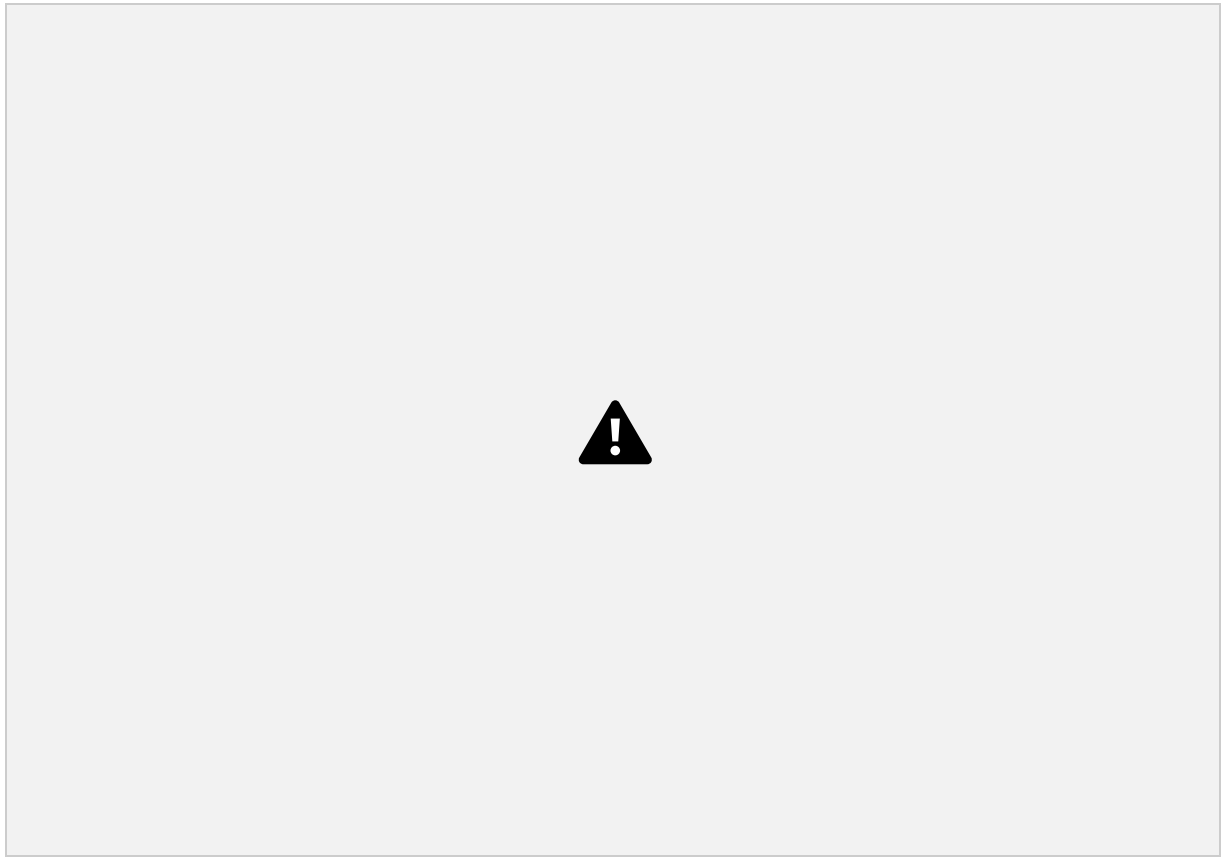
Calculate the number of subnets:

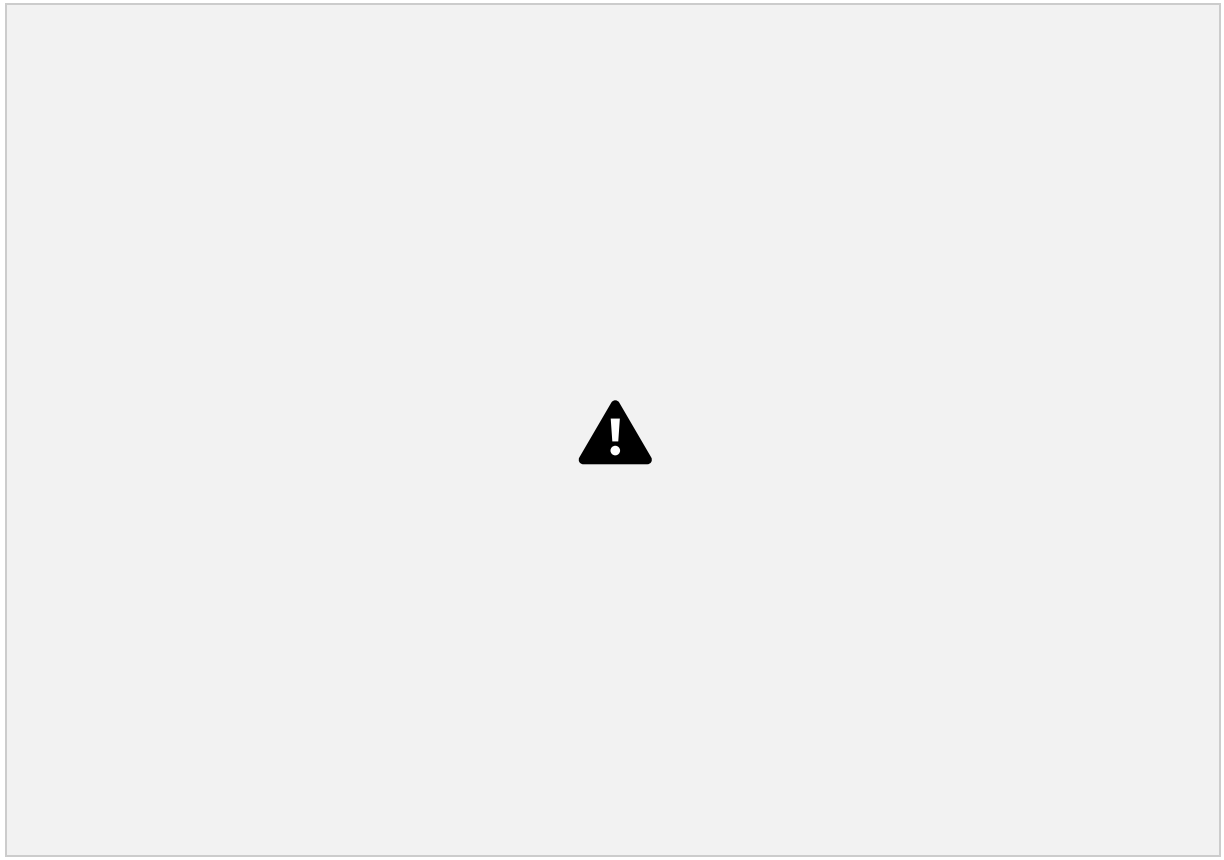
- **2^n** (where n is the number of bits borrowed)
- Subnet needed for each department.

Let's examine the animation in 9.1.4.1

Determining the Subnet Mask

Subnetting Network-Based Requirements





Determining the Subnet Mask

Subnetting To Meet Network Requirements

- Balance the required number of subnets and hosts for the largest subnet.
- Design the addressing scheme to accommodate the maximum number of hosts for each subnet.
- Allow for growth in each subnet.

Determining the Subnet Mask

Determine the Number and Size of the Networks

LAN 1 LAN 2 LAN 3

- Given, Network Address 172.16.0.0/22.
- Available host bits: 10.
  - The largest subnet requires 40 hosts, a minimum of 6 host bits are needed to provide addressing for 40 hosts ($2^6 – 2 = 62$ hosts).
  - The first 4 host bits can be used to allocate subnets ($2^4 = 16$).
    - Because the example

internetwork requires 9 subnets

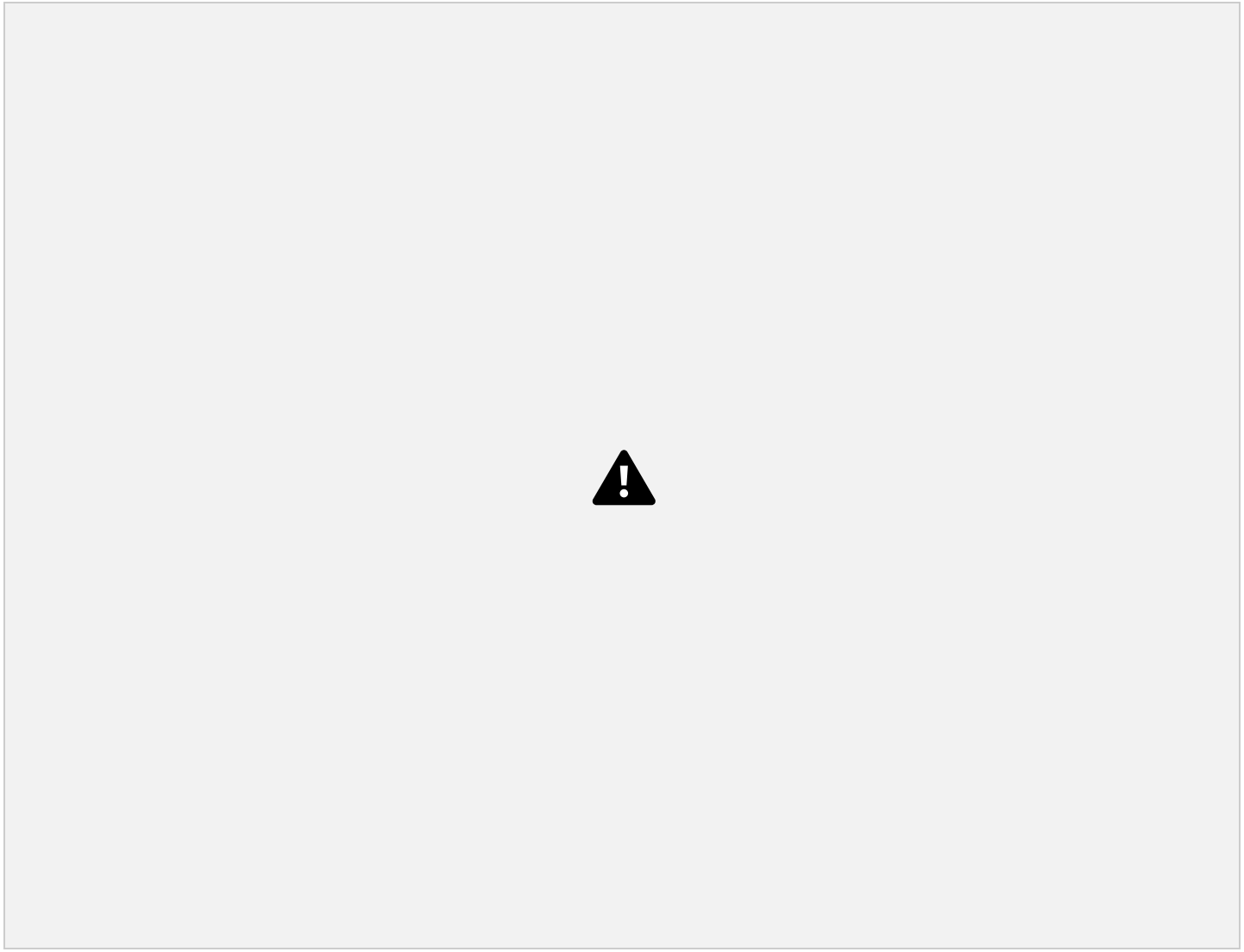
additional growth.

LAN 4 LAN 5 WAN Link 1

this will meet the requirement and allow for some

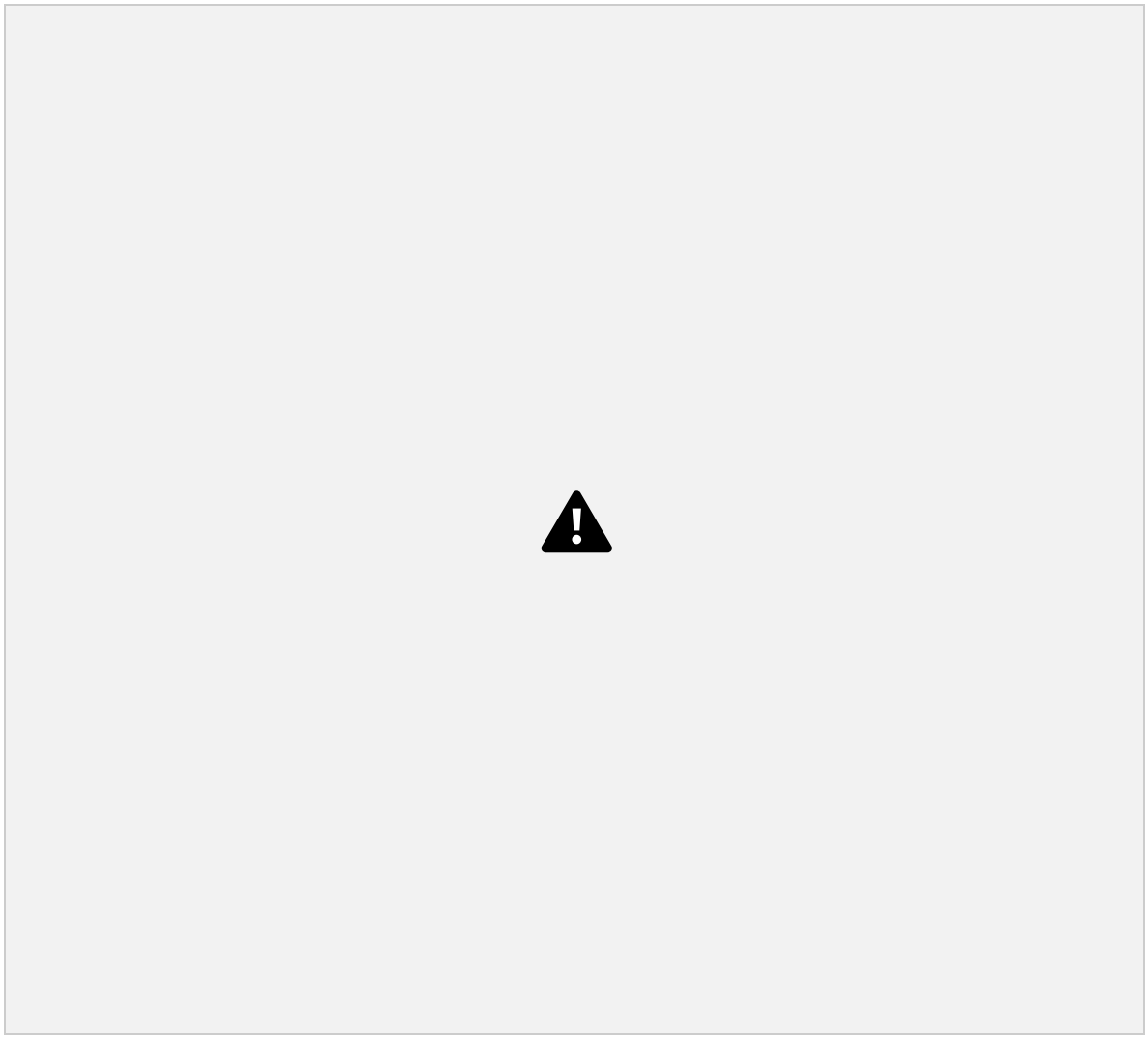
Determining the Subnet Mask

Subnetting To Meet Network Requirements



Determining the Subnet Mask

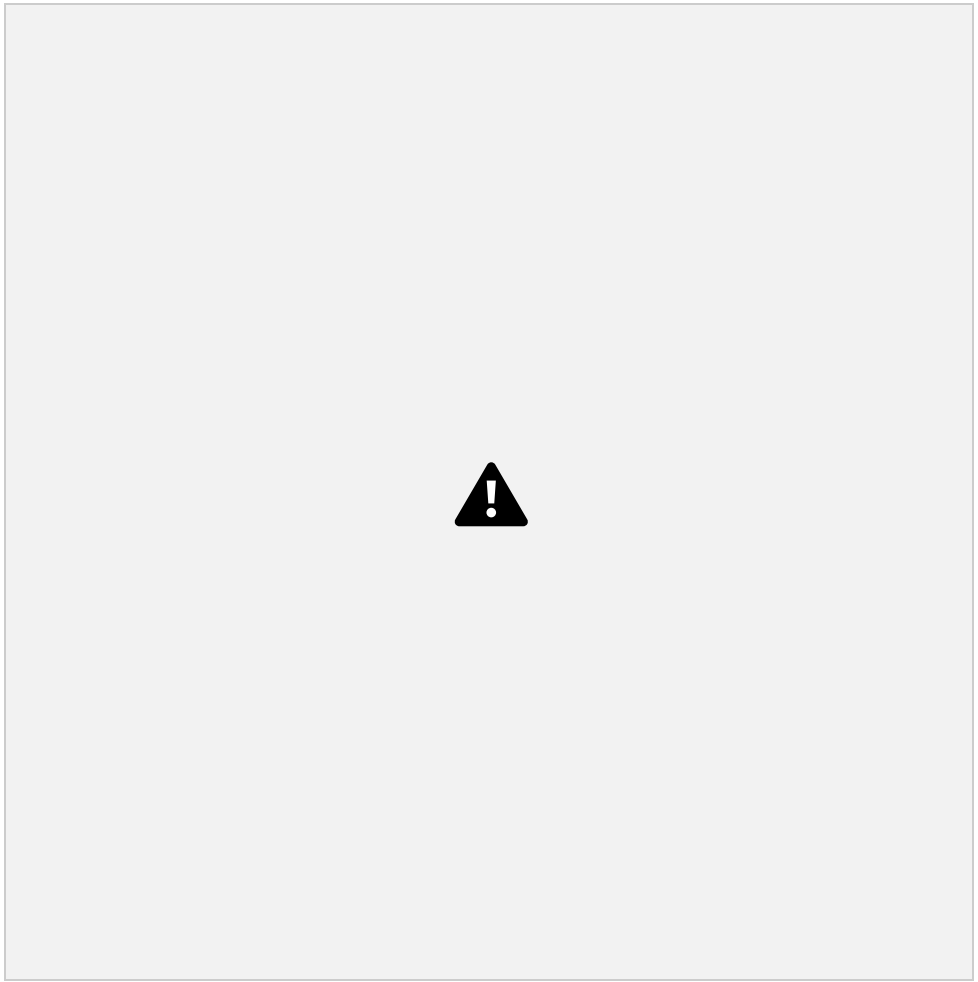
Subnetting To Meet Network Requirements



Benefits of Variable Length Subnet Masking

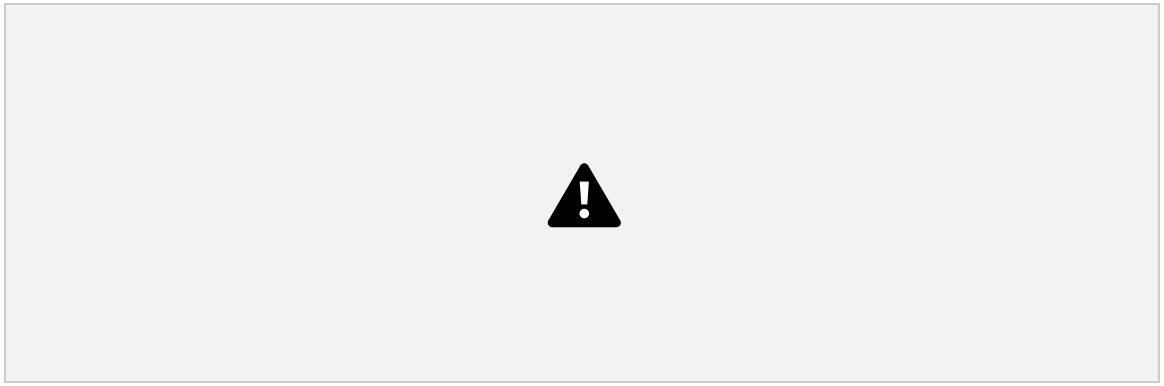
Traditional Subnetting Wastes Addresses

- Traditional subnetting
  - Uses the same number of addresses is allocated for each subnet.
- Subnets that require fewer addresses have unused (wasted) addresses; for example, WAN links only need two addresses.



Benefits of Variable Length Subnet Masking

Traditional Subnetting Wastes Addresses



→ Host portion: 2^5-2=30 hosts per subnet
→ 30-2=28 Each WAN subnet wastes 28 addresses
→ 28 x 3 = 84 addresses are unused and wasted

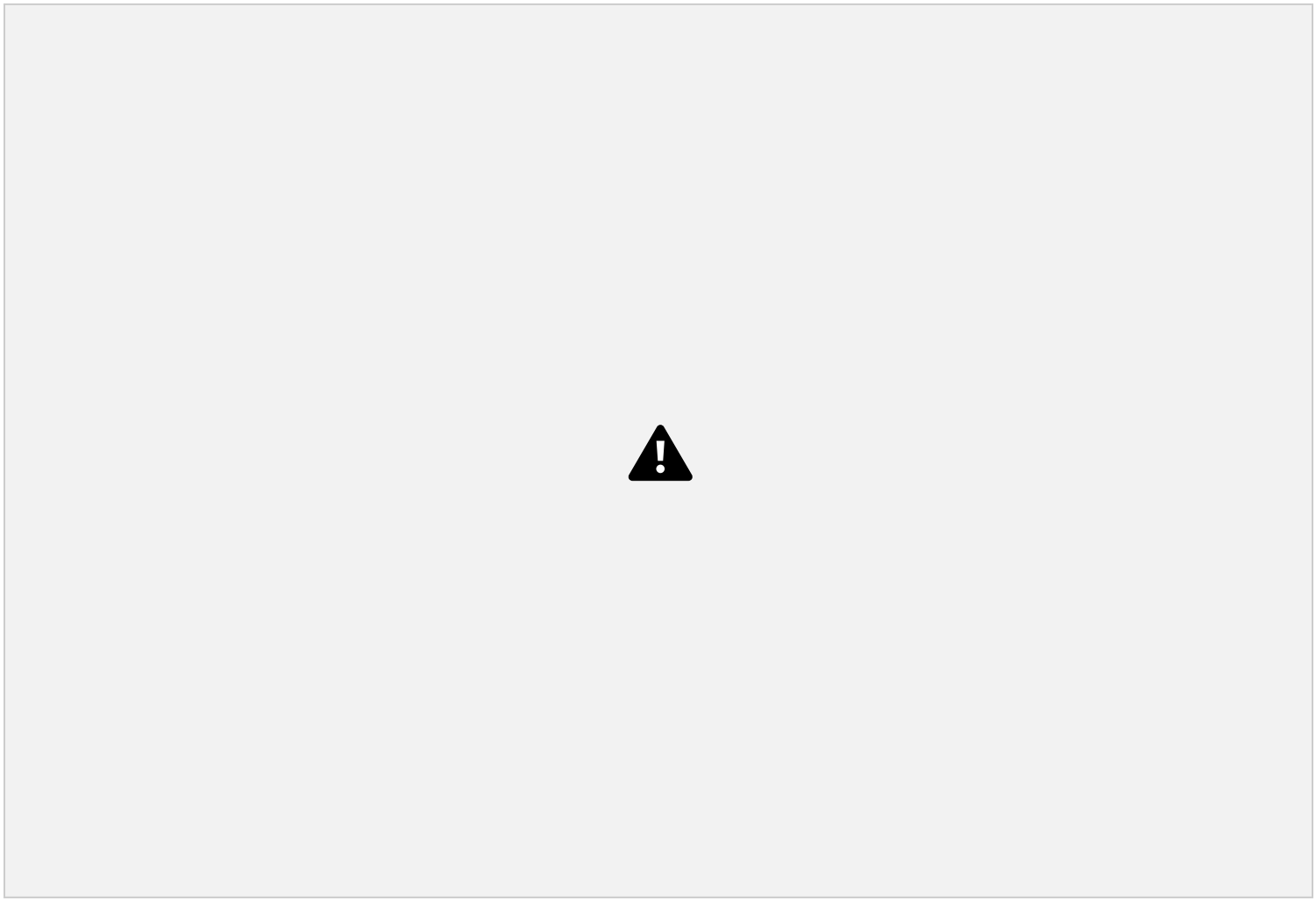
Benefits of Variable Length Subnet Masking

Variable Length Subnet Masks (VLSM)

- The variable-length subnet mask (VLSM) or subnetting a subnet provides more efficient use of addresses.
- VLSM allows a network space to be divided in unequal parts.
- Subnet mask varies, depending on how many bits have been borrowed for a particular subnet.
- Network is first subnetted, and then the subnets are re-subnetted.

Benefits of Variable Length Subnet Masking

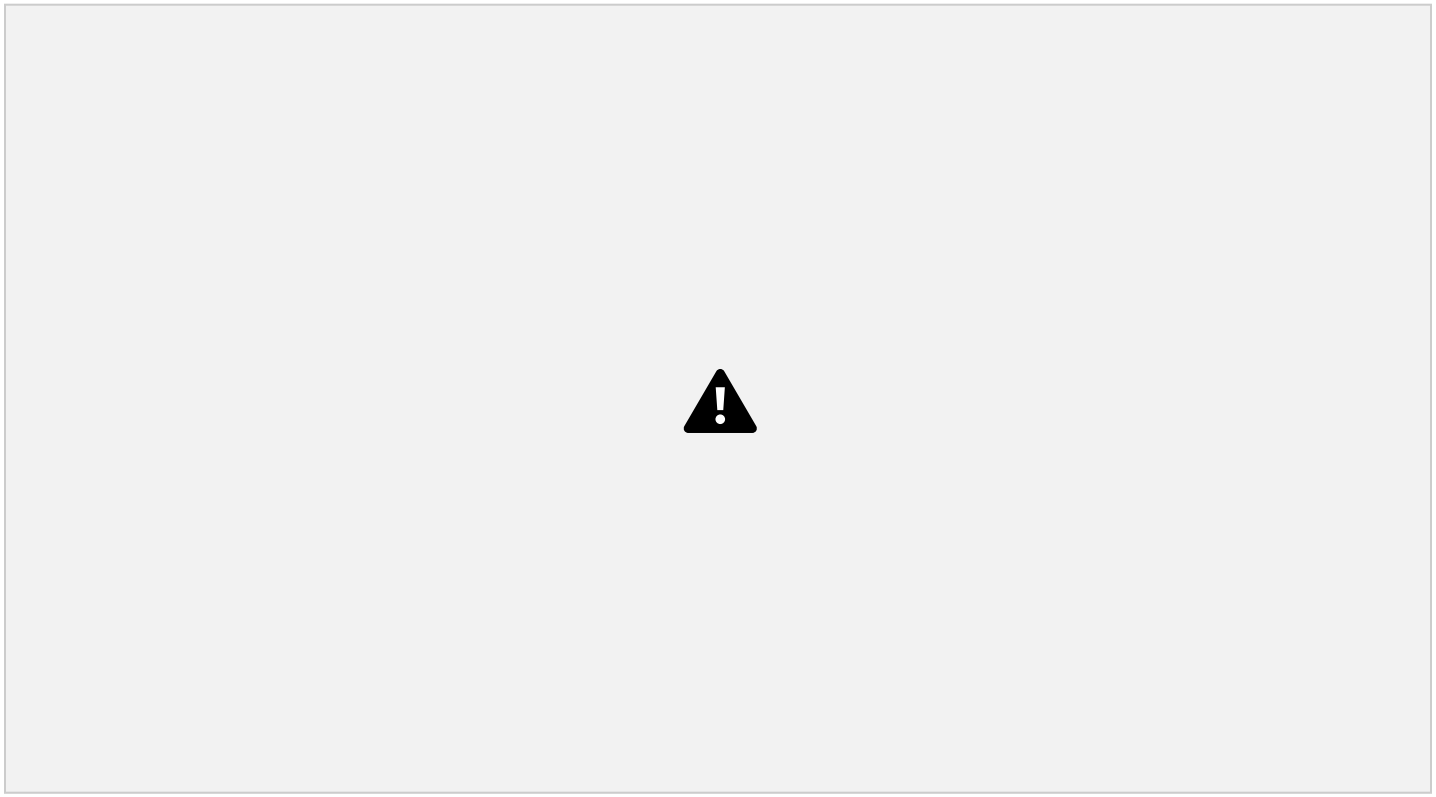
Basic VLSM



Benefits of Variable Length Subnet Masking

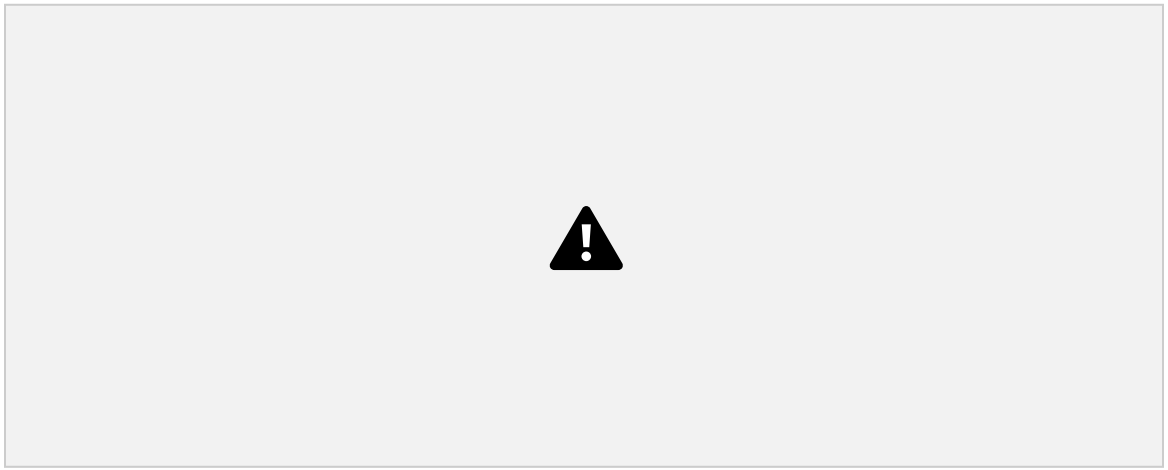
VLSM in Practice

- Using VLSM subnets, the LAN and WAN segments in example below can be addressed with minimum waste.
- Each LANs will be assigned a subnet with /27 mask.
- Each WAN link will be assigned a subnet with /30 mask.



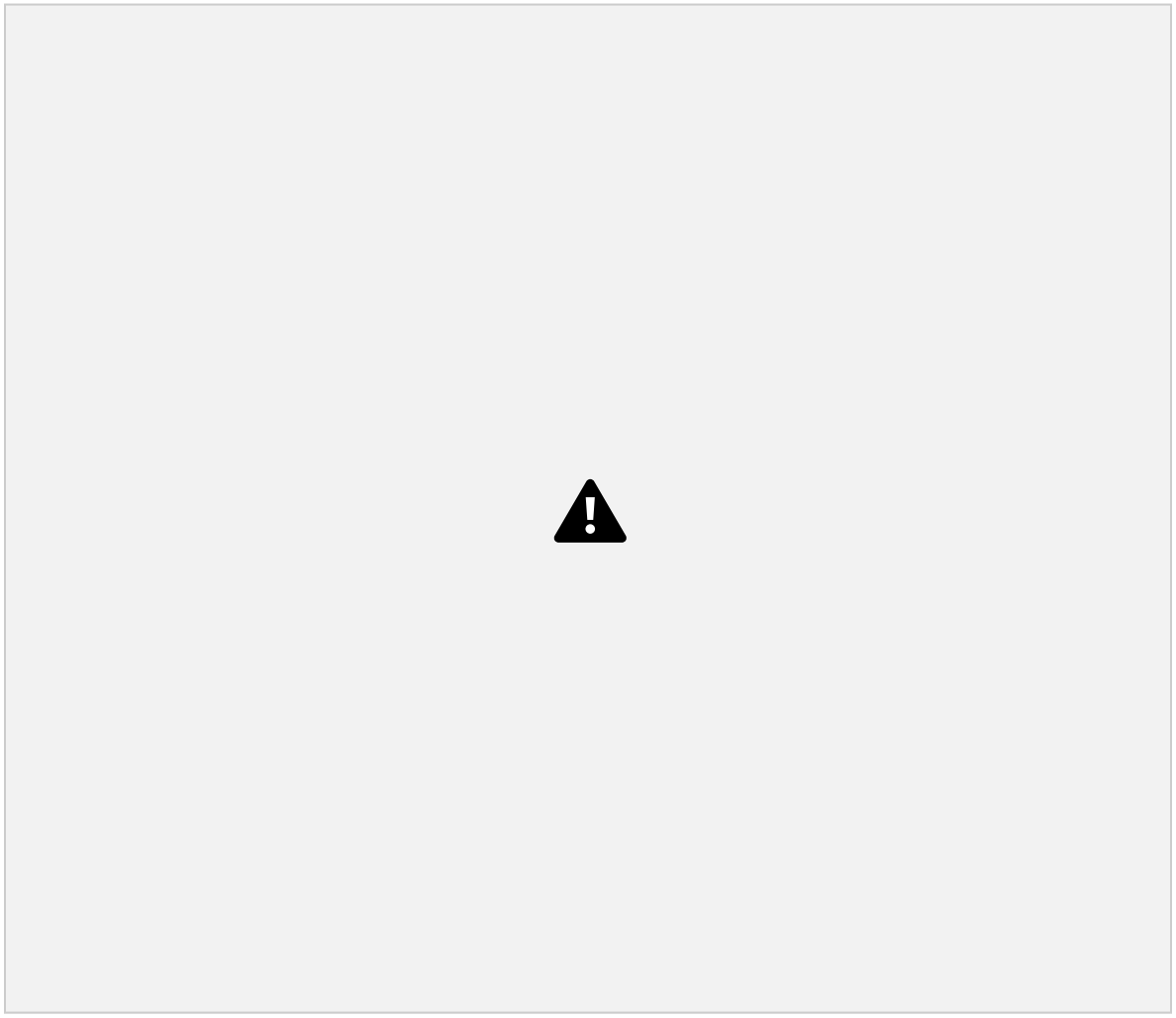
Benefits of Variable Length Subnet Masking

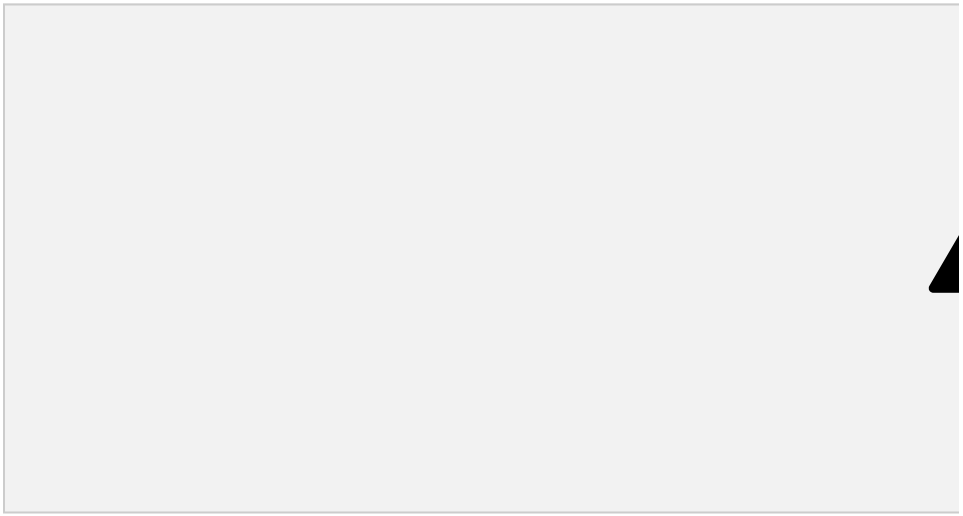
Basic Subnetting of 192.168.20.0/24



Benefits of Variable Length Subnet Masking

VLSM Subnetting of 192.168.20.0/24





Planning to Address the Network

Allocation of network addresses should be planned and documented for the purposes of:

- Preventing duplication of addresses
- Providing and controlling access
- Monitoring security and performance

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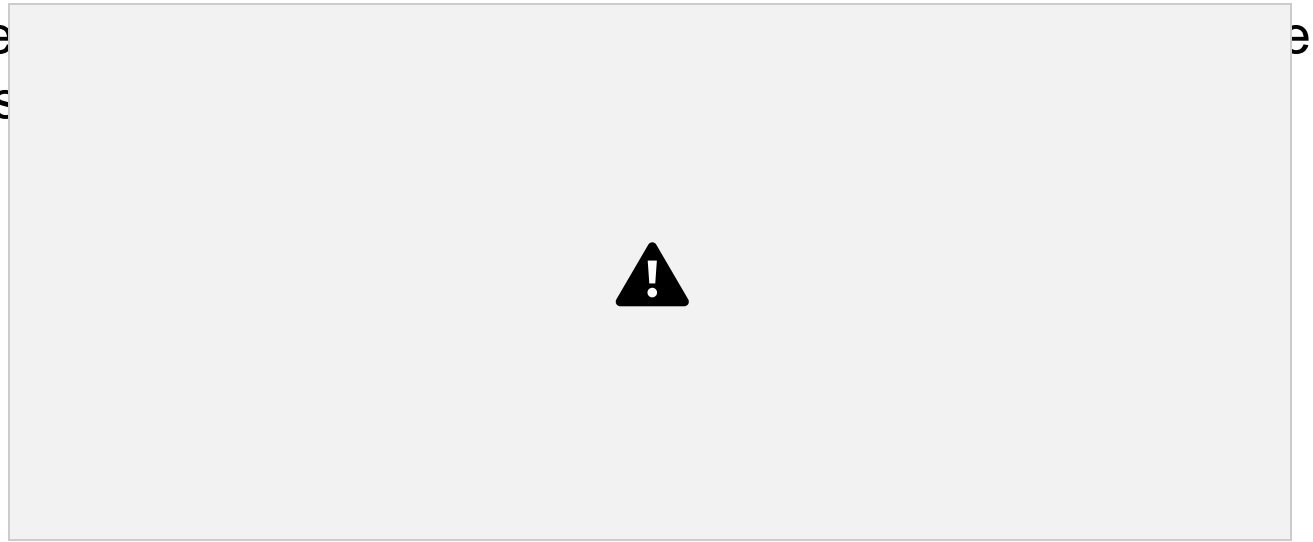

Sample Network Addressing

Plan

