Chapter 8 Subnetting IP networks

Subnetting an IPv4 Network

Network segmentation

Broadcast Domains

In an Ethernet LAN, devices use broadcasts to:

- **Locate other devices** – A device uses Address Resolution Protocol (ARP) which sends Layer 2 broadcasts to a known IPv4 address on the local network to discover the associated MAC address.
- **Locate services** – A host typically acquires its IPv4 address configuration using the Dynamic Host Configuration Protocol (DHCP) which sends broadcasts on the local network to locate a DHCP server.

Switches propagate broadcasts out all interfaces except the interface on which it was received

Routers do not propagate broadcasts

Therefore, each router interface connects a broadcast domain and broadcasts are only propagated within its specific broadcast domain.

A broadcast domain is a logical division of a computer network, in which all nodes can reach each other by broadcast at the data link layer.

Problems with Large Broadcast Domains

A problem with a large broadcast domain is that these **hosts can generate excessive broadcasts and negatively affect the network**.

broadcast traffic resulting in:

- Slow network operations due to the significant amount of traffic it can cause
- Slow device operations because a device must accept and process each broadcast packet

The solution is to reduce the size of the network to create smaller broadcast domains in a process called subnetting. These smaller network spaces are called subnets.

Broadcasts are only propagated within the smaller broadcast domains.

Reasons for Subnetting

- Reduces overall network traffic and improves network performance
- Enables an administrator to implement security policies such as which subnets are allowed or not allowed to communicate together.
- group devices and services into subnets

Octet Boundaries

IPv4 subnets are created by using one or more of the host bits as network bits. This is done by extending the subnet mask to borrow some of the bits from the host portion of the address to create additional network bits

Networks are most easily subnetted at the octet boundary of /8, /16, and /24.

SUBNETTING ON THE OCTET BOUNDRIES USING /24 PREFIX

Subnet Address (65,536 subnet using /24 prefix)	Host Range (254 Host per subnet)	Broadcast Address
10.0.**0**.0/24	10.0.**0**.1 - 10.0.**0**.254	10.0.**0**.255
10.0.**1**.0/24	10.0.**1**.1 - 10.0.**1**.254	10.0.**1**.255
10.0.**2**.0/24	10.0.**2**.1 - 10.0.**2**.254	10.0.**2**.255
.....	.....	.....
10.0.**255**.0/24	10.0.**255**.1 - 10.0.**255**.254	10.0.**255**.255
10.**1**.**0**.0/24	10.**1**.**0**.1 - 10. **1**.**0**.254	10. **1**.**0**..255
10.**1**.**1**.0/24	10.**1**.**1**.1 - 10. **1**.**1**.254	10. **1**.**1**..255
10.**1**.**2**.0/24	10.**1**.**2**.1 - 10. **1**.**2**.254	10. **1**.**2**..255
.....	.....	.....
10.**250**.**0**.0/24	10.**250**.**0**.1 - 10. **250**.**0**.254	10.**250**.**0**.255
.....	.....	.....
10.**255**.**254**.0/24	10.**255**.**254**.1 - 10. **255**.**254**.254	10.**255**.**25**.255
.....	.....	.....
10.**255**.**255**.0/24	10.**255**.**255**.1 - 10. **255**.**255**.254	10.**255**.**255**.255

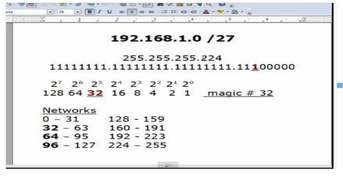
Classless Subnetting

For instance, a /24 network address is commonly subnetted using longer prefix lengths by borrowing bits from the fourth octet. This provides the administrator with additional flexibility when assigning network addresses to a smaller number of end devices.

Subnets can borrow bits from any host bit position to create other masks.

Prefix Length	Subnet Mask	Subnet Mask in Binary Network = N Host = H Total IP addresses in /16 network = 65536	# of Host	# of Network
/25	255.255.255.128	NNNNNNNN.NNNNNNNN.NNNNNNNN.**N**HHHHHHH 11111111. 11111111.11111111.**1**0000000	2^7-2 =126	2^1=2
/26	255.255.255.192	NNNNNNNN.NNNNNNNN.NNNNNNNN.**NN**HHHHHH 11111111. 11111111.11111111.**11**000000	2^6-2 =62	2^2=4
/27	255.255.255.224	NNNNNNNN.NNNNNNNN.NNNNNNNN.**NNN**HHHHH 11111111. 11111111.11111111.**111**00000	2^5-2 =30	2^3=8
/28	255.255.255.240	NNNNNNNN.NNNNNNNN.NNNNNNNN.**NNNN**HHHH 11111111. 11111111.11111111.**1111**0000	2^4-2 =14	2^4=16
/29	255.255.255.248	NNNNNNNN.NNNNNNNN.NNNNNNNN.**NNNNN**HHH 11111111. 11111111.11111111.**11111**000	2^3-2 =6	2^5=32
/30	255.255.255.252	NNNNNNNN.NNNNNNNN.NNNNNNNN.**NNNNNN**HH 11111111. 11111111.11111111.**111111**00	2^2-2 =4	2^6=64

Magic number



Subnetting Based on Host Requirements

- the number of host addresses required for each network
- number of hosts = (2^bits of the host portion)-2
- There are two considerations when planning subnets:
- number of subnets = 2^bits borrowed
- the number of individual subnets needed

Variable Length Subnet Masks

VLSM allows a network space to be divided into unequal parts. With VLSM, the subnet mask will vary depending on how many bits have been borrowed for a particular subnet, thus the "variable" part of the VLSM.

Subnetting an IPv6 Network

There are two types of assignable IPv6 addresses. An IPv6 link-local address is never subnetted because it exists only on the local link. However, an IPv6 global unicast address can be subnetted.

The IPv6 global unicast address normally consists of a /48 global routing prefix (provided by the RIR, Regional Internet Registries), a 16 bit subnet ID, and a 64 bit interface ID.

Subnetting Using the Subnet ID

Increment subnet ID to create 65,536 subnets

2001:0DB8:ACAD:0000::/64
2001:0DB8:ACAD:0001::/64
2001:0DB8:ACAD:0002::/64
2001:0DB8:ACAD:0003::/64
2001:0DB8:ACAD:0004::/64
2001:0DB8:ACAD:0005::/64
2001:0DB8:ACAD:0006::/64
2001:0DB8:ACAD:0007::/64
2001:0DB8:ACAD:0008::/64
2001:0DB8:ACAD:0009::/64
2001:0DB8:ACAD:000A::/64
2001:0DB8:ACAD:000B::/64
2001:0DB8:ACAD:000C::/64

Subnets 13 — 65,534 not shown

2001:0DB8:ACAD:FFFF::/64