

Subnetting

Hour 5

This Hour

- Explain how subnets are used
- Explain the benefits of subnetting
- Develop a subnet mask that meets business needs
- Classless Internet Domain Routing / Supernetting

Subnetting

- Subnet addressing is used by system administrators in order to further subdivide an Internet address within an organization
- Instead of the classful two-level hierarchy, subnetting supports a three-level hierarchy

Network-Prefix	Host-Number
----------------	-------------

Network-Prefix	Subnet-Number	Host-Number
----------------	---------------	-------------

Subnetting

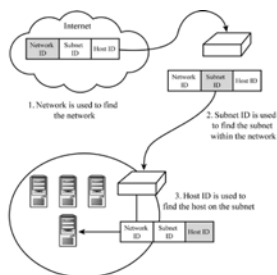
- Subnetting attacked the expanding routing problem by ensuring that the subnet structure of a network is never visible outside of the organization's private network
- The route from the Internet to any subnet of a given IP address is the same, no matter which subnet the destination host is on
- All subnets of a given network number use the same network-prefix but different subnet numbers

Subnetting

Extended-Network-Prefix

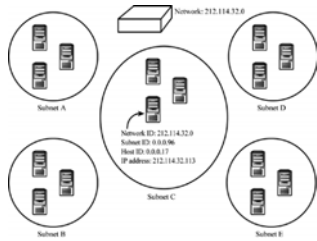
- Routers within the subnetted environment use the extended-network-prefix to route traffic between the individual subnets
- The extended-network-prefix is composed of the classful network-prefix and the subnet-number
- The extended-network-prefix has traditionally been identified by the subnet mask

Example
(fig 5.5)



Example

(Fig 5.7)



Subnet Mask

- The subnet mask is a 32 bit number expressed in decimal format and applied at each interface of a routing device where subnetting is actually required.
- To determine the subnet mask value, a decision is first made as to the number of subnets which are required.

Setting the value of the Mask

- The subnet mask is set by creating a 32 bit binary number using these rules. Place:
 - 1's for the *netid* portion
 - 1's for the *subnet* portion
 - 0's for the host portion
- Convert the resulting binary string into decimal format and apply to each which is using subnetting.

Calculating the *Total* subnets

- When calculating how many subnets can be created from a number of bits, the *bit wieght* is NOT USED:
 - to calculate the total number of addressable subnets, raise two to the number of bits allocated to the subnet mask

Variation in the total number of available Subnets

- The final number of available addressable subnets can vary depending on routing equipment and software:
 - older equipment will not allow the use of *all zeros* or *all ones* to number subnet ID's. This means the loss of two subnet numbers
 - modern equipment supports the use subnet numbers of all zeros and all ones

Calculating the Decimal value of the Subnet Mask

- When converting the subnet mask from binary to decimal, bit weight must be considered in each of the octets where the mask has been applied:
 - a mask of 11100000 becomes

$$128+64+32 = 194$$

Host Numbers

- Two addresses are always invalid in the *hostid*:
 - **all zeros**: which is allocated to the subnet, also called the *segment* or *cable* address. This identifier is used in route tables as *Destination*..
 - **all ones**: which is allocated to the *broadcast address*. Every subnet has it's own unique broadcast address.

Subnet masks

Example #1: Class C

- If sixteen subnets are required in a Class C site, then four subnet bits will be required:
 $2 \times 2 \times 2 \times 2 = 16$
- This leaves four bits remaining in the *hostid* portion, so 14 hosts can exist on each subnet (because two host addresses are lost for the *cable* and *broadcast* addresses).

Subnet Masks

Example #1: Class C

- By using four bits, the subnet mask in binary will be:

11111111.11111111.11111111.11110000

- Which in decimal equates to

255.255.255.240

Subnet Masks

Example #2: Class B

- If 256 subnets were required for a Class B address, eight bits (one octet) would be needed for the mask:

$$2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 256$$

Subnet Masks

Example #2: Class B

- By using eight bits, the subnet mask in binary will be:

11111111.11111111.11111111.00000000

- Which in decimal equates to

255.255.255.000

How is the Subnet Mask used to forward datagrams?

- When a routing interface has non-default subnet mask applied, it performs a LOGICAL AND using:
 - the *destination address* in the IP datagram
 - and the *subnet mask*
- The result of this operation will yield the destination subnet, which can be identified in the route table

LOGICAL AND

- In a LOGICAL AND, which is a binary operation, only the addition of binary values of 1 AND 1 will result in 1.
- This means that the host portion will be cancelled out, since *zeros* are used in the *host* portion of the subnet mask.

LOGICAL AND operation

Example #3: Class B, 8 bit mask

- Destination IP Address: 136.186.105.28
 - Subnet Mask: 255.255.255.0
- 10001000.10111010.**01101001**.00011000
AND
11111111.11111111.**11111111**.00000000
RESULT
10001000.10111010.01101001.00000000
136.186.105.0

LOGICAL AND operation

Example #4: Class C, 5 bit mask

- Destination IP Address: 201.222.5.121
 - Subnet Mask: 255.255.255.248
- 11001001.11011110.00000101.**01111001**
AND
11111111.11111111.11111111.**11111000**
RESULT
11001001.11011110.00000101.01111000
201.222.5.120

Confused?

- In the previous slide, the resulting subnet destination address doesn't end up with a *zero* in the *hostid* portion, as might be expected. This is because the mask operates within an octet, at a bit level. Subnet addresses in these situations will look like host addresses, demonstrating the need to consider the impact of masking.

Default Subnet Mask

- If subnetting is not used, then a default mask is used at the routing interface to complete the route selection process.
- The default mask uses all 1's for the *netid*, which, during the AND operation, will remove the *hostid* portion of the destination address within the datagram, leaving the *netid* for proper route determination.

Default Subnet Masks for IP Address Classes

- Class A = 255.0.0.0
- Class B = 255.255.0.0
- Class C = 255.255.255.0

Bibliography

- “Teach Yourself TCP/IP in 24 Hours, Second Edition”, Joe Casad, Sams Publishing, March 01, 2001
- Addressing (PPT), Tamanna Sait & Aneesha Deo
- Subnetting,
<http://cit.wta.swin.edu.au/cit/subjects/CITP0040/docs/subnets.ppt>
