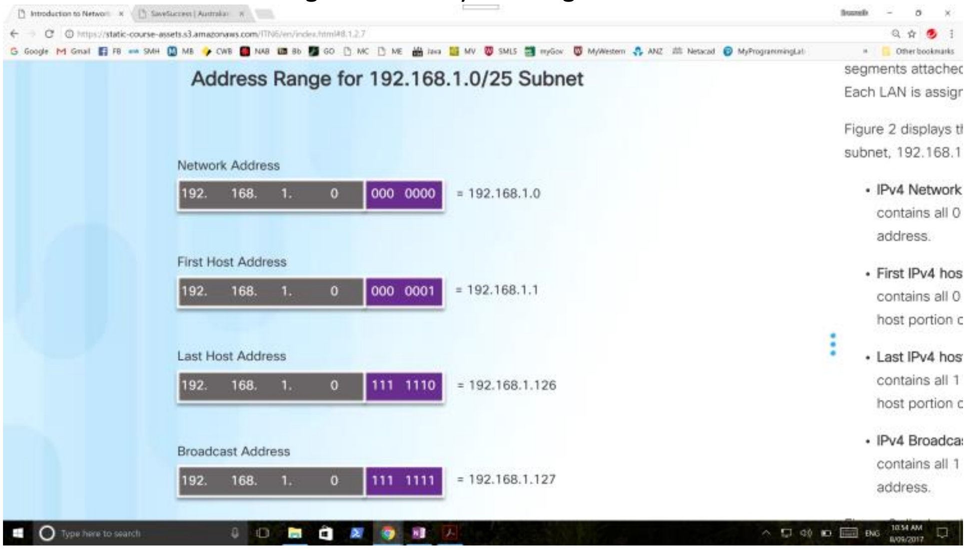
# Week 7-Subnetting

Thursday, 7 September 2017 12:52 AM

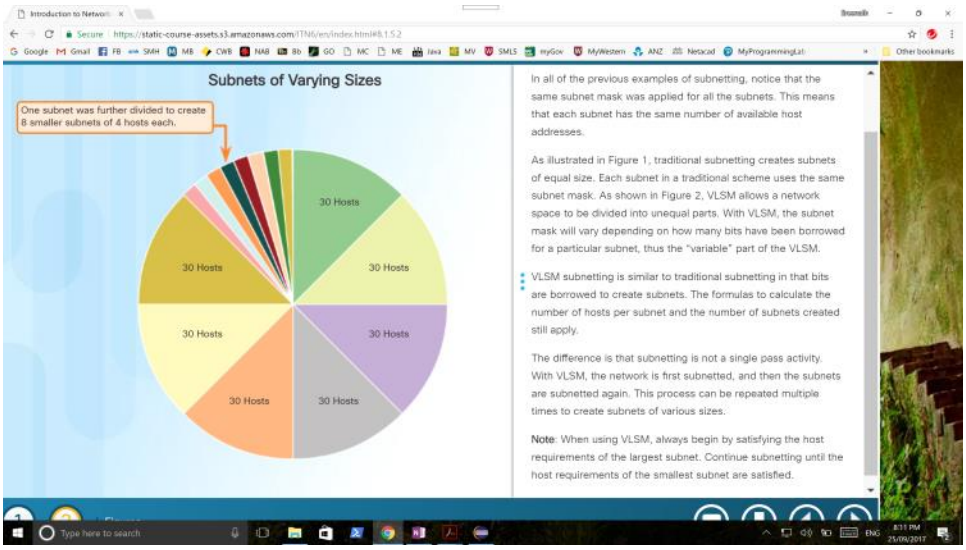
In the original IPv4 address, there are two levels of hierarchy: a network and a host. These two levels of addressing allow for basic network groupings that facilitate in routing packets to a destination network. A router forwards packets based on the network
Subdividing a network adds a level to the network hierarchy, creating, in essence,
levels: a network, a subnetwork, and a host. Introducing an additional level to the hierarchy creates additional sub-groups within an IP network that facilitates faster packet delivery and added filtration, by helping to minimize 'local' traffic.
A problem with a large broadcast domain is that these hosts can generate excessive broadcasts and negatively affect the network
Excessive broadcast traffic results in:

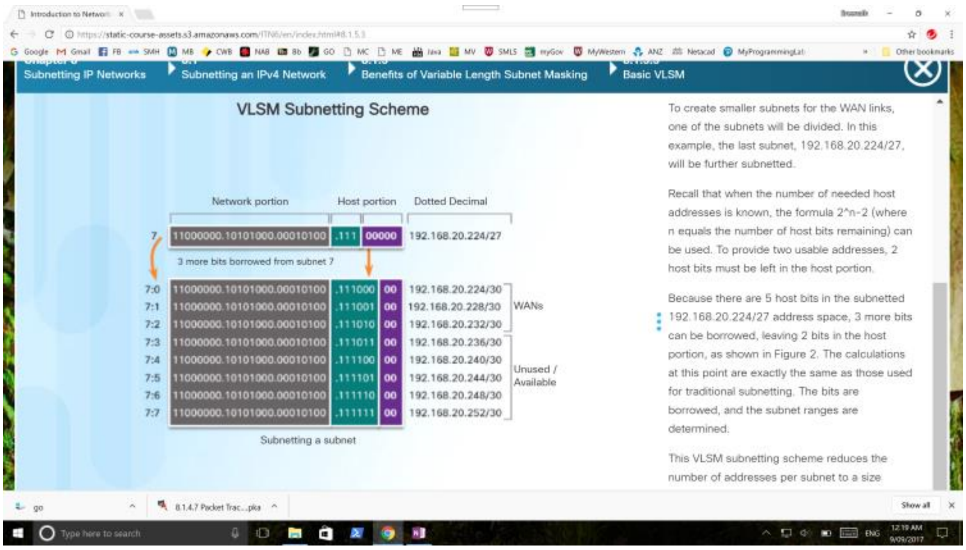
- Slow network operations due to the significant amount of traffic it can cause
- Slow device operations because a device must accept and process each broadcast packet

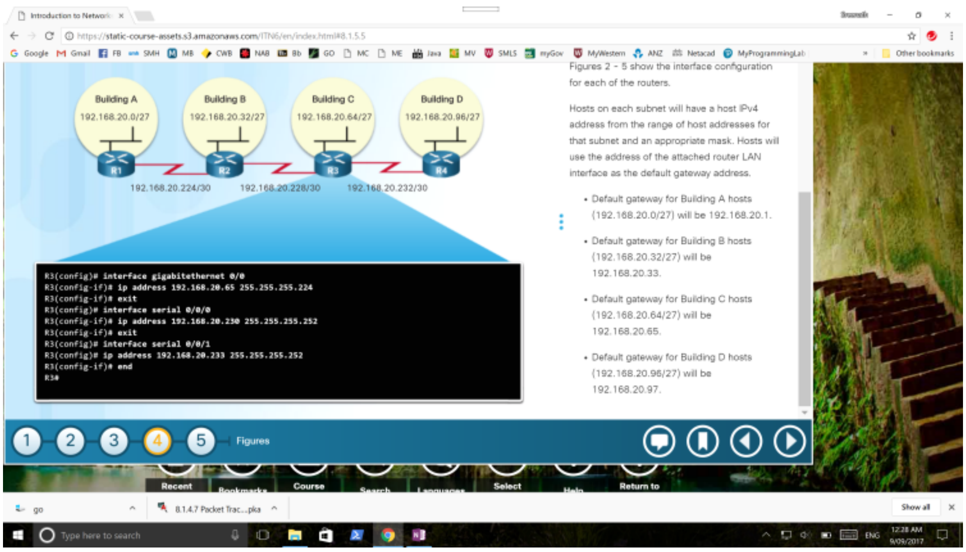
The solution is to reduce the size of the network to create smaller broadcast domains in a process called *subnetting*. These smaller network spaces are called *subnets*.
Subnetting reduces overall network traffic and improves network performance. It also enables an administrator to implement security policies such as which subnets are allowed or not allowed to communicate together.
n-number of host bits borrowed.
Number of subnets possible=$2^n$
Where n is the number of bits borrowed
Number of hosts possible = $2^N$-2
Where N = number of host bits= 32- number of network bits.
Magic number- place value of the last 1 in the network bit
Subnets start from 0 and gets added by the magic number for the next subnet till it reaches 255.

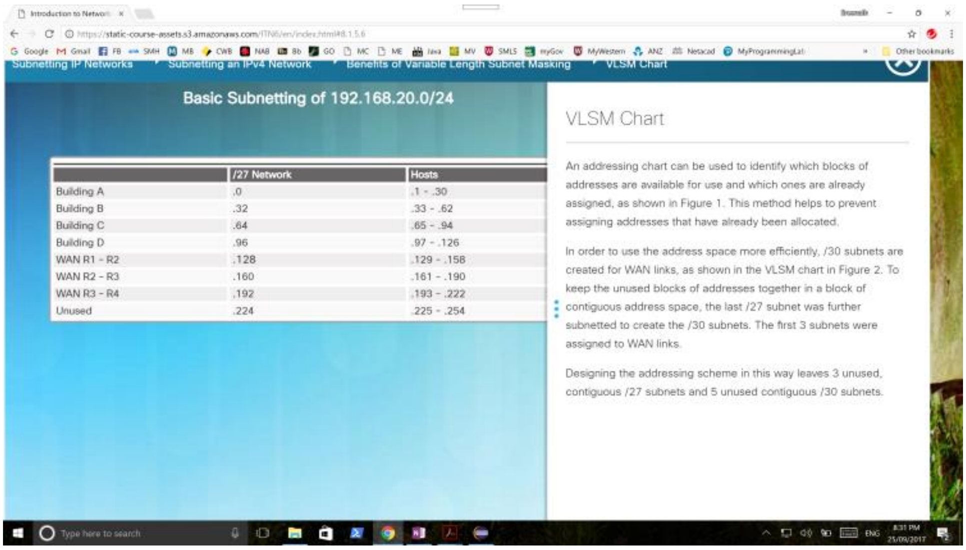



The last two bits cannot be borrowed from the last octet because there would be no host addresses available. Therefore, the longest prefix length possible when subnetting is /30 or 255.255.255.252.
There is an inverse relationship between the number of subnets and the number of hosts. The more bits borrowed to create subnets, the fewer host bits available. If more host addresses are needed, more host bits are required, resulting in fewer subnets.
Subnetting a subnet, or using Variable Length Subnet Mask (VLSM), was designed to avoid wasting addresses.


Subnets of Varying Sizes
One subnet was further divided to create 8 smaller subnets of 4 hosts each.
30 Hosts
30 Hosts
30 Hosts
30 Hosts
30 Hosts
30 Hosts
30 Hosts
In all of the previous examples of subnetting, notice that the same subnet mask was applied for all the subnets. This means that each subnet has the same number of available host addresses.
As illustrated in Figure 1, traditional subnetting creates subnets of equal size. Each subnet in a traditional scheme uses the same subnet mask. As shown in Figure 2, 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.
VLSM subnetting is similar to traditional subnetting in that bits are borrowed to create subnets. The formulas to calculate the number of hosts per subnet and the number of subnets created still apply.
The difference is that subnetting is not a single pass activity. With VLSM, the network is first subnetted, and then the subnets are subnetted again. This process can be repeated multiple times to create subnets of various sizes.
Note: When using VLSM, always begin by satisfying the host requirements of the largest subnet. Continue subnetting until the host requirements of the smallest subnet are satisfied.


Subnetting IP Networks
Subnetting an IPv4 Network
Benefits of Variable Length Subnet Masking
Basic VLSM
VLSM Subnetting Scheme
Network portion
Host portion
Dotted Decimal
7 11000000.10101000.00010100 .111 00000 192.168.20.224/27
3 more bits borrowed from subnet 7
7:0 11000000.10101000.00010100 .111000 00 192.168.20.224/30
7:1 11000000.10101000.00010100 .111001 00 192.168.20.228/30
7:2 11000000.10101000.00010100 .111010 00 192.168.20.232/30
7:3 11000000.10101000.00010100 .111011 00 192.168.20.236/30
7:4 11000000.10101000.00010100 .111100 00 192.168.20.240/30
7:5 11000000.10101000.00010100 .111101 00 192.168.20.244/30
7:6 11000000.10101000.00010100 .111110 00 192.168.20.248/30
7:7 11000000.10101000.00010100 .111111 00 192.168.20.252/30
WANs
Unused / Available
Subnetting a subnet
To create smaller subnets for the WAN links, one of the subnets will be divided. In this example, the last subnet, 192.168.20.224/27, will be further subnetted.
Recall that when the number of needed host addresses is known, the formula 2^n-2 (where n equals the number of host bits remaining) can be used. To provide two usable addresses, 2 host bits must be left in the host portion.
Because there are 5 host bits in the subnetted 192.168.20.224/27 address space, 3 more bits can be borrowed, leaving 2 bits in the host portion, as shown in Figure 2. The calculations at this point are exactly the same as those used for traditional subnetting. The bits are borrowed, and the subnet ranges are determined.
This VLSM subnetting scheme reduces the number of addresses per subnet to a size


Building A
192.168.20.0/27
Building B
192.168.20.32/27
Building C
192.168.20.64/27
Building D
192.168.20.96/27
R1
R2
R3
R4
192.168.20.224/30
192.168.20.228/30
192.168.20.232/30
R3(config)# interface gigabitethernet 0/0
R3(config-if)# ip address 192.168.20.65 255.255.255.224
R3(config-if)# exit
R3(config)# interface serial 0/0/0
R3(config-if)# ip address 192.168.20.230 255.255.255.252
R3(config-if)# exit
R3(config)# interface serial 0/0/1
R3(config)# ip address 192.168.20.233 255.255.255.252
R3(config-if)# end
R3#
Figures 2 - 5 show the interface configuration for each of the routers.
Hosts on each subnet will have a host IPv4 address from the range of host addresses for that subnet and an appropriate mask. Hosts will use the address of the attached router LAN interface as the default gateway address.
• Default gateway for Building A hosts (192.168.20.0/27) will be 192.168.20.1.
• Default gateway for Building B hosts (192.168.20.32/27) will be 192.168.20.33.
• Default gateway for Building C hosts (192.168.20.64/27) will be 192.168.20.65.
• Default gateway for Building D hosts (192.168.20.96/27) will be 192.168.20.97.
Figures



Basic Subnetting of 192.168.20.0/24

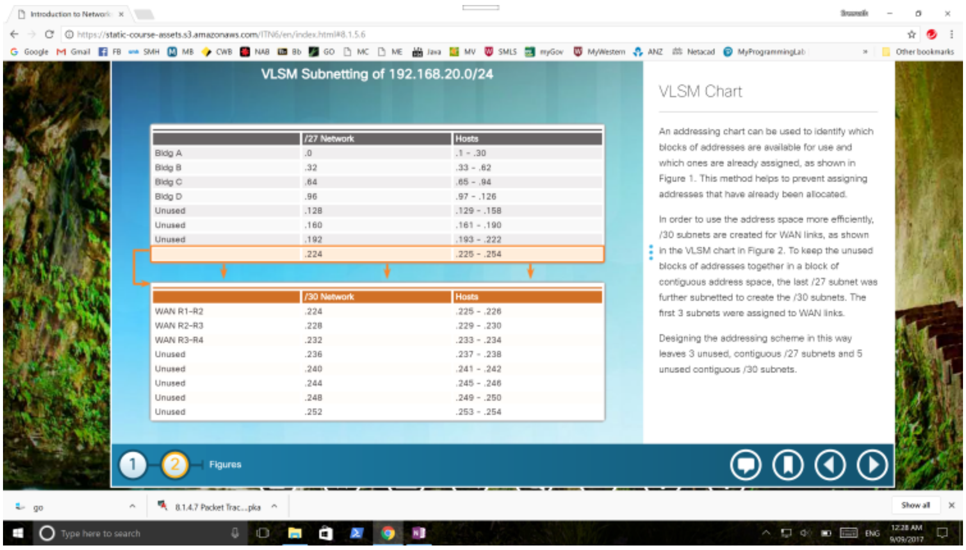
| | /27 Network | Hosts |
|---|---|---|
| Building A | .0 | .1 - .30 |
| Building B | .32 | .33 - .62 |
| Building C | .64 | .65 - .94 |
| Building D | .96 | .97 - .126 |
| WAN R1 - R2 | .128 | .129 - .158 |
| WAN R2 - R3 | .160 | .161 - .190 |
| WAN R3 - R4 | .192 | .193 - .222 |
| Unused | .224 | .225 - .254 |

VLSM Chart

An addressing chart can be used to identify which blocks of addresses are available for use and which ones are already assigned, as shown in Figure 1. This method helps to prevent assigning addresses that have already been allocated.

In order to use the address space more efficiently, /30 subnets are created for WAN links, as shown in the VLSM chart in Figure 2. To keep the unused blocks of addresses together in a block of contiguous address space, the last /27 subnet was further subnetted to create the /30 subnets. The first 3 subnets were assigned to WAN links.

Designing the addressing scheme in this way leaves 3 unused, contiguous /27 subnets and 5 unused contiguous /30 subnets.



VLSM Subnetting of 192.168.20.0/24

| | /27 Network | Hosts |
|---|---|---|
| Bldg A | .0 | .1 - .30 |
| Bldg B | .32 | .33 - .62 |
| Bldg C | .64 | .65 - .94 |
| Bldg D | .96 | .97 - .126 |
| Unused | .128 | .129 - .158 |
| Unused | .160 | .161 - .190 |
| Unused | .192 | .193 - .222 |
| | .224 | .225 - .254 |

| | /30 Network | Hosts |
|---|---|---|
| WAN R1-R2 | .224 | .225 - .226 |
| WAN R2-R3 | .228 | .229 - .230 |
| WAN R3-R4 | .232 | .233 - .234 |
| Unused | .236 | .237 - .238 |
| Unused | .240 | .241 - .242 |
| Unused | .244 | .245 - .246 |
| Unused | .248 | .249 - .250 |
| Unused | .252 | .253 - .254 |

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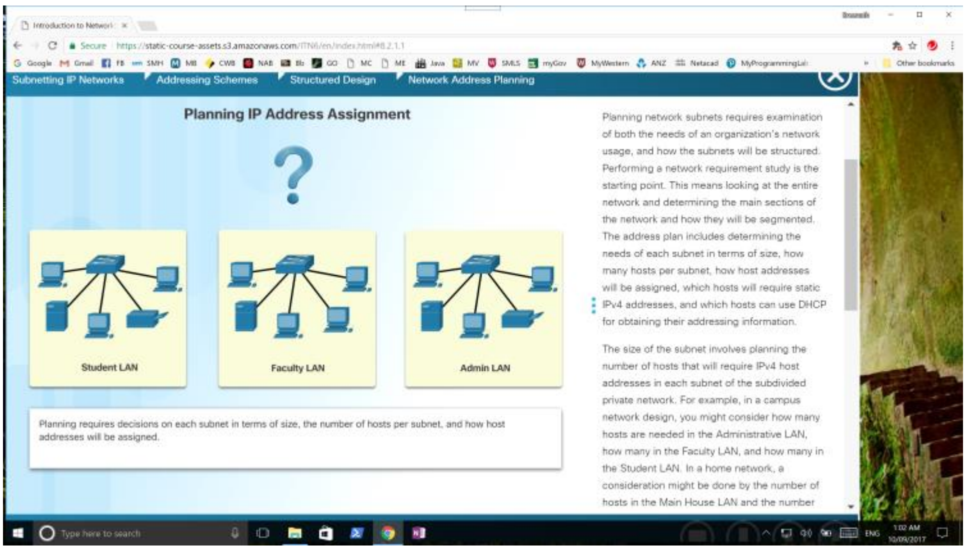


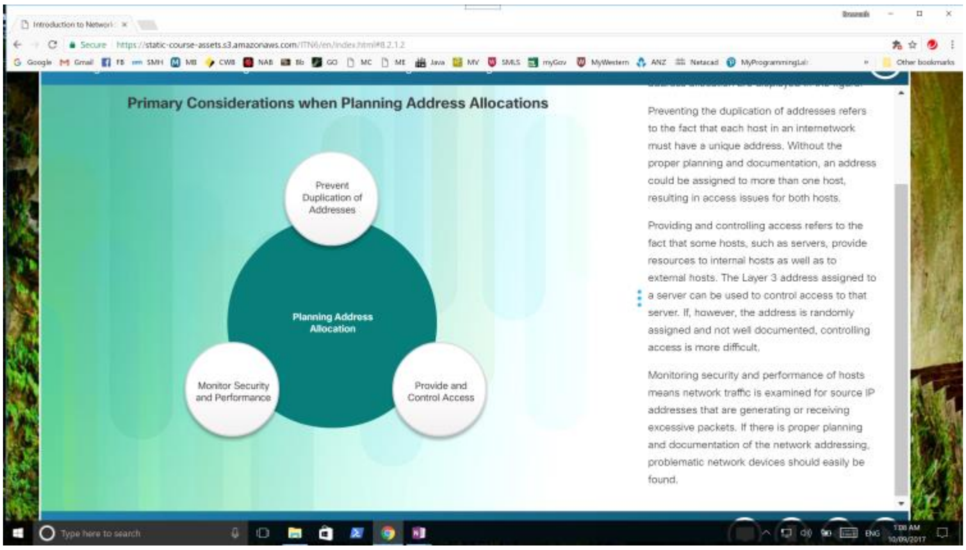
Planning IP Address Assignment

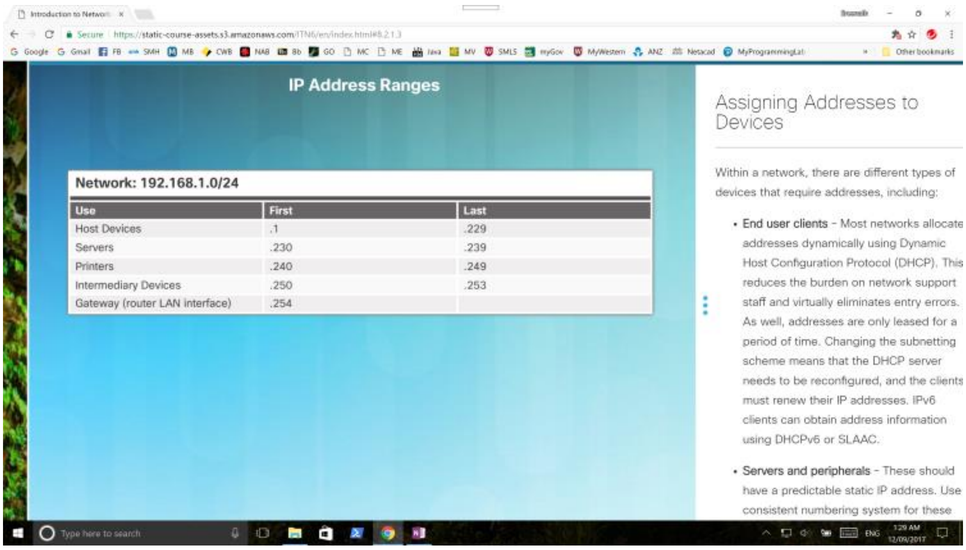


Planning requires decisions on each subnet in terms of size, the number of hosts per subnet, and how host addresses will be assigned.

Planning network subnets requires examination of both the needs of an organization's network usage, and how the subnets will be structured. Performing a network requirement study is the starting point. This means looking at the entire network and determining the main sections of the network and how they will be segmented. The address plan includes determining the needs of each subnet in terms of size, how many hosts per subnet, how host addresses will be assigned, which hosts will require static IPv4 addresses, and which hosts can use DHCP for obtaining their addressing information.

The size of the subnet involves planning the number of hosts that will require IPv4 host addresses in each subnet of the subdivided private network. For example, in a campus network design, you might consider how many hosts are needed in the Administrative LAN, how many in the Faculty LAN, and how many in the Student LAN. In a home network, a consideration might be done by the number of hosts in the Main House LAN and the number




IPv6 subnetting is about building an addressing hierarchy based on the number of subnetworks needed.
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, a 16 bit subnet ID, and a 64 bit interface ID.
The 16 bit subnet ID section of the IPv6 global unicast address can be used by an organization to create internal subnets.