Komunikasi Data dan Jaringan Komputer

D3 – Manajemen Informatika

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- **MATA KULIAH : KOMUNIKASI DATA DAN JARINGAN KOMPUTER**
- **KODE MATA KULIAH : MIN516111**
- **SKS : 3(2-1)**
- **SEMESTER : 2**

Outline

- Subnetting an IPv4 Network
- Addressing Schemes
- Design Considerations for IPv6
- Summary

Objectives

- Explain why routing is necessary for hosts on different networks to communicate.
- Describe IP as a communication protocol used to identify a single device on a network.
- Given a network and a subnet mask, calculate the number of host addresses available.
- Calculate the necessary subnet mask in order to accommodate the requirements of a network.
- Describe the benefits of variable length subnet masking (VLSM)
- Explain how IPv6 address assignments are implemented in a business network.

Reasons for Subnetting

Large networks need to be segmented into smaller sub-networks, creating smaller groups of devices and services in order to:

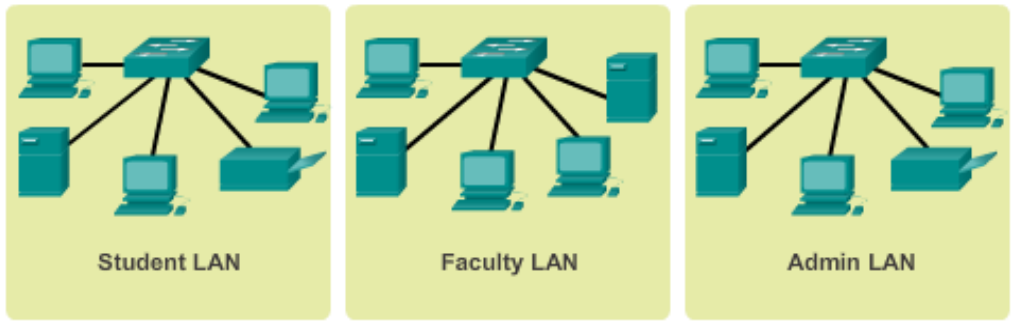
- Control traffic by containing broadcast traffic within subnetwork
- Reduce overall network traffic and improve network performance

Subnetting - process of segmenting a network into multiple smaller network spaces called subnetworks or **Subnets.**

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

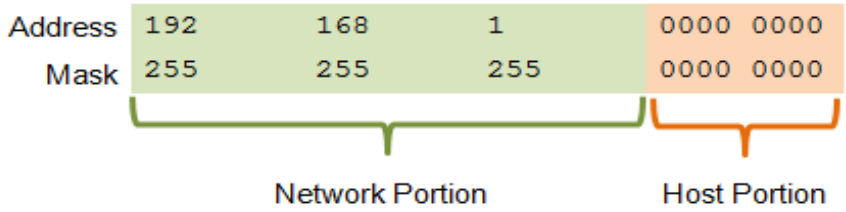
IP Subnetting is FUNdamental

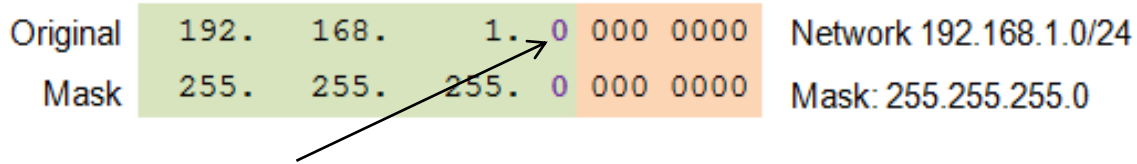


Planning requires decisions on each subnet in terms of size, the number of hosts per subnet, and how host addresses will be assigned.

Basic Subnetting

- Borrowing Bits to Create Subnets
- Borrowing 1 bit $2^1 = 2$ subnets





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

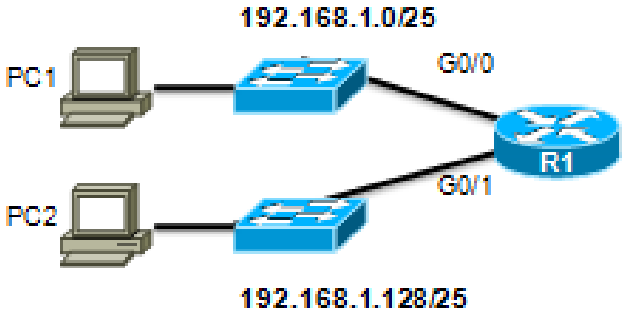
Network 192.168.1.**128-255**/**25**

Mask: 255.255.255.**128**

Subnets in Use

Subnet 0

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



Subnet 1

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

Address Range for 192.168.1.0/25 Subnet

Network Address

192. 168. 1. 0 000 0000 = 192.168.1.0

First Host Address

192. 168. 1. 0 000 0001 = 192.168.1.1

Last Host Address

192. 168. 1. 0 111 1110 = 192.168.1.126

Broadcast Address

192. 168. 1. 0 111 1111 = 192.168.1.127

Address Range for 192.168.1.128/25 Subnet

Network Address

192. 168. 1. 1 000 0000 = 192.168.1.128

First Host Address

192. 168. 1. 1 000 0001 = 192.168.1.129

Last Host Address

192. 168. 1. 1 111 1110 = 192.168.1.254

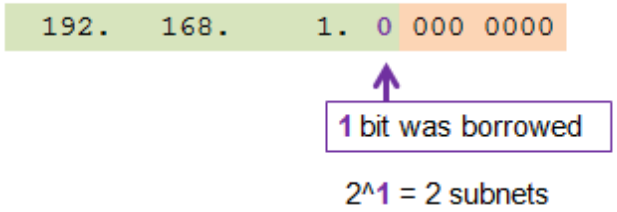
Broadcast Address

192. 168. 1. 1 111 1111 = 192.168.1.255

Subnetting Formulas

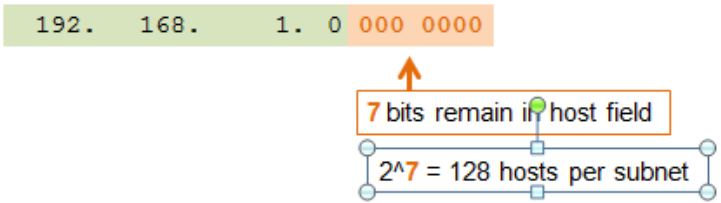
- Calculate Number of Subnets

Subnets = 2^n
(where n = bits borrowed)



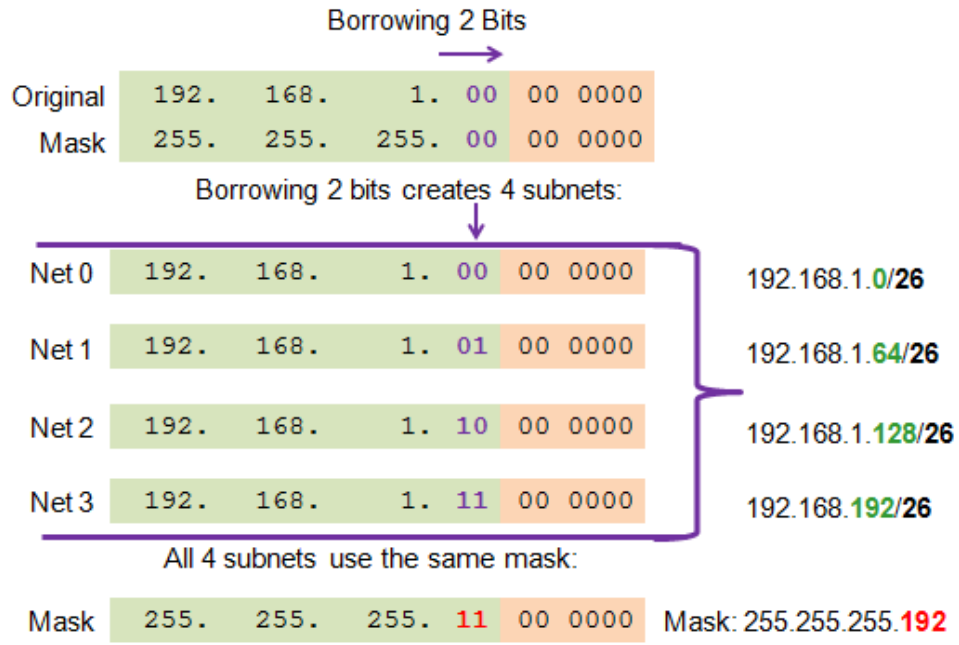
- Calculate Number of Hosts

Hosts = 2^n
(where n = host bits remaining)



Creating 4 Subnets

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



Creating 8 Subnets

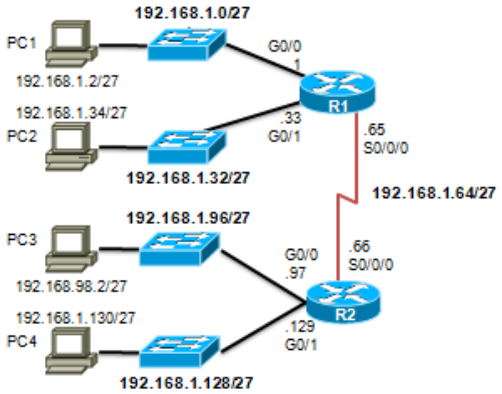
- Borrowing 3 bits to Create 8 Subnets. **$2^3 = 8$ subnets**

Net 0	Network	192.	168.	1.	000	0 0000	192.168.1.1
	Fist	192.	168.	1.	000	0 0001	192.168.1.1
	Last	192.	168.	1.	000	1 1110	192.168.1.30
	Broadcast	192.	168.	1.	000	1 1111	192.168.1.31
Net 1	Network	192.	168.	1.	001	0 0000	192.168.1.32
	Fist	192.	168.	1.	001	0 0001	192.168.1.33
	Last	192.	168.	1.	001	1 1110	192.168.1.62
	Broadcast	192.	168.	1.	001	1 1111	192.168.1.63
Net 2	Network	192.	168.	1.	010	0 0000	192.168.1.64
	Fist	192.	168.	1.	010	0 0001	192.168.1.65
	Last	192.	168.	1.	010	1 1110	192.168.1.94
	Broadcast	192.	168.	1.	010	1 1111	192.168.1.95
Net 3	Network	192.	168.	1.	010	0 0000	192.168.1.96
	Fist	192.	168.	1.	010	0 0001	192.168.1.97
	Last	192.	168.	1.	010	1 1110	192.168.1.126
	Broadcast	192.	168.	1.	010	1 1111	192.168.1.127

Creating 8 Subnets(continued)

Net 4	Network	192.	168.	1.	100	0 0000	192.168.1.128
	Fist	192.	168.	1.	100	0 0001	192.168.1.129
	Last	192.	168.	1.	100	1 1110	192.168.1.158
	Broadcast	192.	168.	1.	100	1 1111	192.168.1.159
Net 5	Network	192.	168.	1.	101	0 0000	192.168.1.160
	Fist	192.	168.	1.	101	0 0001	192.168.1.161
	Last	192.	168.	1.	101	1 1110	192.168.1.190
	Broadcast	192.	168.	1.	101	1 1111	192.168.1.191
Net 6	Network	192.	168.	1.	110	0 0000	192.168.1.192
	Fist	192.	168.	1.	110	0 0001	192.168.1.193
	Last	192.	168.	1.	110	1 1110	192.168.1.222
	Broadcast	192.	168.	1.	110	1 1111	192.168.1.223
Net 7	Network	192.	168.	1.	111	0 0000	192.168.1.224
	Fist	192.	168.	1.	111	0 0001	192.168.1.225
	Last	192.	168.	1.	111	1 1110	192.168.1.254
	Broadcast	192.	168.	1.	111	1 1111	192.168.1.255

Subnet Allocation



Subnetting Based on Host Requirements

There are two considerations when planning subnets:

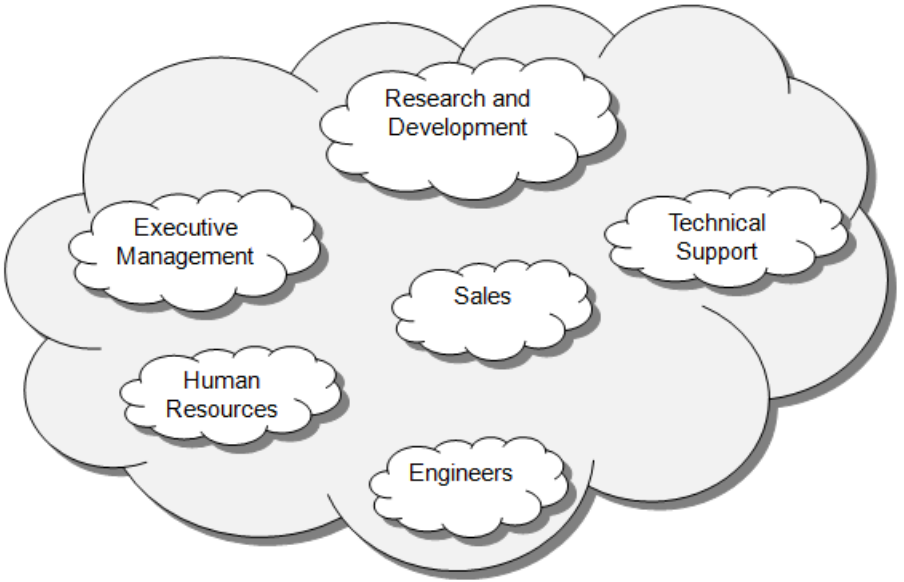
- Number of Subnets required
- Number of Host addresses required
- Formula to determine number of useable hosts
  - **2^n-2**
  - **2^n** (where n is the number the number of host bits remaining) is used to calculate the number of hosts
  - **-2** Subnetwork ID and broadcast address cannot be used on each subnet

Subnetting Network-Based Requirements

Calculate number of subnets

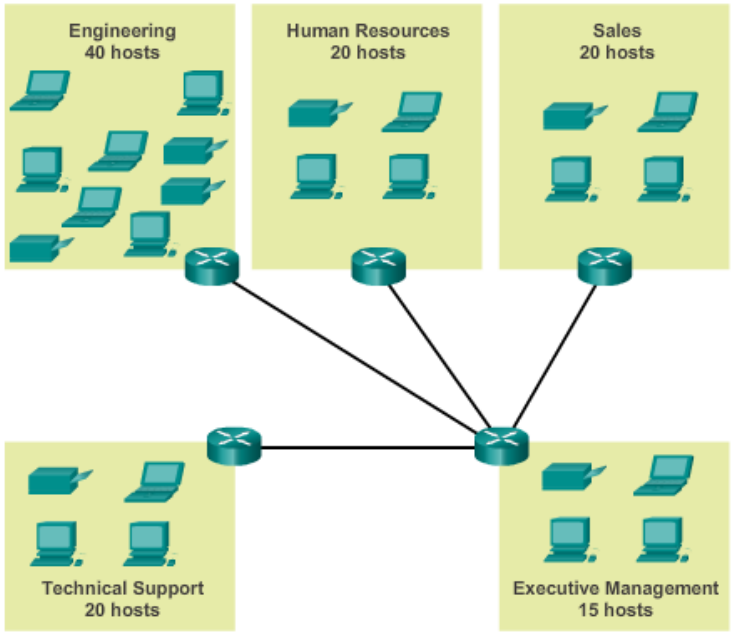
- Formula **2^n** (where n is the number of bits borrowed)

- Subnet needed for each department in graphic



Subnetting To Meet Network Requirements

- It is important to balance the number of subnets needed and the number of hosts required for the largest subnet.
- Design the addressing scheme to accommodate the maximum number of hosts for each subnet.
- Allow for growth in each subnet.



Subnetting To Meet Network Requirements (cont)

Subnets and Addresses

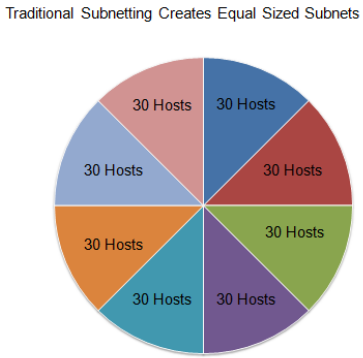
	10101100.00010000.000000**00.00**000000	172.16.0.0/22
0	10101100.00010000.000000**00.00**000000	172.16.0.0/26
1	10101100.00010000.000000**00.01**000000	172.16.0.64/26
2	10101100.00010000.000000**00.10**000000	172.16.0.128/26
3	10101100.00010000.000000**00.11**000000	172.16.0.192/26
4	10101100.00010000.000000**01.00**000000	172.16.1.0/26
5	10101100.00010000.000000**01.01**000000	172.16.1.64/26
6	10101100.00010000.000000**01.10**000000	172.16.1.128/26
	Nets 7 – 14 not shown	
15	10101100.00010000.000000**11.10**000000	172.16.3.128/26
16	10101100.00010000.000000**11.11**000000	172.16.3.192/26

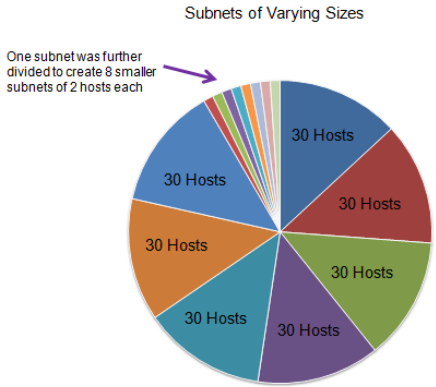
2^4 = 16 subnets

2^6 – 2 = 62 Hosts per subnet

Traditional Subnetting Wastes Addresses

- Traditional subnetting - same number of addresses is allocated for each subnet.
- Subnets that require fewer addresses have unused (wasted) addresses. For example, WAN links only need 2 addresses.
- Variable Length Subnet Mask (VLSM) or subnetting a subnet provides more efficient use of addresses.

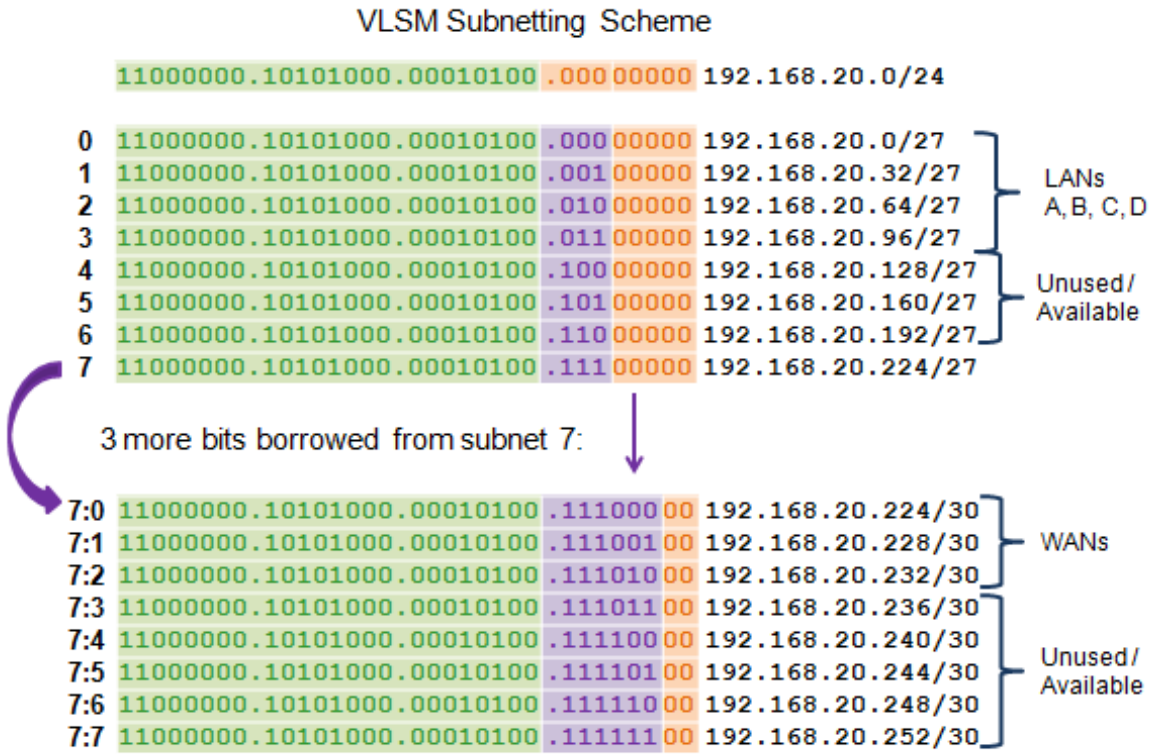




Variable Length Subnet Masks (VLSM)

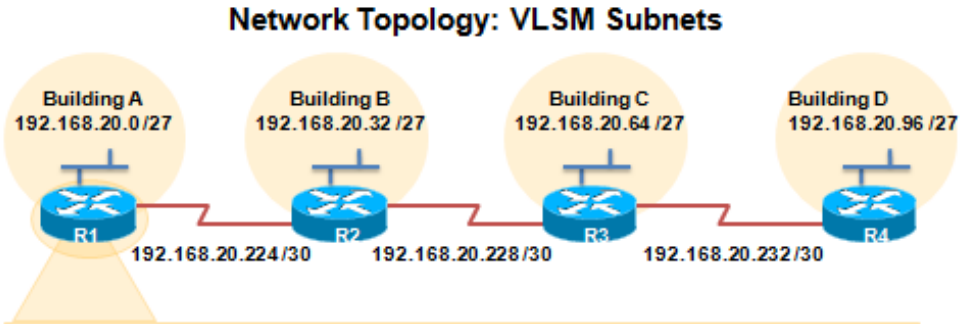
- VLSM allows a network space to be divided in unequal parts.
- Subnet mask will vary depending on how many bits have been borrowed for a particular subnet.
- Network is first subnetted, and then the subnets are subnetted again.
- Process repeated as necessary to create subnets of various sizes.

Basic VLSM


VLSM Subnetting Scheme
11000000.10101000.00010100.000 00000 192.168.20.0/24
0 11000000.10101000.00010100.000 00000 192.168.20.0/27
1 11000000.10101000.00010100.001 00000 192.168.20.32/27
2 11000000.10101000.00010100.010 00000 192.168.20.64/27
3 11000000.10101000.00010100.011 00000 192.168.20.96/27
4 11000000.10101000.00010100.100 00000 192.168.20.128/27
5 11000000.10101000.00010100.101 00000 192.168.20.160/27
6 11000000.10101000.00010100.110 00000 192.168.20.192/27
7 11000000.10101000.00010100.111 00000 192.168.20.224/27
LANs A, B, C, D
Unused / Available
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

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.




```
R1(config)#interface gigabitethernet 0/0
R1(config-if)#ip address 192.168.20.1 255.255.255.224
R1(config-if)#exit
R1(config)#interface serial 0/0/0
R1(config-if)#ip address 192.168.20.225 255.255.255.252
R1(config-if)#end
R1#
```

VLSM Chart

VLSM Subnetting of 192.168.20.0 /24

1

2

	/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

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

Addresses for Clients - usually dynamically assigned using Dynamic Host Configuration Protocol (DHCP)

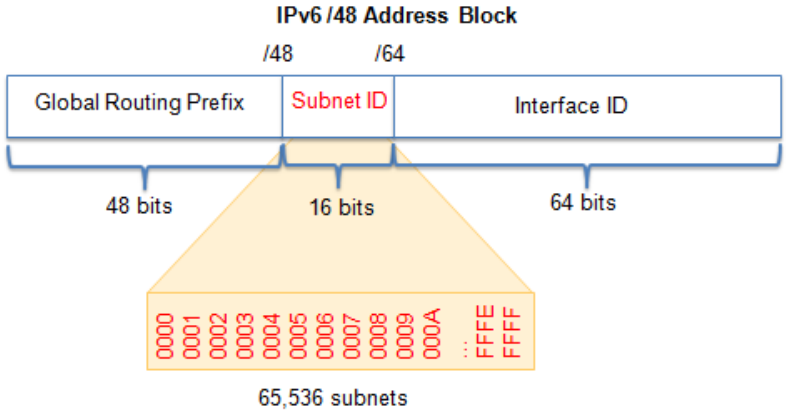
Sample Network Addressing Plan

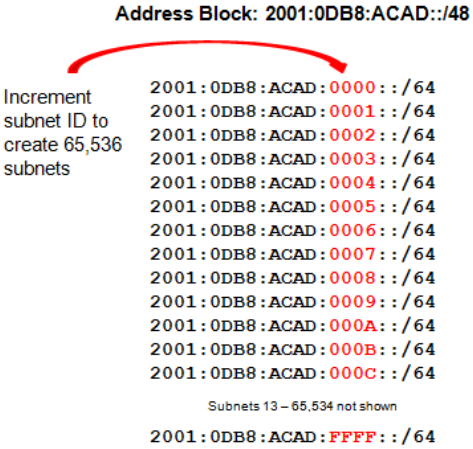
Network: 192.168.1.0/24

Use	First	Last
Host Devices	.1	.229
Servers	.230	.239
Printers	.240	.249
Intermediary Devices	.250	.253
Gateway (router LAN interface)	.254	

Subnetting Using the Subnet ID

An IPv6 Network Space is subnetted to support hierarchical, logical design of the network





IPV6 Subnet Allocation

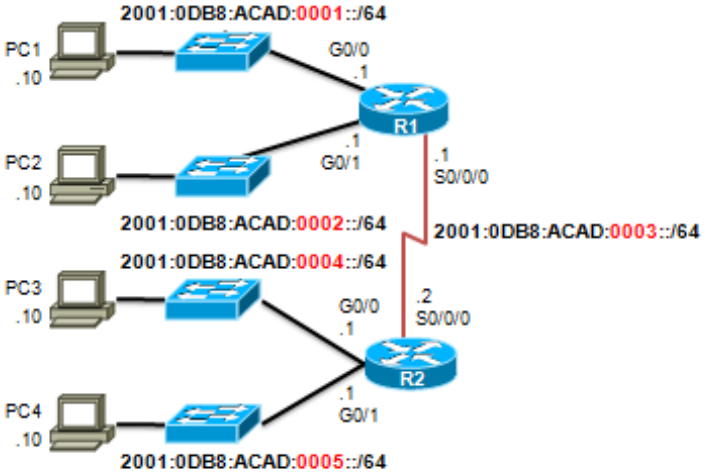
IPv6 Subnetting

Address Block: 2001:0DB8:ACAD::/48

5 subnets allocated from 65,536 available subnets

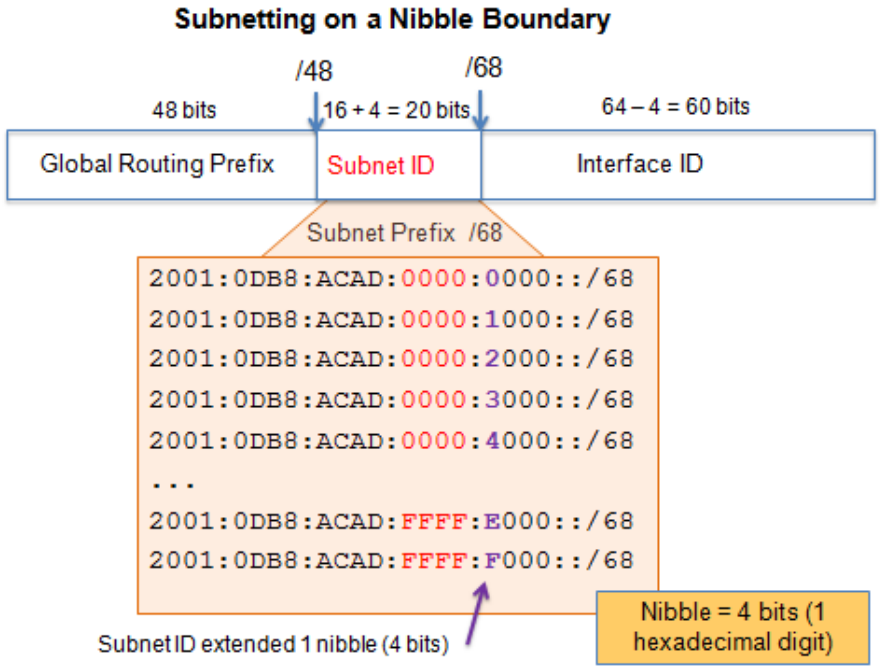
2001:0DB8:ACAD:0000::/64
2001:0DB8:ACAD:0001::/64
2001:0DB8:ACAD:0002::/64
2001:0DB8:ACAD:0003::/64
2001:0DB8:ACAD:0004::/64
2001:0DB8:ACAD:0005::/64
2001:0DB8:ACAD:0006::/64
2001:0DB8:ACAD:0007::/64
2001:0DB8:ACAD:0008::/64
⋮
2001:0DB8:ACAD:FFFF::/64

IPv6 Subnet Allocation



Subnetting into the Interface ID

IPv6 bits can be borrowed from the interface ID to create additional IPv6 subnets



Summary

- Process of segmenting a network, by dividing it into to multiple smaller network spaces, is called subnetting.
- Subnetting a subnet, or using Variable Length Subnet Mask (VLSM) was designed to avoid wasting addresses.
- IPv6 address space is a huge address space so it is subnetted to support the hierarchical, logical design of the network not to conserve addresses.
- Size, location, use, and access requirements are all considerations in the address planning process.
- IP networks need to be tested to verify connectivity and operational performance.

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Buku Referensi:

- William Stallings, Data and Computer Communications Sixth Edition, Prentice Hall. New Jersey, 2007.
- Onno W. Purbo, TCP/IP Standar Desain dan Implementasi. Elex Media Computindo, Jakarta, 1998.
- Cisco