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Inspiring Excellence

Network Layer: Subnetting

Lecture 8 | CSE421 – Computer Networks

Department of Computer Science and Engineering
School of Data & Science

Objectives

- Subnetting
- VLSM
  - Binary Calculation
  - Base 256 Calculation

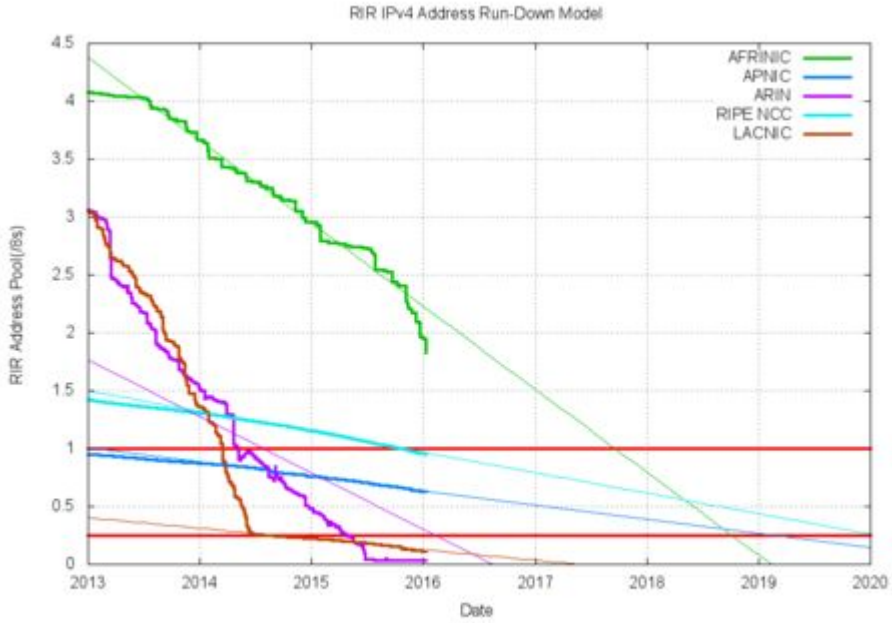
IPv4 Address Exhaustion

This report generated at 10-Jan-2016 08:20 UTC.

IANA Unallocated Address Pool Exhaustion:
03-Feb-2011

Projected RIR Address Pool Exhaustion Dates:

RIR	Projected Exhaustion Date	Remaining Addresses in RIR Pool (/8s)
APNIC:	**19-Apr-2011** (actual)	0.6284
RIPE NCC:	**14-Sep-2012** (actual)	0.9520
LACNIC:	**10-Jun-2014** (actual)	0.1140
ARIN:	**24 Sep-2015** (actual)	
AFRINIC:	**12-Aug-2018**	1.8246



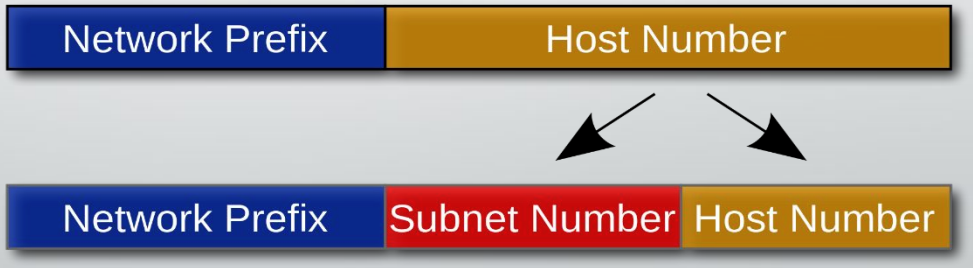
Projection of consumption of Remaining RIR Address Pools

Solutions

- **Long term:**
  - Change to IP version 6.
  - Plenty of addresses using a different scheme
- **Short term:**
  - Use **Subnetting (VLSM & CIDR)** to avoid wasting addresses
  - Use **private addresses** locally and **NAT** for internet access – lets many host share a few public addresses
  - DHCP!

Subnetting

- The strategy used to partition a single physical network into more than one smaller logical sub-networks (subnets).
- Subnets are designed by accepting bits from the IP address's host part and using these bits to assign a number of smaller sub-networks inside the original network.
- Allows an organization to add sub-networks without the need to acquire a new network number via the Internet service provider (ISP).

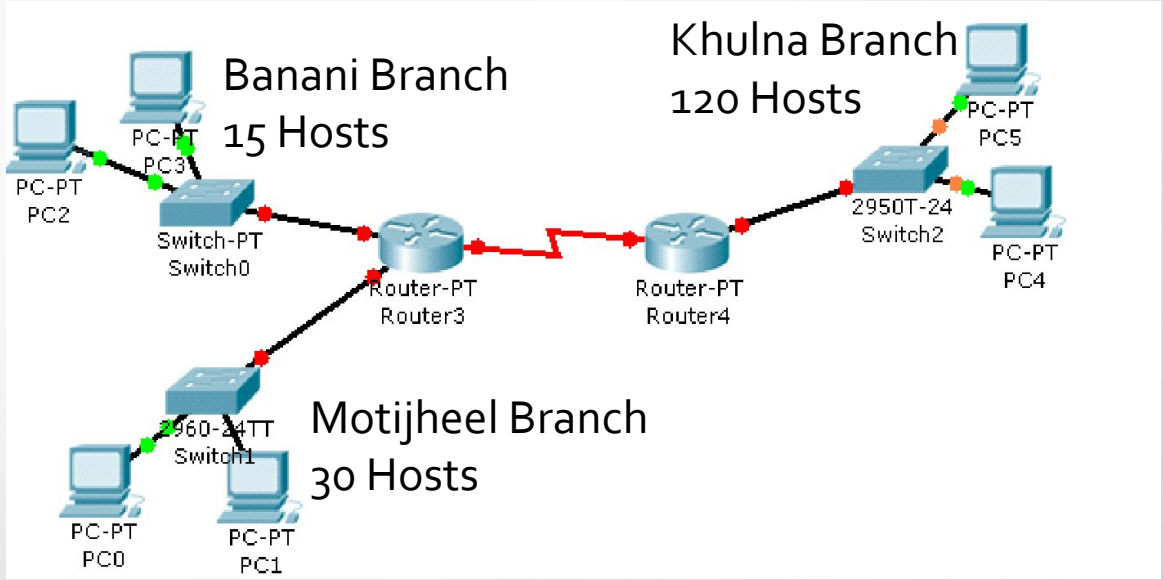


Subnetting

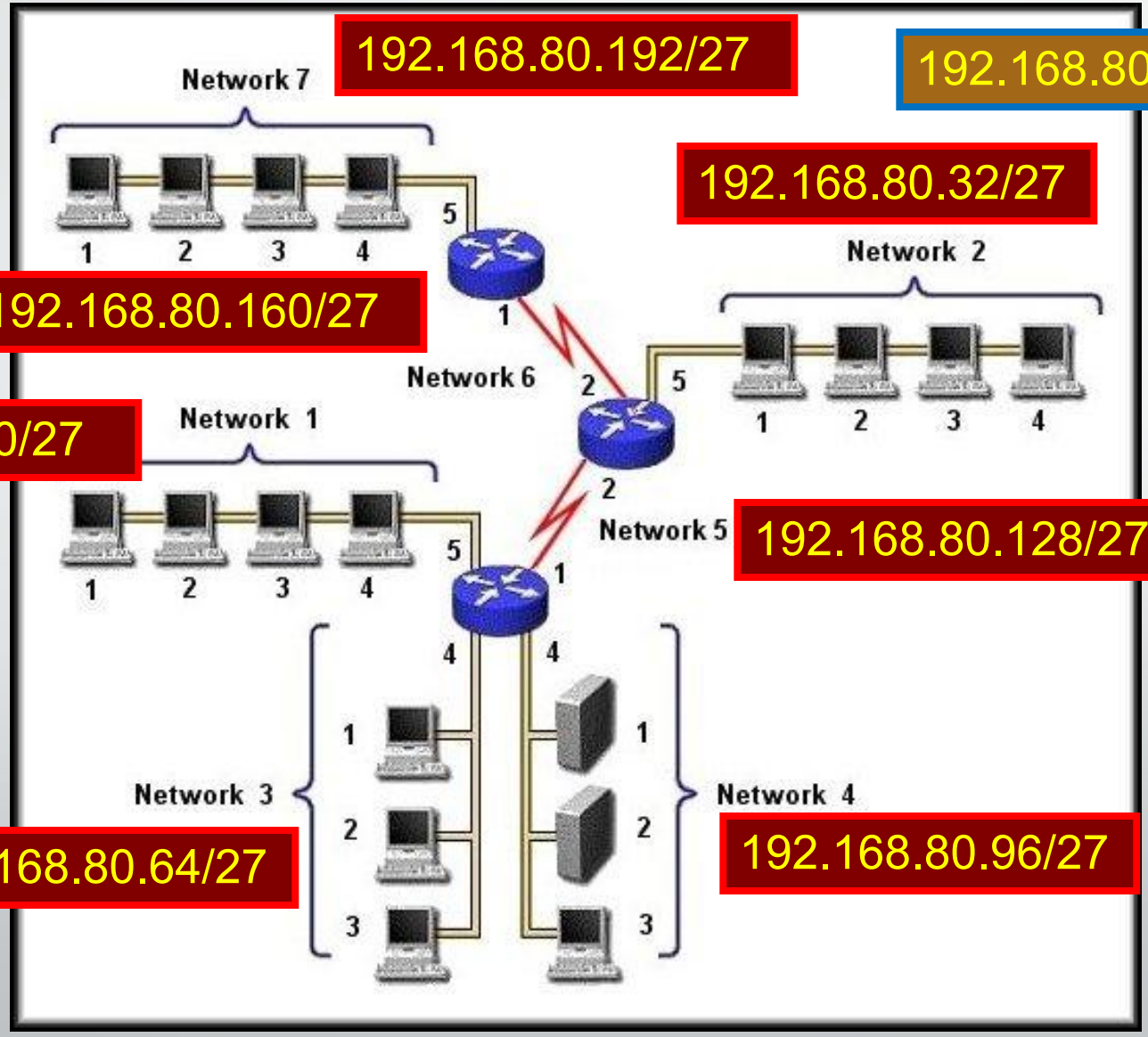
- Three methods of subnetting
  - Classful IP Addressing
  - Fixed Length Subnet Masking
  - Variable Length Masking
- Goal
  - Assign a block of IP addresses to fulfill the total needs of a network
    - A network has 200 hosts per say, give them a network address which can support 200 hosts!
    - Give them the smallest block possible to waste least of the IP addresses but not below 200!
- **Note:** You can assign blocks of size 2^N only. This is because the number of bits assigned to host from an IP address cannot be partial, number of bits is discrete and must be an integer value. (Can you assign 1.5 bits to host and 30.5 bits to network?)

Fixed length subnetting

- All subnets of a main network must have the same subnet mask.
- This means that they must all have the same number of hosts.
- Example
  - How many network addresses do you need for the organization?
  - How many network addresses do you have?
  - How many bits do you have for hosts?
  - How many host bits do you need to borrow to create the number of sub networks that you need?



Fixed Length Subnetting: Example



VLSM

- Also known as **"Variable Length Subnet Masking"**
- Always satisfy the requirements of your biggest LAN and then work your way down to the smallest LAN.
  - Assign a block of IP satisfying only that particular LAN.
    - 200 hosts? Assign a block of size 256 IPs!
    - 1000 hosts? Assign a block of size 1024 IPs!
    - 2 Hosts? Assign a block of size 2 IPs!

Comparison of Subnetting

- Given the network **192.168.1.0/24.**
  - Subnet this to **two hosts** of size **120 (Network A)** and **3 (Network B)**
  - So, **Network A** needs **122** IPs and **Network B** needs **5** IPs.

Classful IP Addressing		Fixed Length Subnet Masking		Variable Length Subnet Masking (VLSM)/CIDR	
Network A:	122	Network A:	122	Network A:	122
Subnet; Class C:	-254	Subnet Size(2^7):	-128	Subnet Size(2^7):	-128
Waste: 254 – 122	132	Waste: 128 – 122	6	Waste: 128 – 122	6
Network B:	5	Network B:	5	Network B:	5
Subnet; Class C:	-254	Subnet Size(2^7):	-128	Subnet Size(2^3):	-8
Waste: 254 – 5	249	Waste: 128 – 5	123	Waste: 128 – 5	3
Total Waste:	**381**	**Total Waste:**	**129**	**Total Waste:**	**9**

**Total Waste = $Waste_{Network\ A} + Waste_{Network\ B}$

**$Waste_{Network\ Y}$ = $Subnet\ Size_{Network\ Y} - Network\ Y_{Host}$

Comparison of Subnetting

- Given the network **192.168.1.0/24.**
  - Subnet this to **two hosts** of size **120 (Network A)** and **3 (Network B)**
  - So, **N**

Classful IP Addressing		Fixed Length Subnet Masking		Variable Length Subnet Masking (VLSM)/CIDR	
Network A:	122	Network A:	122	Network A:	122
Subnet; Class C:	-256	Subnet Size(2^7):	-128	Subnet Size(2^7):	-128
Waste: 254–122	134	Waste: 128–122	6	Waste: 128–122	6
Network B:	5	Network B:	5	Network B:	5
Subnet; Class C:	-256	Subnet Size(2^7):	-128	Subnet Size(2^3):	-8
Waste: 254–5	251	Waste: 128–5	123	Waste: 128–5	3
Total Waste:	**385**	**Total Waste:**	**129**	**Total Waste:**	**9**

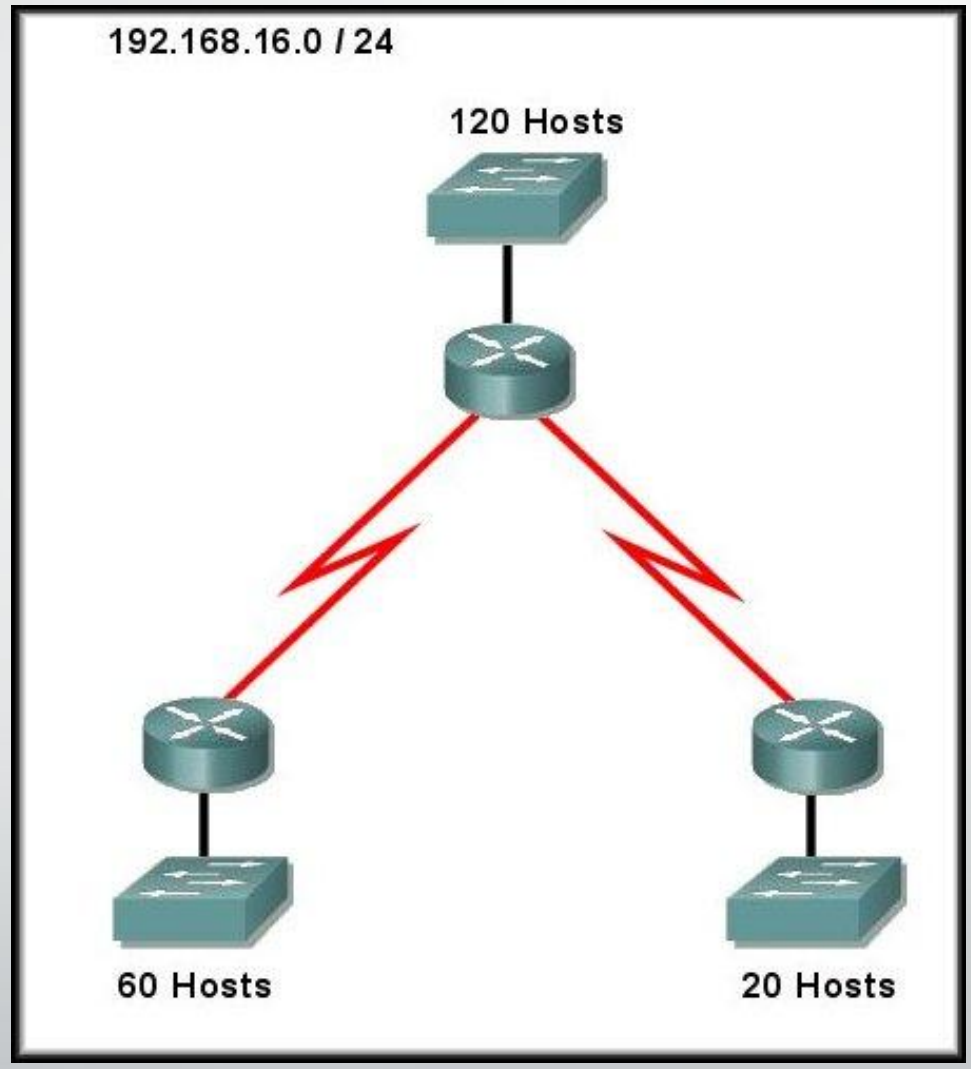
**Total Waste = $Waste_{Network\ A} + Waste_{Network\ B}$

**$Waste_{Network\ Y}$ = $Subnet\ Size_{Network\ Y} - Network\ Y_{Host}$

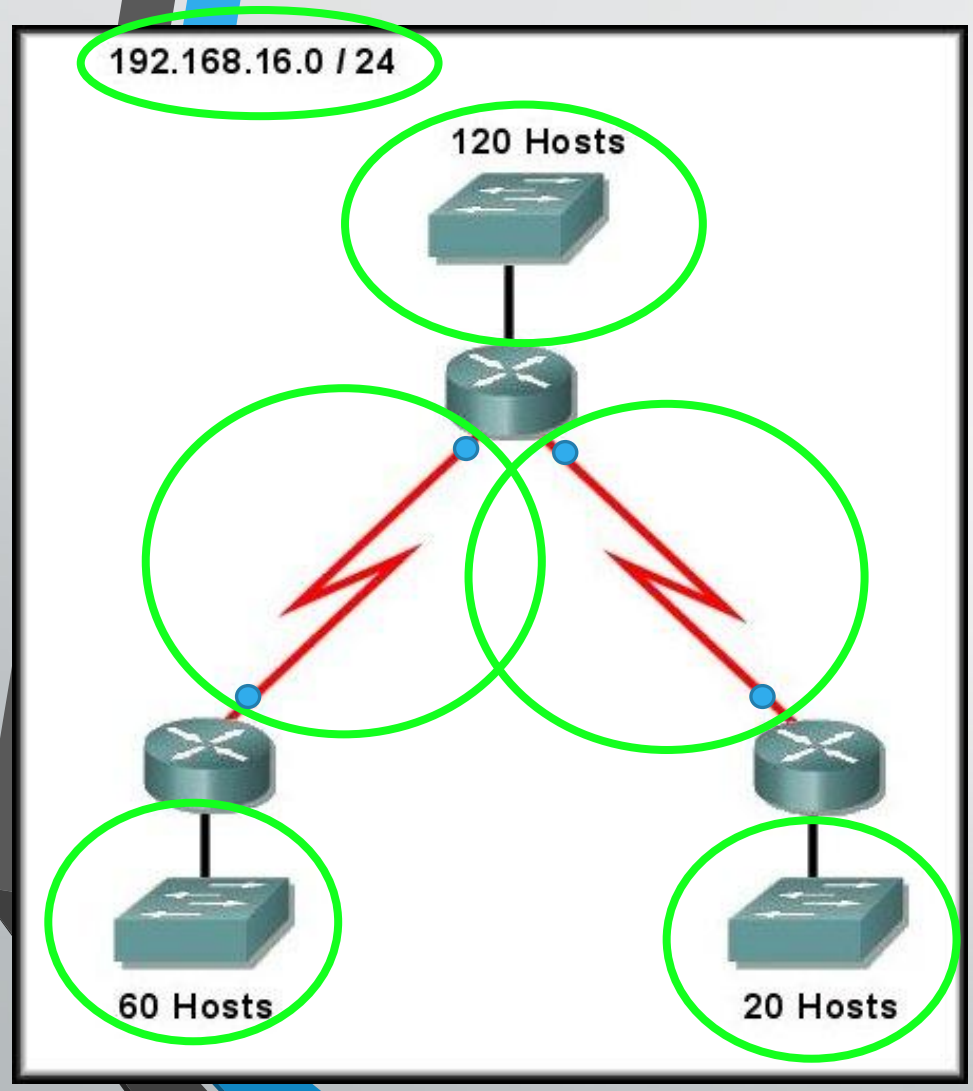
Lots of Waste!

- **Waste:**
  - Classful subnetting wastes addresses.
  - If you are using private addresses then you may not be bothered.
  - Waste of public addresses does matter.
- **Solutions:**
  - Variable Length Subnet Masking (VLSM)
  - Create subnets as per specific host requirements.

VLSM Example 1

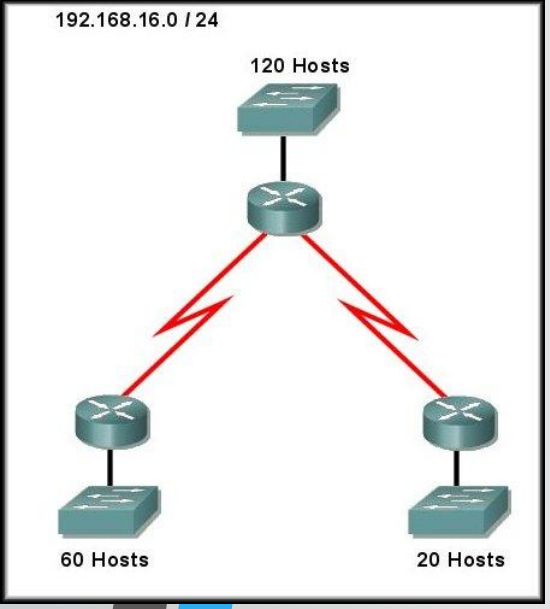


VLSM Example 1



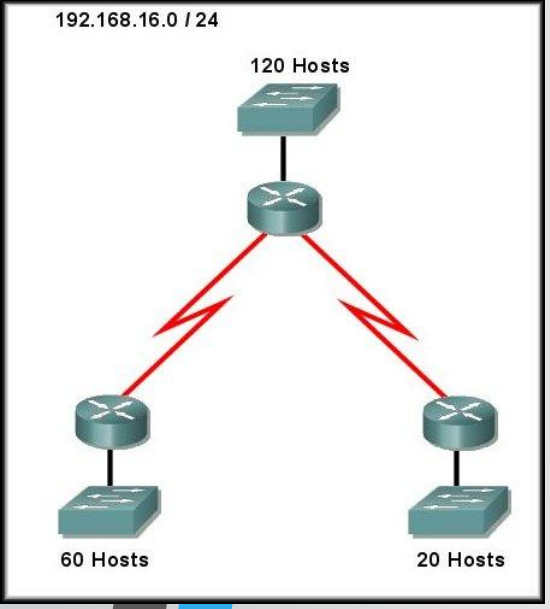
- Network address given: 192.168.16.0/24
- Host requirements (sorted largest to smallest)
  - LAN 1: 120 Hosts
  - LAN 2: 60 Hosts
  - LAN 3: 20 Hosts
  - WAN 1: 2 Hosts
  - WAN 2: 2 Hosts

VLSM Example 1



Host Name	Host requirement	+2	IP Block size	Host bits required	Network bits required
A	120	122	128	7	25
B	60	62	64	6	26
C	20	22	32	5	27
D	2	4	4	2	30
E	2	4	4	2	30

VLSM Example 1



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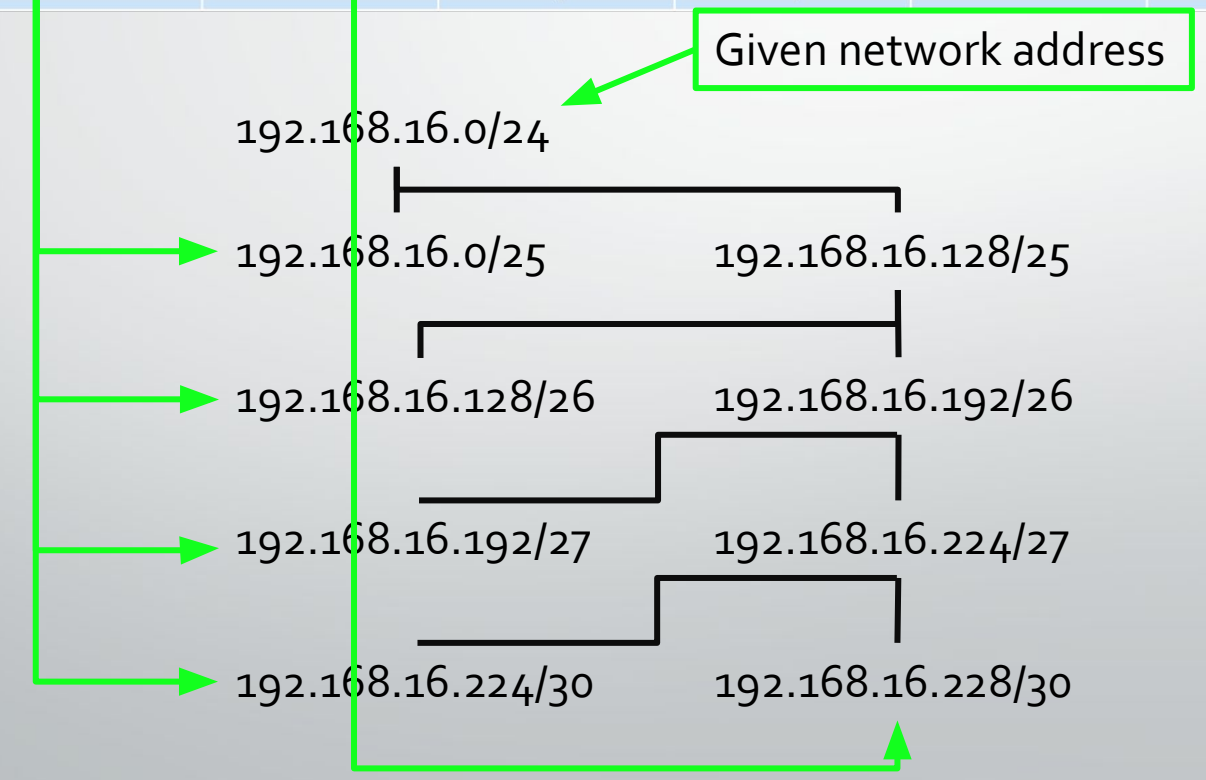
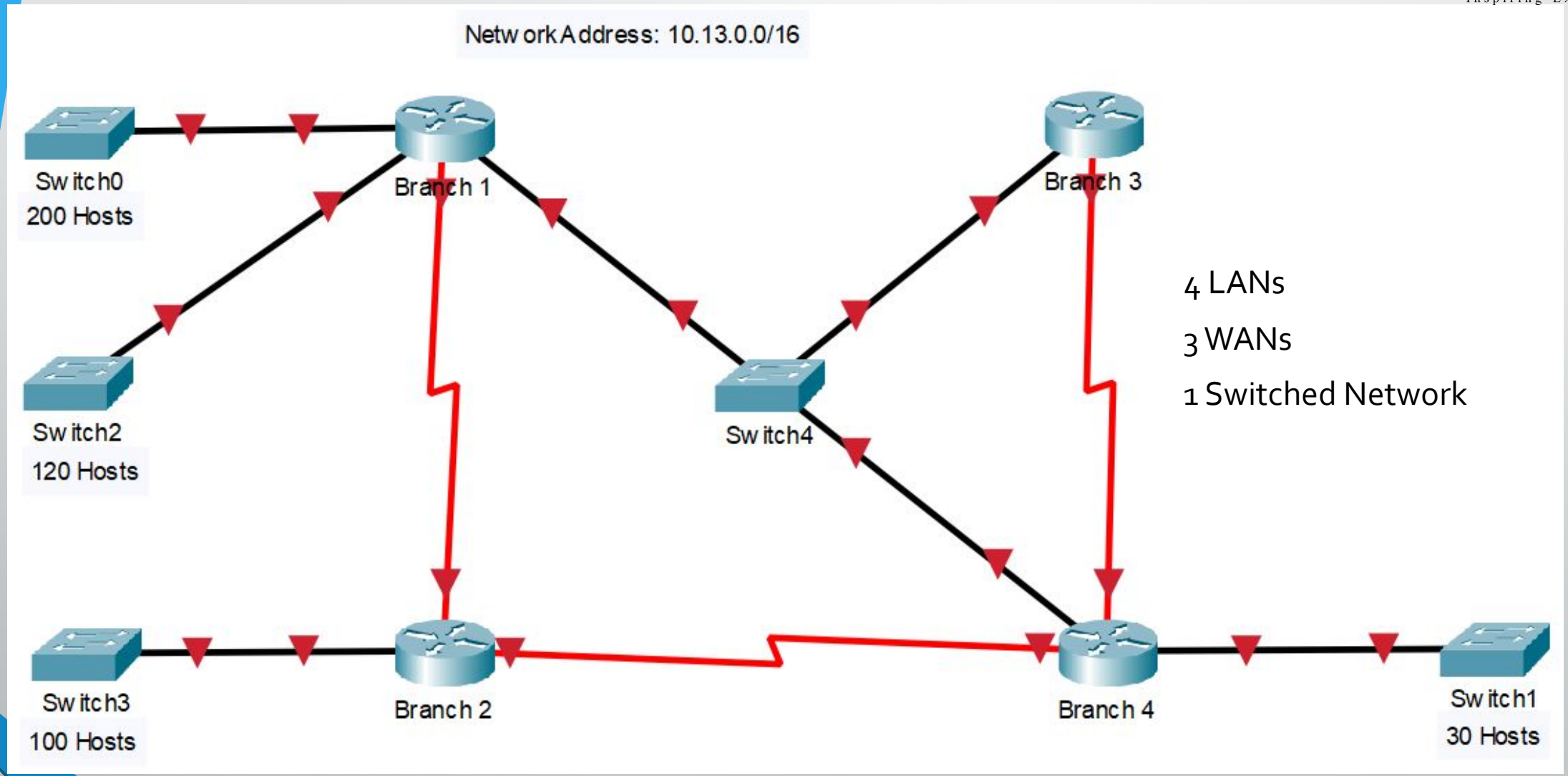


VLSM Example 2

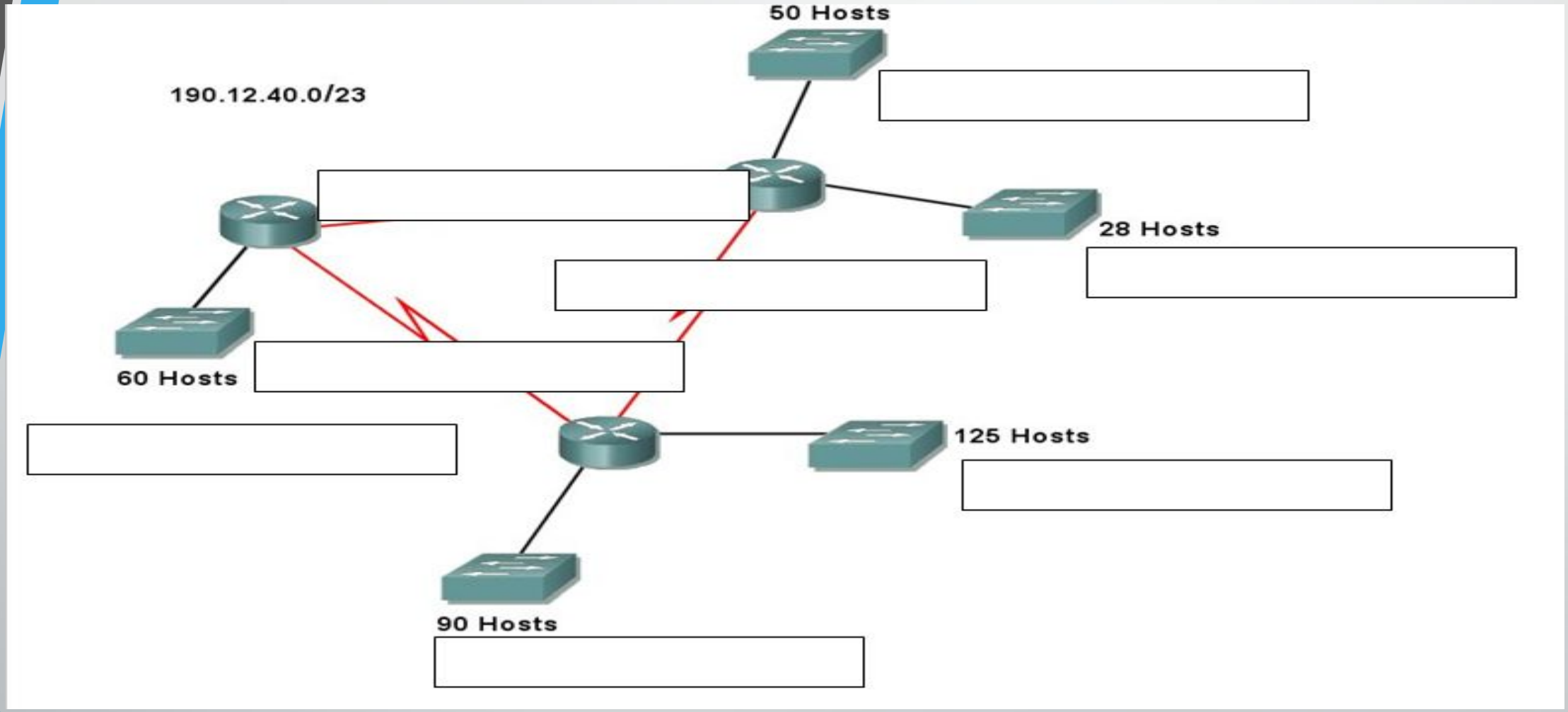


4 LANs

3 WANs

1 Switched Network

VLSM-Exercise # 2



- How many LANs? - 5 LANs
- How many WAN Links? - 3 WAN Links

CIDR Concept

- Also known as **"Classless Inter-Domain Routing"**
- To CIDR-compliant routers, address class is meaningless
- The network portion of the address is determined by the network **subnet mask**, also known as the **prefix** or **prefix length** (/8, /19, etc.)
- Classless routing protocols are complaint with CIDR which means they understand
  - VLSM and
  - Route Summarization.
- All routing protocols are classless nowadays.

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The End