Lab 4

1. Address planning
2. Summary/Default routes
3. Troubleshooting static routing

IPv4 address recap
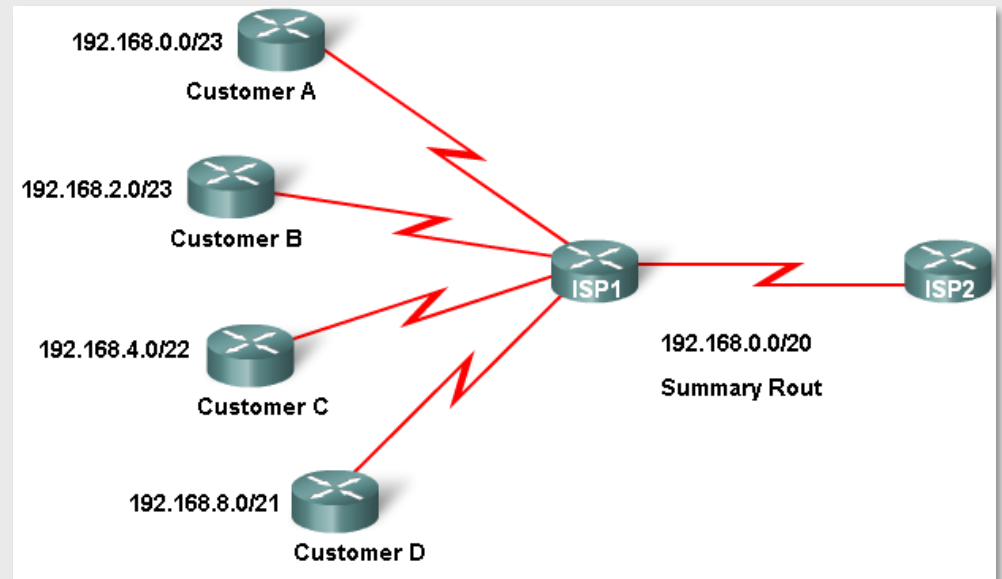
- Classful IPv4 addressing: network address is implicitly determined

IP Address Classes

Address Class	1st octet range (decimal)	1st octet bits (green bits do not change)	Network(N) and Host(H) parts of address	Default subnet mask (decimal and binary)	Number of possible networks and hosts per network
A	1-127**	00000000-01111111	N.H.H.H	255.0.0.0	128 nets (2^7) 16,777,214 hosts per net (2^24-2)
B	128-191	10000000-10111111	N.N.H.H	255.255.0.0	16,384 nets (2^14) 65,534 hosts per net (2^16-2)
C	192-223	11000000-11011111	N.N.N.H	255.255.255.0	2,097,150 nets (2^21) 254 hosts per net (2^8-2)
D	224-239	11100000-11101111	NA (multicast)		
E	240-255	11110000-11111111	NA (experimental)		

**** All zeros (0) and all ones (1) are invalid hosts addresses.**

IPv4 address recap

- Classless IPv4 addressing: network address is explicitly determined by a subnet mask
- CIDR: Classless InterDomain Routing [RFC 1517]
  - subnet portion of address of arbitrary length (VLSM: Variable Length Subnet Mask)
  - address format: `a.b.c.d/x`, where `x` is the number of bits in the subnet portion of the address
- More efficient use of IPv4 address space
  - *sub*-subnetting
- Route summarization
  - *supernetting*
  - Prefix aggregation

192.168.0.0/23
Customer A

192.168.2.0/23
Customer B

192.168.4.0/22
Customer C

192.168.8.0/21
Customer D

ISP1

ISP2

192.168.0.0/20
Summary Rout

IPv4 address recap

- **Public IP (network) addresses**
    - Assigned indirectly by the ISP
    - Assigned directly by IANA (Internet Assigned Numbers Authority)

Class	RFC 1918 Internal Address Range	CIDR Prefix
A	10.0.0.0 - 10.255.255.255	10.0.0.0/8
B	172.16.0.0 - 172.31.255.255	172.16.0.0/12
C	192.168.0.0 - 192.168.255.255	192.168.0.0/16

- **IANA set aside three blocks for private IP addresses [RFC 1918]**
    - Use is unrestricted in private networks
    - Cannot be routed on the public Internet (ISP routers are configured accordingly)
        - Global uniqueness is not guaranteed
- **Advantages and disadvantages of using private address space**
    - Flexibility in network design due to larger address space at disposal
    - Safe choice once outside connectivity is needed
        - but Network Address Translation is needed then
    - May require renumbering in case of several networks merging

IPv4 address recap

Special IPv4 Addresses

Router does not forward TEST-NET and Link-Local addresses.

Internet

Link-Local Network 169.254.0.0 /16 can only communicate within the local LAN.

Network using TEST-NET addresses 192.0.2.0 /24 can only communicate within the local LAN.

- Special addresses [RFC 3330]
  - Network and Broadcast addresses
    - All 0's host address part
    - All 1's host address part
  - "This" network
    - **0.0.0.0/8**, refer to <u>source</u> hosts on "this" network
 - Loopback
    - **127.0.0.1**, is used by hosts to direct traffic to themselves (bypassing lower layers of the stack)
    - **127.0.0.0/8** is actually reserved, no address within this block should ever appear <u>on any network</u>
  - Link-local [RFC 3927]
    - **169.254.0.0/16**, can be automatically assigned by a local host to itself when no other IP configuration means is available
    - Must not be used as destination addresses in packets forwarded to a router, and TTL must be set to 1
  - TEST-NET addresses
    - **192.0.2.0/24**, set aside for use in documentation and example code
    - Should not appear on the Internet
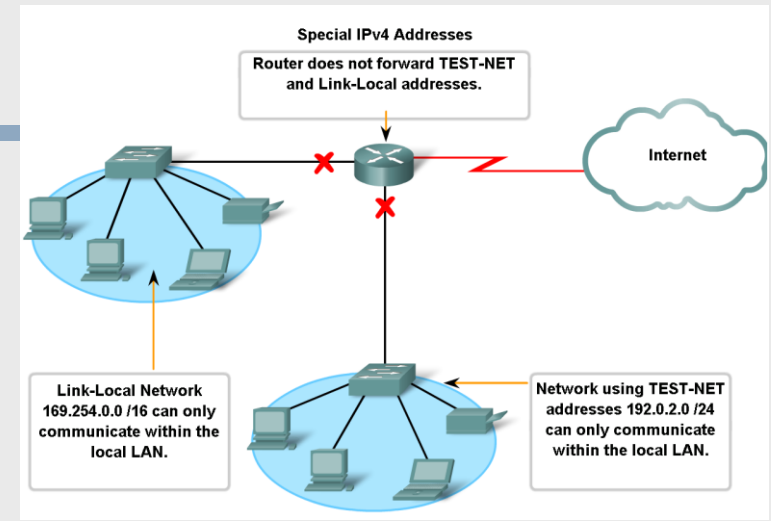
Subnet addresses calculation

- **172.16.20.0/25 network**

Network address
172 . 16. 20. 0/25
10101100.00010000.00010100.00000000
|-------------Network --------------|- host -|
0+0+0+0+0+0+0+0=0
Network address = 172.16.20.0

First host address
172 . 16. 20. 1
10101100.00010000.00010100.00000001
|----------------Network ------------|- host -|
0+0+0+0+0+0+0+1=1
Lowest host address = 172.16.20.1

Broadcast address
172 . 16. 20. 127
10101100.00010000.00010100.01111111
|-------------Network -------------|- host -|
0+64+32+16+8+4+2+1=127
Broadcast address = 172.16.20.127

Last host address
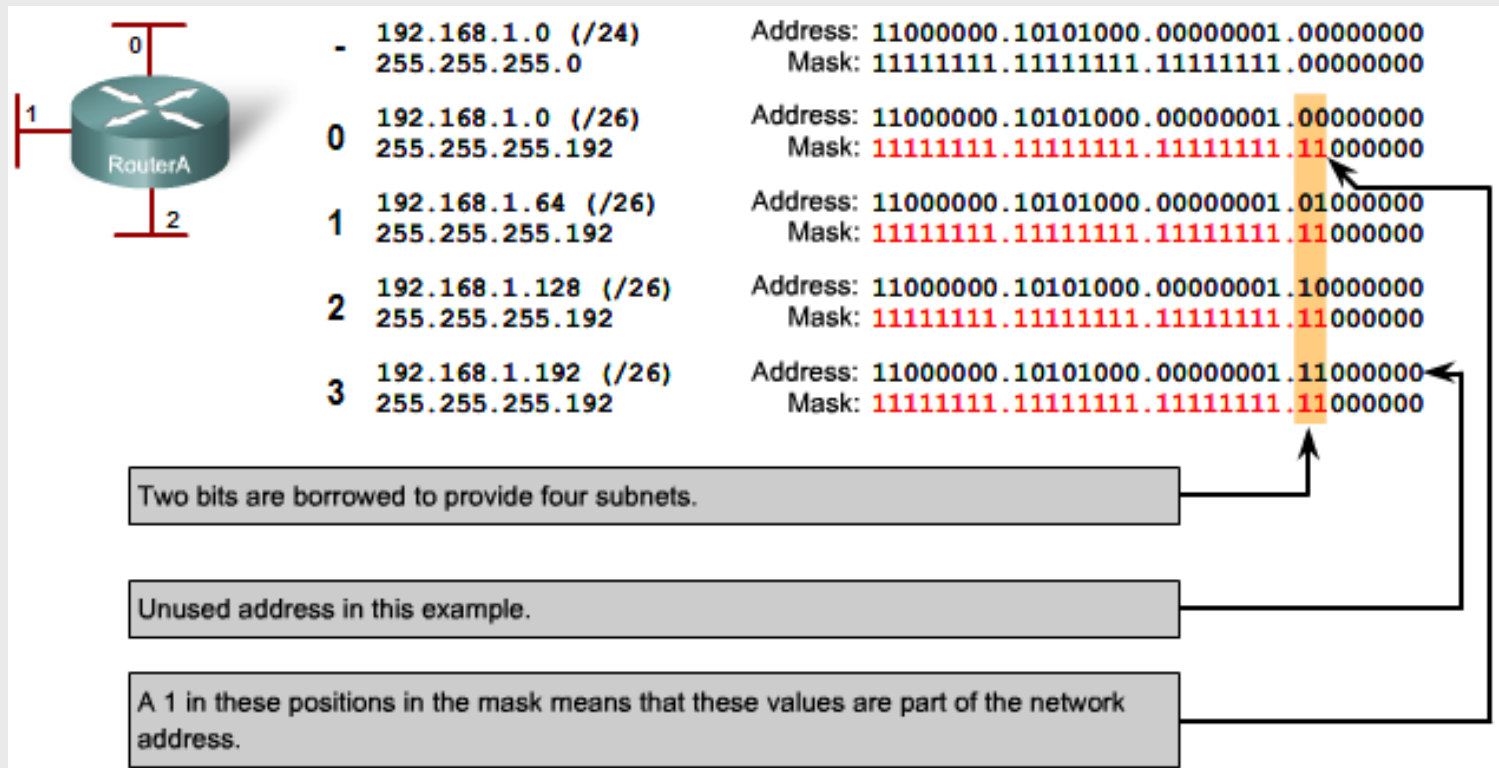172 . 16. 20. 126
10101100.00010000.00010100.01111110
|-------------Network -------------|- host -|
0+64+32+16+8+4+2+0=126
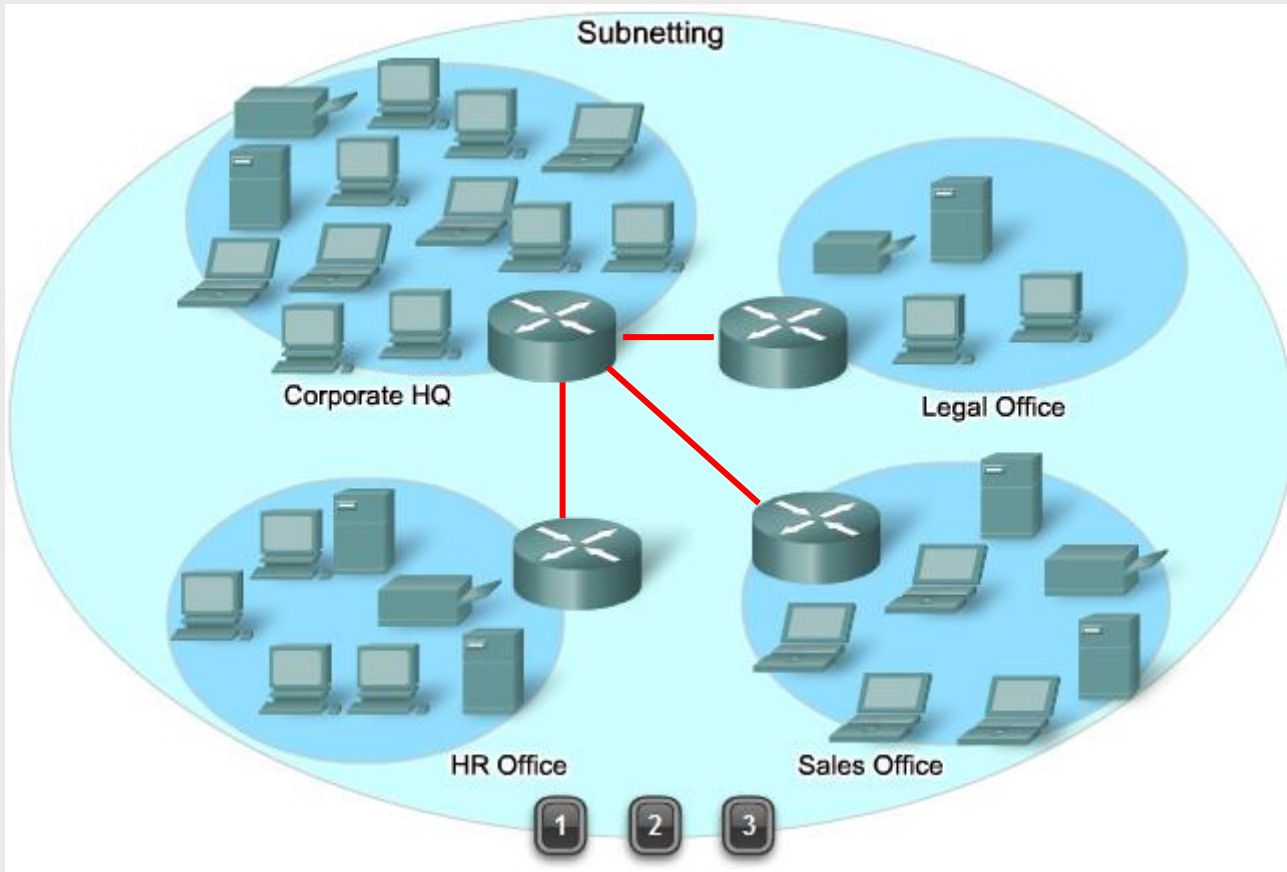Highest host address = 172.16.20.126

Basic subnetting

Addressing Scheme: Example of 4 networks

Subnet	Network address	Host range	Broadcast address
0	192.168.1.0/26	192.168.1.1 – 192.168.1.62	192.168.1.63
1	192.168.1.64/26	192.168.1.65 – 192.168.1.126	192.168.1.127
2	192.168.1.128/26	192.168.1.129 – 192.168.1.190	192.168.1.191
3	192.168.1.192/26	192.168.1.193 – 192.168.1.254	192.168.1.255

RouterA

	Address / Mask	Binary
-	192.168.1.0 (/24) 255.255.255.0	Address: 11000000.10101000.00000001.00000000 Mask: 11111111.11111111.11111111.00000000
0	192.168.1.0 (/26) 255.255.255.192	Address: 11000000.10101000.00000001.00000000 Mask: 11111111.11111111.11111111.11000000
1	192.168.1.64 (/26) 255.255.255.192	Address: 11000000.10101000.00000001.01000000 Mask: 11111111.11111111.11111111.11000000
2	192.168.1.128 (/26) 255.255.255.192	Address: 11000000.10101000.00000001.10000000 Mask: 11111111.11111111.11111111.11000000
3	192.168.1.192 (/26) 255.255.255.192	Address: 11000000.10101000.00000001.11000000 Mask: 11111111.11111111.11111111.11000000

Two bits are borrowed to provide four subnets.

Unused address in this example.

A 1 in these positions in the mask means that these values are part of the network address.
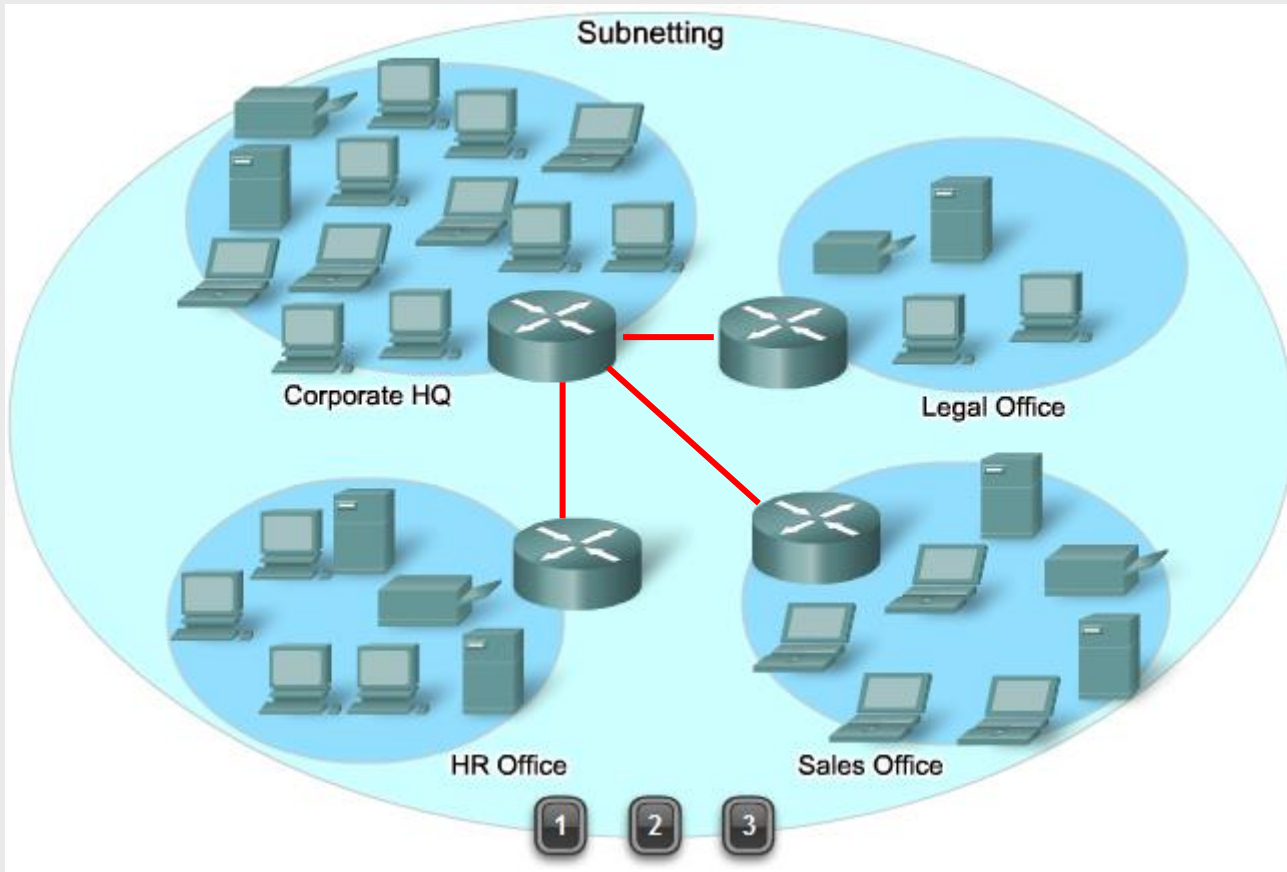
Addressing scheme planning

- Subnetting the available IPv4 address block to <u>efficiently</u> accommodate the <u>required</u> number of hosts of each network

Addressing scheme planning

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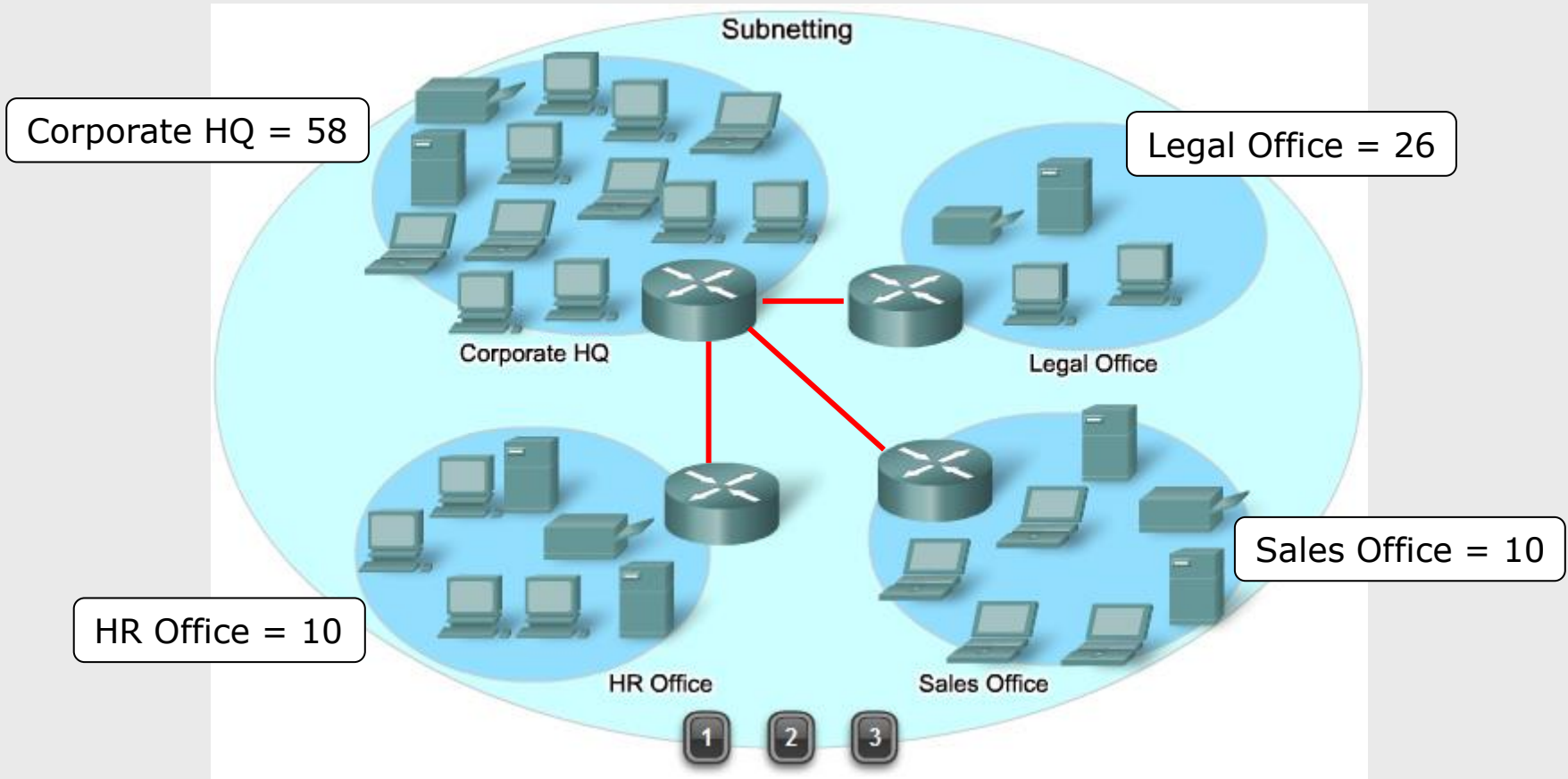

Total number of hosts in the corporate network = 104

Allocate a /?? block

Addressing scheme planning

- Subnetting the available IPv4 address block to <u>efficiently</u> accommodate the <u>required</u> number of hosts of each network

Corporate HQ = 58

Legal Office = 26

Sales Office = 10

HR Office = 10

Total number of hosts in the corporate network = 104

Allocate a /?? block

Addressing scheme planning

- Subnetting the available IPv4 address block to <u>efficiently</u> accommodate the <u>required</u> number of hosts of each network
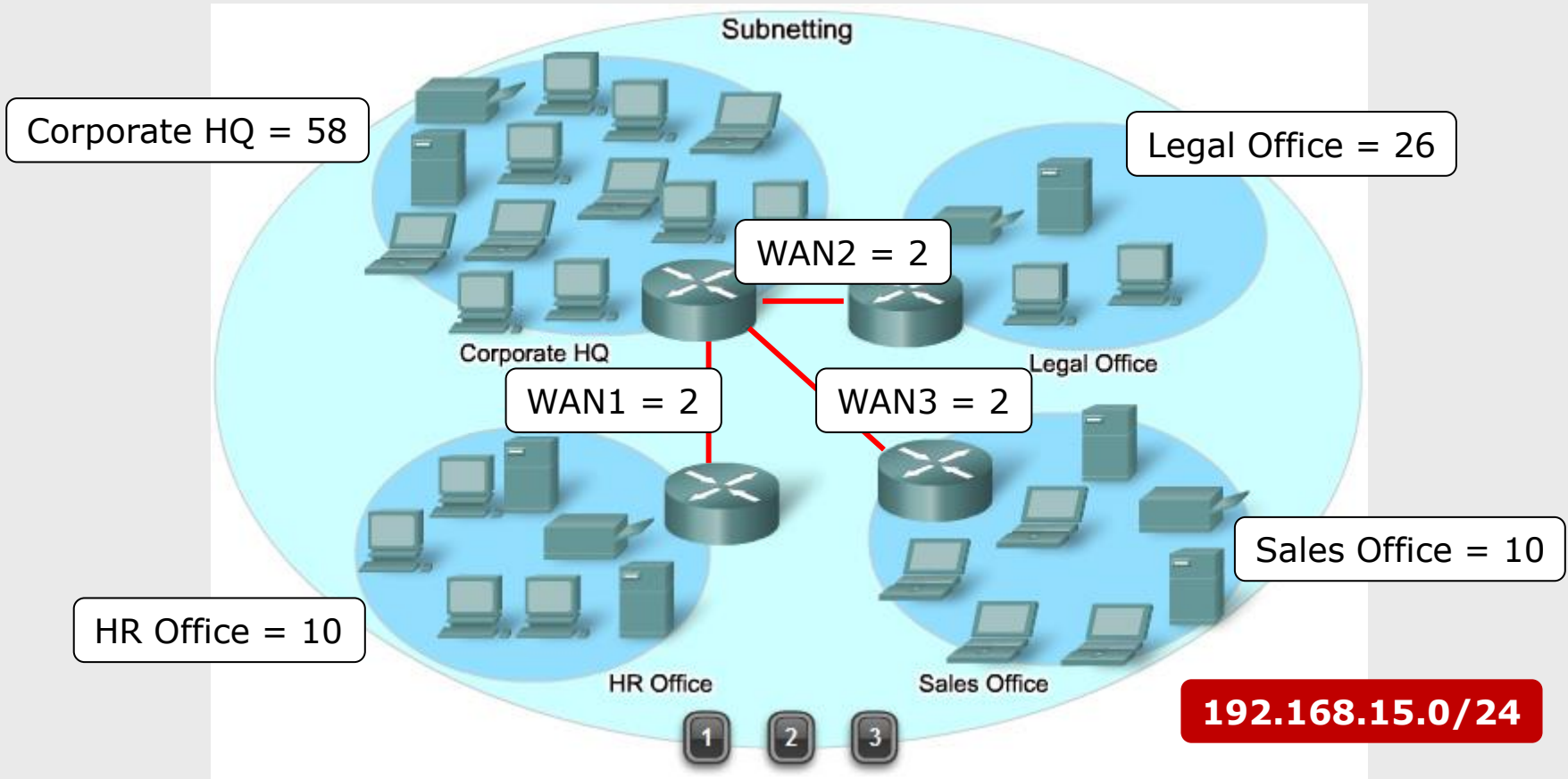

Corporate HQ = 58

Legal Office = 26

WAN2 = 2

WAN1 = 2

WAN3 = 2

Sales Office = 10

HR Office = 10

192.168.15.0/24

Total number of hosts in the corporate network = 104   **Allocate a /24 block**

Allocating addresses

■ VLSM chart: proceed by decreasing size of the address block

Corporate HQ = 58

	/25 (1 subnet bit) 2 subnets 126 hosts	/26 (2 subnet bits) 4 subnets 62 hosts	/27 (3 subnet bits) 8 subnets 30 hosts	/28 (4 subnet bits) 16 subnets 14 hosts	/29 (5 subnet bits) 32 subnets 6 hosts	/30 (6 subnet bits) 64 subnets 2 hsots
.0					.0 (.1- .6)	.0 (.1- .2)
.4				.0 (.1- .14)		.4 (.5- .6)
.8					.8 (.9- .14)	.8 (.9- .10)
.12			.0 .1- .30)			.12 (.13- .14)
.16					.16 (.17- .22)	.16 (.17- .18)
.20				.16 (.17- .30)		.20 (.21- .22)
.24					.24 (.25- .30)	.24 (.25- .26)
.28						.28 (.29- .30)
.32					.32 (.33- .38)	.32 (.33- .34)
.36				.32 (.33- .46)		.36 (.37- .38)
.40					.40 (.41- .46)	.40 (.41- .42)
.44		.0 (.1- .62)	.32 .33- .62)			.44 (.45- .46)
.48					.48 (.49- .54)	.48 (.49- .50)
.52				.48 (.49- .62)		.52 (.53- .54)
.56					.56 (.57- .62)	.56 (.57- .58)
.60	.0					.60 (.61- .62)
.64					.64 (.65- .70)	.64 (.65- .66)
.68				.64 (.65- .78)		.68 (.69- .70)
.72					.72 (.73- .78)	.72 (.73- .74)
.76			.64 (.65- .94)			.76 (.77- .78)
.80					.80 (.81- .86)	.80 (.81- .82)
.84				.80 (.81- .94)		.84 (.85- .86)
.88					.88 (.89- .94)	.88 (.89- .90)
.92		.64 (.65- .126)				.92 (.93- .94)
.96					.96 (.97- .102)	.96 (.97- .98)
.100				.96 (.97- .110)		.100 (.101- .102)
.104					.104 (.105- .110)	.104 (.105- .106)
.108			.96 (.97- .126)			.108 (.109- .110)
.112					.112 (.113- .118)	.112 (.113- .114)
.116				.112 (.113- .126)		.116 (.117- .118)
.120					.120 (.121- .126)	.120 (.121- .122)
.124						.124 (.125- .126)

4/13/2007

by Dale Henninger ee Toderick

Allocating addresses

- VLSM chart: proceed by decreasing size of the address block

Corporate HQ = 58   **192.168.15.0/26**

	/25 (1 subnet bit) 2 subnets 126 hosts	/26 (2 subnet bits) 4 subnets 62 hosts	/27 (3 subnet bits) 8 subnets 30 hosts	/28 (4 subnet bits) 16 subnets 14 hosts	/29 (5 subnet bits) 32 subnets 6 hosts	/30 (6 subnet bits) 64 subnets 2 hsots
.0				.0 (.1- .14)	.0 (.1- .6)	.0 (.1- .2)
.4						.4 (.5- .6)
.8					.8 (.9- .14)	.8 (.9- .10)
.12			.0 (.1- .30)			.12 (.13- .14)
.16				.16 (.17- .30)	.16 (.17- .22)	.16 (.17- .18)
.20						.20 (.21- .22)
.24					.24 (.25- .30)	.24 (.25- .26)
.28						.28 (.29- .30)
.32		.0 (.1- .62)		.32 (.33- .46)	.32 (.33- .38)	.32 (.33- .34)
.36						.36 (.37- .38)
.40					.40 (.41- .46)	.40 (.41- .42)
.44			.32 (.33- .62)			.44 (.45- .46)
.48				.48 (.49- .62)	.48 (.49- .54)	.48 (.49- .50)
.52						.52 (.53- .54)
.56					.56 (.57- .62)	.56 (.57- .58)
.60	.0					.60 (.61- .62)
.64				.64 (.65- .78)	.64 (.65- .70)	.64 (.65- .66)
.68						.68 (.69- .70)
.72					.72 (.73- .78)	.72 (.73- .74)
.76			.64 (.65- .94)			.76 (.77- .78)
.80				.80 (.81- .94)	.80 (.81- .86)	.80 (.81- .82)
.84						.84 (.85- .86)
.88					.88 (.89- .94)	.88 (.89- .90)
.92		.64 (.65- .126)				.92 (.93- .94)
.96				.96 (.97- .110)	.96 (.97- .102)	.96 (.97- .98)
.100						.100 (.101- .102)
.104					.104 (.105- .110)	.104 (.105- .106)
.108			.96 (.97- .126)			.108 (.109- .110)
.112				.112 (.113- .126)	.112 (.113- .118)	.112 (.113- .114)
.116						.116 (.117- .118)
.120					.120 (.121- .126)	.120 (.121- .122)
.124						.124 (.125- .126)

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Allocating addresses

- VLSM chart: proceed by decreasing size of the address block

Legal Office = 26

	/25 (1 subnet bit) 2 subnets 126 hosts	/26 (2 subnet bits) 4 subnets 62 hosts	/27 (3 subnet bits) 8 subnets 30 hosts	/28 (4 subnet bits) 16 subnets 14 hosts	/29 (5 subnet bits) 32 subnets 6 hosts	/30 (6 subnet bits) 64 subnets 2 hsots
.0	.0 (.1- .126)	.0 (.1- .62)	.0 .1- .30)	.0 (.1- .14)	.0 (.1- .6)	.0 (.1- .2)
.4						.4 (.5- .6)
.8					.8 (.9- .14)	.8 (.9- .10)
.12						.12 (.13- .14)
.16				.16 (.17- .30)	.16 (.17- .22)	.16 (.17- .18)
.20						.20 (.21- .22)
.24					.24 (.25- .30)	.24 (.25- .26)
.28						.28 (.29- .30)
.32			.32 .33- .62)	.32 (.33- .46)	.32 (.33- .38)	.32 (.33- .34)
.36						.36 (.37- .38)
.40					.40 (.41- .46)	.40 (.41- .42)
.44						.44 (.45- .46)
.48				.48 (.49- .62)	.48 (.49- .54)	.48 (.49- .50)
.52						.52 (.53- .54)
.56					.56 (.57- .62)	.56 (.57- .58)
.60						.60 (.61- .62)
.64		.64 (.65- .126)	.64 (.65- .94)	.64 (.65- .78)	.64 (.65- .70)	.64 (.65- .66)
.68						.68 (.69- .70)
.72					.72 (.73- .78)	.72 (.73- .74)
.76						.76 (.77- .78)
.80				.80 (.81- .94)	.80 (.81- .86)	.80 (.81- .82)
.84						.84 (.85- .86)
.88					.88 (.89- .94)	.88 (.89- .90)
.92						.92 (.93- .94)
.96			.96 (.97- .126)	.96 (.97- .110)	.96 (.97- .102)	.96 (.97- .98)
.100						.100 (.101- .102)
.104					.104 (.105- .110)	.104 (.105- .106)
.108						.108 (.109- .110)
.112				.112 (.113- .126)	.112 (.113- .118)	.112 (.113- .114)
.116						.116 (.117- .118)
.120					.120 (.121- .126)	.120 (.121- .122)
.124						.124 (.125- .126)

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Allocating addresses

■ VLSM chart: proceed by decreasing size of the address block

Legal Office = 26   **192.168.15.64/27**

Allocating addresses

- VLSM chart: proceed by decreasing size of the address block

Sales Office = 10

HR Office = 10

/25 (1 subnet bit) 2 subnets 126 hosts	/26 (2 subnet bits) 4 subnets 62 hosts	/27 (3 subnet bits) 8 subnets 30 hosts	/28 (4 subnet bits) 16 subnets 14 hosts	/29 (5 subnet bits) 32 subnets 6 hosts	/30 (6 subnet bits) 64 subnets 2 hsots

.0	.0 (.1- .62)	.0 .1- .30)	.0 (.1- .14)	.0 (.1- .6)	.0 (.1- .2)
.4					.4 (.5- .6)
.8				.8 (.9- .14)	.8 (.9- .10)
.12					.12 (.13- .14)
.16			.16 (.17- .30)	.16 (.17- .22)	.16 (.17- .18)
.20					.20 (.21- .22)
.24				.24 (.25- .30)	.24 (.25- .26)
.28					.28 (.29- .30)
.32		.32 .33- .62)	.32 (.33- .46)	.32 (.33- .38)	.32 (.33- .34)
.36					.36 (.37- .38)
.40				.40 (.41- .46)	.40 (.41- .42)
.44					.44 (.45- .46)
.48			.48 (.49- .62)	.48 (.49- .54)	.48 (.49- .50)
.52					.52 (.53- .54)
.56				.56 (.57- .62)	.56 (.57- .58)
.60					.60 (.61- .62)
.64	.64 (.65- .126)	.64 (.65- .94)	.64 (.65- .78)	.64 (.65- .70)	.64 (.65- .66)
.68					.68 (.69- .70)
.72				.72 (.73- .78)	.72 (.73- .74)
.76					.76 (.77- .78)
.80			.80 (.81- .94)	.80 (.81- .86)	.80 (.81- .82)
.84					.84 (.85- .86)
.88				.88 (.89- .94)	.88 (.89- .90)
.92					.92 (.93- .94)
.96		.96 (.97- .126)	.96 (.97- .110)	.96 (.97- .102)	.96 (.97- .98)
.100					.100 (.101- .102)
.104				.104 (.105- .110)	.104 (.105- .106)
.108					.108 (.109- .110)
.112			.112 (.113- .126)	.112 (.113- .118)	.112 (.113- .114)
.116					.116 (.117- .118)
.120				.120 (.121- .126)	.120 (.121- .122)
.124					.124 (.125- .126)

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Allocating addresses

- VLSM chart: proceed by decreasing size of the address block

Sales Office = 10   **192.168.15.96/28**

HR Office = 10   **192.168.15.112/28**

Allocating addresses

- VLSM chart: proceed by decreasing size of the address block
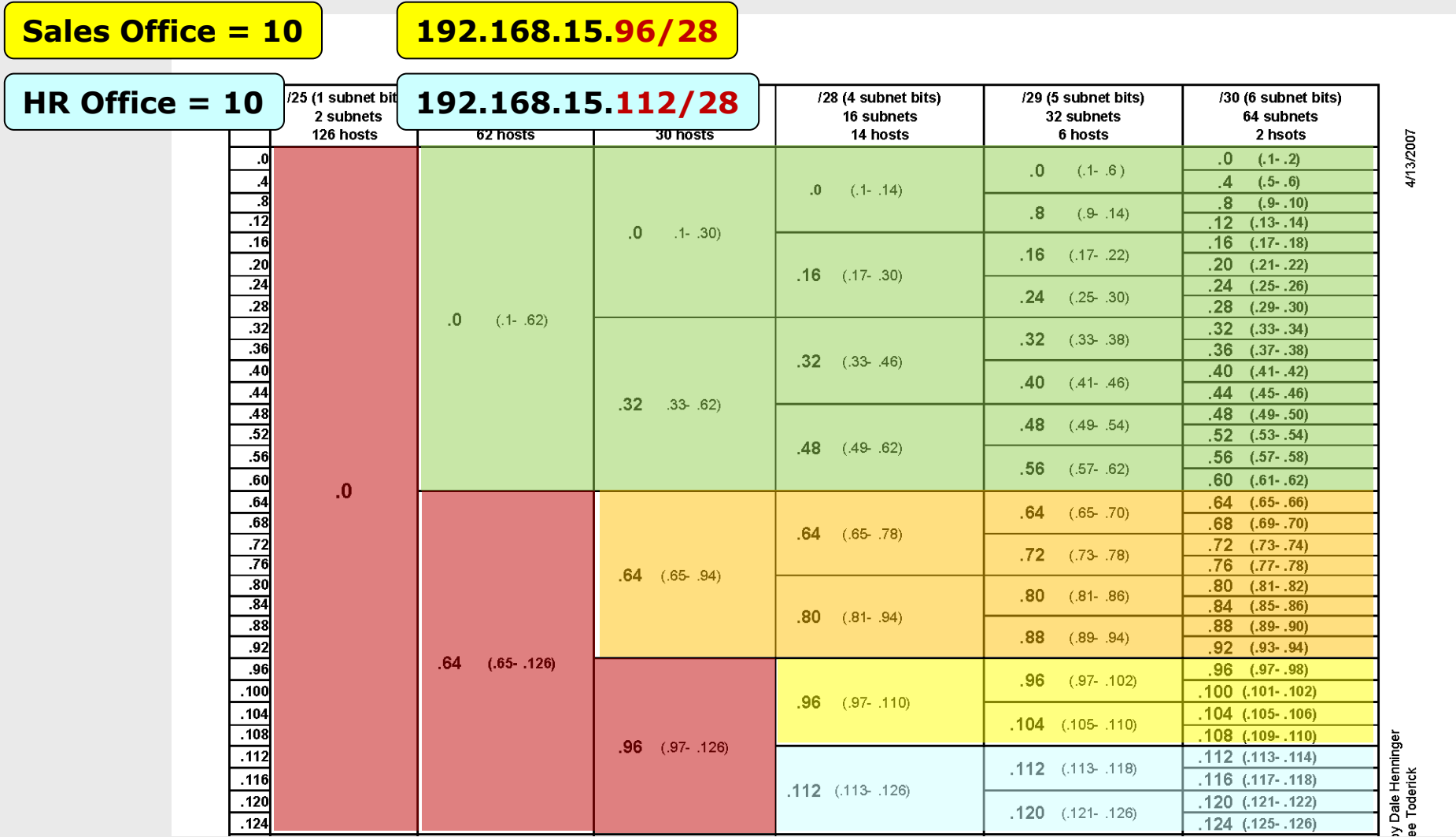
WAN 1= 2

WAN 2= 2

WAN 3= 2

	/25 (1 subnet bit) 2 subnets 126 hosts	/26 (2 subnet bits) 4 subnets 62 hosts	/27 (3 subnet bits) 8 subnets 30 hosts	/28 (4 subnet bits) 16 subnets 14 hosts	/29 (5 subnet bits) 32 subnets 6 hosts	/30 (6 subnet bits) 64 subnets 2 hsots
.112			.96 (.97- .126)		.112 (.113- .118)	.112 (.113- .114)
.116				.112 (.113- .126)		.116 (.117- .118)
.120					.120 (.121- .126)	.120 (.121- .122)
.124						.124 (.125- .126)
.128				.128 (.129- .142)	.128 (.129- .134)	.128 (.129- .130)
.132						.132 (.133- .134)
.136					.136 (.137- .142)	.136 (.137- .138)
.140			.128 (.129- .158)			.140 (.141- .142)
.144				.144 (.145- .158)	.144 (.145- .150)	.144 (.145- .146)
.148						.148 (.149- .150)
.152					.152 (.153- .158)	.152 (.153- .154)
.156						.156 (.157- .158)
.160		.128 (.129- .190)		.160 (.161- .174)	.160 (.161- .166)	.160 (.161- .162)
.164						.164 (.165- .166)
.168					.168 (.169- .174)	.168 (.169- .170)
.172			.160 (.161- .190)			.172 (.173- .174)
.176				.176 (.177- .190)	.176 (.177- .182)	.176 (.177- .178)
.180						.180 (.181- .182)
.184					.184 (.185- .190)	.184 (.185- .186)
.188						.188 (.189- .190)
.192	.128			.192 (.193- .206)	.192 (.193- .198)	.192 (.193- .194)
.196						.196 (.197- .198)
.200					.200 (.201- .206)	.200 (.201- .202)
.204			.192 (.193- .222)			.204 (.205- .206)
.208				.208 (.209- .222)	.208 (.209- .214)	.208 (.209- .210)
.212						.212 (.213- .214)
.216					.216 (.217- .222)	.216 (.217- .218)
.220		192 (.193- .254)				.220 (.221- .222)

Allocating addresses

- VLSM chart: proceed by decreasing size of the address block

WAN 1= 2	192.168.15.128/30
WAN 2= 2	192.168.15.132/30
WAN 3= 2	192.168.15.136/30

/25 (1 subnet bit)	/26 (2 subnet bits)	/27 (3 subnet bits) 8 subnets 30 hosts	/28 (4 subnet bits) 16 subnets 14 hosts	/29 (5 subnet bits) 32 subnets 6 hosts	/30 (6 subnet bits) 64 subnets 2 hsots
.112		.96 (.97- .126)			.112 (.113- .114)
.116			.112 (.113- .126)	.112 (.113- .118)	.116 (.117- .118)
.120				.120 (.121- .126)	.120 (.121- .122)
.124					.124 (.125- .126)
.128				.128 (.129- .134)	.128 (.129- .130)
.132			.128 (.129- .142)		.132 (.133- .134)
.136				.136 (.137- .142)	.136 (.137- .138)
.140		.128 (.129- .158)			.140 (.141- .142)
.144			.144 (.145- .158)	.144 (.145- .150)	.144 (.145- .146)
.148					.148 (.149- .150)
.152				.152 (.153- .158)	.152 (.153- .154)
.156	.128 (.129- .190)				.156 (.157- .158)
.160				.160 (.161- .166)	.160 (.161- .162)
.164			.160 (.161- .174)		.164 (.165- .166)
.168				.168 (.169- .174)	.168 (.169- .170)
.172		.160 (.161- .190)			.172 (.173- .174)
.176			.176 (.177- .190)	.176 (.177- .182)	.176 (.177- .178)
.180					.180 (.181- .182)
.184				.184 (.185- .190)	.184 (.185- .186)
.188					.188 (.189- .190)
.192	.128			.192 (.193- .198)	.192 (.193- .194)
.196			.192 (.193- .206)		.196 (.197- .198)
.200				.200 (.201- .206)	.200 (.201- .202)
.204		.192 (.193- .222)			.204 (.205- .206)
.208			.208 (.209- .222)	.208 (.209- .214)	.208 (.209- .210)
.212					.212 (.213- .214)
.216				.216 (.217- .222)	.216 (.217- .218)
.220		192 (.193- .254)			.220 (.221- .222)

Originally Authored by Dale Henning
Compiled by Lee Toderick

Allocating addresses
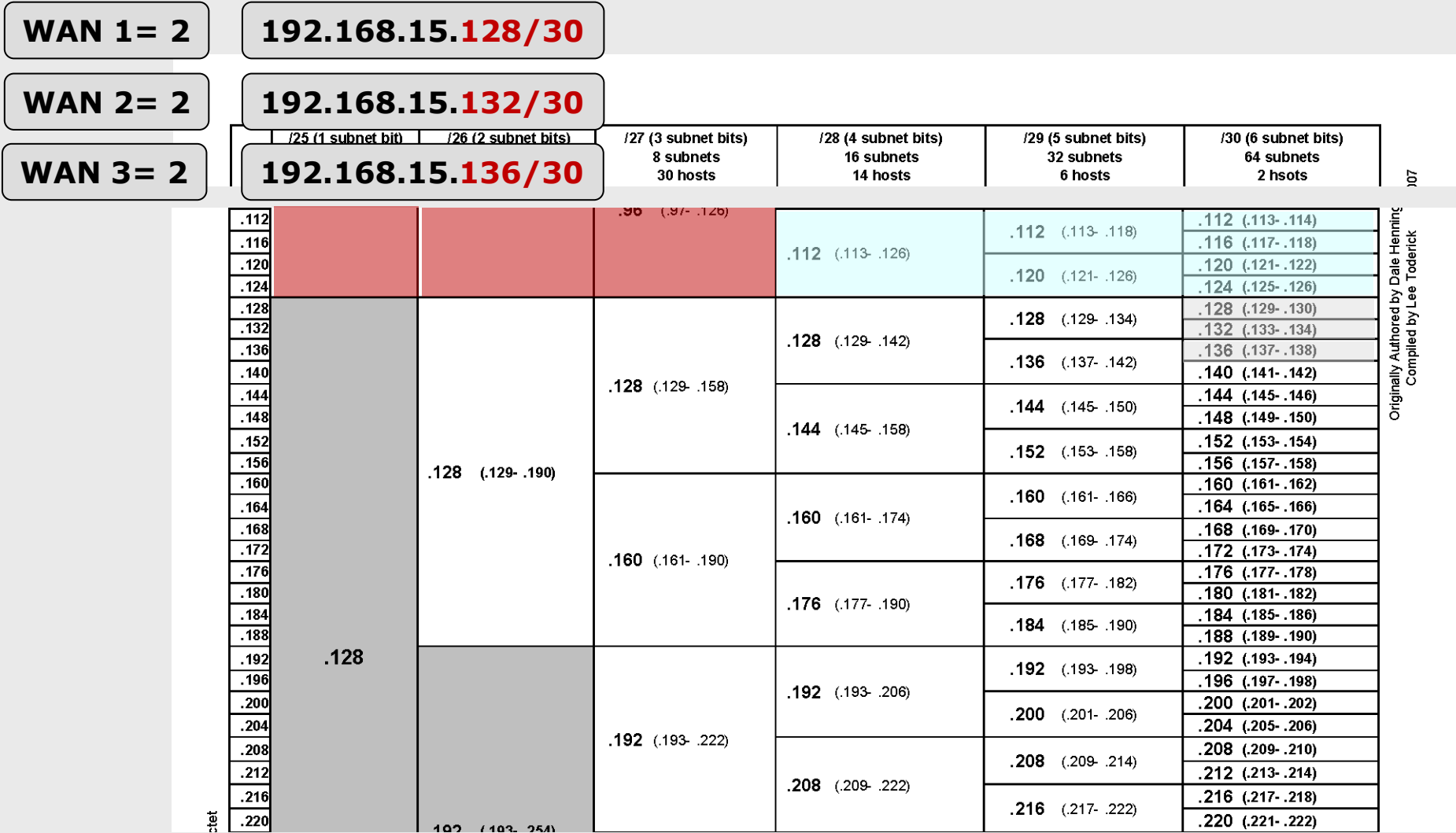
- VLSM chart: proceed by decreasing size of the address block
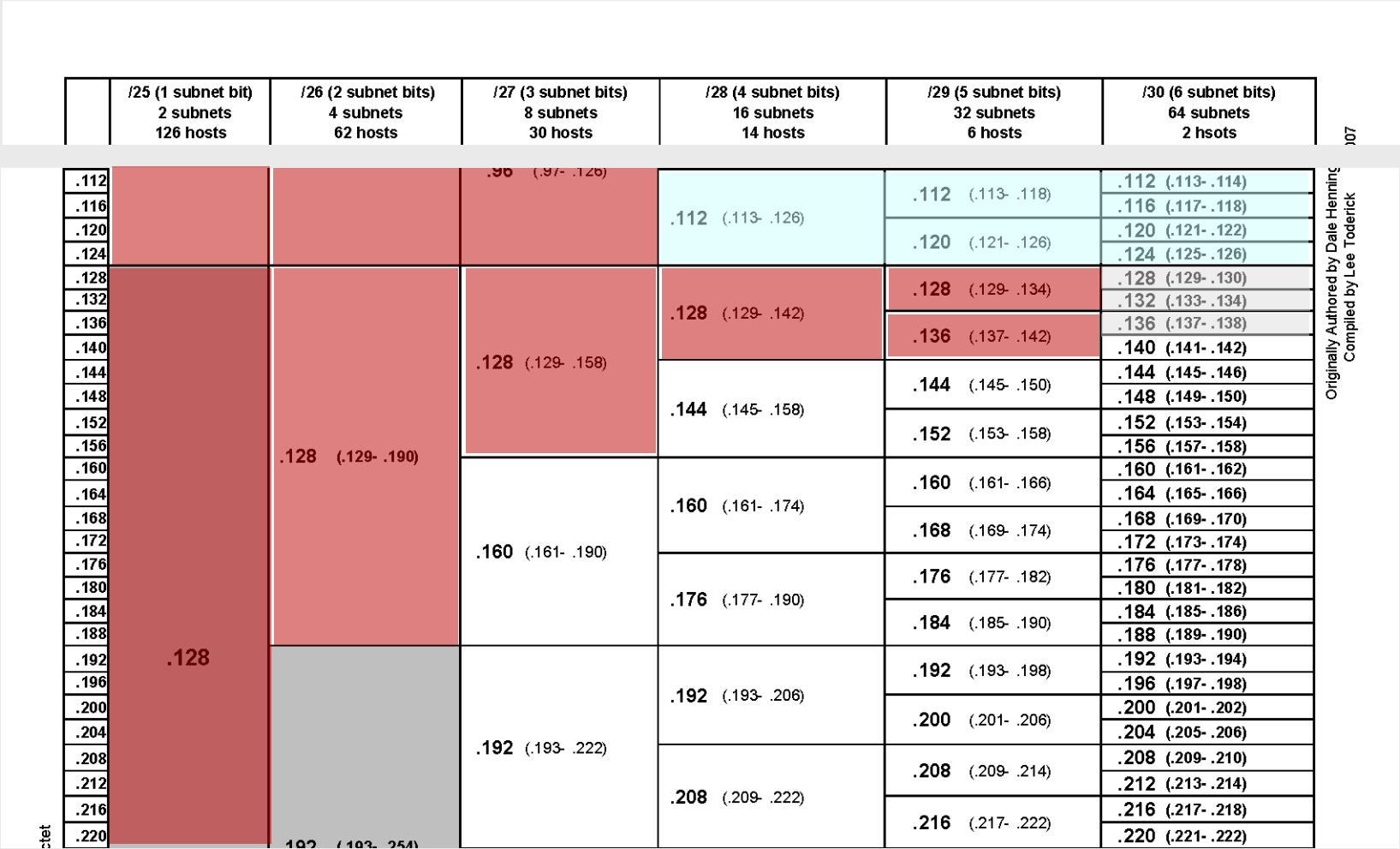
Addressing scheme planning

- Subnetting [...]
 accommoda[...]

Req. addresses	Network prefix	Address range	Broadcast address
Corporate HQ (58)	192.168.15.0/26	.1-.62	.63
Legal Office (26)	192.168.15.64/27	.65-.94	.95
Sales Office (10)	192.168.15.96/28	.97-.110	.111
HR Office (10)	192.168.15.112/28	.113-.126	.127
WAN1 (2)	192.168.15.128/30	.129-.130	.131
WAN2 (2)	192.168.15.132/30	.133-.134	.135
WAN3 (2)	192.168.15.136/30	.137-.138	.139

Corporate HQ = 5[...]

Sales Office = 10

HR Office = 10

HR Office

Sales Office

1 2 3

192.168.15.0/24
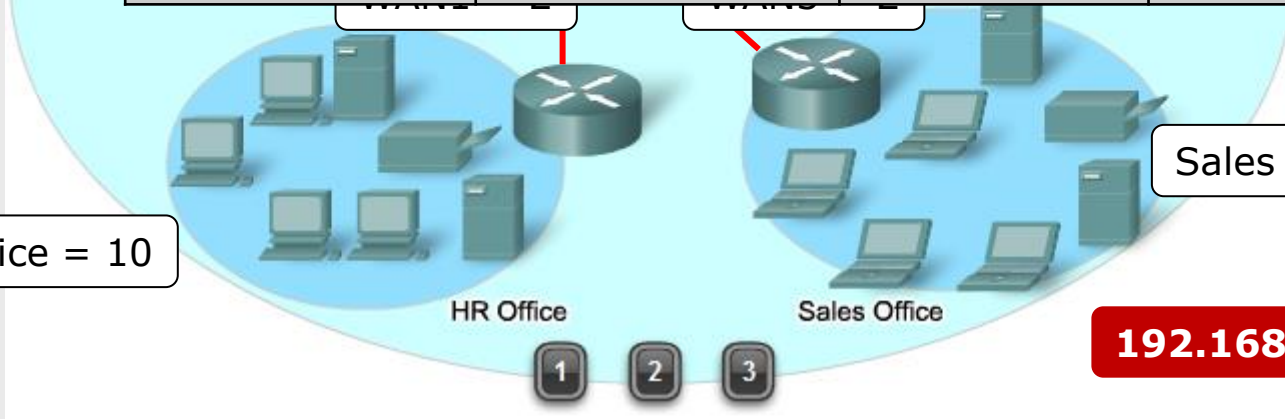
Total number of hosts in the corporate network = 104

Allocate a /24 block

Lab activity

- The block of addresses **172.16.0.0/??** is given
  - Design an addressing scheme
  - *Design and configure static routing accordingly*
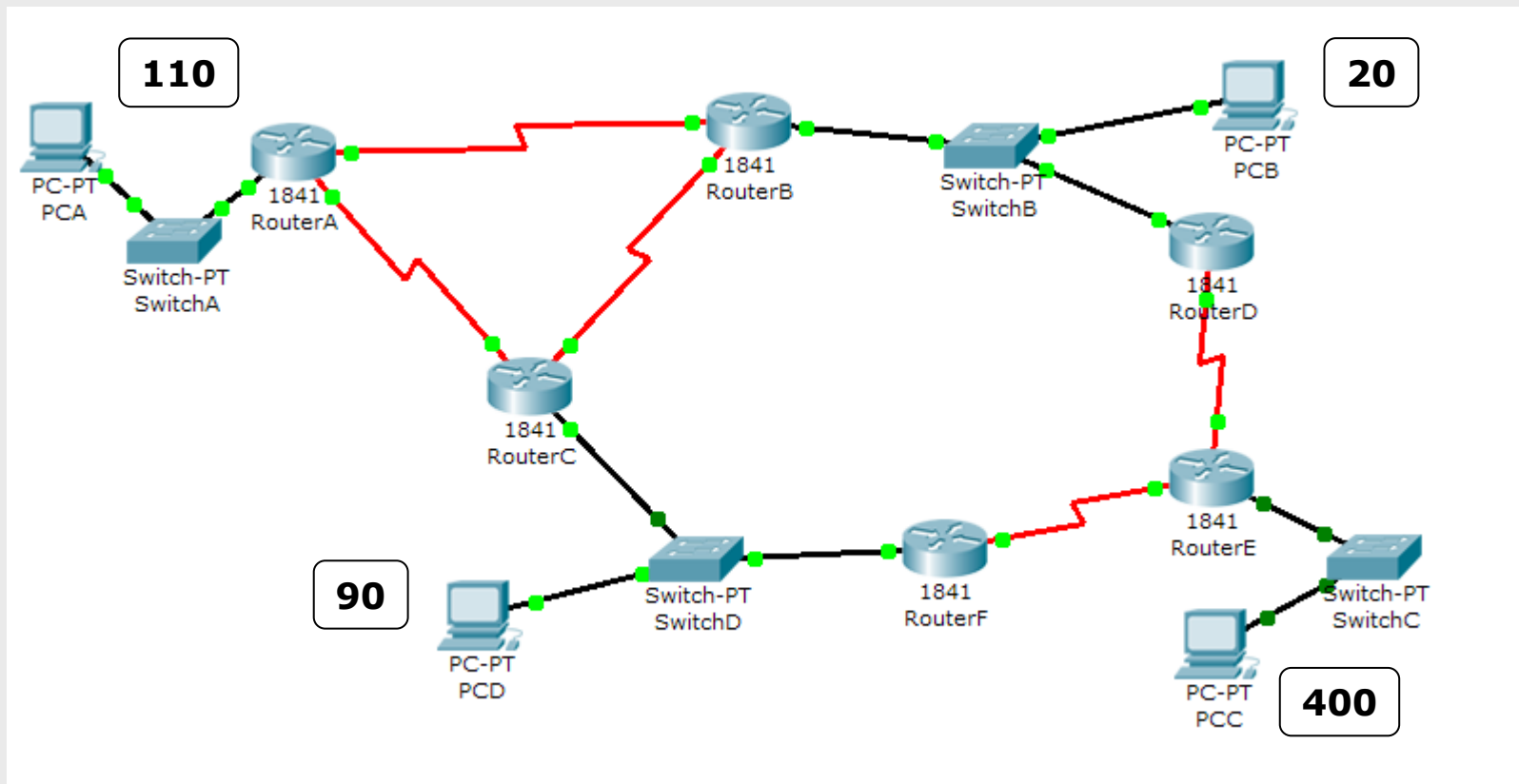
# Lab activity

- The block of addresses **172.16.0.0/22** is given
  - Design an addressing scheme
  - *Design and configure static routing accordingly*

Subnet	Needed	Allocated	Address	Mask	Dec Mask	Assignable Range	Broadcast
LanC	400	510	172.16.0.0	/23	255.255.254.0	172.16.0.1 - 172.16.1.254	172.16.1.255
LanA	110	126	172.16.2.0	/25	255.255.255.128	172.16.2.1 - 172.16.2.126	172.16.2.127
LanD	90	126	172.16.2.128	/25	255.255.255.128	172.16.2.129 - 172.16.2.254	172.16.2.255
LanB	20	30	172.16.3.0	/27	255.255.255.224	172.16.3.1 - 172.16.3.30	172.16.3.31
RA-RB	2	2	172.16.3.32	/30	255.255.255.252	172.16.3.33 - 172.16.3.34	172.16.3.35
RA-RC	2	2	172.16.3.36	/30	255.255.255.252	172.16.3.37 - 172.16.3.38	172.16.3.39
RB-RC	2	2	172.16.3.40	/30	255.255.255.252	172.16.3.41 - 172.16.3.42	172.16.3.43
RD-RE	2	2	172.16.3.44	/30	255.255.255.252	172.16.3.45 - 172.16.3.46	172.16.3.47
RE-RF	2	2	172.16.3.48	/30	255.255.255.252	172.16.3.49 - 172.16.3.50	172.16.3.51

Summary routes

- Route summarization is the process of combining a number of (*static*) routes into a single (*static*) route
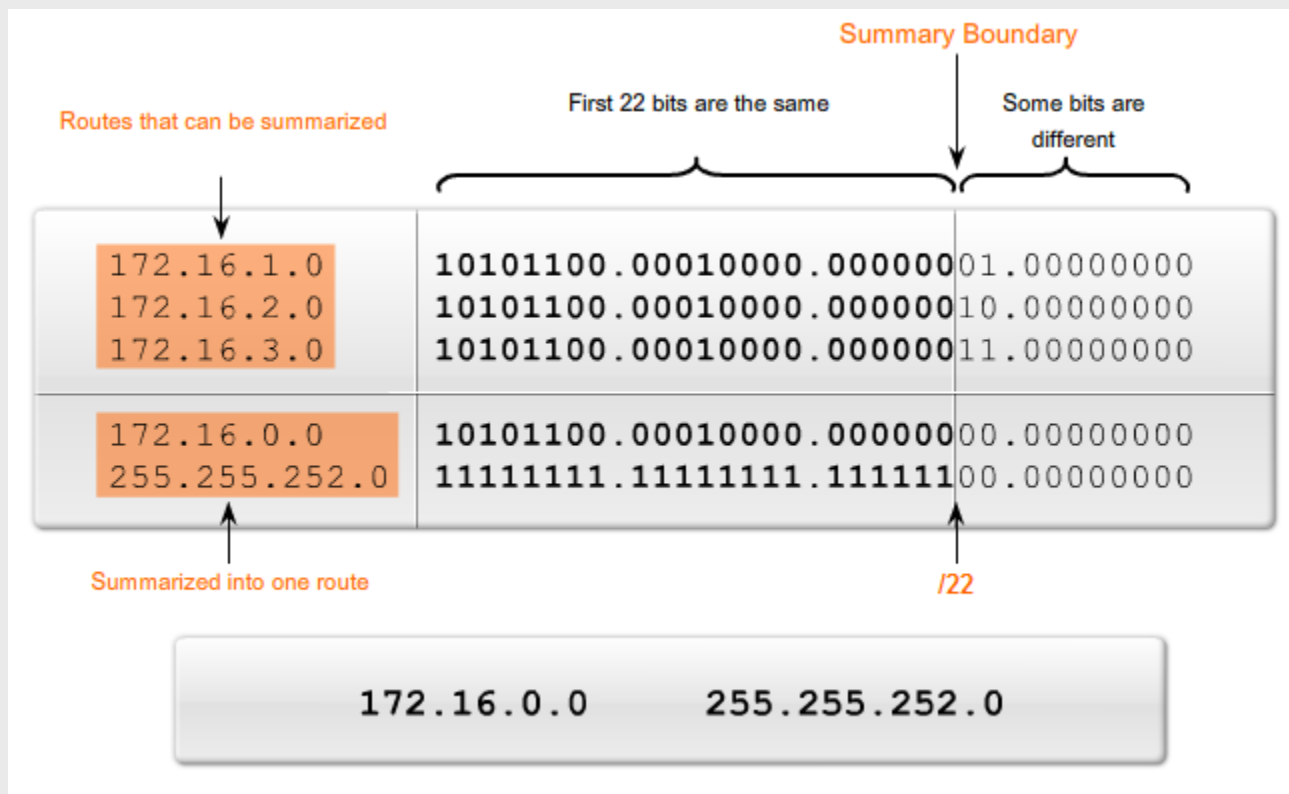
Summary routes

- **Configuring <u>static</u> summary routes**

```
R3#show ip route
<output omitted>

Gateway of last resort is not set

 172.16.0.0/24 is subnetted, 3 subnets
S      172.16.1.0 is directly connected, Serial0/0/1
S      172.16.2.0 is directly connected, Serial0/0/1
S      172.16.3.0 is directly connected, Serial0/0/1
C    192.168.1.0/24 is directly connected, Serial0/0/1
C    192.168.2.0/24 is directly connected, FastEthernet0/0
```
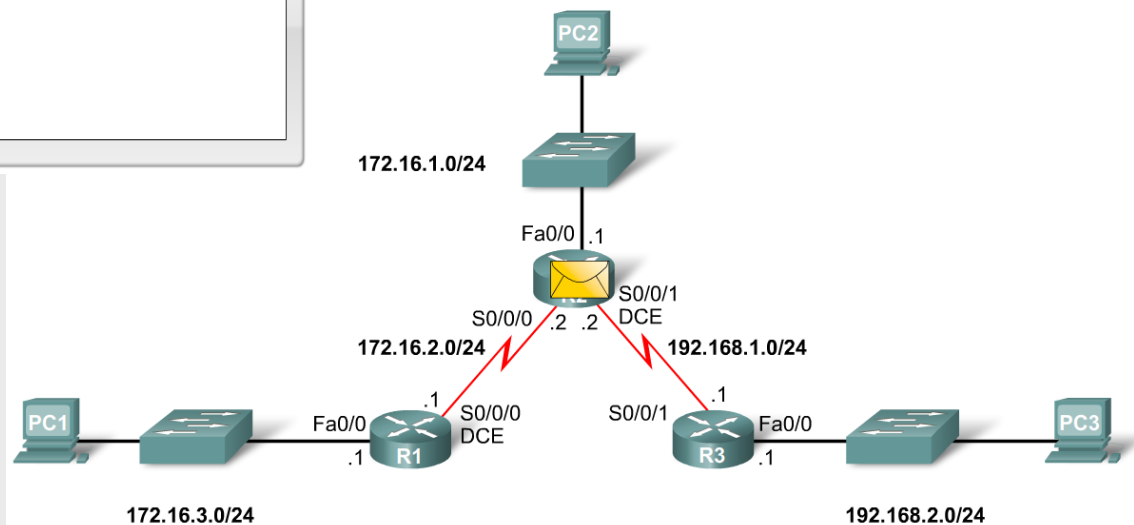
```
R3#show ip route
<output omitted>

Gateway of last resort is not set

     172.16.0.0/22 is subnetted, 1 subnets
S      172.16.0.0 is directly connected, Serial0/0/1
C    192.168.1.0/24 is directly connected, Serial0/1
C    192.168.2.0/24 is directly connected, FastEthernet0/0
```
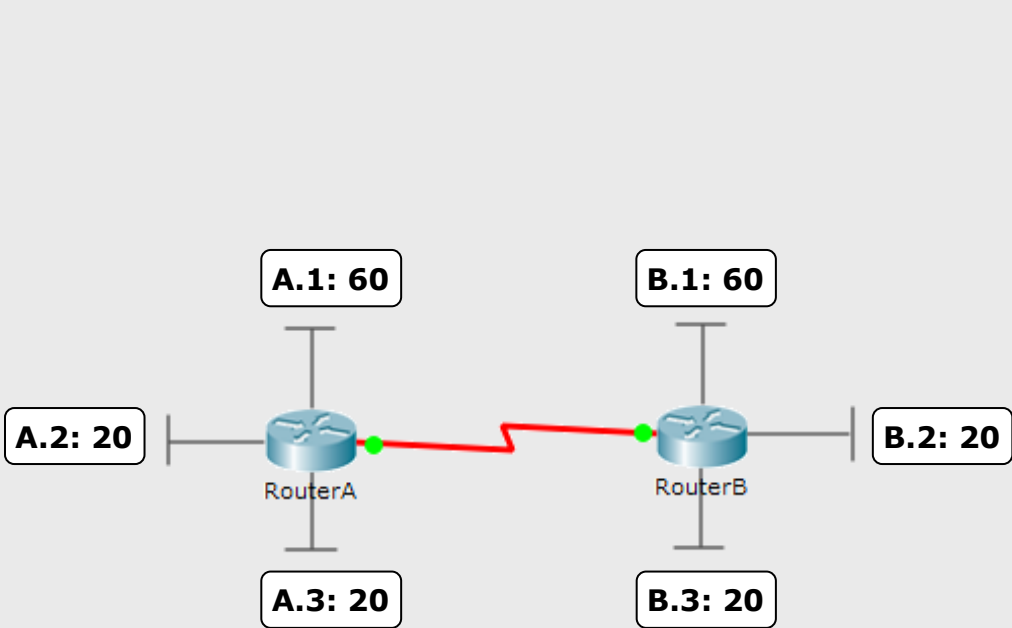

172.16.1.0/24

Fa0/0 .1

S0/0/1
DCE

S0/0/0 .2 .2

172.16.2.0/24   **192.168.1.0/24**

.1
S0/0/0
DCE

S0/0/1

.1
Fa0/0

Fa0/0
.1 R1   R3 .1

PC1   PC3

172.16.3.0/24   **192.168.2.0/24**

Address planning & summarization

- Allocating prefixes by decreasing network size might be sub-optimal <u>for the purpose of summarization</u>

Req. addr.	Network prefix
A.1 (60)	192.168.0.0/26
B.1 (60)	192.168.0.64/26
A.2 (20)	192.168.0.128/27
A.3 (20)	192.168.0.160/27
B.2 (20)	192.168.0.192/27
B.3 (20)	192.168.0.224/27

A.1: 60   B.1: 60

A.2: 20   RouterA   RouterB   B.2: 20

A.3: 20   B.3: 20

192.168.0.0/25

192.168.0.128/25

Req. addr.	Network prefix
A.1 (60)	192.168.0.0/26
A.2 (20)	192.168.0.64/27
A.3 (20)	192.168.0.96/27
B.1 (60)	192.168.0.128/26
B.2 (20)	192.168.0.192/27
B.3 (20)	192.168.0.224/27

Lab activity

- The block of addresses **172.16.0.0/??** is given
  - Design an addressing scheme to favor route summarization
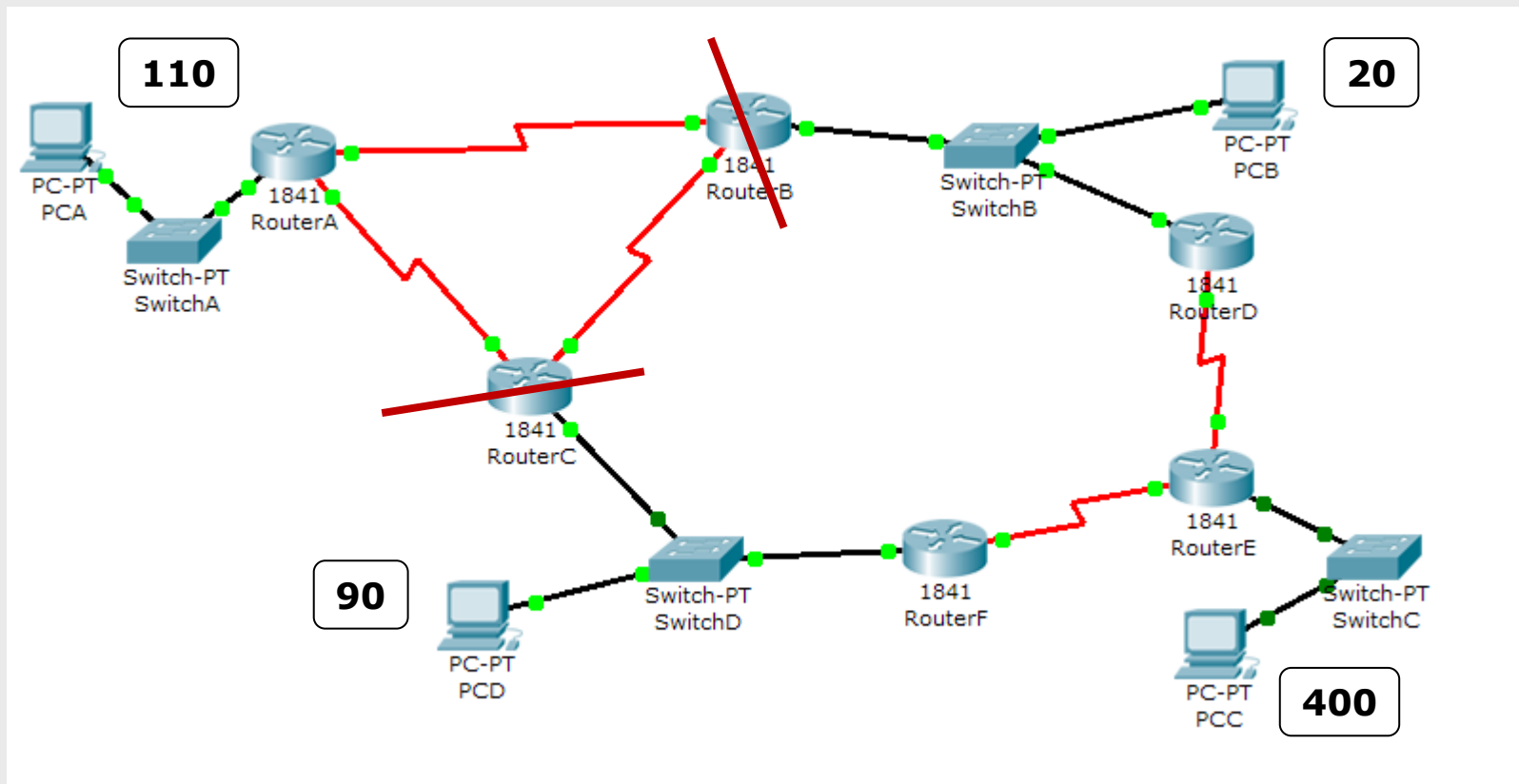
Lab activity

- The block of addresses **172.16.0.0/21** is given

172.16.0.0/22

Subnet	Needed	Allocated	Address	Mask	Dec Mask	Assignable Range	Broadcast
LanC	400	510	172.16.0.0	/23	255.255.254.0	172.16.0.1 - 172.16.1.254	172.16.1.255
LanD	90	126	172.16.2.0	/25	255.255.255.128	172.16.2.1 - 172.16.2.126	172.16.2.127
LanB	20	30	172.16.2.128	/27	255.255.255.224	172.16.2.129 - 172.16.2.158	172.16.2.159
RD-RE	2	2	172.16.2.160	/30	255.255.255.252	172.16.2.161 - 172.16.2.162	172.16.2.163
RE-RF	2	2	172.16.2.164	/30	255.255.255.252	172.16.2.165 - 172.16.2.166	172.16.2.167
LanA	110	126	172.16.4.0	/25	255.255.255.128	172.16.4.1 - 172.16.4.126	172.16.4.127
RA-RB	2	2	172.16.4.128	/30	255.255.255.252	172.16.4.129 - 172.16.4.130	172.16.4.131
RA-RC	2	2	172.16.4.132	/30	255.255.255.252	172.16.4.133 - 172.16.4.134	172.16.4.135
RB-RC	2	2	172.16.4.136	/30	255.255.255.252	172.16.4.137 - 172.16.4.138	172.16.4.139

172.16.4.0/24

Default static route

- A default static route will match all packets for which there is no other route matching the destination address in the routing table
  - Route **0.0.0.0/0** is the default static route
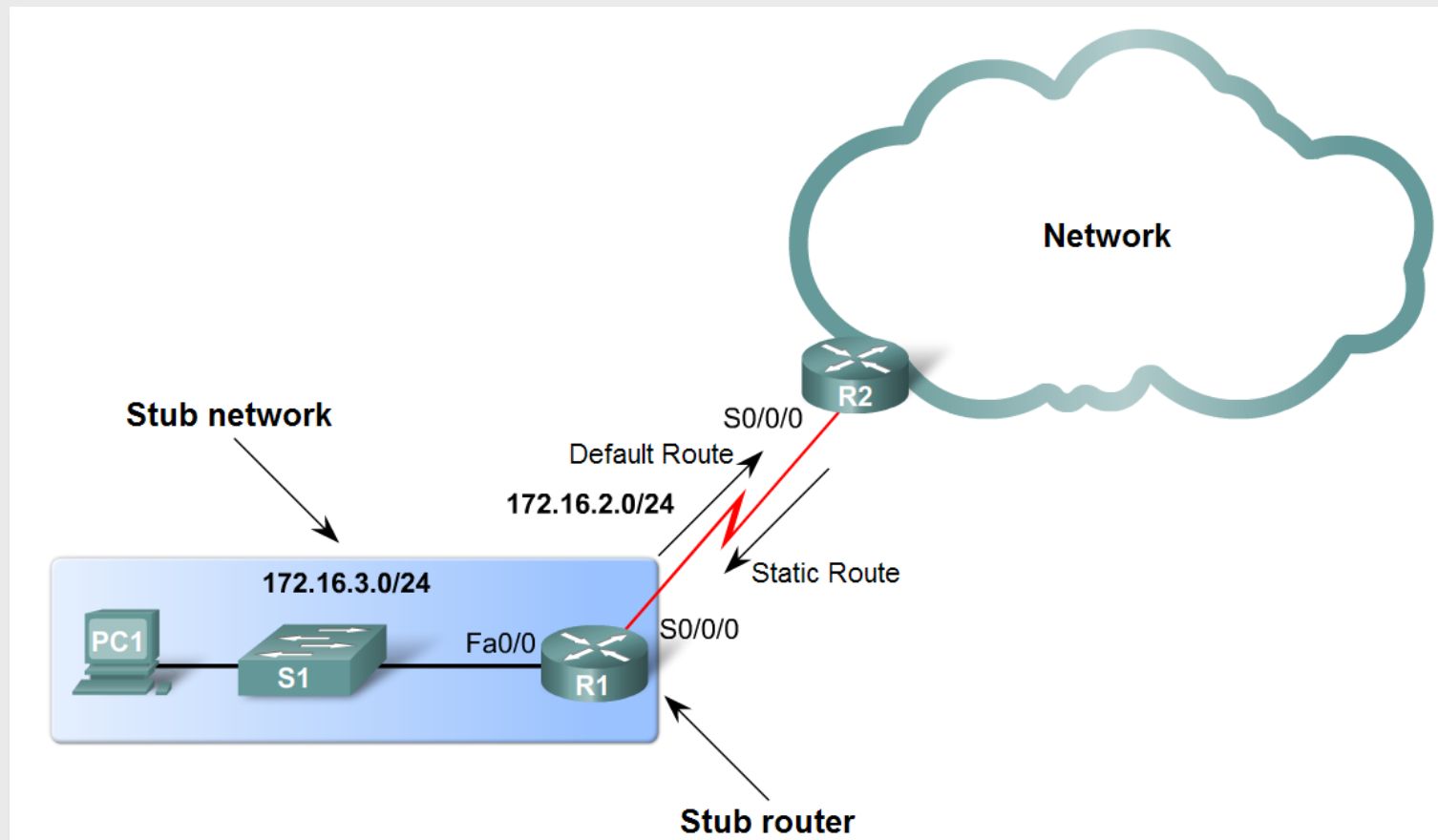
Default static route
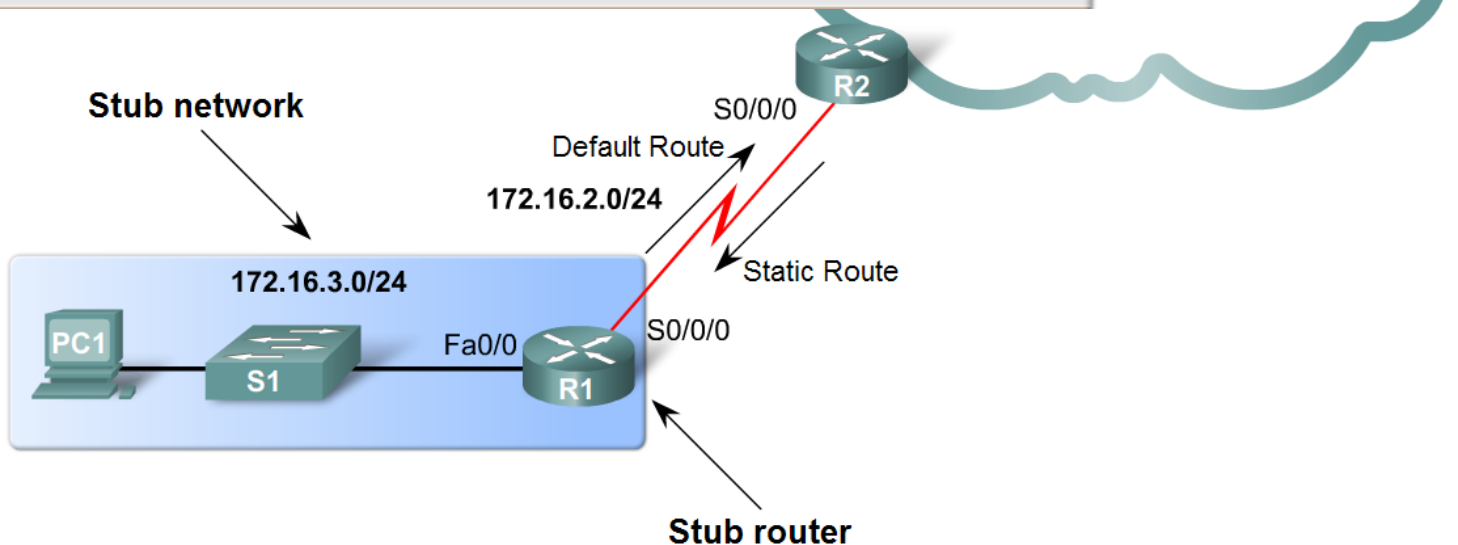
- Configuring a default static route
  - `Router(config)#ip route 0.0.0.0 0.0.0.0 [exit-interface | ip-address]`


```
R1#show ip route

       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 0.0.0.0 to network 0.0.0.0

     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.2.0 is directly connected, Serial0/0/0
C       172.16.3.0 is directly connected, FastEthernet0/0
S*   0.0.0.0/0 is directly connected, Serial0/0/0
R1#
```

Stub network

Default Route

172.16.2.0/24

172.16.3.0/24

Static Route

S0/0/0 R2

S0/0/0

PC1   S1   Fa0/0   R1

Stub router

Troubleshooting static routes

- Connectivity troubleshooting tools
  - **`ping`**
  - **`traceroute`**
  - **`show ip route`**
  - **`show ip interface brief`**
  - **`show cdp neighbors detail`**