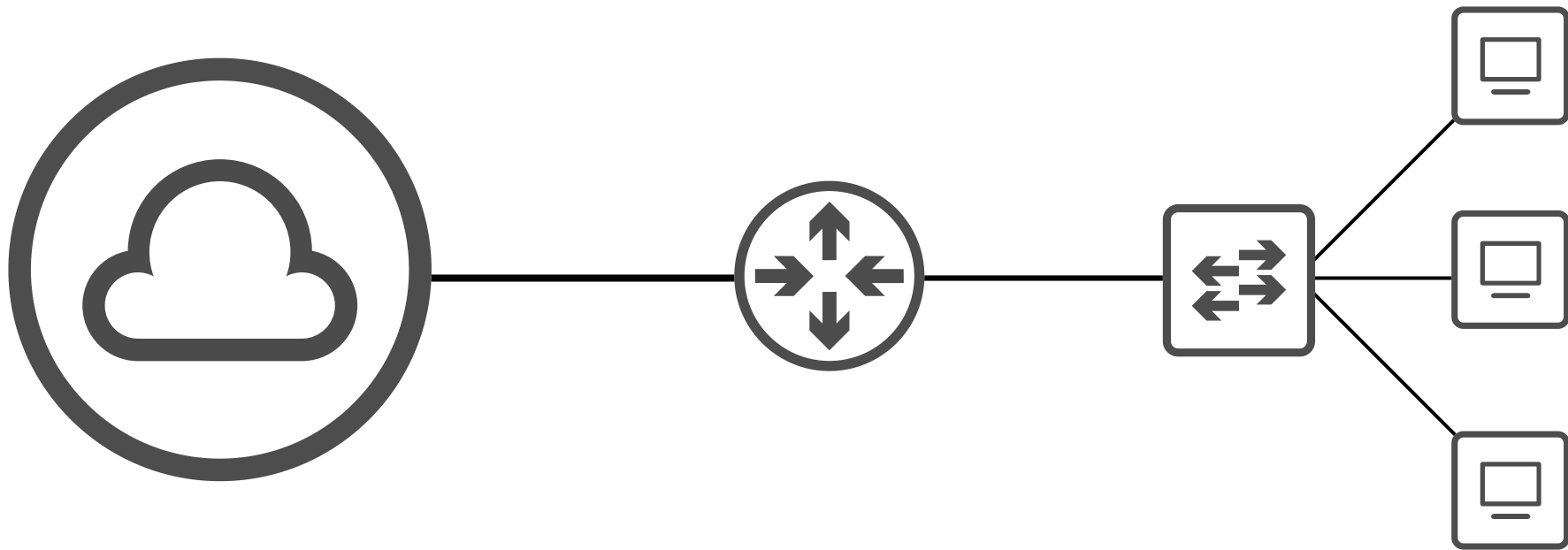




CCNA 200-301 Day 13

Subnetting (Part 1)





Things we'll cover

- CIDR (Classless Inter-Domain Routing)
- The process of subnetting

IPv4 Address Classes

Class	First octet (binary)	First octet range (decimal)	
A	0xxxxxxx	0 - 127	0.0.0.0 ~ 127.255.255.255
B	10xxxxxx	128 - 191	128.0.0.0 ~ 191.255.255.255
C	110xxxxx	192 - 223	192.0.0.0 ~ 223.255.255.255
D	1110xxxx	224 - 239	224.0.0.0 ~ 239.255.255.255
E	1111xxxx	240 - 255	240.0.0.0 ~ 255.255.255.255

IPv4 Address Classes

Class	First octet	First octet numeric range	Prefix Length
A	0xxxxxxx	0-127	/8
B	10xxxxxx	128-191	/16
C	110xxxxx	192-223	/24

IPv4 Address Classes

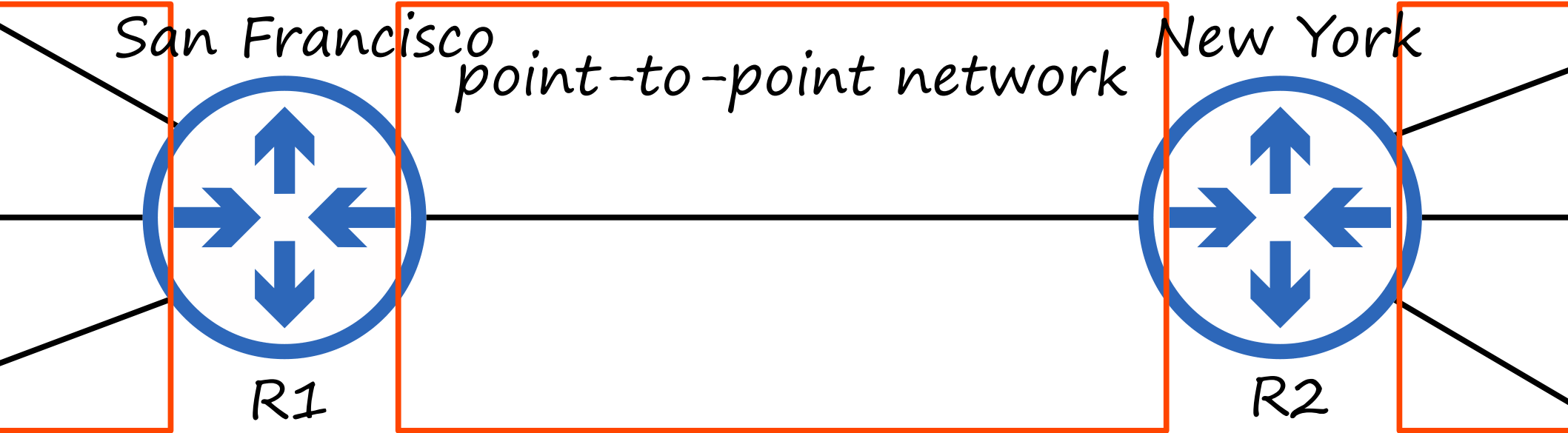
Class	Leading bits	Size of <i>network number</i> bit field	Size of <i>rest</i> bit field	Number of networks	Addresses per network
Class A	0	8	24	128 (2^7)	16,777,216 (2^{24})
Class B	10	16	16	16,384 (2^{14})	65,536 (2^{16})
Class C	110	24	8	2,097,152 (2^{21})	256 (2^8)

IPv4 Address Classes

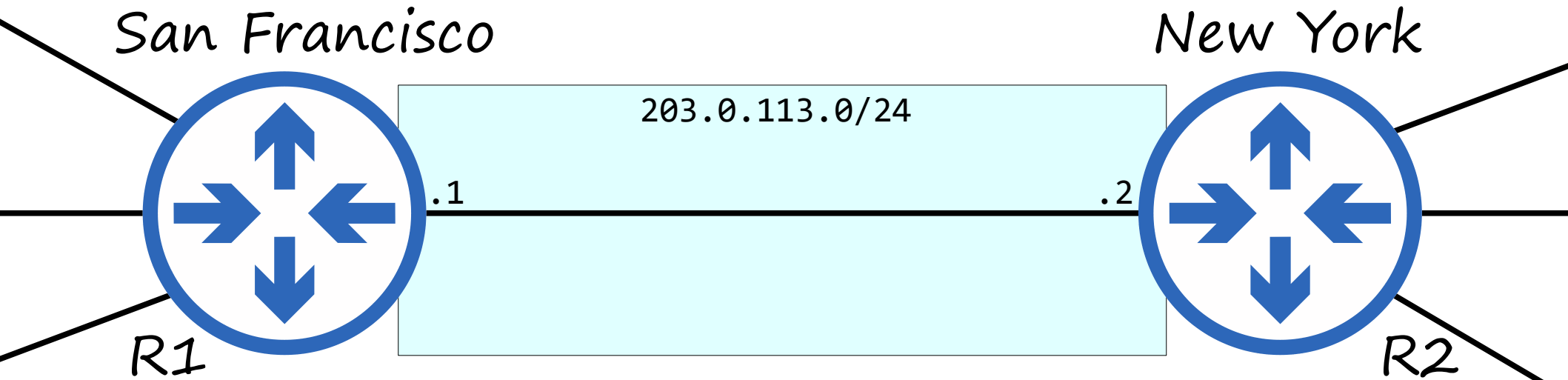


- The IANA (Internet Assigned Numbers Authority) assigns IPv4 addresses/networks to companies based on their size.
- For example, a very large company might receive a **class A** or **class B** network, while a small company might receive a **class C** network.
- However, this led to many wasted IP addresses.

IPv4 Address Classes



IPv4 Address Classes



256 addresses

- 1 network address (203.0.113.0)
- 1 broadcast address (203.0.113.255)
- 1 R1's address (203.0.113.1)
- 1 R2's address (203.0.113.2)

=252 addresses
WASTED



IPv4 Address Classes

- Company X needs IP addressing for 5000 end hosts.
- A class C network does not provide enough addresses, so a class B network must be assigned.
- This will result in about 60000 addresses being wasted.

CIDR (Classless Inter-Domain Routing)

- When the Internet was first created, the creators did not predict that the Internet would become as large as it is today.
- This resulted in wasted address space like the examples I showed you (there are many more examples).
- The IETF (Internet Engineering Task Force) introduced CIDR in 1993 to replace the 'classful' addressing system.

CIDR (Classless Inter-Domain Routing)

- With CIDR, the requirements of...

Class A = /8

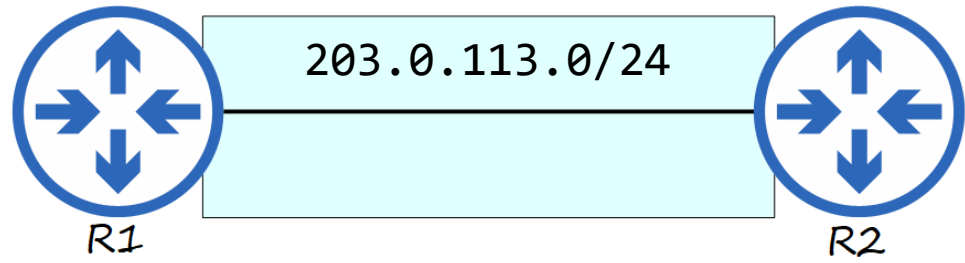
Class B = /16

Class C = /24

...were removed.

- This allowed larger networks to be split into smaller networks, allowing greater efficiency.
- These smaller networks are called 'subnetworks' or 'subnets'.

CIDR



1 1 0 0 1 0 1 1 . 0 0 0 0 0 0 0 0 . 0 1 1 1 0 0 0 1 . 0 0 0 0 0 0 0 0

203 . 0 . 113 . 0

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 0 0 0 0 0 0 0 0

255 . 255 . 255 . 0

network address, broadcast address

$2^8 - 2 = 254$ usable addresses.

↑
number of host bits

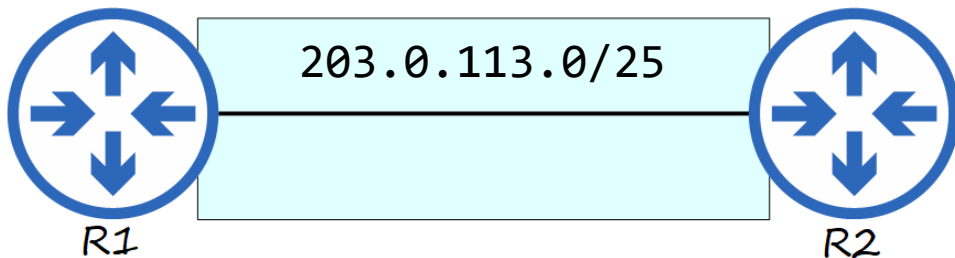
How many usable addresses are there in each network?

- 203.0.113.0/25
- 203.0.113.0/26
- 203.0.113.0/27
- 203.0.113.0/28
- 203.0.113.0/29
- 203.0.113.0/30
- 203.0.113.0/31
- 203.0.113.0/32

$2^n - 2 = \text{usable addresses}$

n = number of host bits

CIDR (/25)



1 1 0 0 1 0 1 1 . 0 0 0 0 0 0 0 0 . 0 1 1 1 0 0 0 1 . 0 0 0 0 0 0 0 0

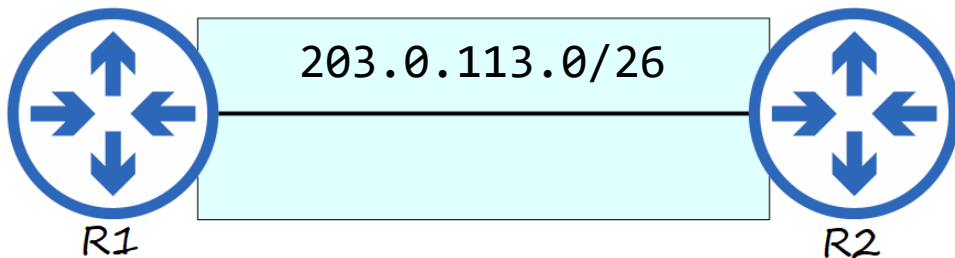
203 . 0 . 113 . 0

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 0 0 0 0 0 0 0

255 . 255 . 255 . 128

$2^7 - 2 = 126$ usable addresses.

CIDR (/26)



1 1 0 0 1 0 1 1 . 0 0 0 0 0 0 0 0 . 0 1 1 1 0 0 0 1 . 0 0 0 0 0 0 0 0

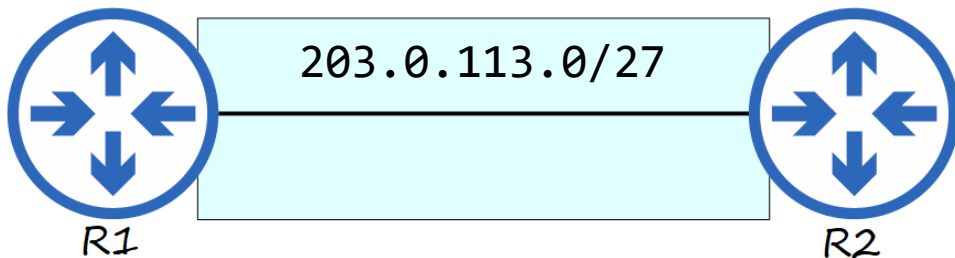
203 . 0 . 113 . 0

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 0 0 0 0 0 0

255 . 255 . 255 . 192

$2^6 - 2 = 62$ usable addresses.

CIDR (/27)



1 1 0 0 1 0 1 1 . 0 0 0 0 0 0 0 0 . 0 1 1 1 0 0 0 1 . 0 0 0 0 0 0 0 0

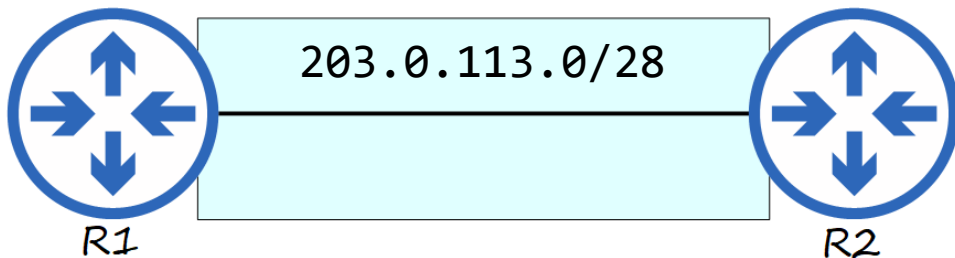
203 . 0 . 113 . 0

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 0 0 0 0 0

255 . 255 . 255 . 224

$2^5 - 2 = 30$ usable addresses.

CIDR (/28)



1 1 0 0 1 0 1 1 . 0 0 0 0 0 0 0 0 . 0 1 1 1 0 0 0 1 . 0 0 0 0 0 0 0 0

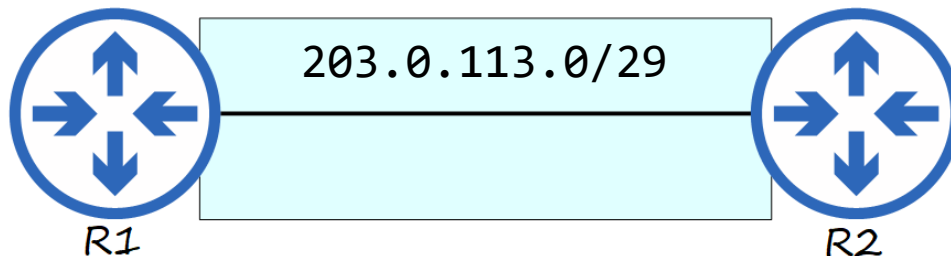
203 . 0 . 113 . 0

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 0 0 0 0

255 . 255 . 255 . 240

$2^4 - 2 = 14$ usable addresses.

CIDR (/29)



1 1 0 0 1 0 1 1 . 0 0 0 0 0 0 0 0 . 0 1 1 1 0 0 0 1 . 0 0 0 0 0 0 0 0

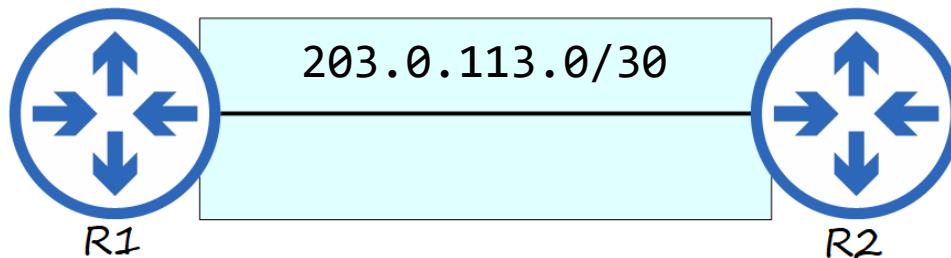
203 . 0 . 113 . 0

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 0 0 0

255 . 255 . 255 . 248

$2^3 - 2 = 6$ usable addresses.

CIDR (/30)



1 1 0 0 1 0 1 1 . 0 0 0 0 0 0 0 0 . 0 1 1 1 0 0 0 1 . 0 0 0 0 0 0 0 0

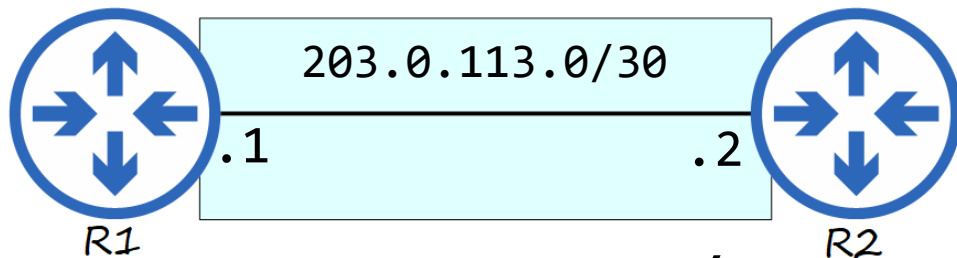
203 . 0 . 113 . 0

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 0 0

255 . 255 . 255 . 252

$2^2 - 2 = 2$ usable addresses.

CIDR (/30)



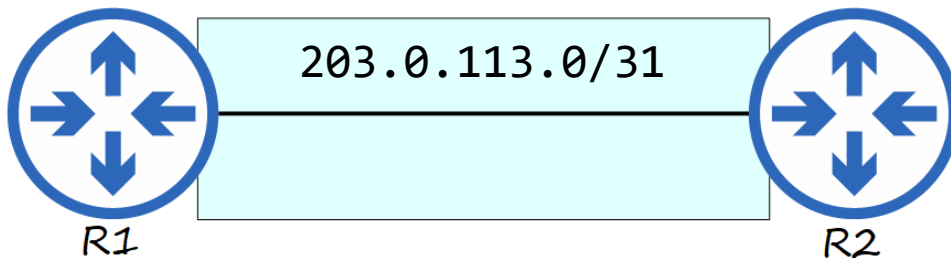
$$203.0.113.0/30$$

$$= 203.0.113.0 - 203.0.113.3$$

1	1	0	0	1	0	1	1	.	0	0	0	0	0	0	0	0	.	0	1	1	1	0	0	0	1	.	0	0	0	0	0	0	0	0	0
1	1	0	0	1	0	1	1	.	0	0	0	0	0	0	0	0	0	.	0	1	1	1	0	0	0	1	.	0	0	0	0	0	0	0	1
1	1	0	0	1	0	1	1	.	0	0	0	0	0	0	0	0	0	.	0	1	1	1	0	0	0	1	.	0	0	0	0	0	0	1	0
1	1	0	0	1	0	1	1	.	0	0	0	0	0	0	0	0	0	.	0	1	1	1	0	0	0	1	.	0	0	0	0	0	0	1	1

The remaining addresses in the 203.0.113.0/24 address block (203.0.113.4 - 203.0.113.255) are now available to be used in other subnets!

CIDR (/31)



1 1 0 0 1 0 1 1 . 0 0 0 0 0 0 0 0 . 0 1 1 1 0 0 0 1 . 0 0 0 0 0 0 0 0

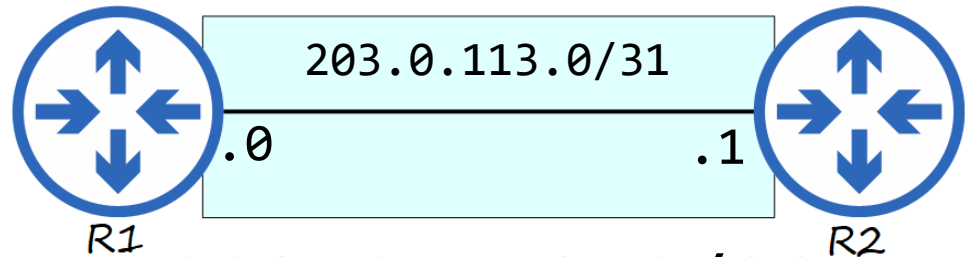
203 . 0 . 113 . 0

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 0

255 . 255 . 255 . 254

$2^1 - 2 = 0$ usable addresses.

CIDR (/31)



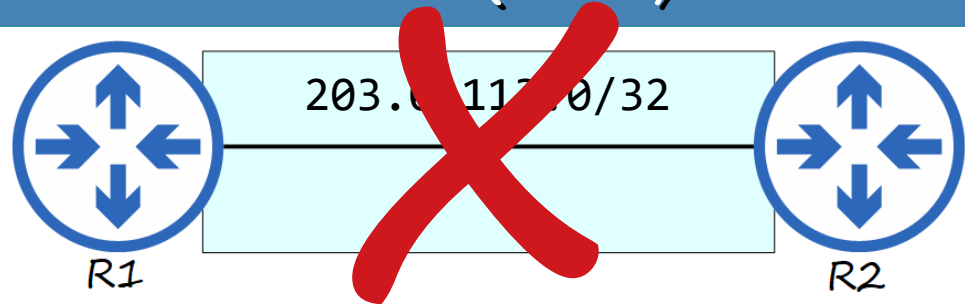
$$203.0.113.0/30$$
$$= 203.0.113.0 - 203.0.113.1$$

1	1	0	0	1	0	1	1	.	0	0	0	0	0	0	0	0	.	0	1	1	1	0	0	0	1	.	0	0	0	0	0	0	0	0	0
1	1	0	0	1	0	1	1	.	0	0	0	0	0	0	0	0	.	0	1	1	1	0	0	0	1	.	0	0	0	0	0	0	0	0	1

```
Router(config-if)#ip address 203.0.113.0 255.255.255.254
% Warning: use /31 mask on non point-to-point interface cautiously
Router(config-if)#
```

The remaining addresses in the 203.0.113.0/24 address block (203.0.113.2 - 203.0.113.255) are now available to be used in other networks!

CIDR (/32)



1 1 0 0 1 0 1 1 . 0 0 0 0 0 0 0 0 . 0 1 1 1 0 0 0 1 . 0 0 0 0 0 0 0 0

203 . 0 . 113 . 0

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1

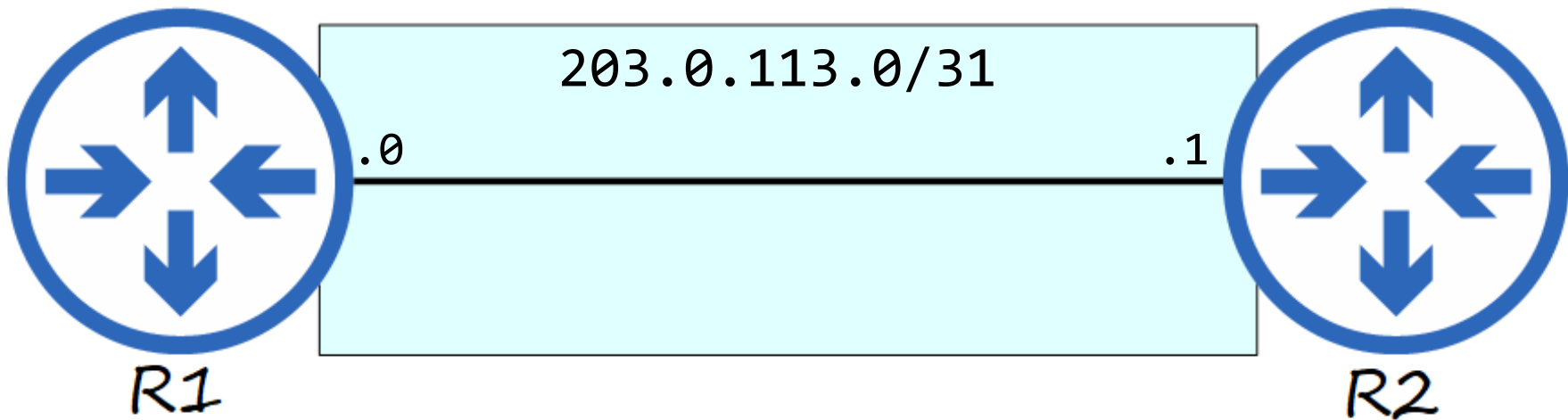
255 . 255 . 255 . 255

$2^0 - 2 = -1$ usable addresses?

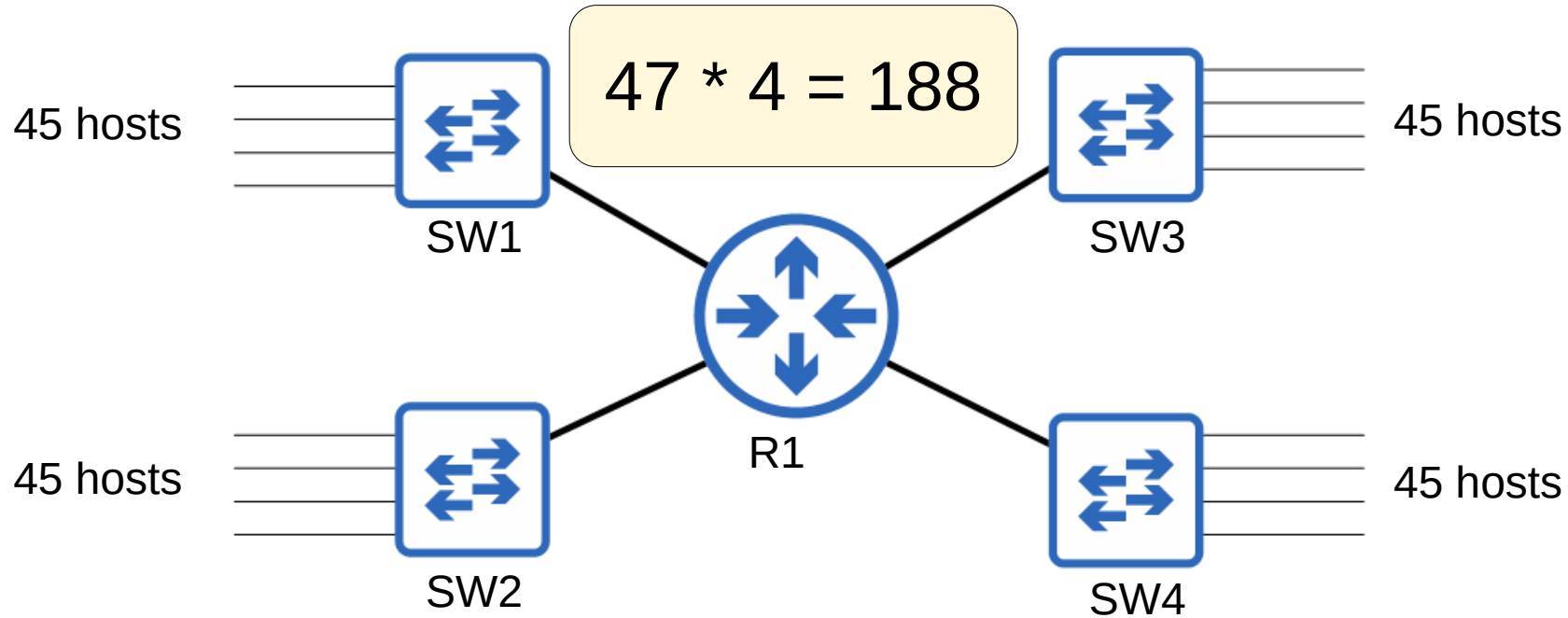
CIDR Notation

Dotted Decimal	CIDR Notation
255.255.255.128	/25
255.255.255.192	/26
255.255.255.224	/27
255.255.255.240	/28
255.255.255.248	/29
255.255.255.252	/30
255.255.255.254	/31
255.255.255.255	/32

Subnetting



Subnetting



192.168.1.0/24

Divide the 192.168.1.0/24 network into four subnets that can accommodate the number of hosts required.

1 1 0 0 0.0.0.0 . 1 0 1 0 1 0 0 0 . 0 0 0 0 0 0 0 1 . 0 0 0 0 0 0 0 0
192 . 168 . 1 . 0

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 0 0
255 . 255 . 255 . 252

$2^2 - 2 = 2$ usable addresses



$$2 * 2 = 4$$



Subnetting

1 1 0 0 0.0.0.0 . 1 0 1 0 1 0 0 0 . 0 0 0 0 0 0 0 1 . 0 0 0 0 0 0 0 0

192

.

168

.

1

.

0

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 0 0 0

255

.

255

.

255

.

248

$2^3 - 2 = 6$ usable addresses



$$2 * 2 * 2 = 8$$

1 1 0 0 0.0.0.0 . 1 0 1 0 1 0 0 0 . 0 0 0 0 0 0 0 1 . 0 0 0 0 0 0 0 0
 192 . 168 . 1 . 0

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 0 0 0 0
 255 . 255 . 255 . 240

$2^4 - 2 = 14$ usable addresses



$$2 * 2 * 2 * 2 = 16$$

1 1 0 0 0.0.0.0 . 1 0 1 0 1 0 0 0 . 0 0 0 0 0 0 0 1 . 0 0 0 0 0 0 0 0
 192 . 168 . 1 . 0

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 0 0 0 0 0
 255 . 255 . 255 . 224

$2^5 - 2 = 30$ usable addresses



$$2 * 2 * 2 * 2 * 2 = 32$$

1 1 0 0 0.0.0.0 . 1 0 1 0 1 0 0 0 . 0 0 0 0 0 0 0 1 . 0 0 0 0 0 0 0 0
 192 . 168 . 1 . 0

1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 0 0 0 0 0 0
 255 . 255 . 255 . 192

$$2^6 - 2 = 62 \text{ usable addresses}$$



$$2 * 2 * 2 * 2 * 2 * 2 = 64$$

QUIZ

The first subnet (Subnet 1) is 192.168.1.0/26. What are the remaining subnets?

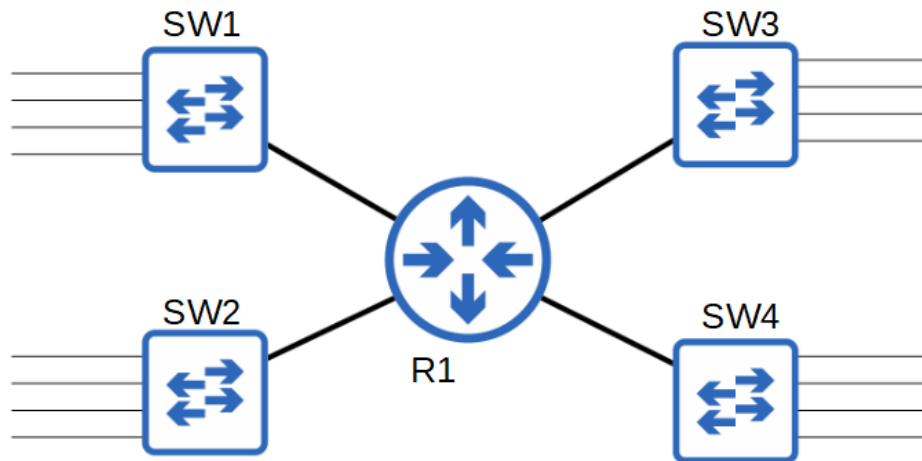
HINT: Find the broadcast address of Subnet 1. The next address is the network address of Subnet 2. Repeat the process for Subnets 3 and 4.

Subnet 1:
192.168.1.0/26

Subnet 2:
()/26

Subnet 3:
()/26

Subnet 4:
()/26



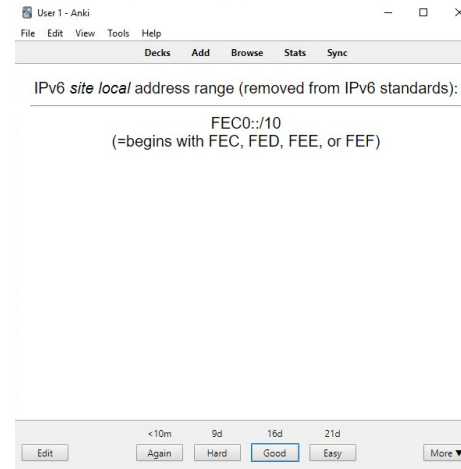
192.168.1.0/24



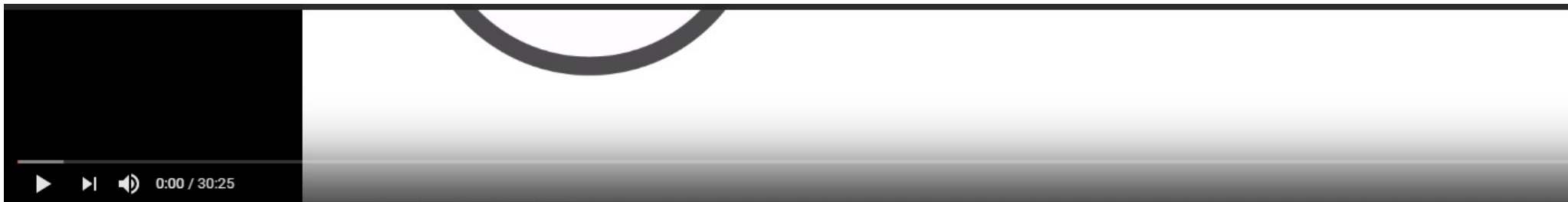
Things we covered

- CIDR (Classless Inter-Domain Routing)
- The process of subnetting (basics!)

- Review flash cards
(link in the description)



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