



IPv4 Addressing



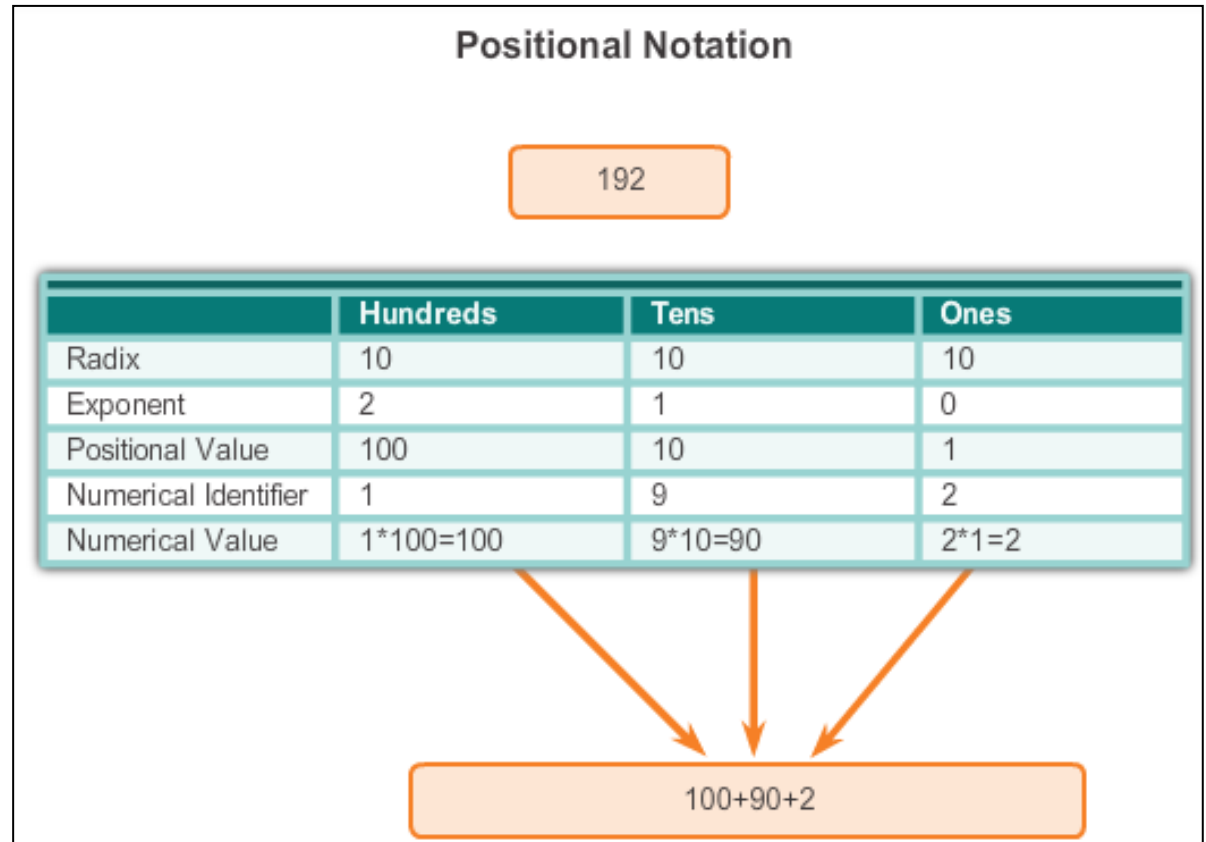
Cisco | Networking Academy®
Mind Wide Open™



IPv4 Address Structure

Binary Notation

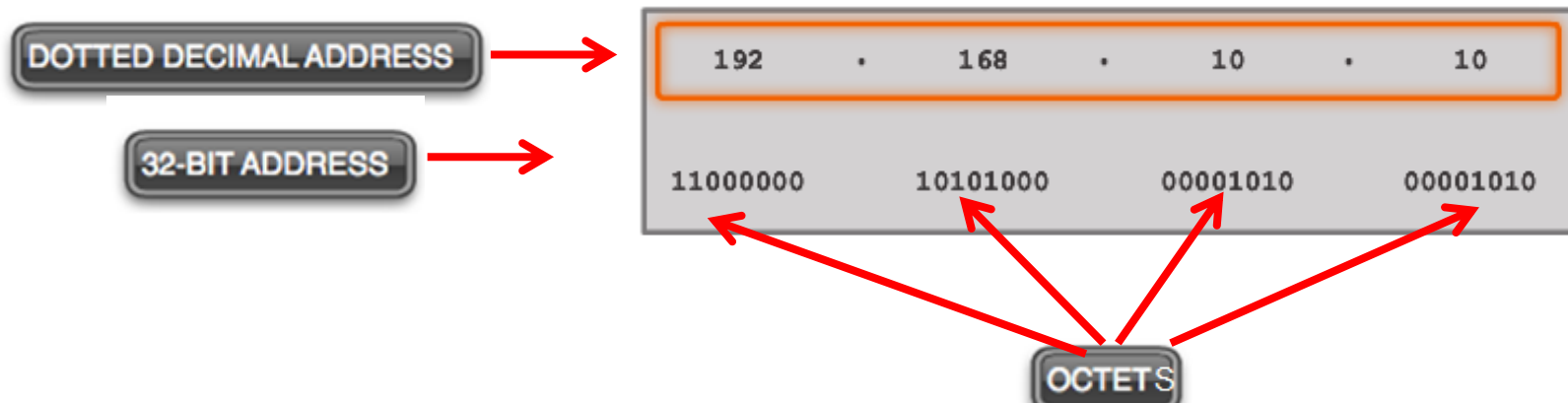
- Binary notation refers to the fact that computers communicate in 1s and 0s
- Positional notation - converting binary to decimal requires an understanding of the mathematical basis of a numbering system





IPv4 Address Structure

Binary Number System



Radix	2	2	2	2	2	2	2	2
Exponent	7	6	5	4	3	2	1	0
Octet Bit Values	128	64	32	16	8	4	2	1
Binary Address	1	1	0	0	0	0	0	0
Binary Bit Values	128	64	0	0	0	0	0	0

Add the binary bit values.
 $128 + 64 = 192$



IPv4 Address Structure

Converting a Binary Address to Decimal

Practice

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1
1	0	1	1	0	0	0	0

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1
1	1	1	1	1	1	1	1



IPv4 Address Structure

Converting a Binary Address to Decimal

Prac

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1
1	0	1	1	0	0	0	0

Answer = 176

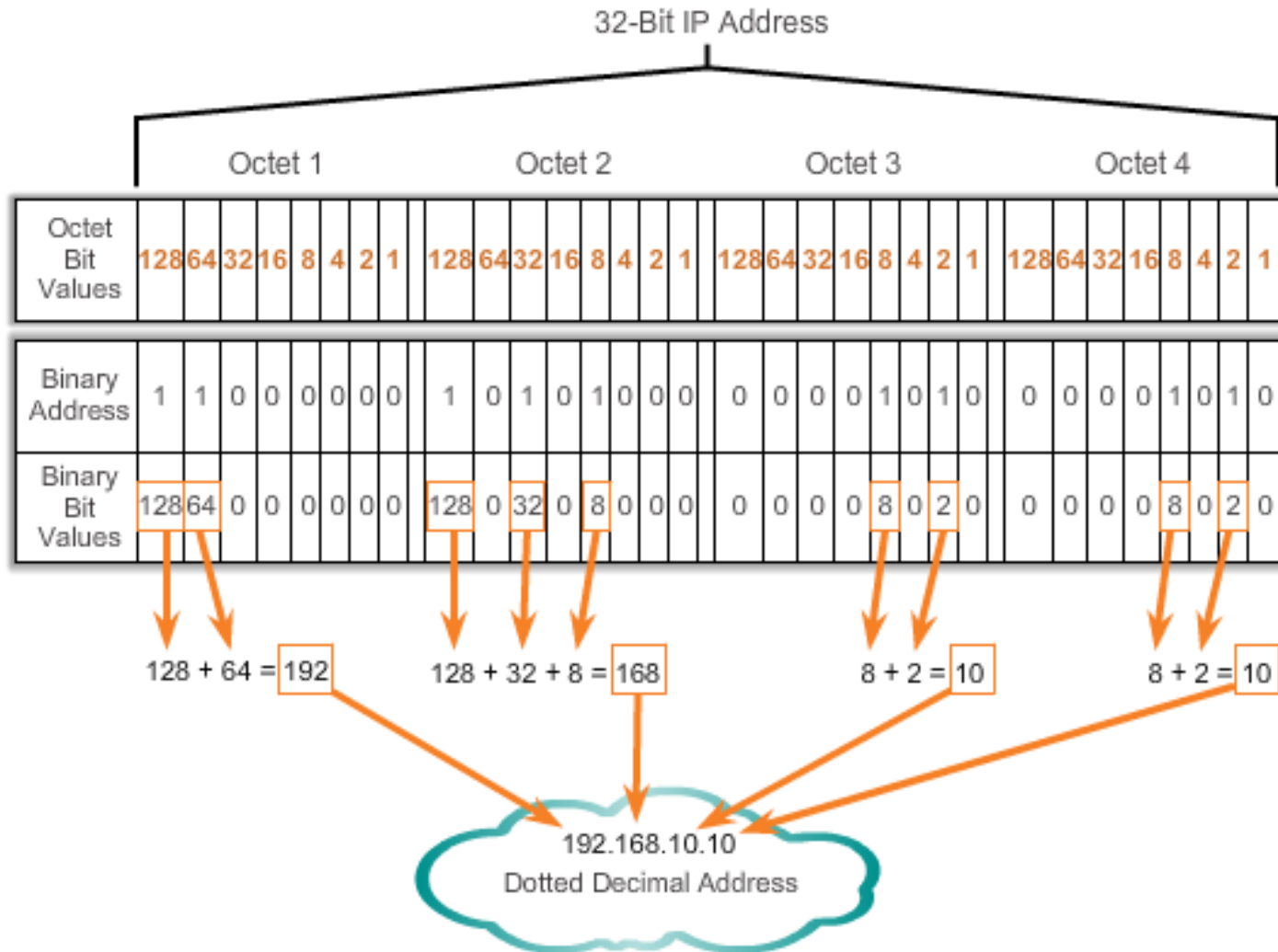
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1
1	1	1	1	1	1	1	1

Answer = 255



IPv4 Address Structure

Converting a Binary Address to Decimal

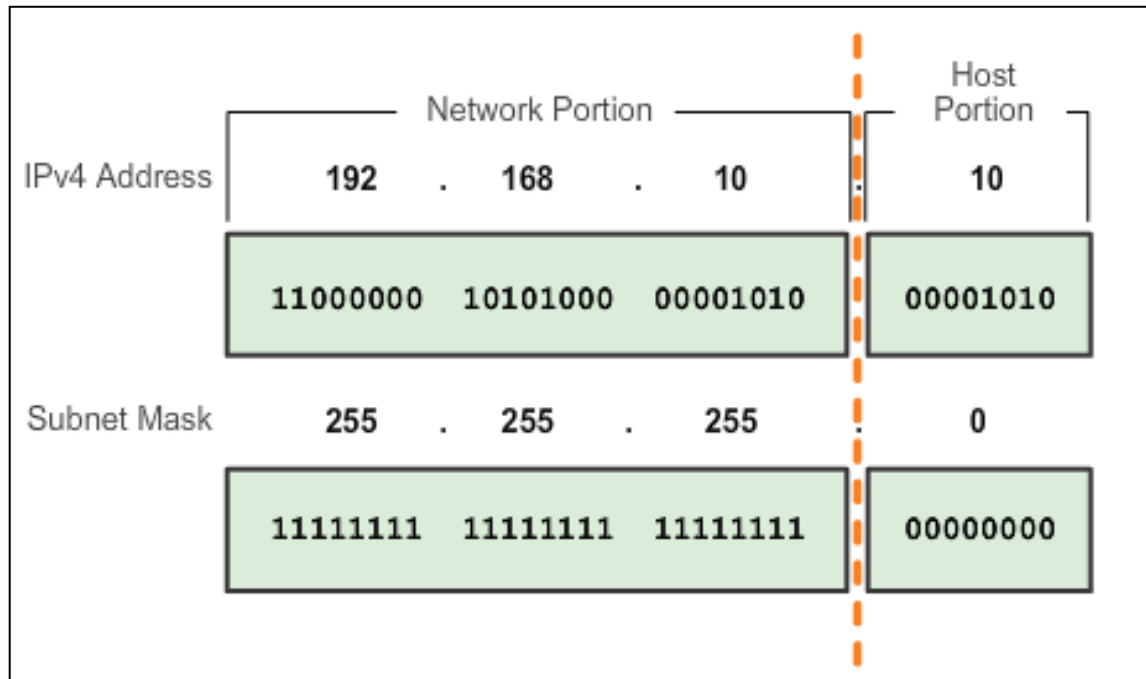




IPv4 Subnet Mask

Network Portion and Host Portion of an IPv4 Address

- To define the network and host portions of an address, a device uses a separate 32-bit pattern called a subnet mask
- The subnet mask does not actually contain the network or host portion of an IPv4 address, it just says where to look for these portions in a given IPv4 address





IPv4 Subnet Mask

Network Portion and Host Portion of an IPv4 Address (cont.)

Valid Subnet Masks

Subnet Value	Bit Value							
	128	64	32	16	8	4	2	1
255	1	1	1	1	1	1	1	1
254	1	1	1	1	1	1	1	0
252	1	1	1	1	1	1	0	0
248	1	1	1	1	1	0	0	0
240	1	1	1	1	0	0	0	0
224	1	1	1	0	0	0	0	0
192	1	1	0	0	0	0	0	0
128	1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0



IPv4 Subnet Mask

Examining the Prefix Length

	Dotted Decimal	Significant bits shown in binary
Network Address	10.1.1.0/24	10.1.1.00000000
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.254	10.1.1.11111110
Broadcast Address	10.1.1.255	10.1.1.11111111
Number of hosts: $2^8 - 2 = 254$ hosts		

Network Address	10.1.1.0/25	10.1.1.00000000
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.126	10.1.1.01111110
Broadcast Address	10.1.1.127	10.1.1.01111111
Number of hosts: $2^7 - 2 = 126$ hosts		

Network Address	10.1.1.0/26	10.1.1.00000000
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.62	10.1.1.00111110
Broadcast Address	10.1.1.63	10.1.1.00111111
Number of hosts: $2^6 - 2 = 62$ hosts		



IPv4 Subnet Mask

Examining the Prefix Length (cont.)

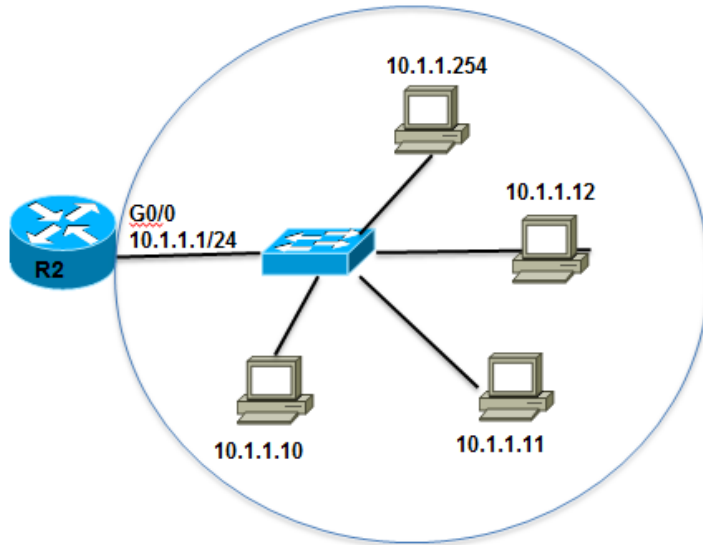
	Dotted Decimal	Significant bits shown in binary
Network Address	10.1.1.0/27	10.1.1.00000000
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.30	10.1.1.00011110
Broadcast Address	10.1.1.31	10.1.1.00011111
Number of hosts: $2^5 - 2 = 30$ hosts		

Network Address	10.1.1.0/28	10.1.1.00000000
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.14	10.1.1.00001110
Broadcast Address	10.1.1.15	10.1.1.00001111
Number of hosts: $2^4 - 2 = 14$ hosts		



IPv4 Subnet Mask

IPv4 Network, Host, and Broadcast Address



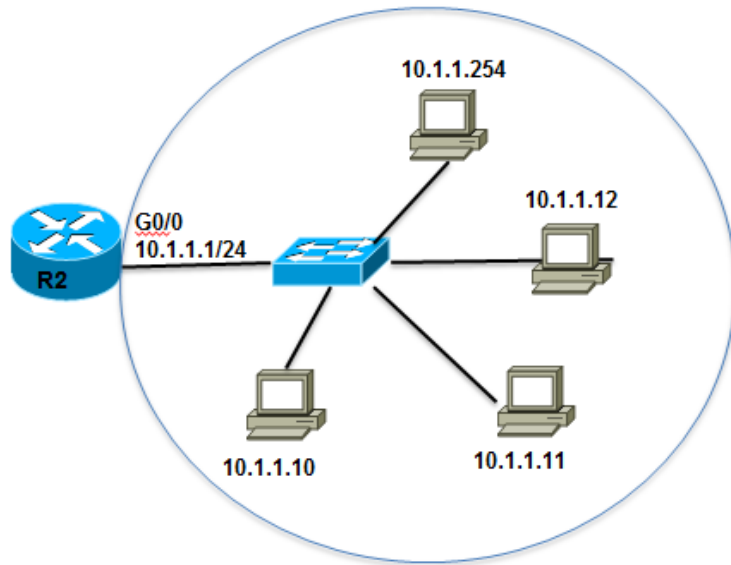
10.1.1.0/24

Network Portion			Host Portion	
10	1	1	0	
00001010	00000001	00000001	00000000	All 0s – NETWORK ADDRESS
10	1	1	10	
00001010	00000001	00000001	00001010	0s and 1s in host portion
10	1	1	255	
00001010	00000001	00000001	11111111	All 1s – BROADCAST ADDRESS



IPv4 Subnet Mask

First Host and Last Host Addresses



10.1.1.0/24

Network Portion			Host Portion	
10	1	1	1	FIRST HOST
00001010	00000001	00000001	00000001	All 0s and a 1 in the host portion
10	1	1	254	LAST HOST
00001010	00000001	00000001	11111110	All 1s and a 0 in the host portion



IPv4 Subnet Mask

Bitwise AND Operation

1 AND 1 = 1 1 AND 0 = 0 0 AND 1 = 0 0 AND 0 = 0

IPv4 Address	192	.	168	.	10	.	10
	11000000		10101000		00001010		00001010
Subnet Mask	255	.	255	.	255	.	0
	11111111		11111111		11111111		00000000
Network Address	192	.	168	.	10	.	0
	11000000		10101000		00001010		00000000



Subnetting an IPv4 Network

Subnetting Formulas

Calculate number of subnets

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

192. 168. 1. 0 000 0000



1 bit was borrowed

$2^1 = 2$ subnets

Calculate number of hosts

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

192. 168. 1. 0 000 0000



7 bits remain in host field

$2^7 = 128$ addresses per subnet
 $2^7 - 2 = 126$ valid hosts per subnet