Module 5: Sayı Sistemleri

CCNA1

Introduction to Networks v7.0
(ITN)

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Module 5: Number Systems

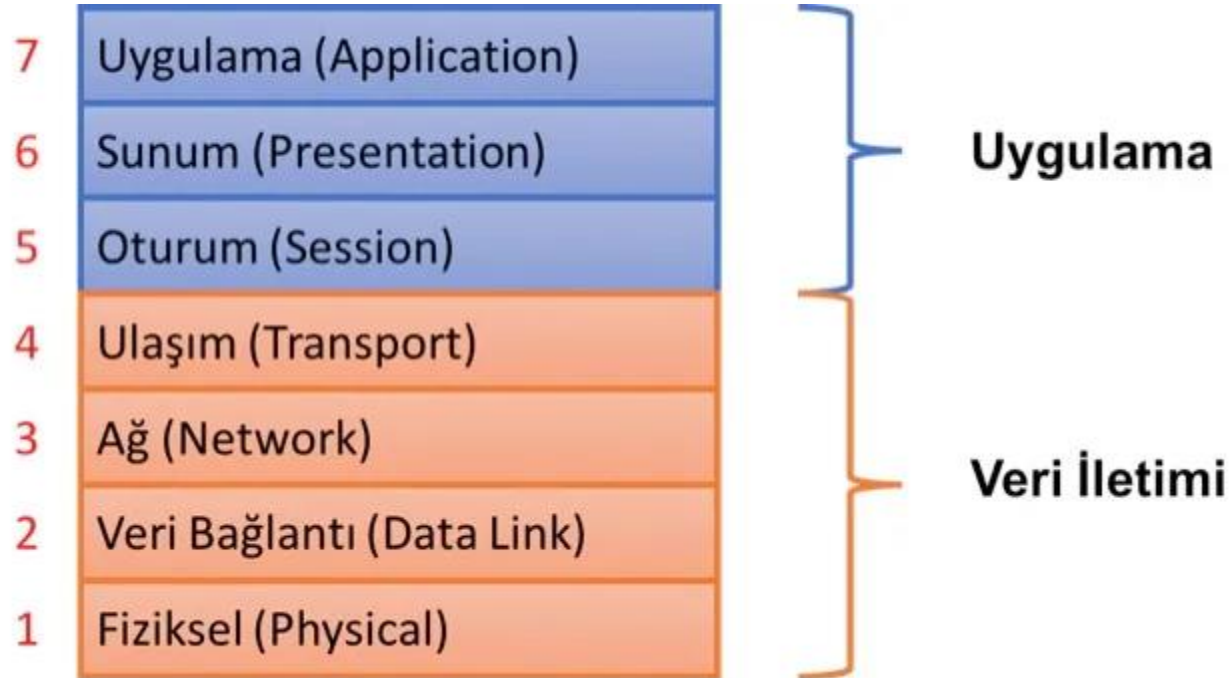Introduction to Networks v7.0
(ITN)

Module Objectives

Module Title: Number Systems

Module Objective: Calculate numbers between decimal, binary, and hexadecimal systems.

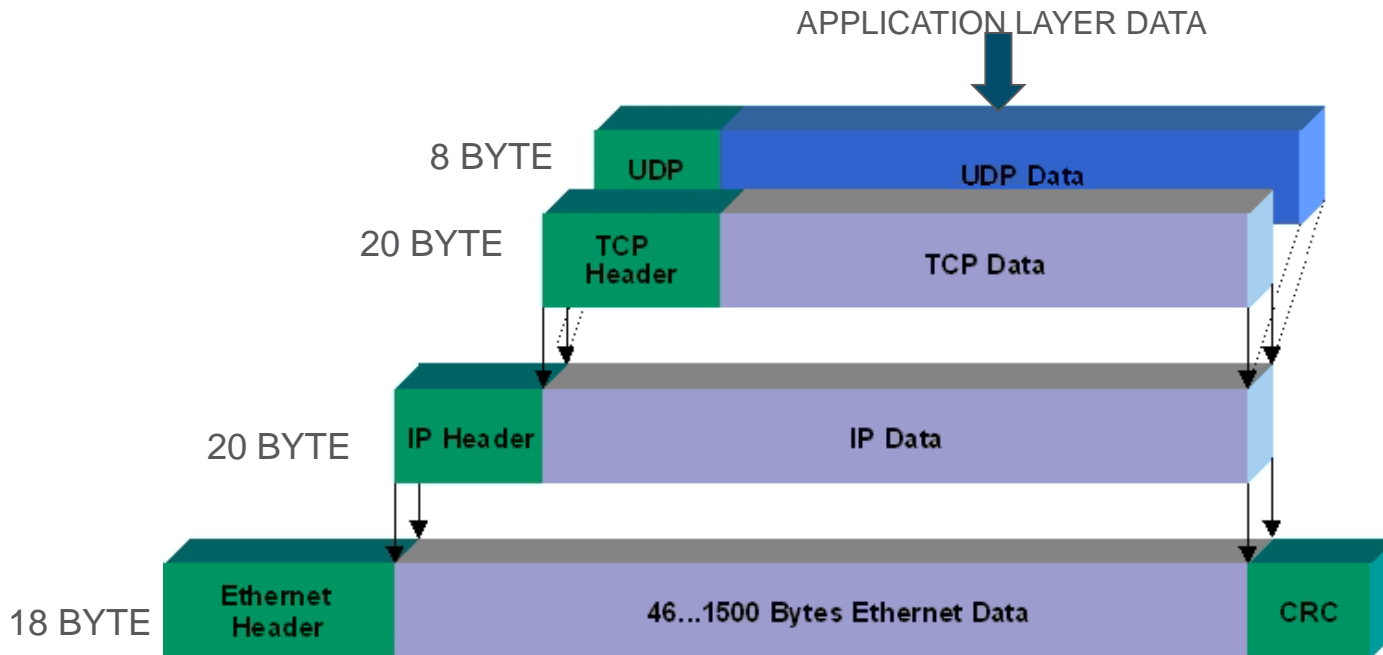| Topic Title	Topic Objective
Binary Number System	Calculate numbers between decimal and binary systems.
Hexadecimal Number System	Calculate numbers between decimal and hexadecimal systems.

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APPLICATION LAYER DATA

8 BYTE — UDP | UDP Data

20 BYTE — TCP Header | TCP Data

20 BYTE — IP Header | IP Data

18 BYTE — Ethernet Header | 46...1500 Bytes Ethernet Data | CRC

5.1 Binary Number System
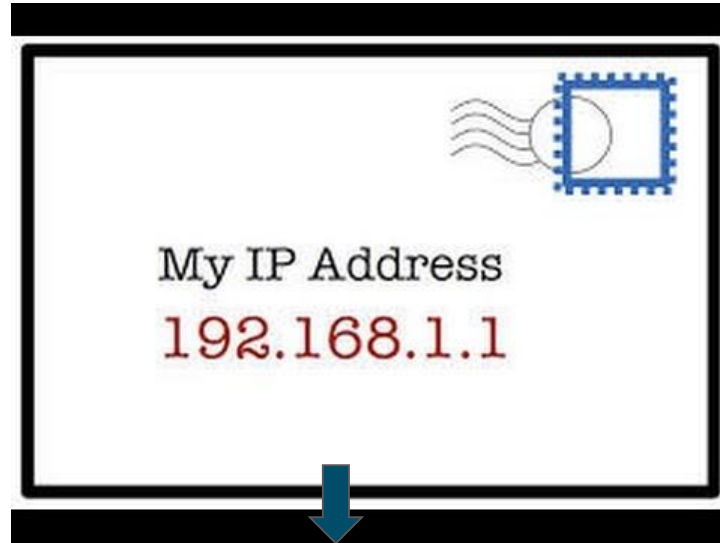
Binary and IPv4 Addresses

0101100001000110010110000010001110

- Binary numbering system consists of 1s and 0s, called bits
- Decimal numbering system consists of digits 0 through 9
- Hosts, servers, and network equipment using binary addressing to identify each other.
- Each address is made up of a string of 32 bits, divided into four sections called octets.
- Each octet contains 8 bits (or 1 byte) separated by a dot.
- For ease of use by people, this dotted notation is converted to dotted decimal.

IPv4 Adresleri

My IP Address
192.168.1.1
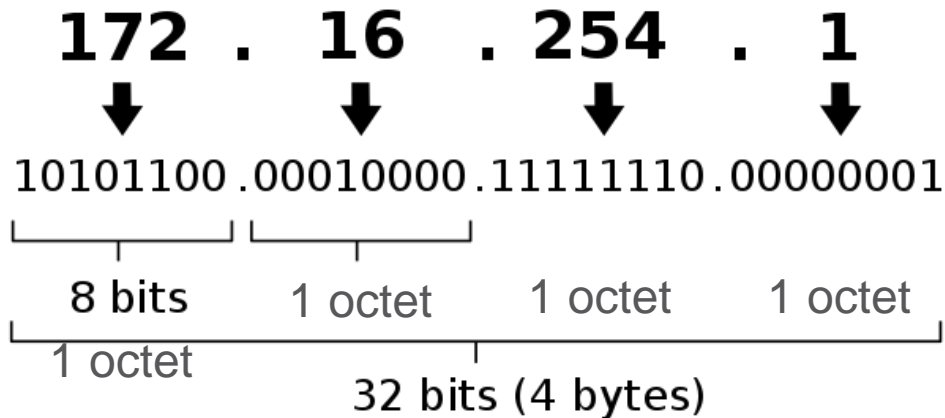
noktalı onluk gösterim: (dotted decimal notation)

IPv4 (Internet Protocol) Adresleri

noktalı onluk gösterim: (dotted decimal notation)

IPv4 address in dotted-decimal notation

172 . 16 . 254 . 1

10101100.00010000.11111110.00000001

8 bits   1 octet   1 octet   1 octet

1 octet

32 bits (4 bytes)

Video – Convert Between Binary and Decimal Numbering Systems

This video will cover the following:

- Positional notation review
- Powers of 10 review
- Decimal – base 10 numbering review
- Binary – base 2 numbering review
- Convert an IP address in binary to decimal numbering

Binary Positional Notation

- Positional notation means that a digit represents different values depending on the "position" the digit occupies in the sequence of numbers.
- The decimal positional notation system operates as shown in the tables below.

Radix	10	10	10	10
Position in Number	3	2	1	0
Calculate	(10^3)	(10^2)	(10^1)	(10^0)
Position Value	1000	100	10	1

	Thousands	Hundreds	Tens	Ones
Positional Value	1000	100	10	1
Decimal Number (1234)	1	2	3	4
Calculate	1 x 1000	2 x 100	3 x 10	4 x 1
Add them up…	1000	+ 200	+ 30	+ 4
Result	**1,234**			

Binary Positional Notation (Cont.)

	128	64	32	16	8	4	2	1
—	—	—	—	—	—	—	—	—

The binary positional notation system operates as shown in the tables below.

Radix	2	2	2	2	2	2	2	2
Position in Number	7	6	5	4	3	2	1	0
Calculate	(2^7)	(2^6)	(2^5)	(2^4)	(2^3)	(2^2)	(2^1)	(2^0)
Position Value	128	64	32	16	8	4	2	1

Positional Value	128	64	32	16	8	4	2	1
Binary Number (11000000)	1	1	0	0	0	0	0	0
Calculate	1x128	1x64	0x32	0x16	0x8	0x4	0x2	0x1
Add Them Up…	128	+ 64	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0
Result	192							

Binary Number System
Convert Binary to Decimal

Convert 11000000.10101000.00001011.00001010 to decimal.

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

Positional Value	128	64	32	16	8	4	2	1
Binary Number (11000000)	1	1	0	0	0	0	0	0
Calculate	1x128	1x64	0x32	0x16	0x8	0x4	0x2	0x1
Add Them Up…	128	+ 64	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0
Binary Number (10101000)	1	0	1	0	1	0	0	0
Calculate	1x128	0x64	1x32	0x16	1x8	0x4	0x2	0x1
Add Them Up…	128	+ 0	+ 32	+ 0	+ 8	+ 0	+ 0	+ 0
Binary Number (00001011)	0	0	0	0	1	0	1	1
Calculate	0x128	0x64	0x32	0x16	1x8	0x4	1x2	1x1
Add Them Up…	0	+ 0	+ 0	+ 0	+ 8	+ 0	+ 2	+ 1
Binary Number (00001010)	0	0	0	0	1	0	1	0
Calculate	0x128	0x64	0x32	0x16	1x8	0x4	1x2	0x1
Add Them Up…	0	+ 0	+ 0	+ 0	+ 8	+ 0	+ 2	+ 0

➡ 192

➡ 168

192.168.11.10

➡ 11

➡ 10

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İkilikten Ondalığa Çevirme - Çevirmeler

(0-255). (0-255).(0-255).(0-255)

128	64	32	16	8	4	2	1		
0	0	0	0	0	0	0	0	=	0
0	0	0	0	0	0	1	1	=	?
0	1	0	1	1	0	0	1	=	89
1	1	1	0	0	0	0	0	=	?
0	0	0	1	1	1	1	1	=	?
1	1	1	1	1	1	1	1	=	255

Decimal to Binary Conversion

The binary positional value table is useful in converting a dotted decimal IPv4 address to binary.

- Start in the 128 position (the most significant bit). Is the decimal number of the octet (n) equal to or greater than 128?
- If no, record a binary 0 in the 128 positional value and move to the 64 positional value.
- If yes, record a binary 1 in the 128 positional value, subtract 128 from the decimal number, and move to the 64 positional value.
- Repeat these steps through the 1 positional value.

No $n >= 128$ Yes

Positional Value	128	64	32	16	8	4	2	1

Add 0

Add 1
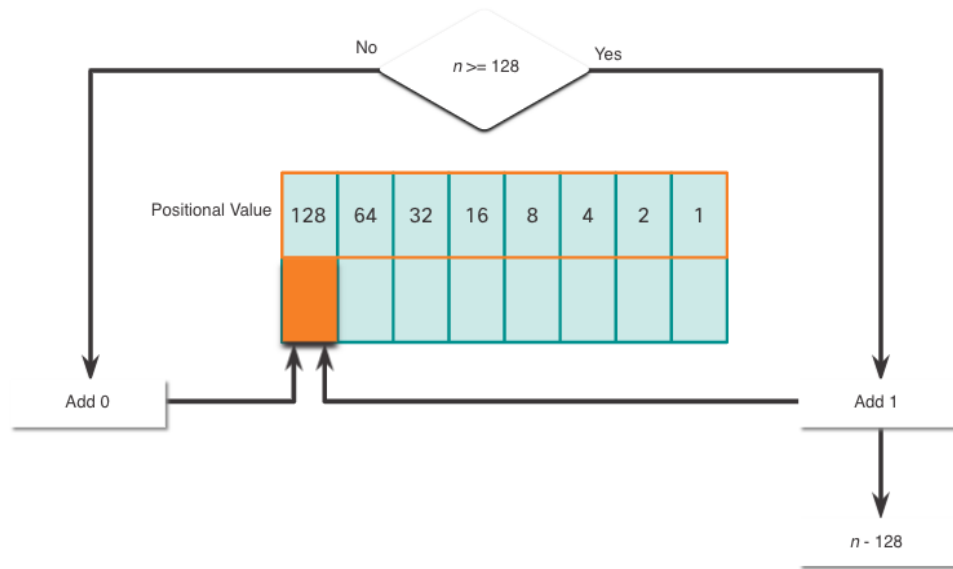
$n - 128$

Decimal to Binary Conversion Example

- Convert decimal 168 to binary

Is 168 > 128?
- Yes, enter 1 in 128 position and subtract 128 (168-128=40)

Is 40 > 64?
- No, enter 0 in 64 position and move on

Is 40 > 32?
- Yes, enter 1 in 32 position and subtract 32 (40-32=8)

Is 8 > 16?
- No, enter 0 in 16 position and move on

Is 8 > 8?
- Equal. Enter 1 in 8 position and subtract 8 (8-8=0)

No values left. Enter 0 in remaining binary positions

128	64	32	16	8	4	2	1
1	0	1	0	1	0	0	0

Decimal 168 is written as 10101000 in binary

Ondalıktan İkiliğe Çevirme - Çevirmeler

Convert Decimal to Binary

192.168.10.10

192	168	10	10
11000000	10101000	00001010	00001010

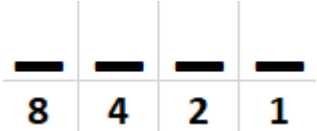|							
___	___	___	___	___	___	___	___
128	64	32	16	8	4	2	1
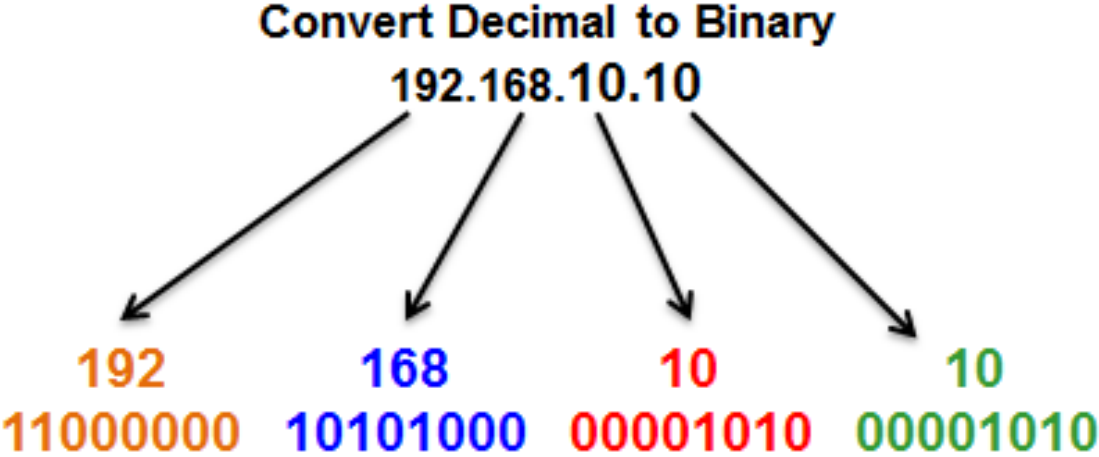
IPv4 Addresses

- Routers and computers only understand binary, while humans work in decimal. It is important for you to gain a thorough understanding of these two numbering systems and how they are used in networking.
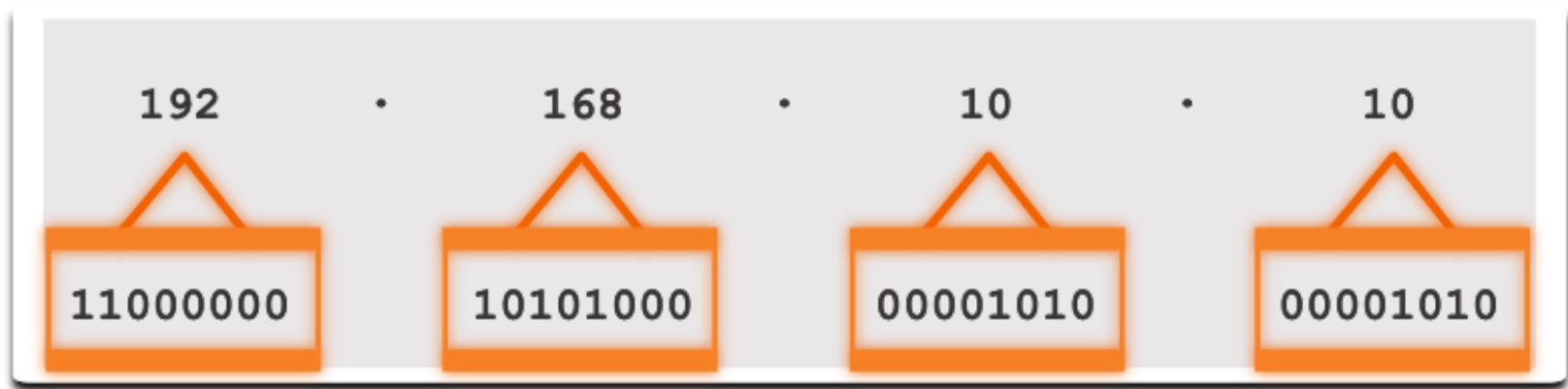
5.2 Hexadecimal Number System

Hexadecimal and IPv6 Addresses

8 | 4 | 2 | 1

1000 0011

1000 0011 0111 1001 1010 0001 0000 0011 1111 1110 ....

Binary	Decimal	Hexadecimal
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	10	A
1011	11	B
1100	12	C
1101	13	D
1110	14	E
1111	15	F

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Hexadecimal and IPv6 Addresses

- To understand IPv6 addresses, you must be able to convert hexadecimal to decimal and vice versa.

- Hexadecimal is a base sixteen numbering system, using the digits 0 through 9 and letters A to F.

- It is easier to express a value as a single hexadecimal digit than as four binary bit.

- Hexadecimal is used to represent IPv6 addresses and MAC addresses.

Binary	Decimal	Hexadecimal
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	10	A
1011	11	B
1100	12	C
1101	13	D
1110	14	E
1111	15	F

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Hexadecimal and IPv6 Addresses

32 bit   (IPv4 address)

0001 0000 . 0010 0000 . 0011 0000 . 0100 0000
     16   .   32   .   48   .   64

48 bit (MAC Address)

0001 0000 : 0010 0000 : 0011 0000 : 0100 0000 : 0101 0000 : 0110 0000
     10   :   20   :   30   :   40   :   50   :   60

128 bit (IPv6 Address)

0001 0000 0010 0000 : 0011 0000 0100 0000 : 0101 0000 0110 0000 : 0111 0000 1000 0000
          1020   :   3040   :   5060   :   7080
1001 0000 1010 0000 : 1011 0000 1100 0000 : 1101 0000 1110 0000 : 1111 0000 0000 0000
          90A0   :   B0C0   :   D0E0   :   F000
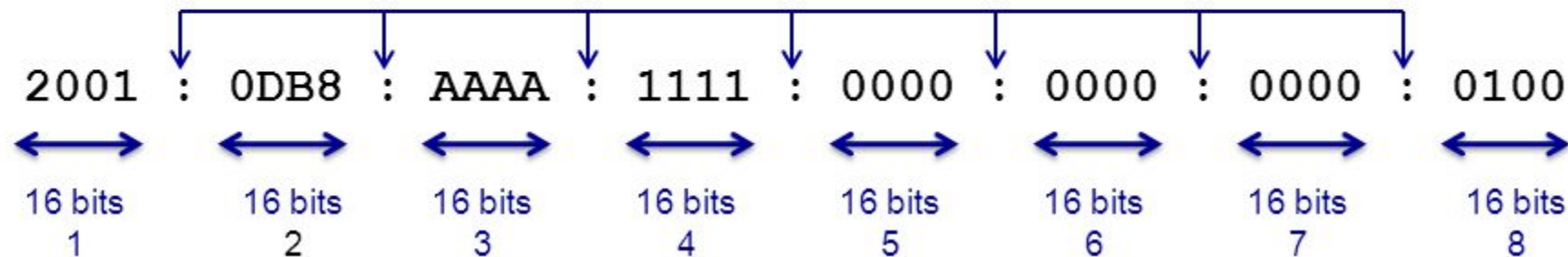
4 adet Decimal digit

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

| 8 | 4 | 2 | 1 |

12 adet Hexadecimal digit

8 Hextet
32 adet Hexadecimal digit

Hexadecimal and IPv6 Addresses

IPv6 Address Notation (8 Hextet)

2001:0DB8:AAAA:1111:0000:0000:0000:0100

| 2001 | : | 0DB8 | : | AAAA | : | 1111 | : | 0000 | : | 0000 | : | 0000 | : | 0100 |

16 bits 1 — 16 bits 2 — 16 bits 3 — 16 bits 4 — 16 bits 5 — 16 bits 6 — 16 bits 7 — 16 bits 8

Hexadecimal and IPv6 Addresses (Cont.)

- IPv6 addresses are 128 bits in length. Every 4 bits is represented by a single hexadecimal digit. That makes the IPv6 address a total of 32 hexadecimal values.

- The figure shows the preferred method of writing out an IPv6 address, with each X representing four hexadecimal values.

- Each four hexadecimal character group is referred to as a hextet.
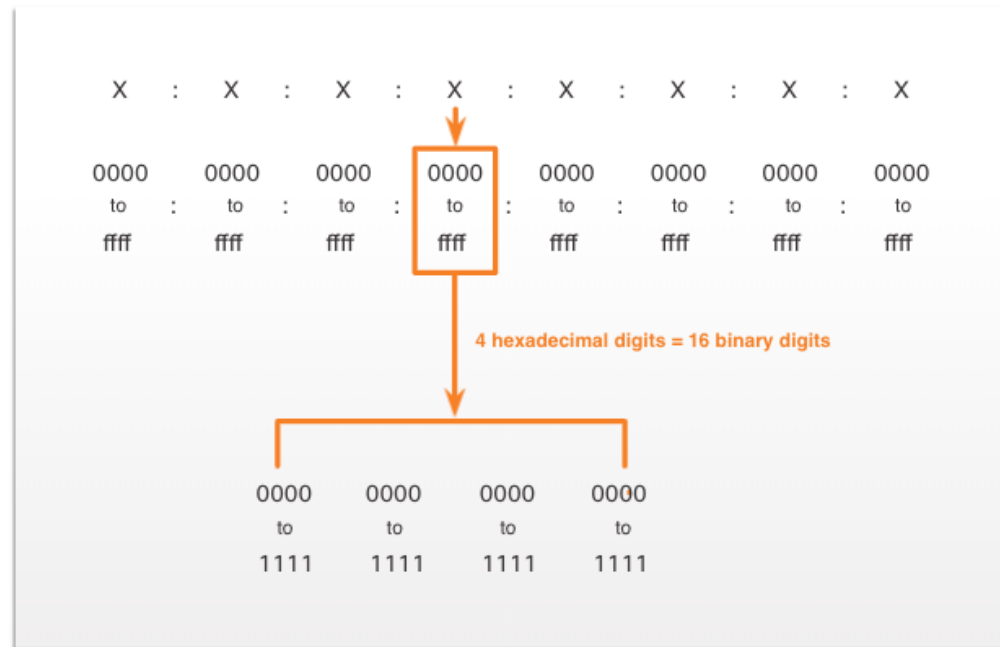
Video – Converting Between Hexadecimal and Decimal Numbering Systems

This video will cover the following:

- Characteristics of the Hexadecimal System
- Convert from Hexadecimal to Decimal
- Convert from Decimal to Hexadecimal

Decimal to Hexadecimal Conversions

Follow the steps listed to convert decimal numbers to hexadecimal values:

- Convert the decimal number to 8-bit binary strings.
- Divide the binary strings in groups of four starting from the rightmost position.
- Convert each four binary numbers into their equivalent hexadecimal digit.

For example, **168** converted into hex using the three-step process.

- 168 in binary is **10101000**.
- 10101000 in two groups of four binary digits is **1010** and **1000**.
- 1010 is hex A and 1000 is hex 8, so 168 is A8 in hexadecimal.

128	64	32	16	8	4	2	1

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Hexadecimal to Decimal Conversions

Follow the steps listed to convert hexadecimal numbers to decimal values:

- Convert the hexadecimal number to 4-bit binary strings.
- Create 8-bit binary grouping starting from the rightmost position.
- Convert each 8-bit binary grouping into their equivalent decimal digit.

For example, **D2** converted into decimal using the three-step process:

- D2 in 4-bit binary strings is **1110** and **0010**.
- 1110 and 0010 is **11100010** in an 8-bit grouping.
- **11100010** in binary is equivalent to 210 in decimal, so D2 is 210 is decimal

5.3 Module Practice and Quiz

What did I learn in this module?

- Binary is a base two numbering system that consists of the numbers 0 and 1, called bits.
- Decimal is a base ten numbering system that consists of the numbers 0 through 9.
- Binary is what hosts, servers, and networking equipment uses to identify each other.
- Hexadecimal is a base sixteen numbering system that consists of the numbers 0 through 9 and the letters A to F.
- Hexadecimal is used to represent IPv6 addresses and MAC addresses.
- IPv6 addresses are 128 bits long, and every 4 bits is represented by a hexadecimal digit for a total of 32 hexadecimal digits.
- To convert hexadecimal to decimal, you must first convert the hexadecimal to binary, then convert the binary to decimal.
- To convert decimal to hexadecimal, you must first convert the decimal to binary and then the binary to hexadecimal.