

## Network I Lab 01

### Part 01 : Decimal to Binary Conversion

#### Objective

- Learn to convert decimal values to binary values.
- Practice converting decimal values to binary values.

#### Background

Knowing how to convert decimal values to binary values is valuable when converting human readable IP addresses in dotted decimal format to machine-readable binary format. This is normally done for calculation of subnet masks and other tasks. The following is an example of an IP address in 32-bit binary form and dotted decimal form.

**Binary IP Address: 11000000.10101000.00101101.01111001**

**Decimal IP Address: 192.168.45.121**

A tool that makes the conversion of decimal values to binary values simple is the following table. The first row is created by counting right to left from one to eight, for the basic eight bit positions. The table will work for any size binary value. The value row starts with one and doubles, Base 2, for each position to the left.

Position	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1

128	207
	128
64	79
	64
8	15
	8
4	7
	4
2	3
	2
	1

The same conversion table and simple division can be used to convert binary values to decimal values.

#### Steps

##### To convert 207 to binary:

1. Start with the digit farthest to the left. Determine if the decimal value can be divided by it. Since it will go one time, put a 1 in row three of the conversion table under the 128 value and calculate the remainder, 79.
2. Since the remainder can be divided by the next value, 64, put a 1 in row three under the 64 value of the table.
3. Since the remainder cannot be divided by either 32 or 16, put 0s in row three of our table under the 32 and 16 values.
4. Continue until there is no remainder.



5. If necessary, use row four to check the work.

Position	8	7	6	5	4	3	2	1	
Value	128	64	32	16	8	4	2	1	
	1	1	0	0	1	1	1	1	
	128	64			8	4	2	1	= 207

6. Convert the following decimal values to binary values:

a. 123 \_\_\_\_\_

b. 202 \_\_\_\_\_

c. 67 \_\_\_\_\_

d. 7 \_\_\_\_\_

e. 252 \_\_\_\_\_

f. 91 \_\_\_\_\_

g. 116.127.71.3 \_\_\_\_\_

h. 255.255.255.0 \_\_\_\_\_

i. 192.143.255.255 \_\_\_\_\_

j. 12.101.9.16 \_\_\_\_\_

## Part 02: Binary to Decimal Conversion

### Objective

- Learn the process of converting binary values to decimal values.
- Practice converting binary values to decimal values.

### Background

The following is an example of an IP address in 32-bit binary form and dotted decimal form.

**Binary IP Address: 11000000.10101000.00101101.01111001**

**Decimal IP Address: 192.168.45.121**

Binary data is made up of ones and zeros. Ones represent on and zeros represent off. Binary data can be grouped in varying increments, 110 or 1011. In TCP/IP binary data is usually grouped in eight digit groups called a Byte.

A Byte, 8 bits, can range from 00000000 to 11111111 creating 256 combinations with decimal values ranging from 0 to 255. IP addressing uses 4 bytes, or 32 bits, to identify both the network and specific device. The specific device can be a node or host. The example at the beginning of this lab is an example of an IP address in both binary decimal formats. A tool that makes the conversion of binary to decimal values simple is the following table. The first row is created by counting right to left from one to eight for the basic eight bit positions. The table will work for any size binary value. The value row starts with one and doubles, base 2, for each position to the left.

Position Value	8	7	6	5	4	3	2	1
	128	64	32	16	8	4	2	1

### Steps

1. Enter the binary bits in row three. For example 10111001
2. Put the decimal values in row four only for the third row 1s. Technically the row two values are being multiplied by row three.
3. Now just add row four across.

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

= 185

4. Convert the following binary values to decimals:

- a. 1110 \_\_\_\_\_
- b. 100110 \_\_\_\_\_



c. 11111111 \_\_\_\_\_

d. 11010011 \_\_\_\_\_

e. 01000001 \_\_\_\_\_

f. 11001110 \_\_\_\_\_

g. 01110101 \_\_\_\_\_

h. 10001111 \_\_\_\_\_

i. 11101001.00011011.10000000.10100100

\_\_\_\_\_

j. 10101010.00110100.11100110.00010111

\_\_\_\_\_

### Part 03: Hexadecimal Conversions

#### Objective

- Learn the process to convert hexadecimal values to decimal and binary values.
- Learn the process to convert decimal and binary values to hexadecimal values.
- Practice converting between decimal, binary and hexadecimal values.

#### Background / Preparation

The Hexadecimal (Hex) number system is used to refer to the binary numbers in a NIC or IPv6 address. The word hexadecimal comes from the Greek word for 16. Hexadecimal is often abbreviated "0x", zero and lower case x. Hex numbers use 16 unique digits to display any combination of eight binary digits as only two hexadecimal digits.

A Byte, or 8 bits, can range from 00000000 to 11111111. A Byte can create 256 combinations with decimal values ranging from 0 to 255 or Hex values 0 to FF. Each Hex value represents only four binary bits. The alpha (A-F) values are not case sensitive.

A tool that makes the conversion of hexadecimal to decimal values simple is the following table. Use the same techniques as covered in binary to decimal conversions. The first row is the two Hex positions. The value row starts as 1 and 16, base 16, for each position to the left.

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

Position Value	2	1
	16	1

**Note:** Steps are provided at the end of this lab in the use of the Windows Scientific Calculator to check the work.

#### Steps for Hex to decimal conversion

1. Break the Hex value into pairs. Start at the right side. For example 77CE becomes 77 and CE. Insert a zero in the first position if necessary to complete the first pair.
2. Put each Hex pair in row three. The value in parenthesis is the decimal value of A-F.
3. To get the decimal values in row four, multiply the row two values by row three

4. Now just add row four across.

Position	<b>2</b>	<b>1</b>	
Value	16	1	
	7	7	
	112	7	= 119

Position	<b>2</b>	<b>1</b>	
Value	16	1	
	C(12)	E(14)	
	192	14	= 206

#### Steps for decimal to Hex conversion

1. To be valid for the purpose of this lab, the decimal value will be between 0 and 256. The first Hex value is derived by dividing the decimal value by 16. If the value is greater than 9 it will need to be put in Hex form A-F.
2. The second value is the remainder from step 1. If the value is greater than 9 it will need to be put in Hex form A-F.
3. For example, 209 divided by 16 is 13 with a remainder of 1. 13 equals D in Hex. Therefore, 209 equals D1.

#### Steps for Hex to binary conversion

1. This is the easiest conversion. Remember that each Hex value converts to four binary bits, so work right to left.
2. For example, to convert **77AE** to binary. Start with E. Use the table at the beginning of this lab to go directly to binary. The other alternative is to convert the value to decimal, E = 14, and then use the last four positions of the table used in the decimal to binary conversions.
  - 14 divided by 8 is 1 with a remainder of 6.
  - 6 divided by 4 is 1 with a remainder of 2.
  - 2 divided by 2 is 1 with no remainder.
 Add zeros if necessary to end up with four bits.

Position Value	4	3	2	1	
	8	4	2	1	
	1	1	1	0	
	8	4	2		= 14

3. Using the same technique, A becomes 1010 and the total so far is 10101110

Position Value	4	3	2	1	
	8	4	2	1	
	1	0	1	0	
	8		2		= 10

4. Using the same technique, the two 7s each become 0111 and the total is 01110111.10101110

Position Value	4	3	2	1	
	8	4	2	1	
	0	1	1	1	
		4	2	1	= 7

#### Steps for binary to Hex conversion

1. Each Hex value equals four binary bits. Start by breaking the binary value into 4-bit units from right to left. Add any leading zeros required to end up with all 4-bit values. 01101110. 11101100 would become 0110 1110 1110 1100.
2. Use the table at the beginning of this lab to go directly to Hex. The other alternative is to convert each 4-bit binary value to decimal, 0-15. Then convert the decimal to Hex, 0-F.

Position Value	4	3	2	1	
	8	4	2	1	
	1	1	0	0	
	8	4			
Position Value	4	3	2	1	
	8	4	2	1	
	1	1	1	0	
	8	4	2		

3. The result is 6E-EC.

**Practice**

Convert the following values to the other two forms:

	Decimal	Hex	Binary
1		a9	
2		FF	
3		Bad1	
4		E7-63-1C	
5	53		
6	115		
7	19		
8	212.65.119.45		
9			10101010

10			110
11			11111100.00111100
12			00001100.10000000.11110000.11111111





### Checking conversions with the Windows Calculator

It is important to be able to perform the previous calculations manually. However, to check the work using the Windows Calculator applet, access the Calculator. Click **Start > Programs > Accessories** and then **Calculator**. Click on the **View** menu to make sure that the calculator is in **Scientific** mode.

Click on the button for the type of number to be entered, Hex, Dec or Bin. Enter the number in that form. To convert from one form to another, click on one of the alternate buttons.