BINARY, HEXADECIMAL, AND DATA TRANSFER UNITS

BINARY

Binary - a base-2 system, used in mathematics and computer science, where values are expressed as 0 or 1. For computers, which work entirely with binary at their core, 1 is true or "on" and 0 is false or "off."

1 bit = 1 binary digit (0 or 1)
8 bits = 1 byte

Binary Math Table

Example: To convert the decimal number 147 to a binary value:

1. Use the table below, moving from left to right, subtracting the binary place value (i.e. 128) from the decimal number (i.e. 147) as you go.
2. Enter a binary "1" in any table column that can be subtracted from the remaining decimal number (in bold below) and a binary "0" for any that cannot be subtracted (in gray below).

147 - 128 = 19
19 - 64
19 - 32

19 - 16 = 3
3 - 8
3 - 4

3 - 2 = 1
1 - 1 = 0

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

The 8 bit binary value that represents the decimal value 147 would be 10010011.

HEXADECIMAL

Hexadecimal - a base-16 system, used in computer science as a shorthand way to represent binary values. One hexadecimal digit represents four binary digits. Hexadecimal letters can be written as uppercase or lowercase.

Examples in IT

- 30:60:7b:43:5f:e4 (MAC address)
- fe80::80e2:2600:280:44fd (IPv6 address)

CONVERSIONS

Decimal	Binary	Hexadecimal
0	0	0
1	1	1
2	10	2
3	11	3
4	100	4
5	101	5
6	110	6
7	111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

DATA TRANSFER UNITS

Data Transfer Rate (DTR) - the amount of digital data, or *throughput*, that is moved from one place to another in a given time.

DTR = D / T (D is the size of the data, T is the time to transfer the data)

To find the DTR of a 100 Mb file that is transferred in two minute:

1. Convert the time into seconds. (2 min x 60 sec/min = 120 seconds)
2. Use DTR = D / T to solve. (100 Mb / 120 seconds = 0.83 Mbps)

To find how many bits are in 2 TB:

- Convert TB to B. (1 TB = 1 trillion bytes, so 2 TB = 2 trillion bytes)
- 2 trillion bytes * 8 bits per byte = 16 trillion bits

Metric Unit	Value
Kbps (Kilobits per second)	1000 bits
Mbps (Megabits/s)	1 million bits
Gbps (Gigabits/s)	1 billion bits
Tbps (Terabits/s)	1 trillion bits

Binary Unit	Value
Kibps (Kibibits per second)	1024 bits
Mibps (Mebibits/s)	1,048,576 bits
Gibps (Gibibits/s)	1,073,741,824 bits
Tibps (Tebibits/s)	1,099,511,627,776 bits

HOW MANY BITS AND WHY?

IPv4 Address - 32 bits

- **Decimal** address: 182.186.2.243
- **Binary** representation: 1011 0110.1011 1010.0000 0010.1111 0011
- 8 bits x 4 octets = **32 bits**

MAC Address - 48 bits

- **Hexadecimal** address: 30:60:7b:43:5f:e4
- **Binary** representation:
  0011 0000:0110 0000:0111 1011:0100 0011:0101 1111:1110 0100
- 8 bits x 6 octets = **48 bits**

IPv6 Address - 128 bits

- **Hexadecimal** address: fe80::80e2:2600:280:44fd
- **Binary** representation:
  1111 1110 1000 0000:
  0000 0000 0000 0000:
  0000 0000 0000 0000:
  0000 0000 0000 0000:
  1000 0000 1110 0010:
  0010 0110 0000 0000:
  0000 0010 1000 0000:
  0100 0100 1111 1101
- 16 bits x 8 groups = **128 bits**