Lecture 01

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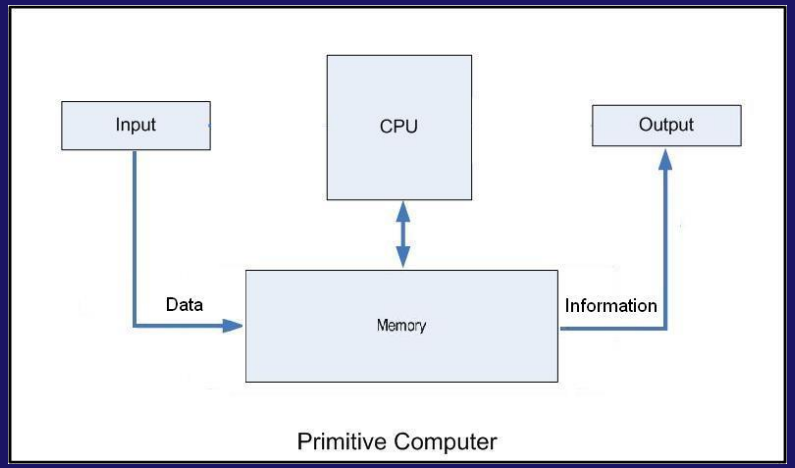
What is a Computer?

- A computer is a programmable machine that works on the instruction given by the user.
- The computer runs only by the combination of hardware and software.
- Earlier computers were used only for calculating. Like - adding or subtracting a number.
- A computer takes inputs, processes them, and produces outputs.
- The inputs and outputs are often data.
- Computers work with data; humans work with information.



Data vs Information

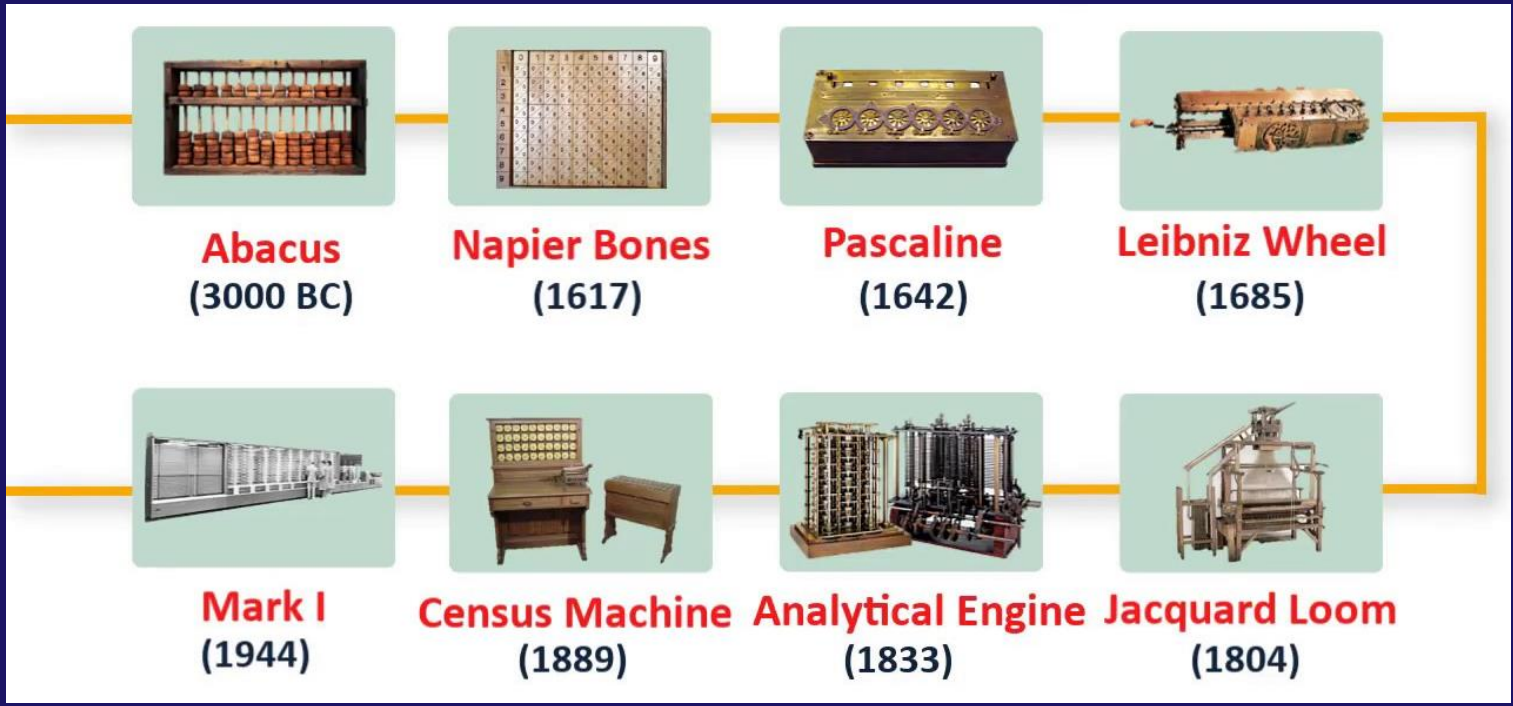
31	32	42	55	67	77
19	18	27	37	48	58
2.05	2.09	2.4	2.99	3.54	2.83
13	12	13	12	12	11
90	128	180	212	263	295

Data

	Jan	Feb	Mar	Apr	May	Jun
Average high in °F:	31	32	42	55	67	77
Average low in °F:	19	18	27	37	48	58
Av. precipitation in inch:	2.05	2.09	2.4	2.99	3.54	2.83
Days with precipitation:	13	12	13	12	12	11
Hours of sunshine:	90	128	180	212	263	295

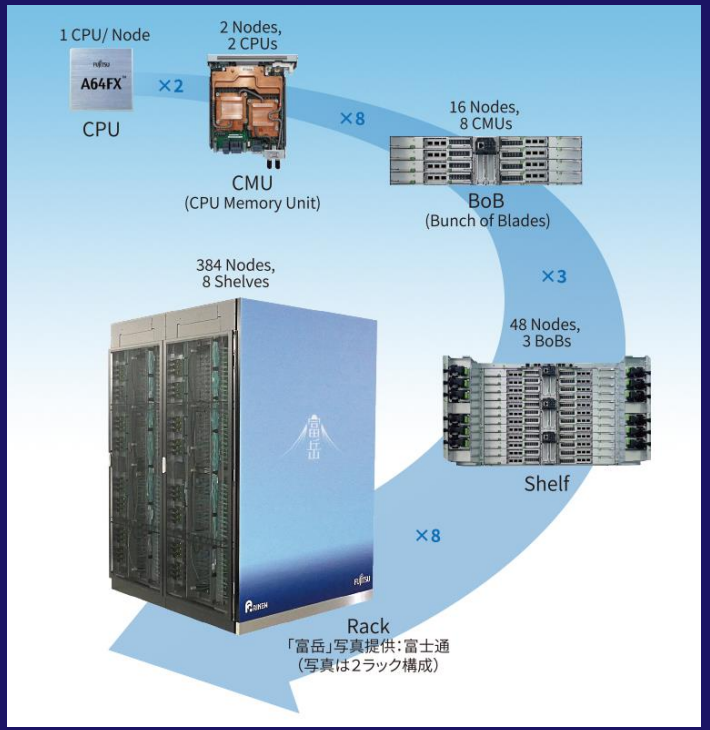
Information

Evolution of Computers



Supercomputer

Currently the most powerful supercomputer is **Fugaku** made by fujitsu.

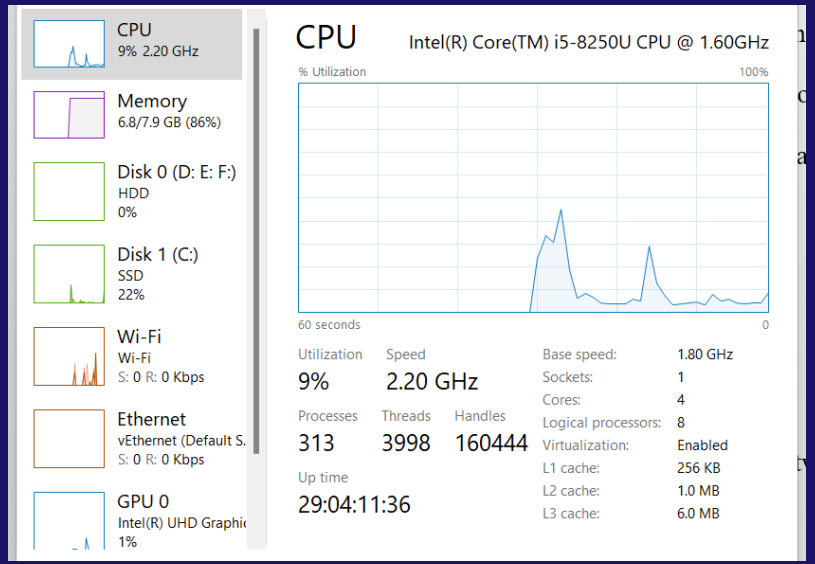


Elements of a Computer

Component	Purpose
Input devices	Send data to the CPU.
Output devices	Receive data from the CPU.
Memory	Holds data. There are two types: ✓ Read-only memory (ROM) contains primary operating system software. ✓ Random-access memory (RAM) holds data temporarily for the CPU.
Storage	Holds data permanently, whether the CPU is running or not.
Central processing unit (CPU)	Controls all other components.

Central Processing Uni (CPU)

- The CPU is composed of one or more cores.
- A core is controlled by the CPU and independently processes computer instructions.
- Splitting work over multiple cores enables the computer to process that work faster.
- Hyperthreading and similar technologies double the number of cores available to the operating system.
- Parallelization is the process of writing software to take advantage of multiple cores.

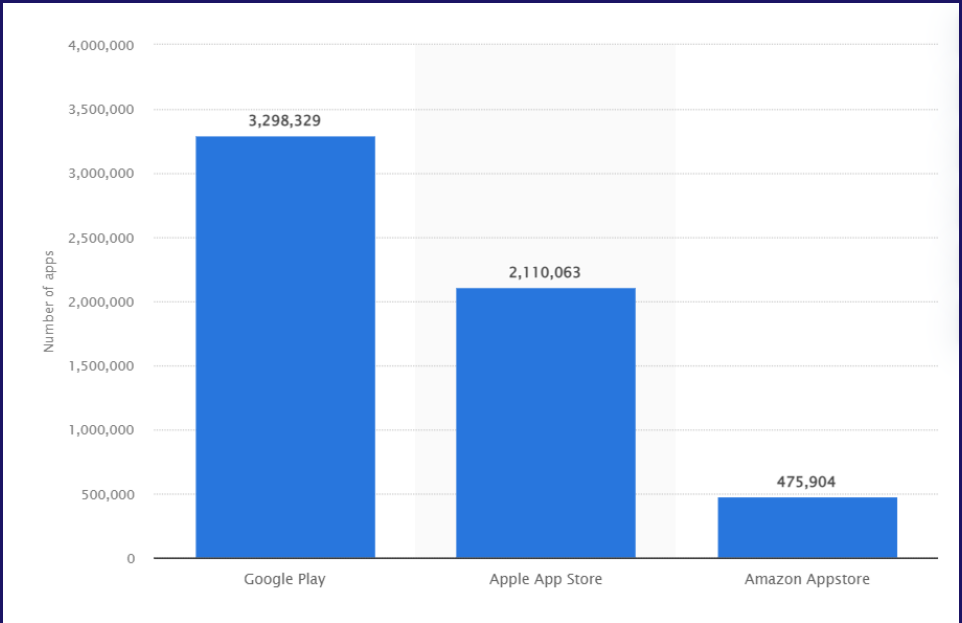


Software and Categories

- Software is that part of a computer system that you cannot touch.
- Software represents instructions and data.
- There are tens of millions of applications.
- The two primary software categories are:
  - System software – basic input-output systems (BIOSs), operating systems, drivers, etc.1
  - Application software – end-user software.
- The first programmer was thought to be Ada Lovelace. She wrote an algorithm for Charles Babbage's Analytical Engine to calculate a series of Bernoulli numbers.

App download statistics

Here are the number of mobile applications by app store as of 2022 third quarter, according to Statista



Computer Language (Binary)

- A bit is the smallest unit of information processed by a computer.
- Its value is either on or off, 1 or 0, or true or false.
- This corresponds to an electrical component that may either be on or off, or at low or high voltage.
- The electrical components of a computer lends themselves to using the binary numbering system.
- A computer gets all its instructions, and reads and writes all its data, in the form of bits.
- Personal computers can handle 32 or 64 bits at a time.
- Since a computer only understands bits, and humans understand characters on a screen or a page, a conversion is required when the two communicate.
- To enable this communication, every instruction and datum we need processed by a computer is assigned codes.
- Software automatically:
  - Encodes our instructions and data in a form the computer can understand.
  - Decodes data and instruction results from the computer in a form we can understand.
- For example:
  - When we type a key on the keyboard, it is converted from a mechanical signal, to an electrical signal, and then to a stream of zeroes and ones that encodes the instructions and data we need processed by the computer.
  - When we print a document, the computer sends out a stream of zeroes and ones that are converted to electrical signals, and then to mechanical signals that control where the ink is placed on a page.

Binary Units

Data unit	Description	Possible values
bit	Basic unit of data	$2^1 = 2$
byte	Group of eight bits	$2^8 = 256$

Sample bit string	0	1	1	0	1	0	0	1
8 bits	bit	bit	bit	bit	bit	bit	bit	bit
1 byte	byte							

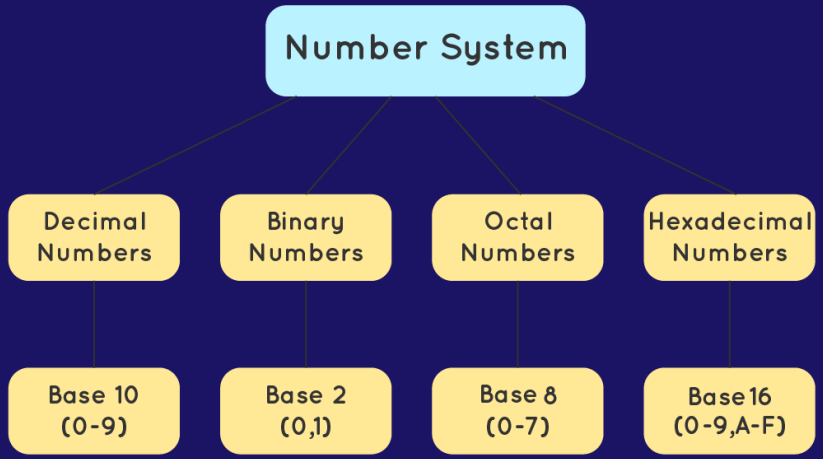
Metric Prefixes

- Metric prefixes enables us to describe large multiples of bytes.
- There is sometimes confusion when using metric prefixes: sometimes people mean multiples of 1,000; other times they mean multiples of 1,024. Computer Science means multiples of 1,024 (powers of 2).

Metric prefix	Approximate size	Actual size
kilobyte (KB)	~thousands of bytes	$2^{10} = 1{,}024^1 = 1{,}024$ bytes
megabyte (MB)	~millions of bytes	$2^{20} = 1{,}024^2 = 1{,}048{,}576$ bytes
gigabyte (GB)	~billions of bytes	$2^{30} = 1{,}024^3 = 1{,}073{,}741{,}824$ bytes
terabyte (TB)	~trillions of bytes	$2^{40} = 1{,}024^4 = 1{,}099{,}511{,}627{,}776$ bytes
petabyte (PB)	~quadrillions of bytes	$2^{50} = 1{,}024^5 = 1{,}125{,}899{,}906{,}842{,}620$ bytes
exabyte (EB)	~quintillions of bytes	$2^{60} = 1{,}024^6 = 1{,}152{,}921{,}504{,}606{,}846{,}976$ bytes

Number Systems

- The technique to represent and work with numbers is called number system.
- Decimal number system is the most common number system.
- Other popular number systems include binary number system, octal number system, hexadecimal number system, etc.



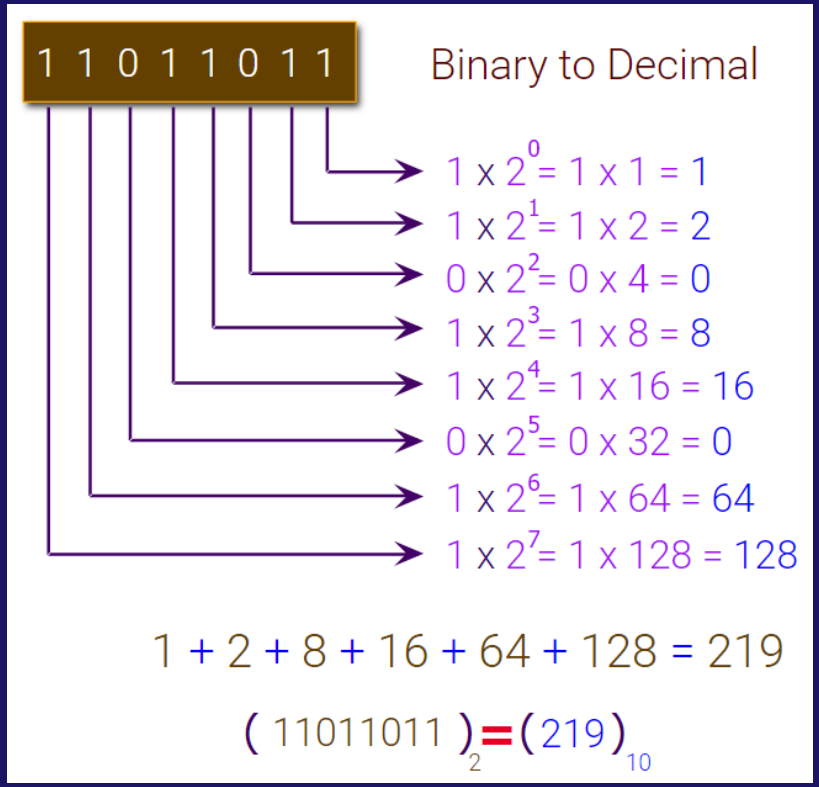
HEXADECIMAL	DECIMAL	OCTAL	BINARY
0	0	0	0000
1	1	1	0001
2	2	2	0010
3	3	3	0011
4	4	4	0100
5	5	5	0101
6	6	6	0110
7	7	7	0111
8	8	10	1000
9	9	11	1001
A	10	12	1010
B	11	13	1011
C	12	14	1100
D	13	15	1101
E	14	16	1110
F	15	17	1111

Binary Number System

- Binary number system is used to define a number in binary system.
- Binary system is used to represent a number in terms of two numbers only, 0 and 1.
- The binary number system is used commonly by computer languages like Java, C++.
- As the computer only understands binary language that is 0 or 1, all inputs given to a computer are decoded by it into series of 0's or 1's to process it further

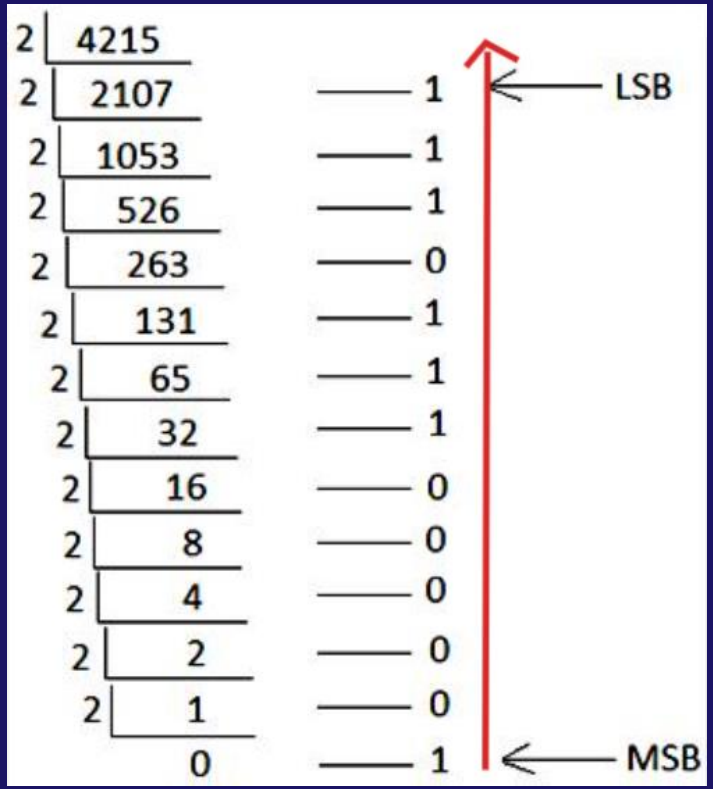
Decimal Number	Binary Number
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010

Binary to Decimal Conversion



Decimal to Binary Conversion

$4215_{10} = 1000001110111_2$

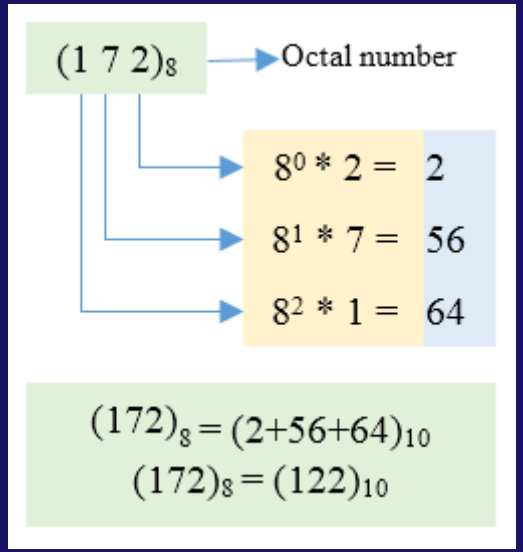


Octal Number System

- A number system with its base as eight and uses digits from 0 to 7 is called Octal Number System.
- Octal numbers use a lesser number of digits as compared to decimal and hexadecimal which makes it easy to compute in fewer steps
- Octal numbers can be made from binary numbers by grouping binary digits in its 3-bit representation.

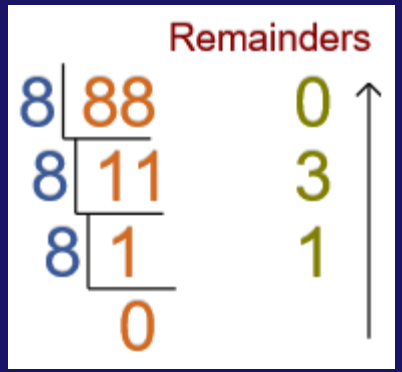
Octal	Binary
0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

Conversion from Octal to Decimal number

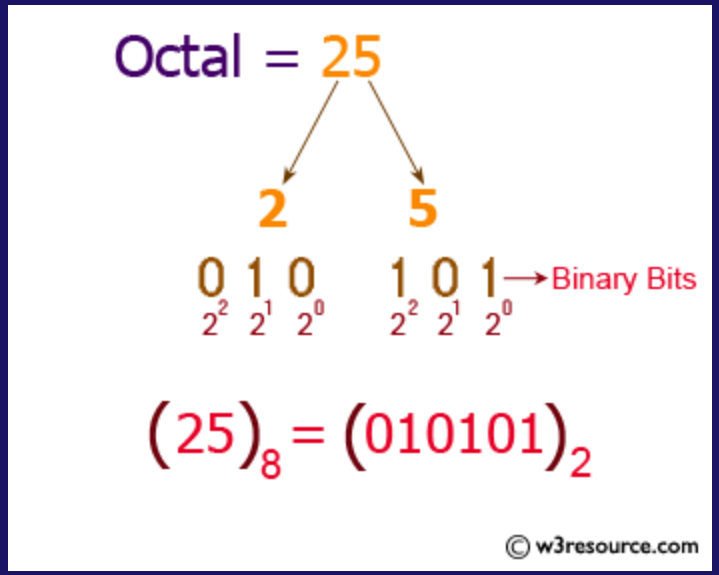


Conversion from Decimal to Octal number

$(88)_{10} = (130)_{8}$



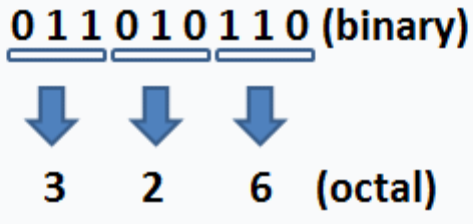
Conversion from Octal to Binary Numbers



Conversion from Binary to Octal Numbers

$(11010110)_2 = (326)_8$

To convert binary numbers into octal ones, you only have to make 3-bit groups and convert directly each group:

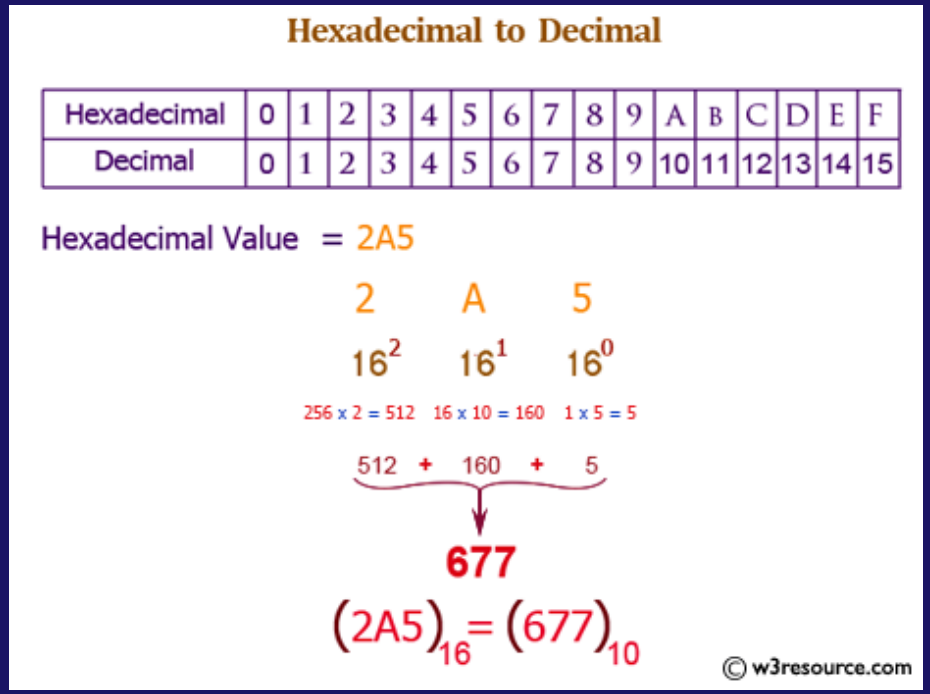


Hexadecimal Number System

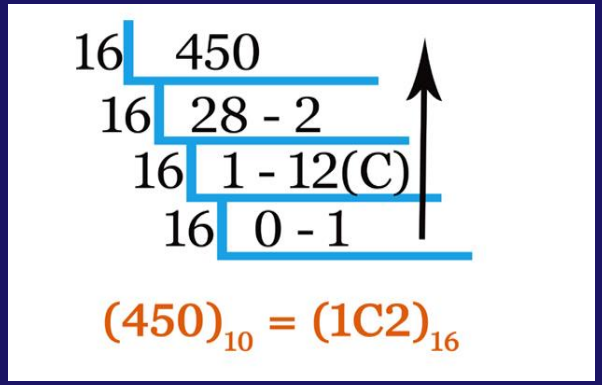
- The hexadecimal number system is described as a 16-digit number representation of numbers from 0 - 9 and digits from A - F.
- In other words, the first 9 numbers or digits are represented as numbers while the next 6 digits are represented as symbols from A - F.

Hexadecimal Digit	Decimal Digit	Binary Digit
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
A	10	1010
B	11	1011
C	12	1100
D	13	1101
E	14	1110
F	15	1111

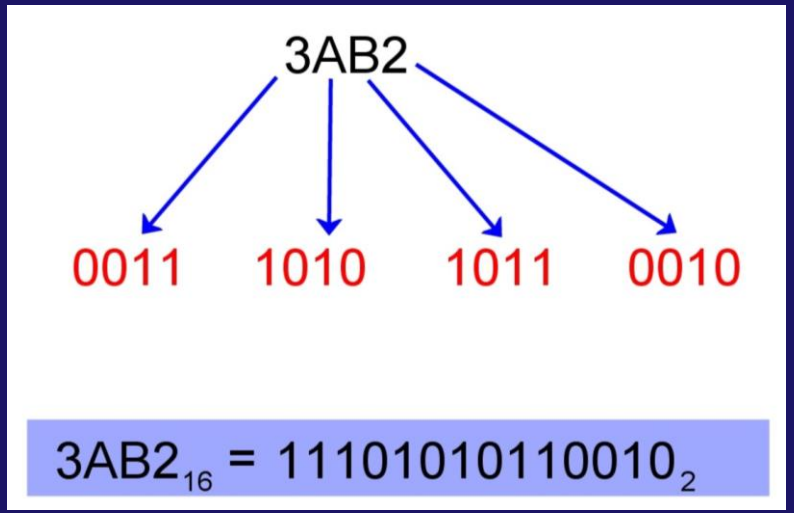
Conversion from Hexadecimal to Decimal number



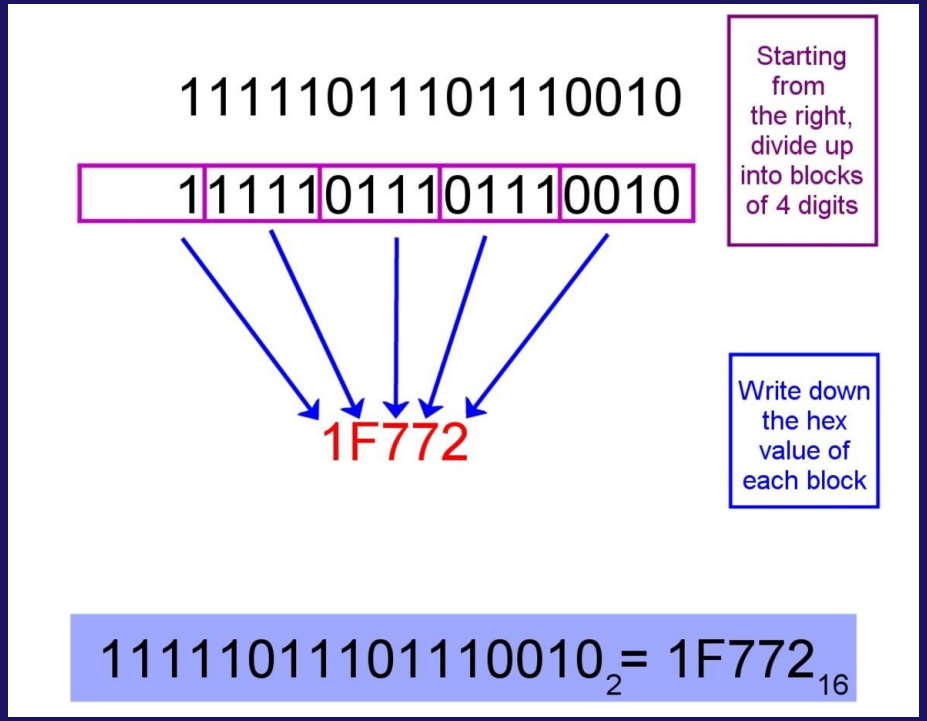
Conversion from Decimal to Hexadecimal number



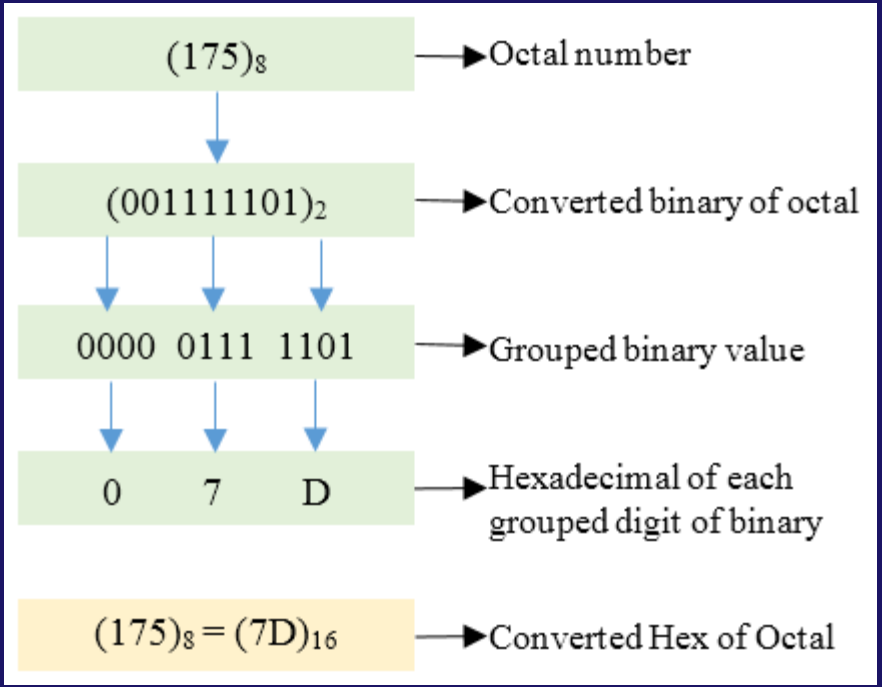
Conversion from Hexadecimal to Binary Numbers



Conversion from Binary to Hexadecimal Numbers



Conversion from Octal to Hexadecimal Numbers



Conversion from Hexadecimal to Octal Numbers