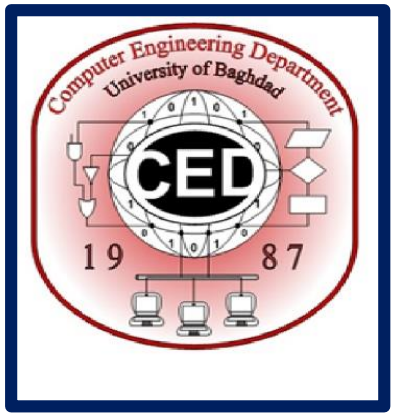

Basic Concepts of Digital Signal Processing

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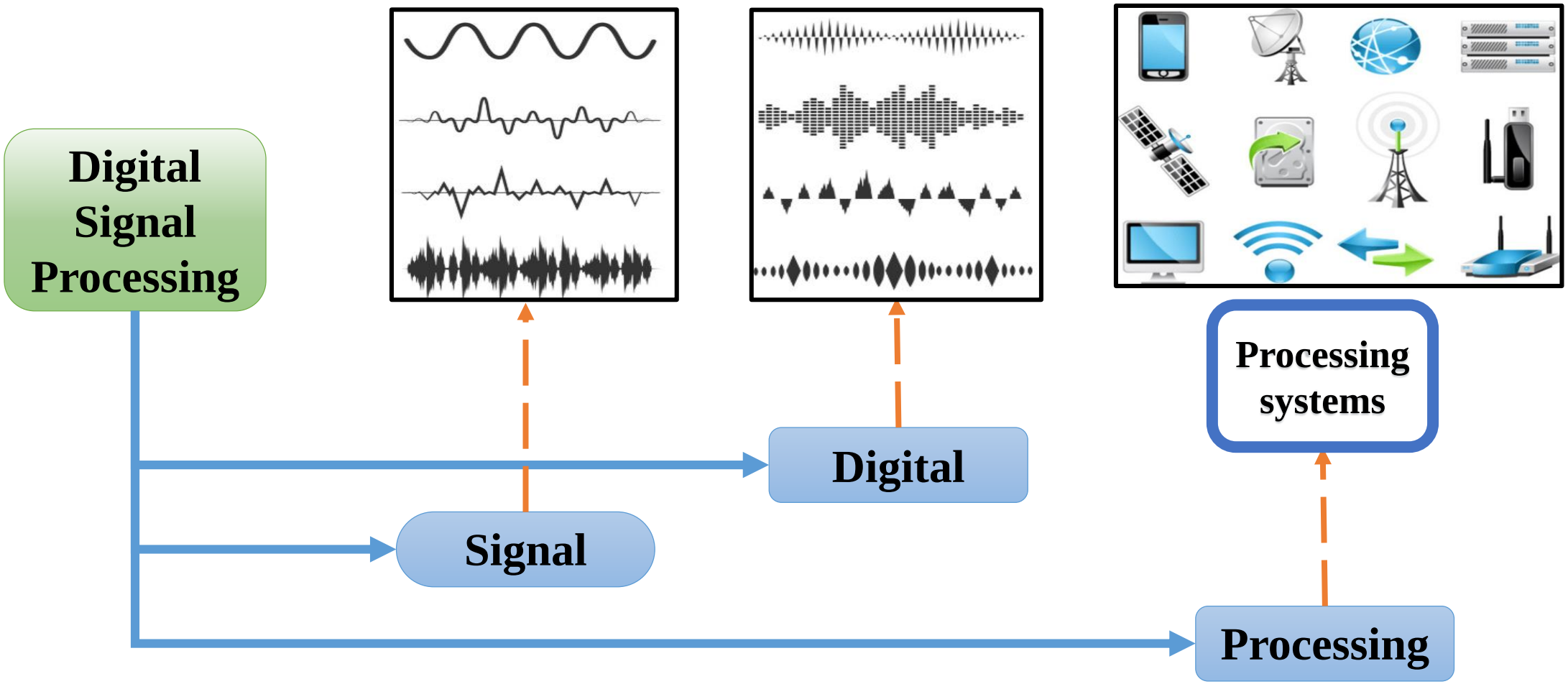
The Objectives of this lecture:

1. To introduce the student to the meaning of digital signal processing (DSP) terminology.
2. To introduce the student to the importance of digital signal processing in daily life.
3. To introduce the student to some applications of digital signal processing.

What is the meaning of Digital Signal Processing (DSP) terminology?

Digital Signal Processing (DSP) is the mathematical processing of the information signal, (audio, temperature, image, voice, and video) to modify or improve them in some manner.



What is signal?

A signal is a function that conveys information about a phenomenon, i.e. it is a function of independent variables (one or more) such as:

- time,
- distance,
- and temperature.

It carries information from one point to another point. The value of the function (i.e., the dependent variable) can be a real- valued scalar quantity, a complex-valued quantity, or perhaps a vector.

Classification of the signals based on dimensions?

Signals can have:

1- one independent variable such as audio,

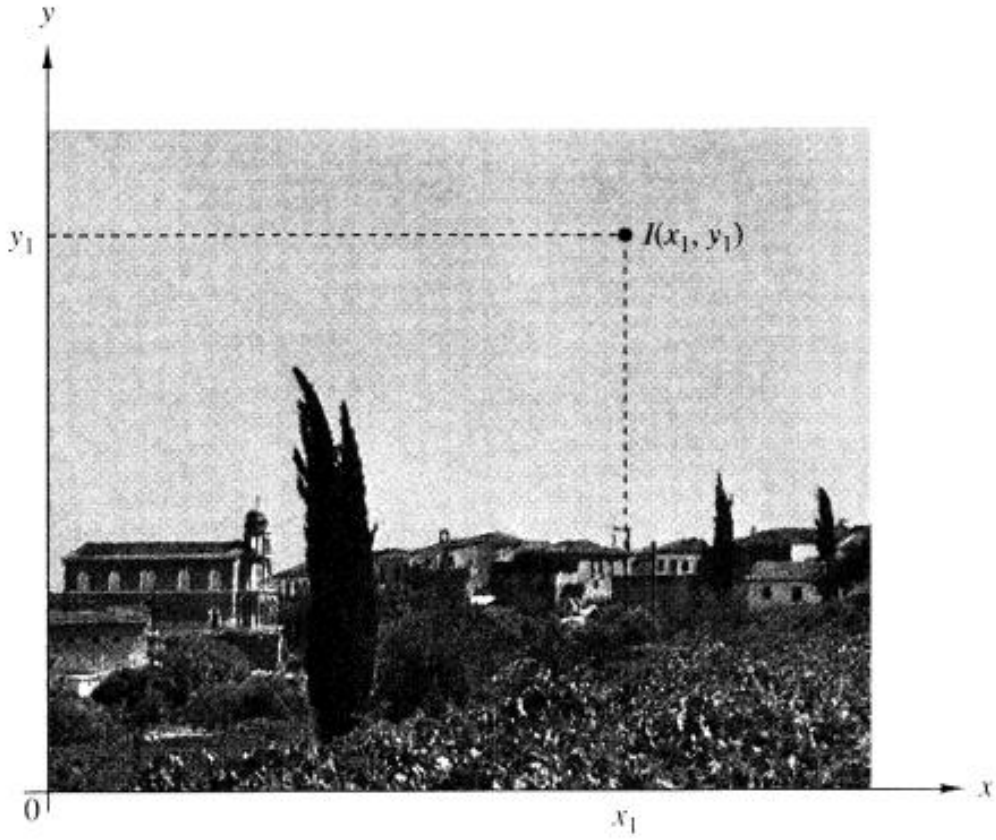
2- two independent variables such as the image, and

3- three variable such as the video.

If the signal is a function of a single independent variable, the signal is called a one-dimensional signal. On the other hand, a signal is called M-dimensional signal if its value is a function of M independent variables. For example, the picture in the following figure is a 2D signal, because the brightness (or Intensity) is a function of two independent variables $I(x, y)$.

Classification of the signals based on dimensions?

The picture in the following figure is a 2D signal, because the brightness (or Intensity) is a function of two independent variables $I(x,y)$.



Another classification of the signals?

- In the same concepts, there are single channel and multi- channel signals based on the generation source of the signal. Because, signals may be generated by multiple sources or multiple sensors. Such signals are represented in vector form. For $s_k(t)$ is an electrical signal comes from kth sensor as a function of time, where:

$k = 1,2,3$. Then $p = 3$ signals is defined by a vector $S_3(t) = \begin{bmatrix} s_1(t) \\ s_2(t) \\ s_3(t) \end{bmatrix}$

- Note, the color TV picture is a three-channel, three-dimensional signal, while the black-white TV picture can be written as $I\ (x, y, t)$ because the intensity is a function of time, so it is a three dimensional signal.

The Interested Signals in everyday life.

1- Speech heard always in telephony, radio and any where.

2- Radar signals to find the distance target.

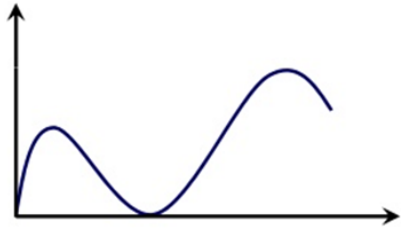
3- Sound and music.

4- Videos and images, that people watch on TV.

5- Biomedical signals such as heart, brain (electroencephalogram), blood pressure.

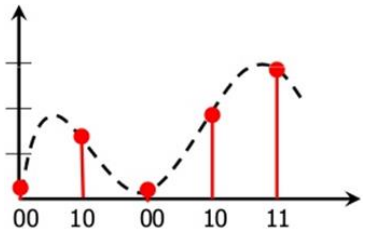
What is the meaning of Digital?

Analog refers to something that is Continuous, a set of specific points of data and all possible points between.



while:

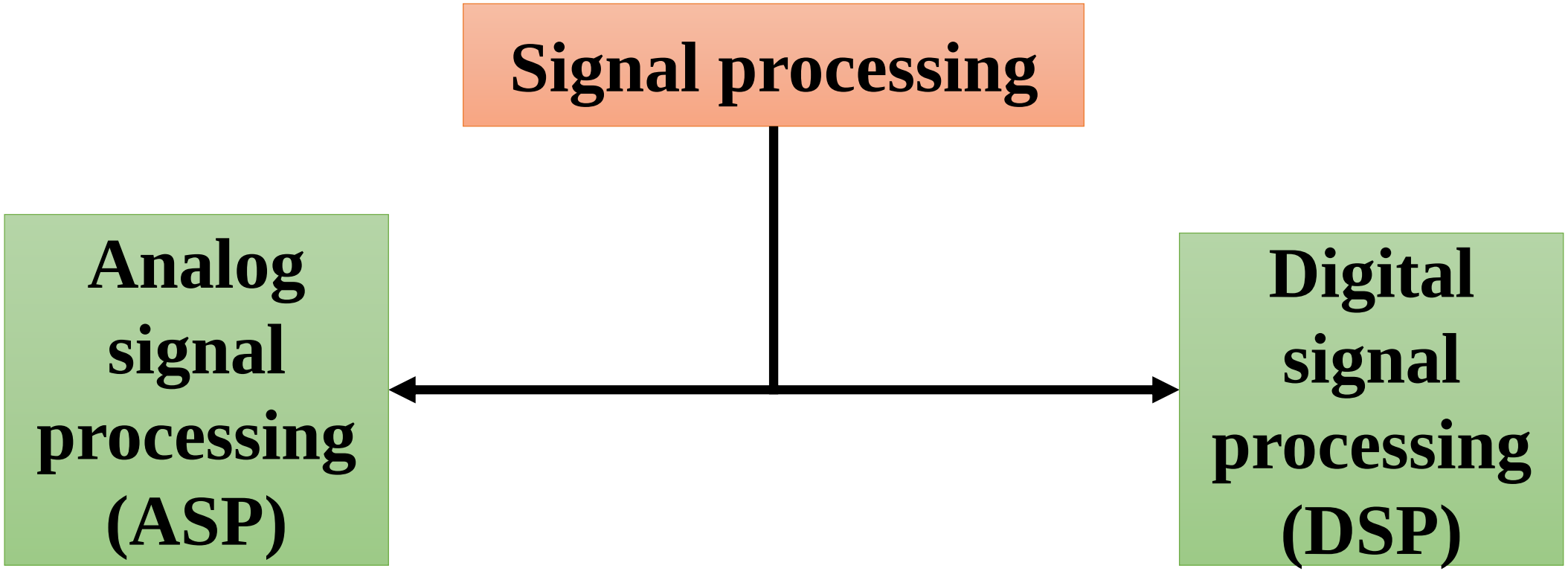
Digital to something that is discrete, a set of specific points of data with no other points between.



Types of Signals

What is the meaning of Processing?

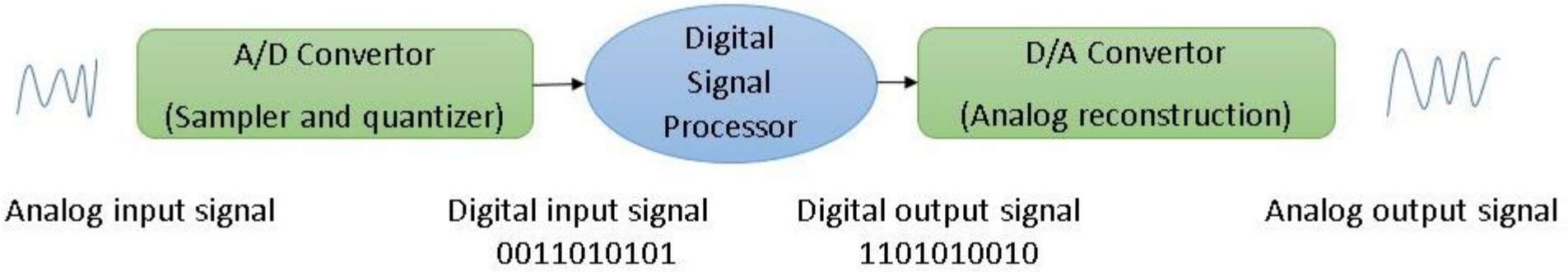
Processing: the operations applied on the signal to either extraction of useful information to be used or to changing the signals characteristics. In general, signal processing can be done in two way to obtain the processed signal as shown:



Digital signal processing is implemented in three basic steps:

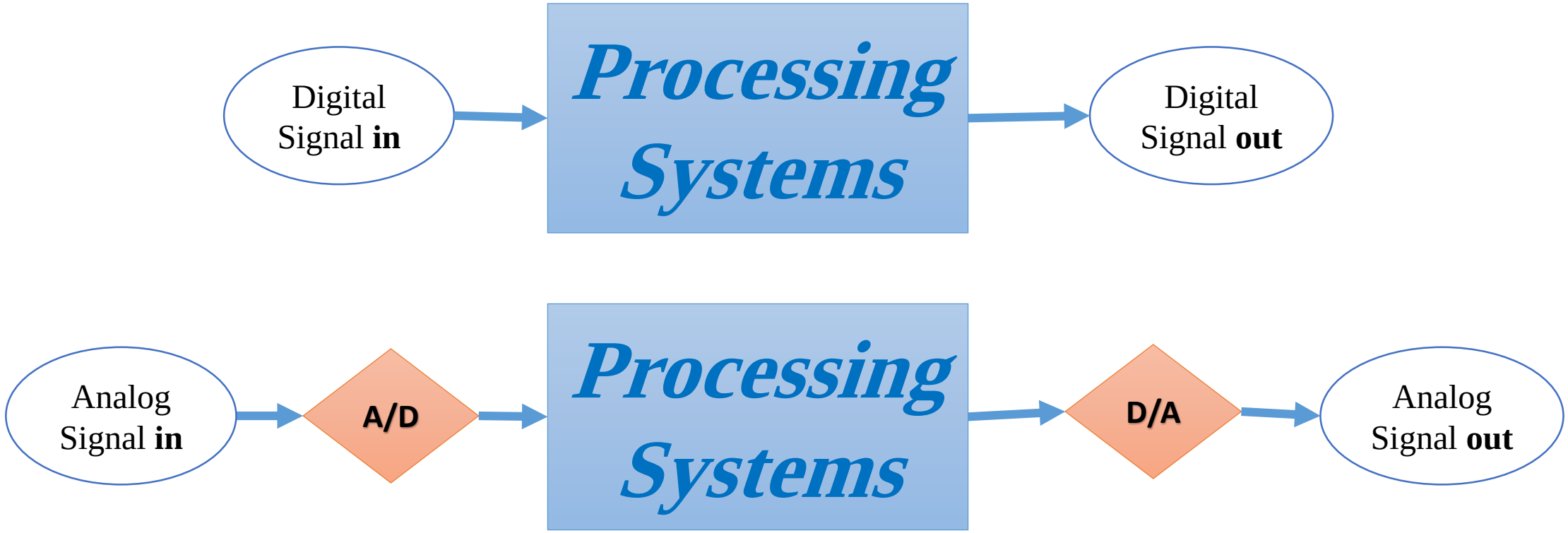
1. The analog signal is *digitized*, that is, it is *sampled* and each sample *quantized* to a finite number of bits. This process is implemented using an interface between the analog signal and the digital signal processor, which is called Analog- to- digital (A/D) convertor. It needs an analog filter prior ADC to determine the frequency range of the signal before the sampling process.
2. The digitized samples are processed by a digital signal processor.
3. The resulting digital output samples are converted back into analog form using an analog reconstruct, that is the Digital- to- Analog convertor (D/A). An analog filter is also needed after the D/A to remove the sharp transitions from the output of the DAC.

A typical digital signal processing system

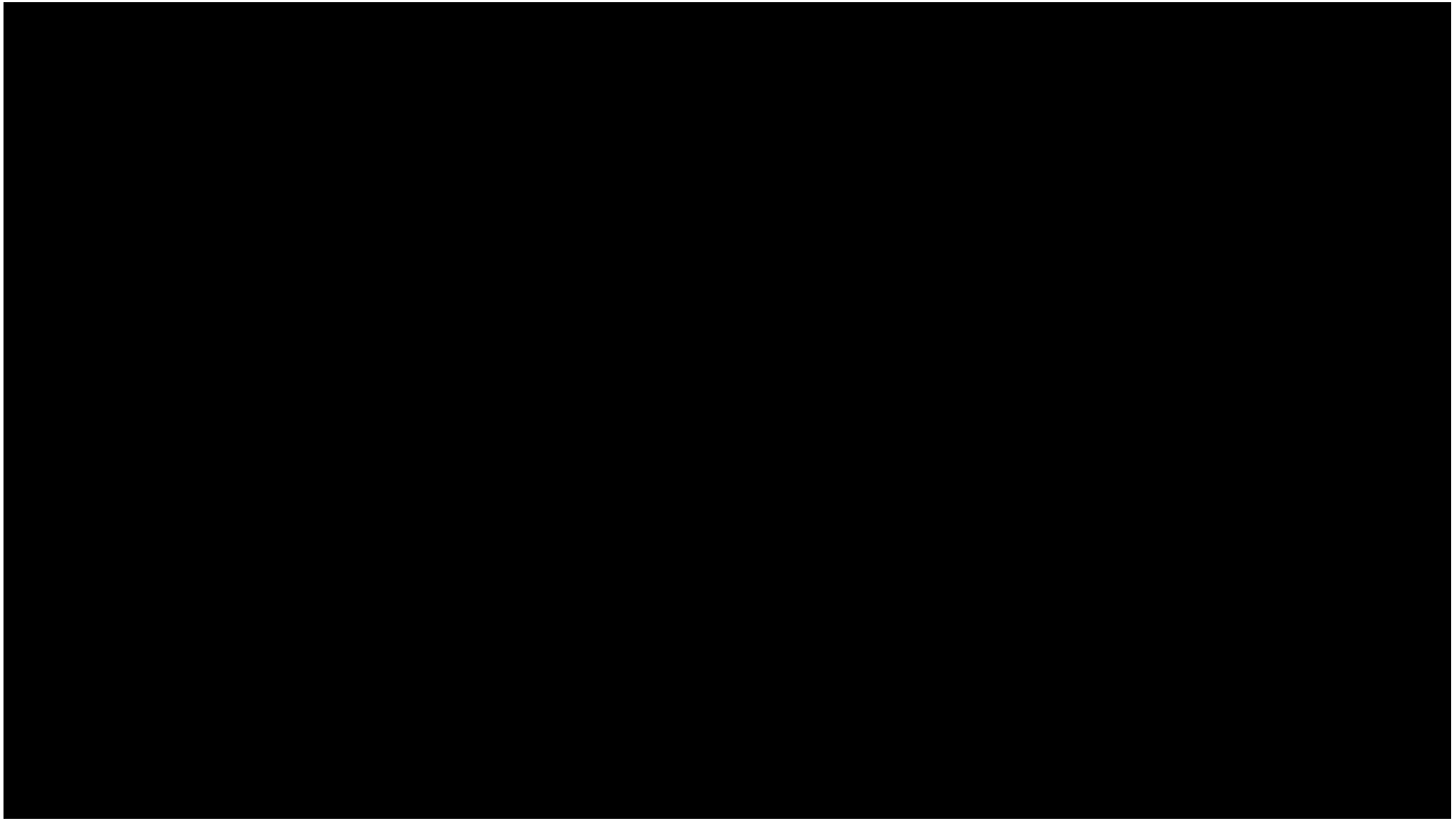


What is Digital Signal Processing?

It is an operation or transformation performed on digital signal using computer or other special-purpose digital hardware.

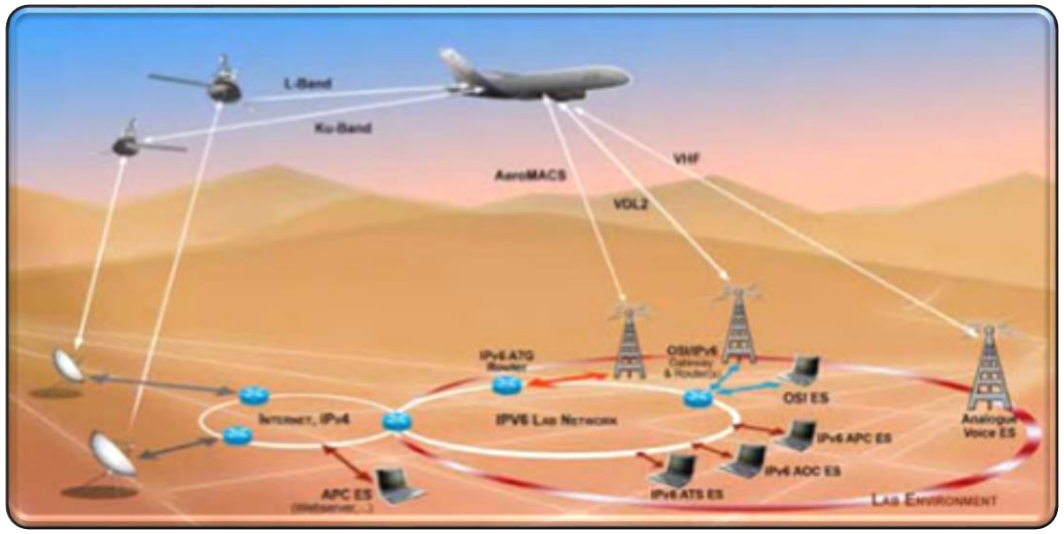


Signal Conversion from Analog and Digital



Important applications in human life

Aerospace, Defense, and Communications

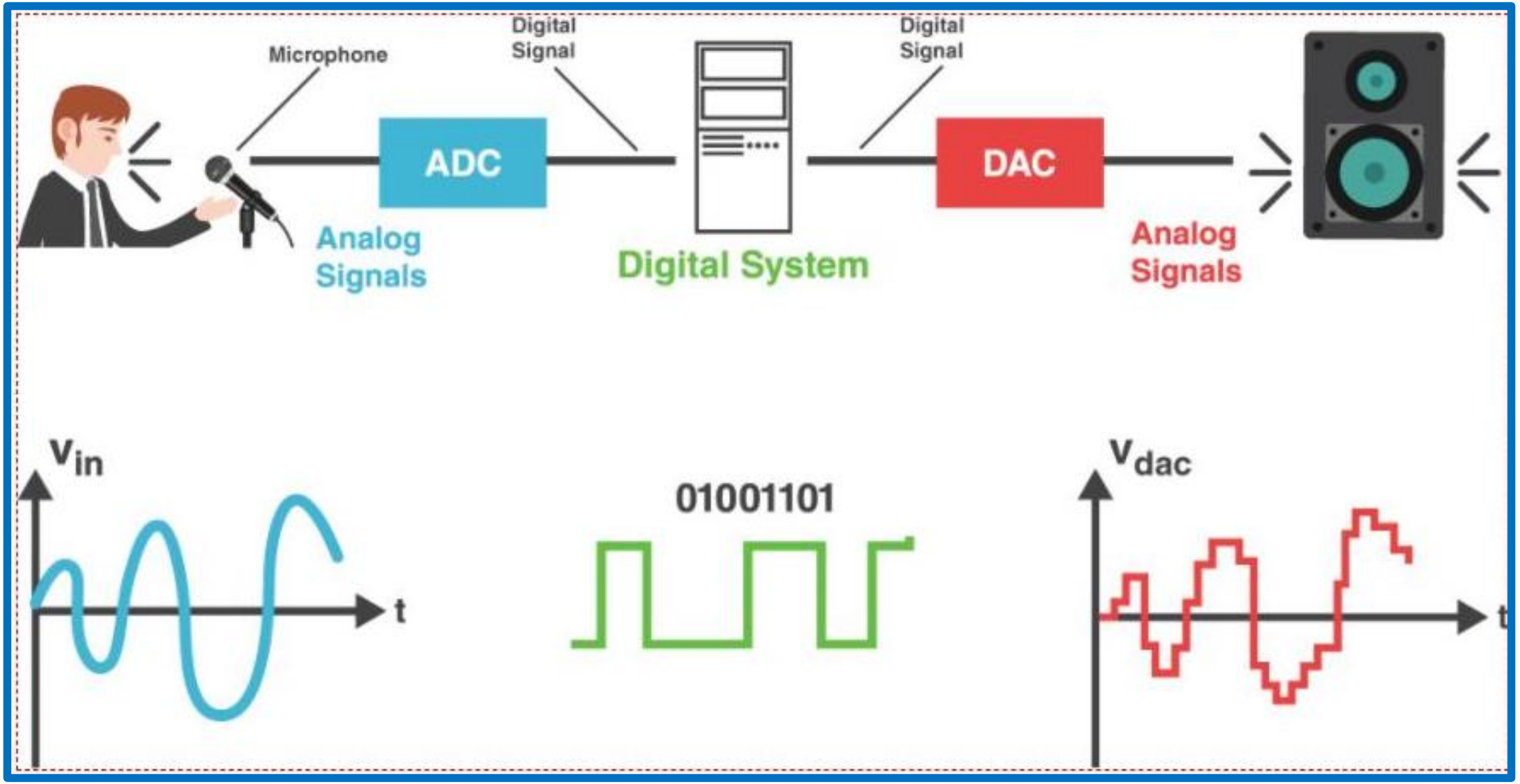


Consumer Electronics and Digital Health

Automative

Industrial Automation

Examples of DSP systems



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