# **Embedded Systems**

**System**

A system is an arrangement in which all its unit assemble work together according to a set of rules. It can also be defined as a way of working, organizing or doing one or many tasks according to a fixed plan. For example, a watch is a time displaying system. Its components follow a set of rules to show time. If one of its parts fails, the watch will stop working. So we can say, in a system, all its subcomponents depend on each other.

**Embedded System**

As its name suggests, Embedded means something that is attached to another thing. An embedded system can be thought of as a computer hardware system having software embedded in it. An embedded system can be an independent system or it can be a part of a large system. An embedded system is a microcontroller or microprocessor based system which is designed to perform a specific task. For example, a fire alarm is an embedded system; it will sense only smoke.

An embedded system has three components −

* It has hardware.
* It has application software.
* It has Real Time Operating system (RTOS) that supervises the application software and provide mechanism to let the processor run a process as per scheduling by following a plan to control the latencies. RTOS defines the way the system works. It sets the rules
* during the execution of application program. A small-scale embedded system may not have RTOS.

So, we can define an embedded system as a Microcontroller based, software driven, reliable, real-time control system.

# **Classification of Embedded Systems**

[**Embedded Systems**](https://www.geeksforgeeks.org/introduction-of-embedded-systems-set-1/) are classified based on the two factors i.e.

1. Performance and Functional Requirements
2. Performance of Micro-controllers

**Based on Performance and Functional Requirements it is divided into 4**

1. **Real-Time Embedded Systems**

A Real-Time Embedded System is strictly time specific which means these embedded systems provides output in a particular/defined time interval. These type of embedded systems provide quick response in critical situations which gives most priority to time based task performance and generation of output. That’s why real time embedded systems are used in defense sector, medical and health care sector, and some other industrial applications where output in the right time is given more importance.

Further this Real-Time Embedded System is divided into two types i.e.

* + **Soft Real Time Embedded Systems –**  
    In these types of embedded systems time/deadline is not so strictly followed. If deadline of the task is passed (means the system didn’t give result in the defined time) still result or output is accepted.
  + **Hard Real-Time Embedded Systems –**  
    In these types of embedded systems time/deadline of task is strictly followed. Task must be completed in between time frame (defined time interval) otherwise result/output may not be accepted.

**Examples :**

* + Traffic control system
  + Military usage in defense sector
  + Medical usage in health sector

1. **Stand Alone Embedded Systems**
2. Stand Alone Embedded Systems are independent systems which can work by themselves they don’t depend on a host system. It takes input in digital or analog form and provides the output.

**Examples:**

* + MP3 players
  + Microwave ovens
  + calculator

1. **Networked Embedded Systems**

Networked Embedded Systems are connected to a network which may be wired or wireless to provide output to the attached device. They communicate with embedded web server through network.

**Examples :**

* + Home security systems
  + ATM machine
  + Card swipe machine

1. **Mobile Embedded Systems**

Mobile embedded systems are small and easy to use and requires less resources. They are the most preferred embedded systems. In portability point of view mobile embedded systems are also best.

**Examples:**

* + MP3 player
  + Mobile phones
  + Digital Camera

**Based on Performance and micro-controller it is divided into 3 types as follows:**

1. **Small Scale Embedded Systems:**

Small Scale Embedded Systems are designed using an 8-bit or 16-bit micro-controller. They can be powered by a battery. The processor uses very less/limited resources of memory and processing speed. Mainly these systems does not act as an independent system they act as any component of computer system but they did not compute and dedicated for a specific task.

1. **Medium Scale Embedded Systems :**

Medium Scale Embedded Systems are designed using an 16-bit or 32-bit micro-controller. These medium Scale Embedded Systems are faster than that of small-Scale Embedded Systems. Integration of hardware and software is complex in these systems. [Java](https://www.geeksforgeeks.org/java/), [C](https://www.geeksforgeeks.org/c-programming-language/), [C++](https://www.geeksforgeeks.org/c-plus-plus/) are the programming languages are used to develop medium scale embedded systems. Different type of software tools like compiler, debugger, simulator etc are used to develop these type of systems.

1. **Sophisticated or Complex Embedded Systems:**

Sophisticated or Complex Embedded Systems are designed using multiple 32-bit or 64-bit micro-controller. These systems are developed to perform large scale complex functions. These systems have high hardware and software complexities. We use both hardware and software components to design final systems or hardware products.