

## SUMMARY

Embedded systems are specialized computer systems designed to perform specific functions and are integrated into larger mechanical or electronic systems. There are four main types of embedded systems based on functionality: standalone, networked, mobile, and real-time embedded systems.

Standalone embedded systems are self-contained units that can function independently without relying on a host computer. Examples include digital cameras, microwave ovens, and portable music players. These systems have their own processors, memory, user interfaces, and output mechanisms, allowing them to operate autonomously. Networked embedded systems rely on communication with web servers through wired or wireless networks. They connect and interact with other devices, systems, or users over a network, utilizing protocols and communication interfaces. IoT devices, home automation systems, and smart grids are examples of network embedded systems. Mobile embedded systems are designed for use while on the move and are characterized by their small, portable form factor. Examples include smartphones, tablets, and wearable devices. These systems prioritize mobility and incorporate features such as power efficiency, battery operation, and wireless connectivity. Real-time embedded systems are designed to provide results or responses within strict time constraints. They are crucial for applications where timely and deterministic responses are critical, such as automotive systems, industrial control systems, and medical devices. Real-time embedded systems can be classified as hard real-time systems, where meeting deadlines is crucial for safety, or soft real-time systems, where occasional missed deadlines are tolerated to some extent.

Embedded systems have certain characteristics such as being time-specific, low-cost, easy to operate, and task-specific. They exhibit advantages such as simplified manufacturing processes, cost-effectiveness, improved stability and speed, higher reliability, task-specific functionality, compact size, low power consumption, scalability, improved product quality, adaptability to diverse environments, reduced error occurrence, and real-time responsiveness. However, embedded systems also have some disadvantages, including limited adaptability, complexity in development, challenges in scalability, maintenance and update complexities, and limited computing power compared to general-purpose systems.

Embedded systems consist of hardware and software components. The hardware includes components like power supply, microcontrollers, memory, timers/counters, communication ports, and input/output mechanisms. The software includes an editor, compiler,

assembler, emulator, linker, and debugger. Real-time operating systems (RTOS) are specialized operating systems designed for real-time applications and provide services and functions for real-time task scheduling and resource management.

Embedded systems perform various functions, including control functions, where they oversee and manage the operation of other devices or systems, such as engine control modules in cars or industrial assembly lines. They also perform monitoring functions by collecting data from sensors and devices, such as home security systems. Additionally, embedded systems can perform processing and communication functions, data storage and retrieval functions, and user interface functions.

Finally, embedded systems play a vital role in numerous industries and applications, providing specialized and optimized functionality for specific tasks and contributing to improved efficiency, reliability, and performance.