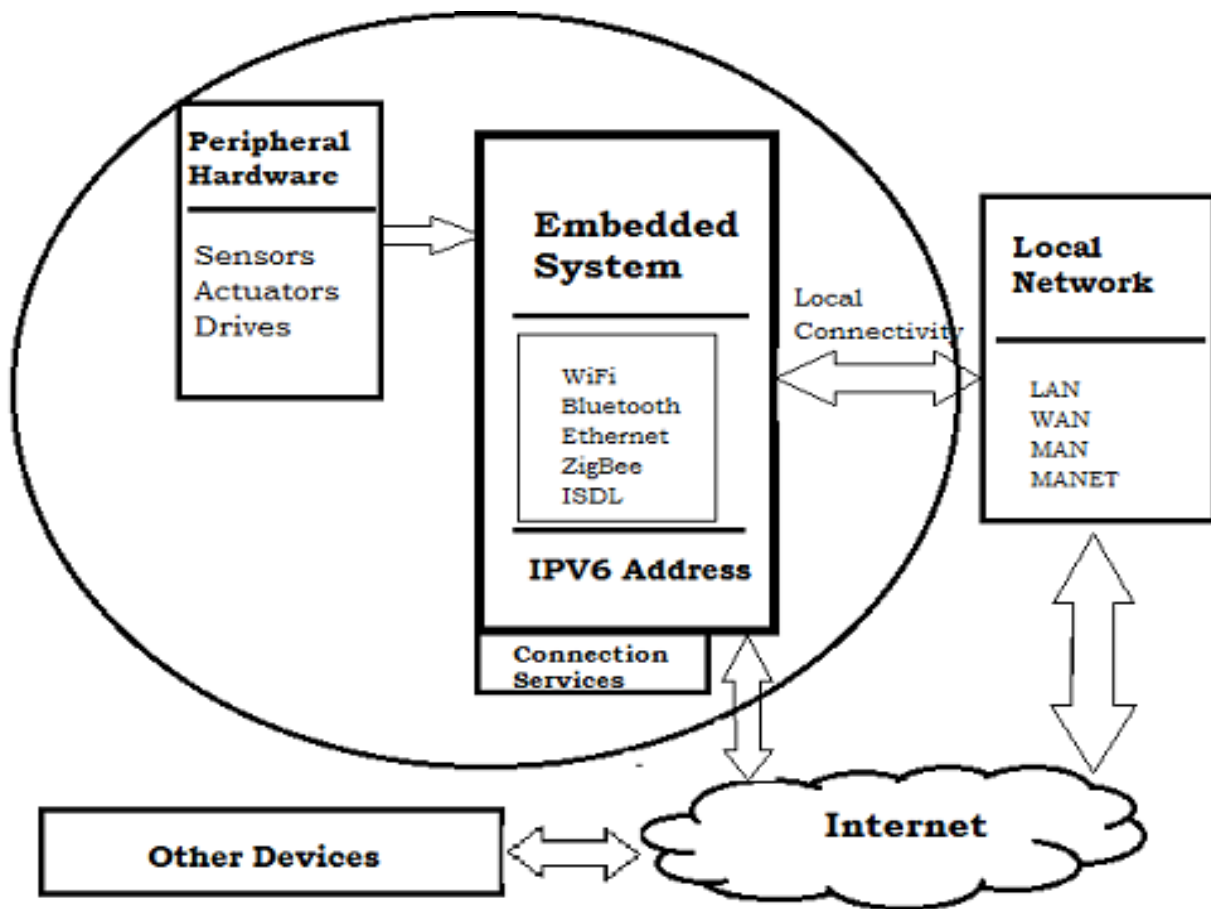


EMBEDDED COMPUTING BASICS



Internet of Things (IoT)

1. Introduction to Embedded Computing

- Embedded systems are specialized computing systems that perform dedicated tasks within larger systems.
- Found in appliances, cars, medical devices, and industrial applications.

2. Characteristics of Embedded Systems

- **Real-time operation** – Meet strict timing constraints.
- **Power efficiency** – Operate on low power, often battery-driven.
- **Compact size** – Minimal hardware footprint.
- **Reliability** – Designed for continuous operation with minimal failure.

3. Components of an Embedded System

- **Microcontroller (MCU) or Microprocessor (MPU)** – The core processing unit.
- **Memory (RAM, ROM, Flash)** – Stores firmware and runtime data.
- **Input/Output (I/O) Interfaces** – Interact with sensors, actuators, and other peripherals.
- **Timers & Interrupts** – Manage precise event handling.
- **Communication Interfaces** – SPI, I2C, UART, CAN, etc.

4. Embedded Software & Firmware

- **Bare-metal programming** – Writing code directly on hardware without an OS.
- **RTOS (Real-Time Operating System)** – Manages tasks, scheduling, and resource allocation.
- **Embedded C & C++** – Primary languages used for embedded software.

5. Types of Embedded Systems

- **Standalone Embedded Systems** – Do not require an external host (e.g., digital watches, calculators).
- **Networked Embedded Systems** – Communicate over networks (e.g., smart home devices).
- **Mobile Embedded Systems** – Found in mobile devices (e.g., GPS, smartphones).
- **Real-Time Embedded Systems** – Require immediate processing (e.g., medical devices, automotive systems).

6. Development Tools & Debugging

- **IDE & Compilers:** Keil, Arduino IDE, MPLAB, Eclipse.
- **Debuggers:** JTAG, SWD, in-circuit debuggers.
- **Simulators:** Proteus, QEMU for software testing.

7. Applications of Embedded Systems

- **Automotive:** ABS, airbag control, engine management.
- **Industrial:** PLCs, robotics, automation.
- **★ Consumer Electronics:** Smart TVs, cameras, ★ gaming consoles.
- **Medical Devices:** Pacemakers, diagnostic tools.