IFA511 Komunikasi Antar Perangkat (Internet of Things - IoT)

Perkuliahan 9 & 10

Embedded System and Programming

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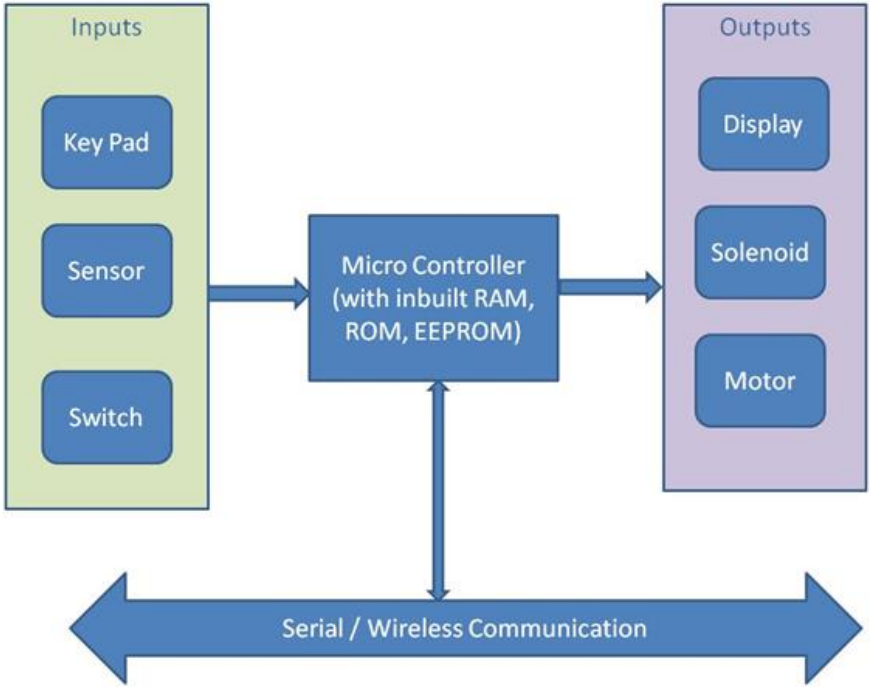
Tangerang Selatan

Embedded System/Computer

- Any sort of device which includes a programmable computer but itself is not intended to be a general-purpose computer
- General purpose
- Dedicated



Embedded systems overview

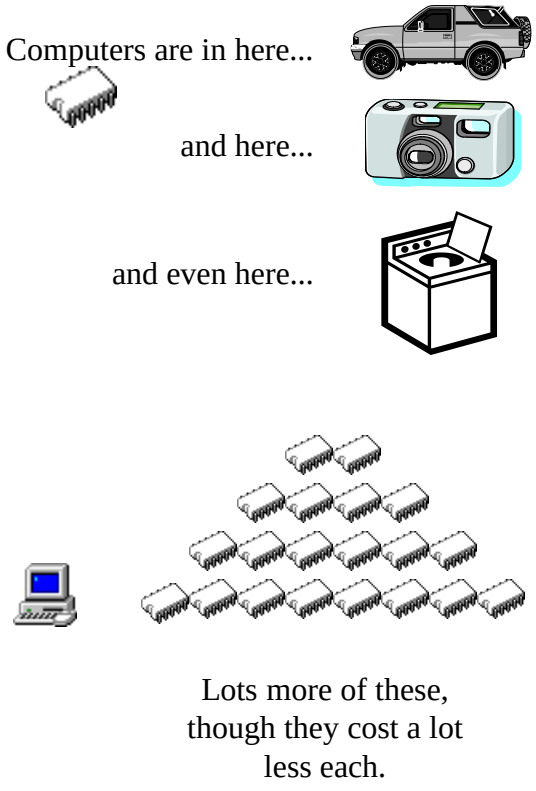
- Computing systems are everywhere
- Most of us think of “desktop” computers
  - PC’s
  - Laptops
  - Servers

- But there’s another type of computing system
  - Far more common...

Slide credit Vahid/Givargis, Embedded Systems Design: A Unified Hardware/Software Introduction, 2000

Embedded systems overview

- Embedded computing systems
  - Computing systems embedded within electronic devices
  - Hard to define. Nearly any computing system other than a desktop computer
  - Billions of units produced yearly, versus millions of desktop units
  - Perhaps 50 per household and per automobile



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A “short list” of embedded systems

Anti-lock brakes
Auto-focus cameras
Automatic teller machines
Automatic toll systems
Automatic transmission
Avionic systems
Battery chargers
Camcorders
Cell phones
Cell-phone base stations
Cordless phones
Cruise control
Curbside check-in systems
Digital cameras
Disk drives
Electronic card readers
Electronic instruments
Electronic toys/games
Factory control
Fax machines
Fingerprint identifiers
Home security systems
Life-support systems
Medical testing systems
Modems
MPEG decoders
Network cards
Network switches/routers
On-board navigation
Pagers
Photocopiers
Point-of-sale systems
Portable video games
Printers
Satellite phones
Scanners
Smart ovens/dishwashers
Speech recognizers
Stereo systems
Teleconferencing systems
Televisions
Temperature controllers
Theft tracking systems
TV set-top boxes
VCR’s, DVD players
Video game consoles
Video phones
Washers and dryers

And the list goes on and on

Slide credit Vahid/Givargis, Embedded Systems Design: A Unified Hardware/Software Introduction, 2000

Types of Embedded Systems

Four General Embedded System Types

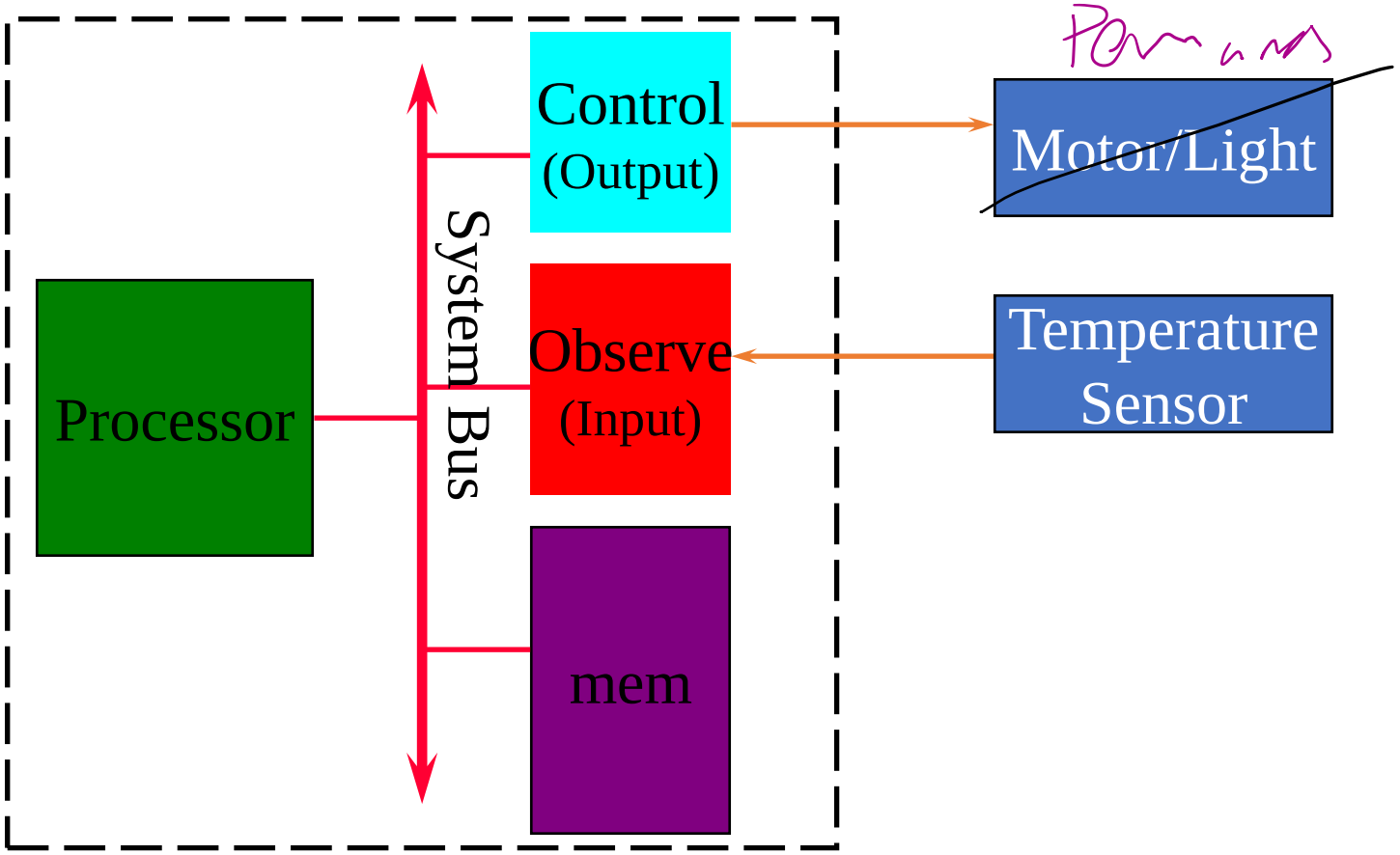
- **General Computing**
  - Applications similar to desktop computing, but in an embedded package
  - Video games, set-top boxes, wearable computers, automatic tellers
- **Control Systems**
  - Closed-loop feedback control of real-time system
  - Vehicle engines, chemical processes, nuclear power, flight control
- **Signal Processing**
  - Computations involving large data streams
  - Radar, Sonar, video compression
- **Communication & Networking**
  - Switching and information transmission
  - Telephone system, Internet

Slide credit P Koopman, CMU

Typical Embedded Systems

- Are designed to observed (through sensors) and control something (through actuators)
  - E.g. air condition senses room temperature and maintains it at set temperature via thermostat.

Embedded System Block Diagram



Slide credit Y Williams, GWU

Processors

- Microprocessors for PCs
- Embedded processors or Microcontrollers for embedded systems
  - Often with lower clock speeds
  - Integrated with memory and
  - I/O devices e.g. A/D D/A PWM CAN
  - Higher environmental specs

Types of Embedded Processors

- Computational micros (32- or 64-bit datapaths)
  - CPU of workstations, PCs, or high-end portable devices (PDAs)
  - x86, PA-RISC, PowerPC, SPARC, etc.
- Embedded general purpose micros (32-bit datapaths)
  - Designed for a wide range of embedded applications
  - Often scaled-down version of computational micros
  - ARM, PowerPC, MIPS, x86, 68K, etc.
- Microcontrollers (4-, 8-, or 16-bit datapaths)
  - Integrate processing unit, memory, I/O buses, and peripherals
  - Often low-cost, high-volume devices
- Domain-specific processors (datapath size varies greatly)
  - Designed for a particular application domain
  - Digital signal processors, multimedia processors, graphics processors, network processors, security processors, etc.

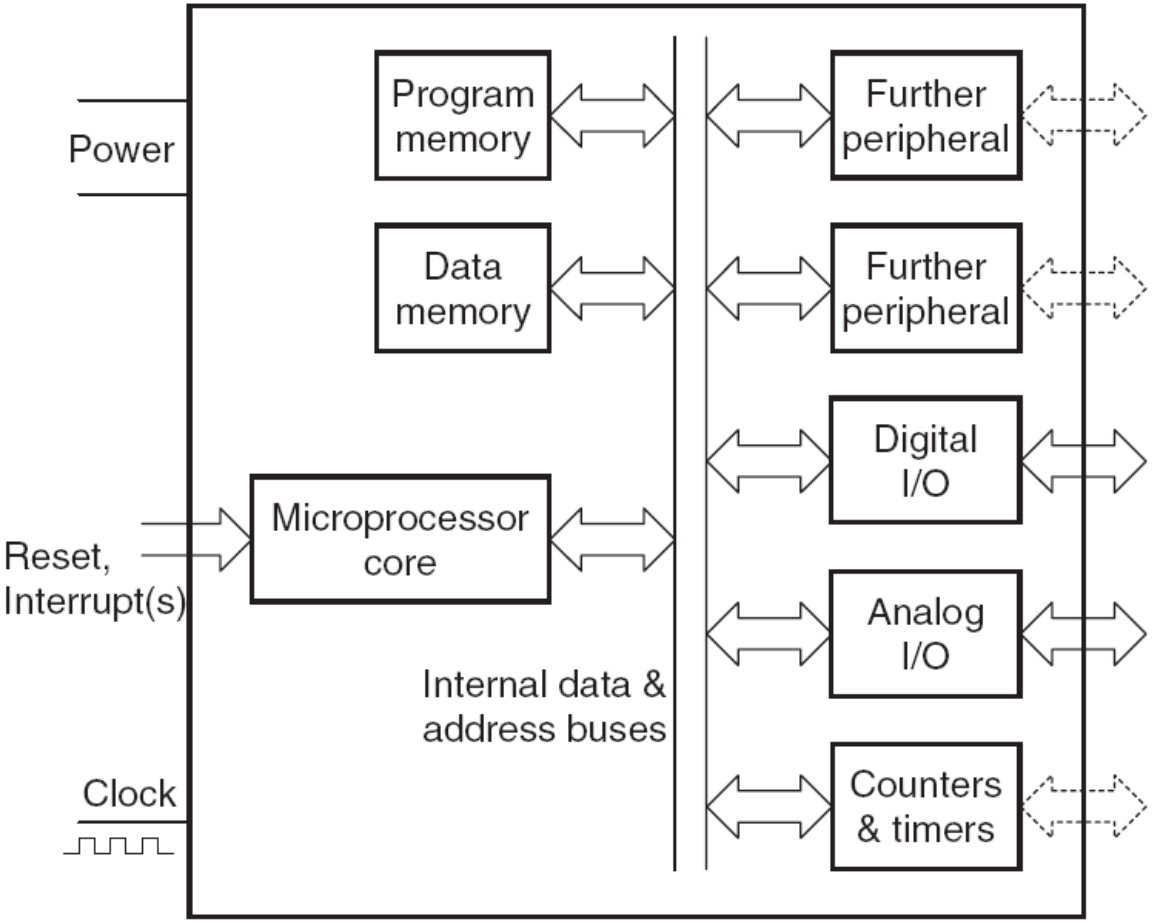
Slide credit - Mike Schulte

Microprocessors and Microcontrollers

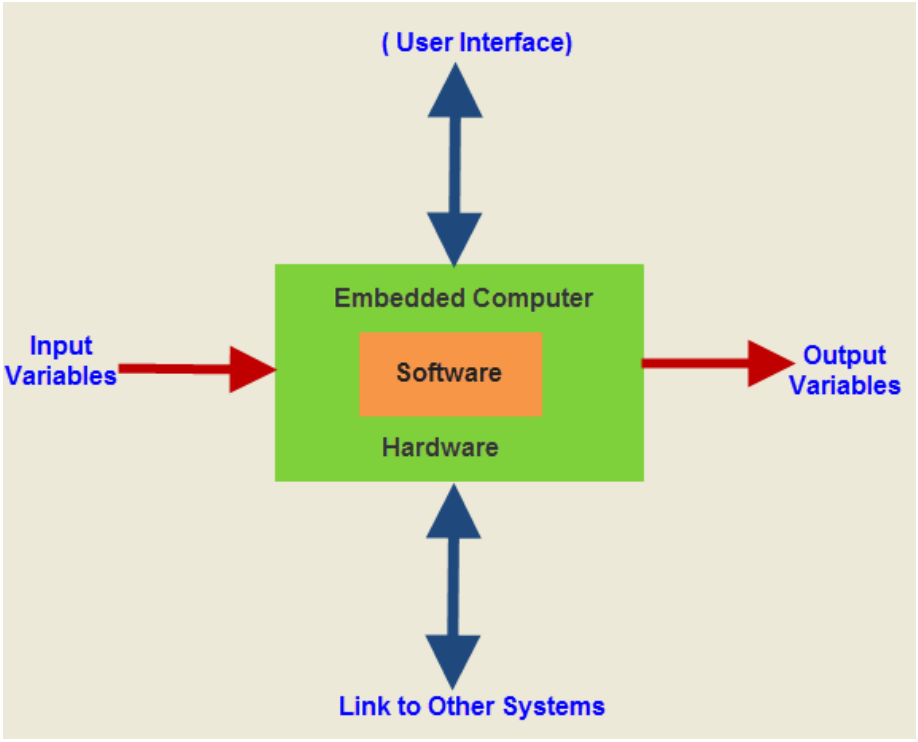
- The microprocessor is a processor on one silicon chip.

- The microcontrollers are used in embedded computing.
- The microcontroller is a microprocessor with added circuitry.

Microcontrollers

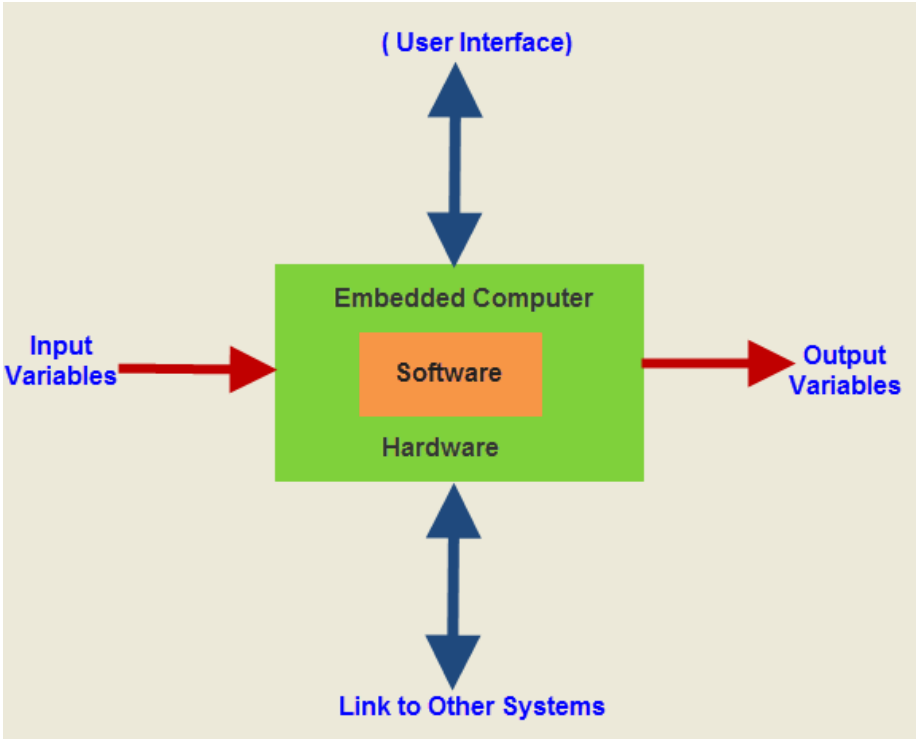


Build an Embedded System (1)

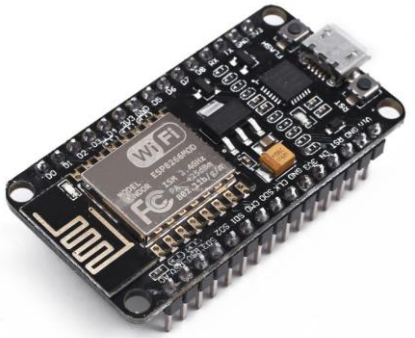


NodeMCU ESP-12

Build an Embedded System (2)



NodeMCU ESP-12



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```
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(100);                       // wait for a second
  digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW
  delay(100);                       // wait for a second
}
```