IFA511 Komunikasi Antar Perangkat (Internet of Things - IoT)

Fundamentals of IoT: Basic Concepts, Architecture, and Applications

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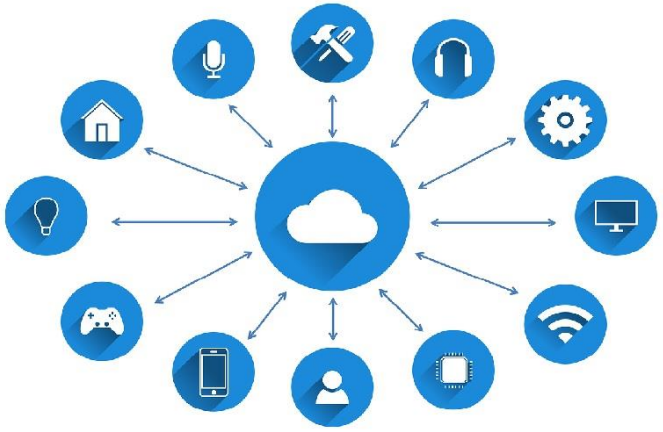
Tangerang Selatan

Internet of Things (IoT)

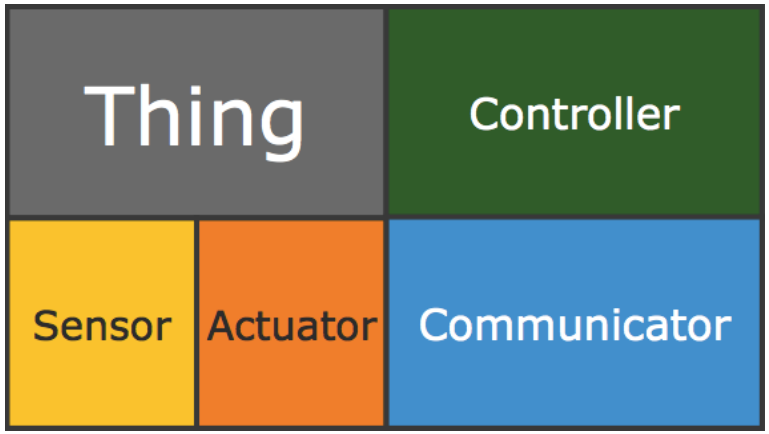
- The Internet of Things (IoT) describes the network of physical objects—“things”—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.

- By means of low-cost computing, the cloud, big data, analytics, and mobile technologies, physical things can share and collect data with minimal human intervention.



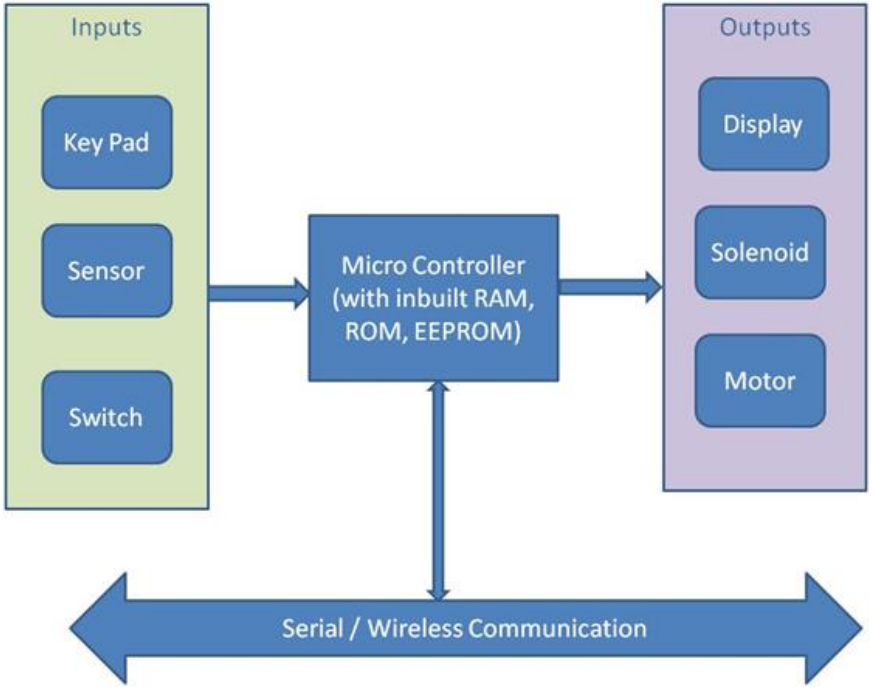
https://www.oracle.com/internet-of-things/what-is-iot/

Components of an IoT Device

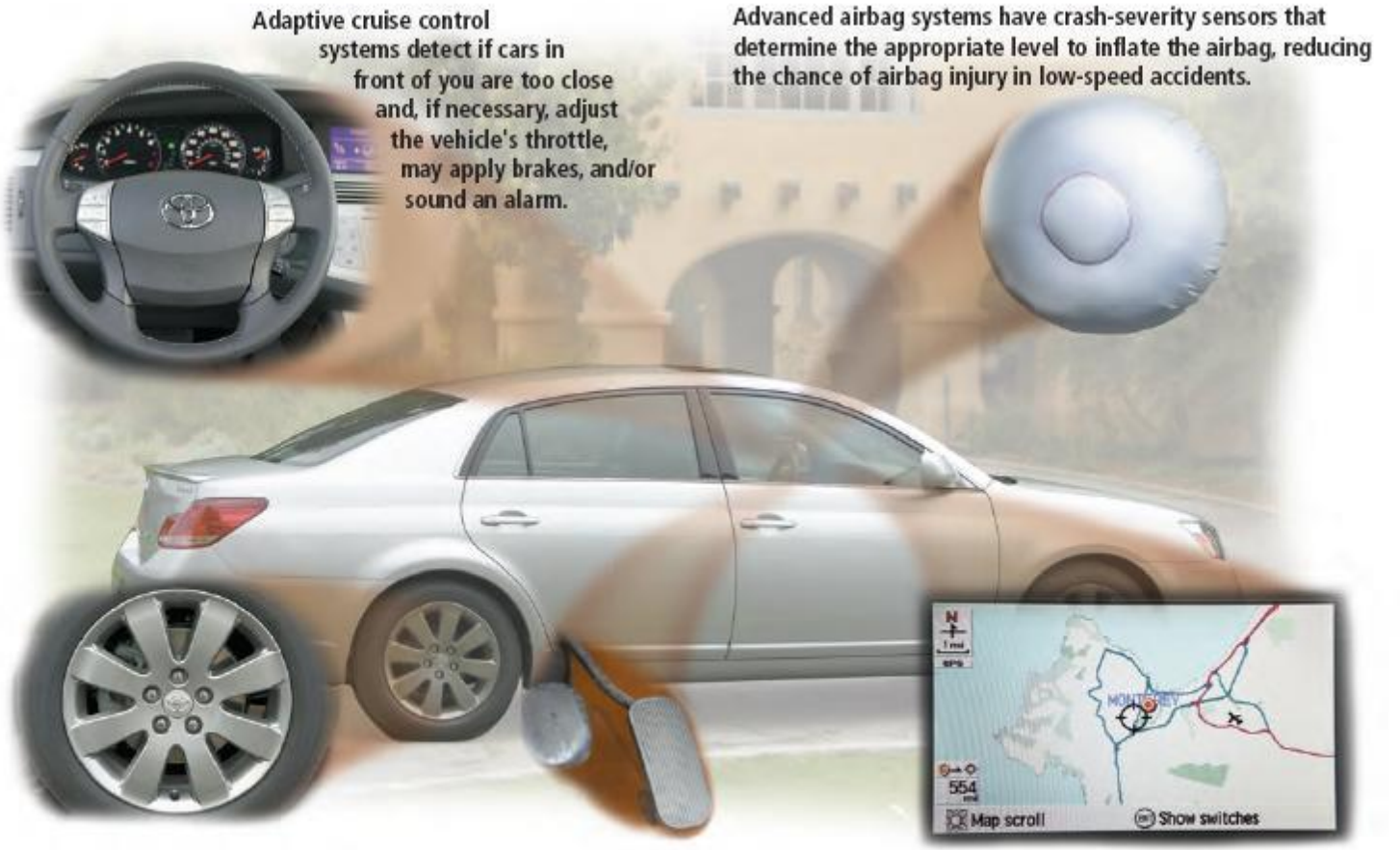


Embedded System/Computer

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



Automotive Embedded Systems



Automotive Embedded Systems

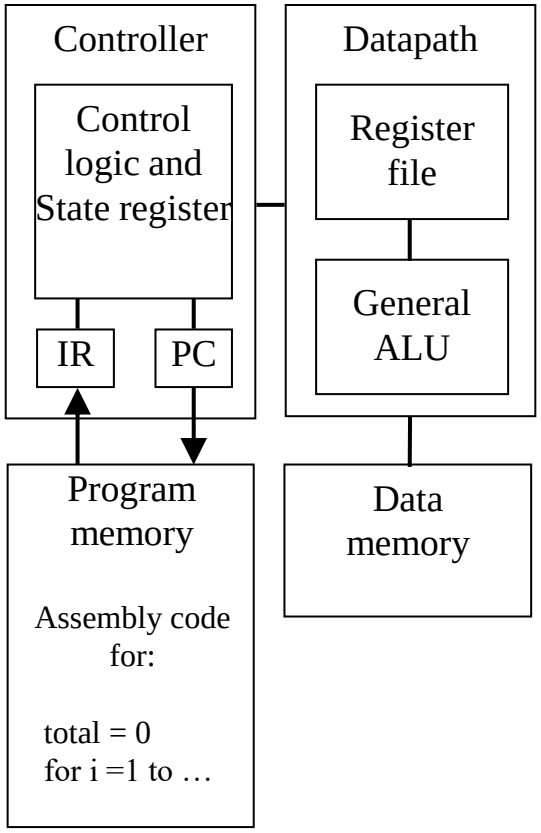
- Today's high-end automobile may have 100+ microprocessors:
  - Seat belt; dashboard devices; engine control; ABS; automatic stability control; navigation system; infotainment system; collision avoidance system; tire pressure monitoring; lane warning; adaptive cruise control; climate control; airbag control unit; electric window and central locking; parking aid; automatic wiper control; alarm and immobilizer; power seat; electric power steering; electronic transmission; active suspension

Embedded Processor Market

- 80 million PCs every year
- 3 billion embedded CPUs every year
- Embedded systems market growing, while PC market mostly saturated

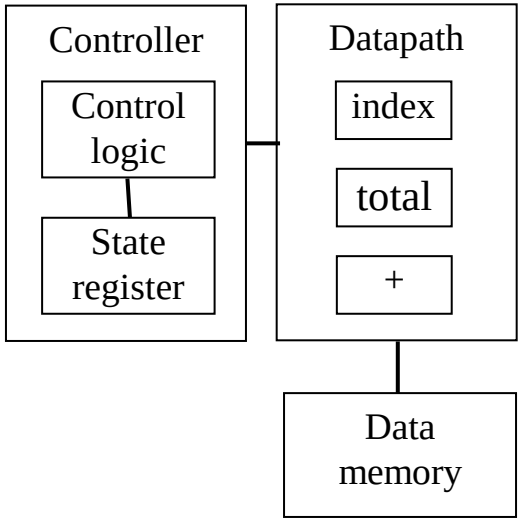
General-Purpose Processor

- Programmable device, “microprocessor”
- Features
  - Program memory
  - General data path with large register file and general ALU
- User benefits
  - Low time-to-market and NRE costs
  - High flexibility
- Examples: Intel Core i7, AMD Ryzen 5, etc.



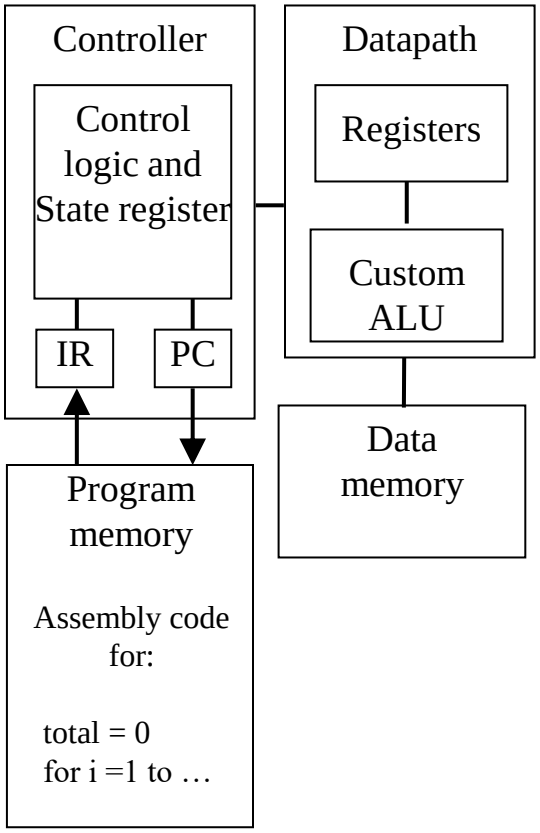
Dedicated Processor

- Digital circuit designed specifically for one purpose
- Features
  - Contains only the components needed to execute a single program
  - No program memory
- Benefits
  - Fast
  - Low power
  - Small size



Application-Specific Processor (ASIC)

- Programmable processor optimized for a particular class of applications that have common characteristics (compromise)
- Features
  - Program memory
  - Optimized data path
  - Special functional units
- Benefits
  - Some flexibility, good performance, size, and power, “reusable”

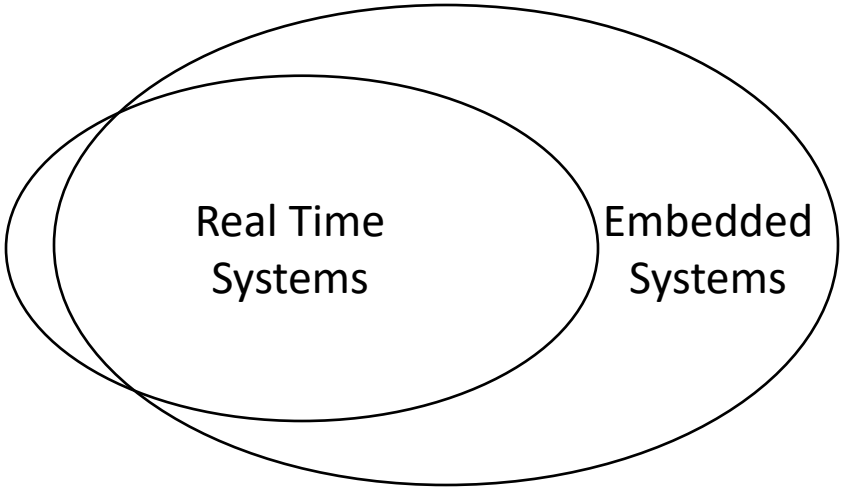


Characteristics of Embedded Systems

- Dedicated functionality
- Real-time operation
- Small size and low weight
- Low power
- Harsh environments
- Safety-critical operation
- Cost sensitive

Embedded vs. Real Time Systems

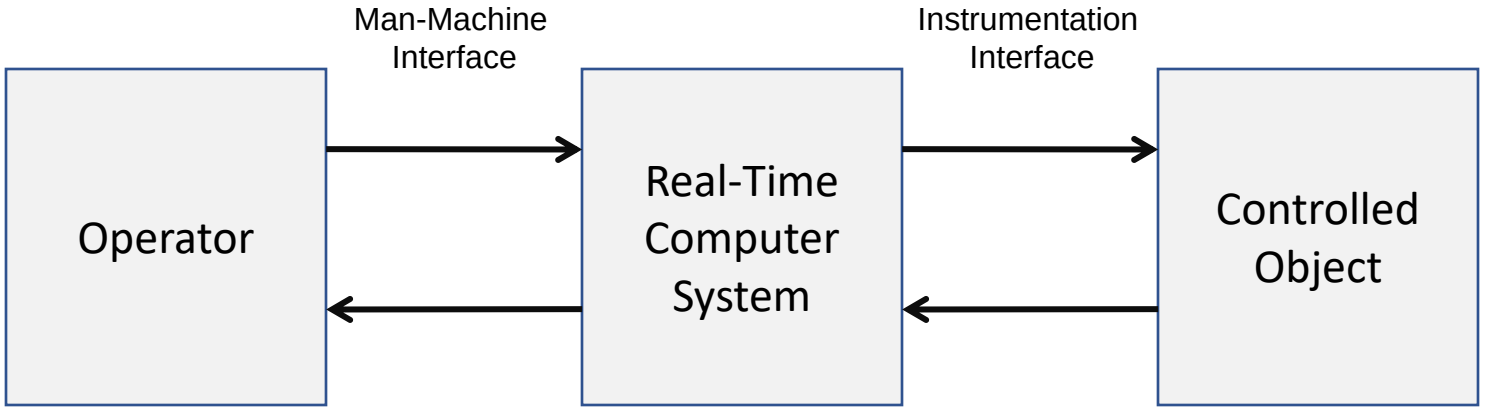
- Embedded system: is a computer system that performs a limited set of specific functions; it often interacts with its environment
- RTS: Correctness of the system depends not only on the logical results, but also on the **time** in which the results are produced



Examples

- Real Time Embedded:
  - Nuclear reactor control
  - Flight control
  - Basically any safety critical system
  - GPS
  - MP3 player
  - Mobile phone
- Real Time, but not Embedded:
  - Stock trading system
  - Skype
  - Pandora, Netflix
- Embedded, but not Real Time:
  - Home temperature control
  - Sprinkler system
  - Washing machine, refrigerator, etc.

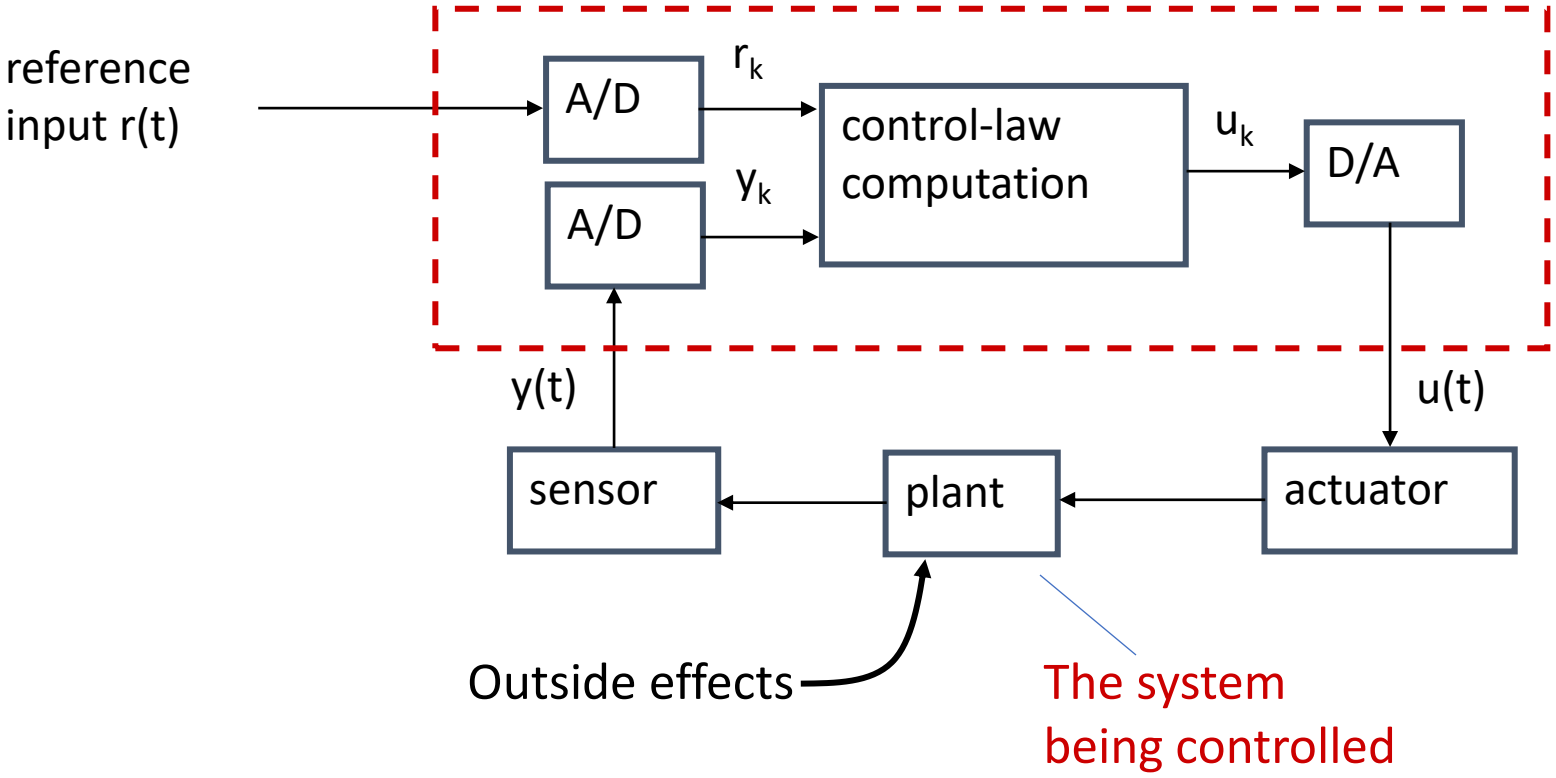
Control Systems



- **Man-machine interface:** input devices, e.g., keyboard and output devices, e.g., display
- **Instrumentation interface**: sensors and actuators that transform between physical signals and digital data
- Most control systems are hard real-time
- **Deadlines** are determined by the controlled object, i.e., the temporal behavior of the physical phenomenon (fuel injection vs. ATM)

Control System Example

Example: A simple one-sensor, one-actuator control system.



Control Systems Cont'd.

Pseudo-code for this system:

```
set timer to interrupt periodically with period T;
at each timer interrupt do
        do analog-to-digital conversion to get y;
        compute control output u;
        output u and do digital-to-analog conversion;
end do
```

T is called the **sampling period**. *T* is a key design choice. *T*ypical range for *T*: seconds to milliseconds.

Sensors and Actuators

- Sensors:
  - They are mainly input components
  - They sense and collect surrounding information
- Actuators:
  - They are mainly output components
  - They alter the surrounding

Communications

- Connects devices with each other & the cloud
- Communication type:
  - Wireline (e.g., copper wires, optical fibers)
  - Wireless (e.g., RF, IR); RF-based communication is the most popular choice
- Popular RF-based communication solutions:
  - IEEE 802.15.4
  - IEEE 802.11 (or Wifi)
  - Bluetooth
  - Near Field Communication (NFC), e.g., RFID

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