Microprocessor Systems

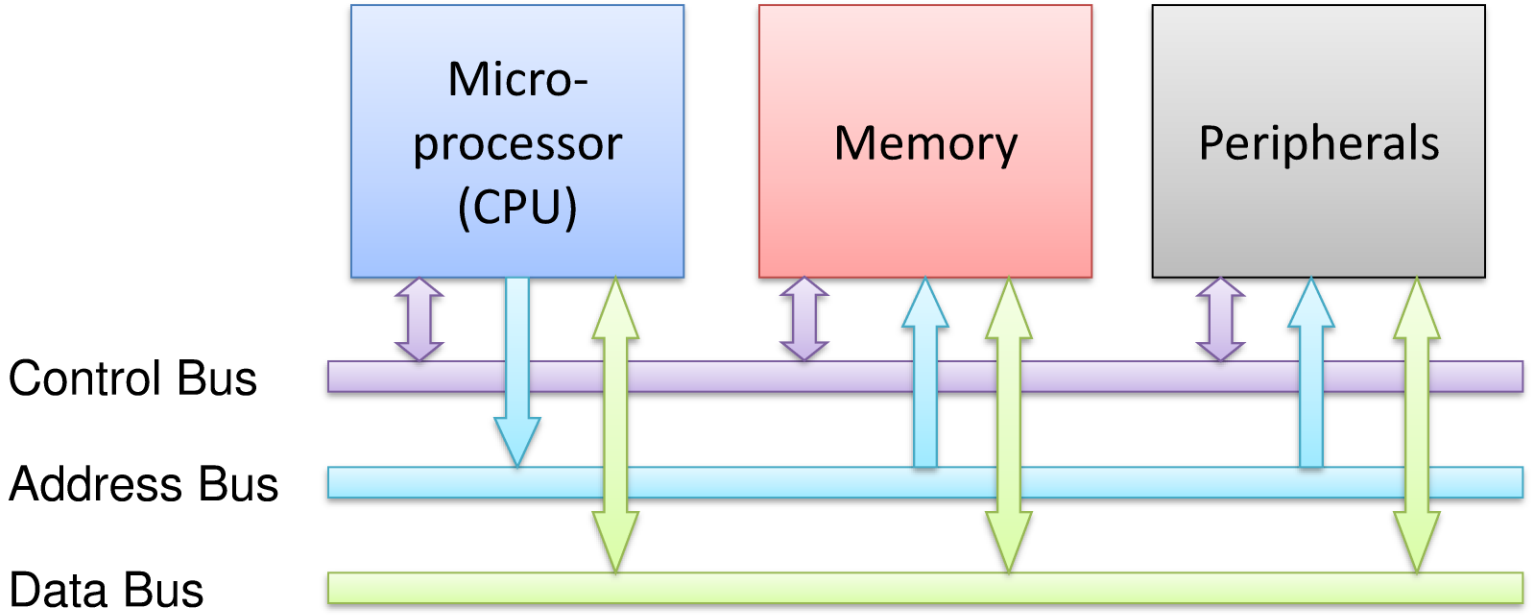
Networks and Embedded Software

Module 4.1.1

by Wolfgang Neff

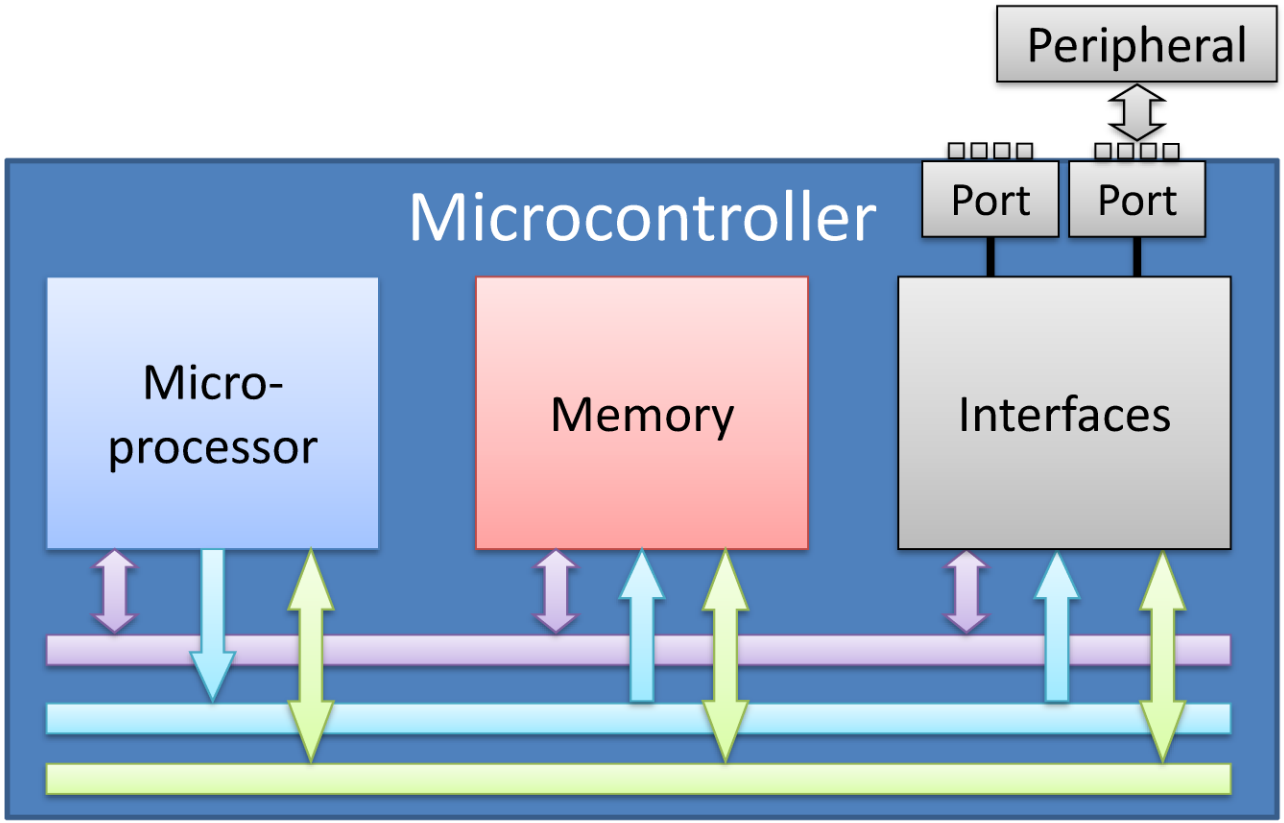
Components (1)

- Microprocessor System



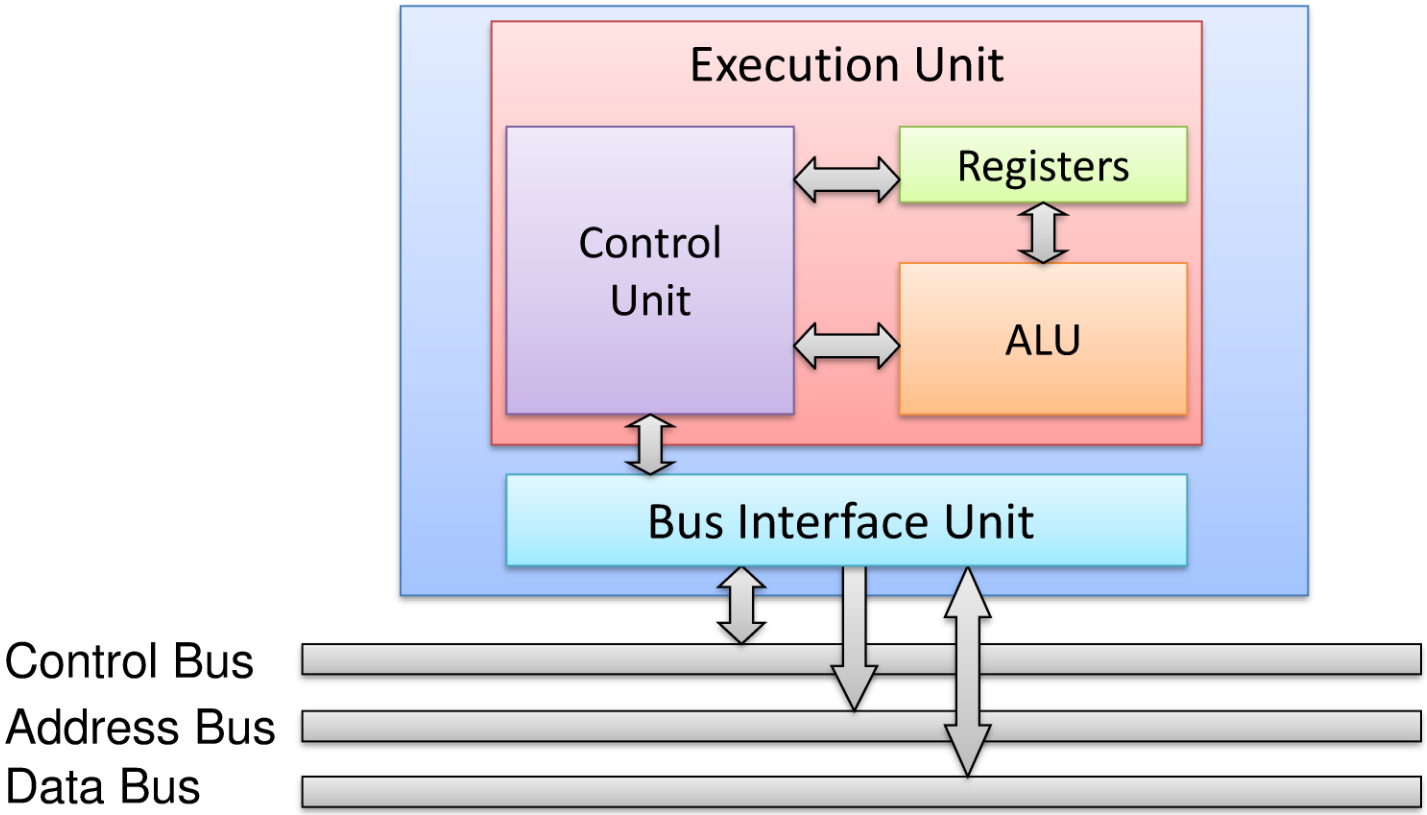
Components(2)

- Microcontroller / System on a Chip



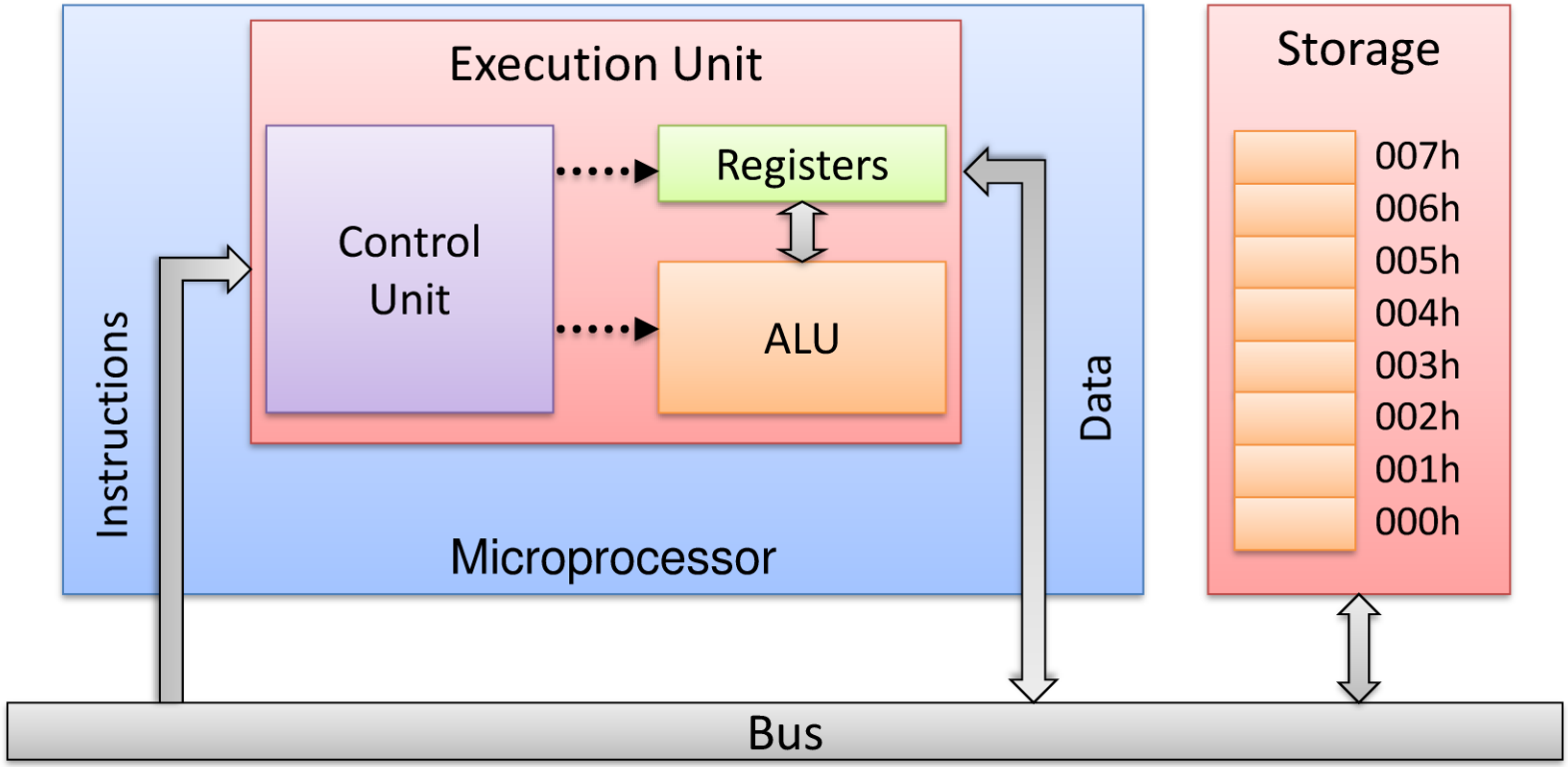
Components (3)

- Microprocessor (details: module 4.1.2)



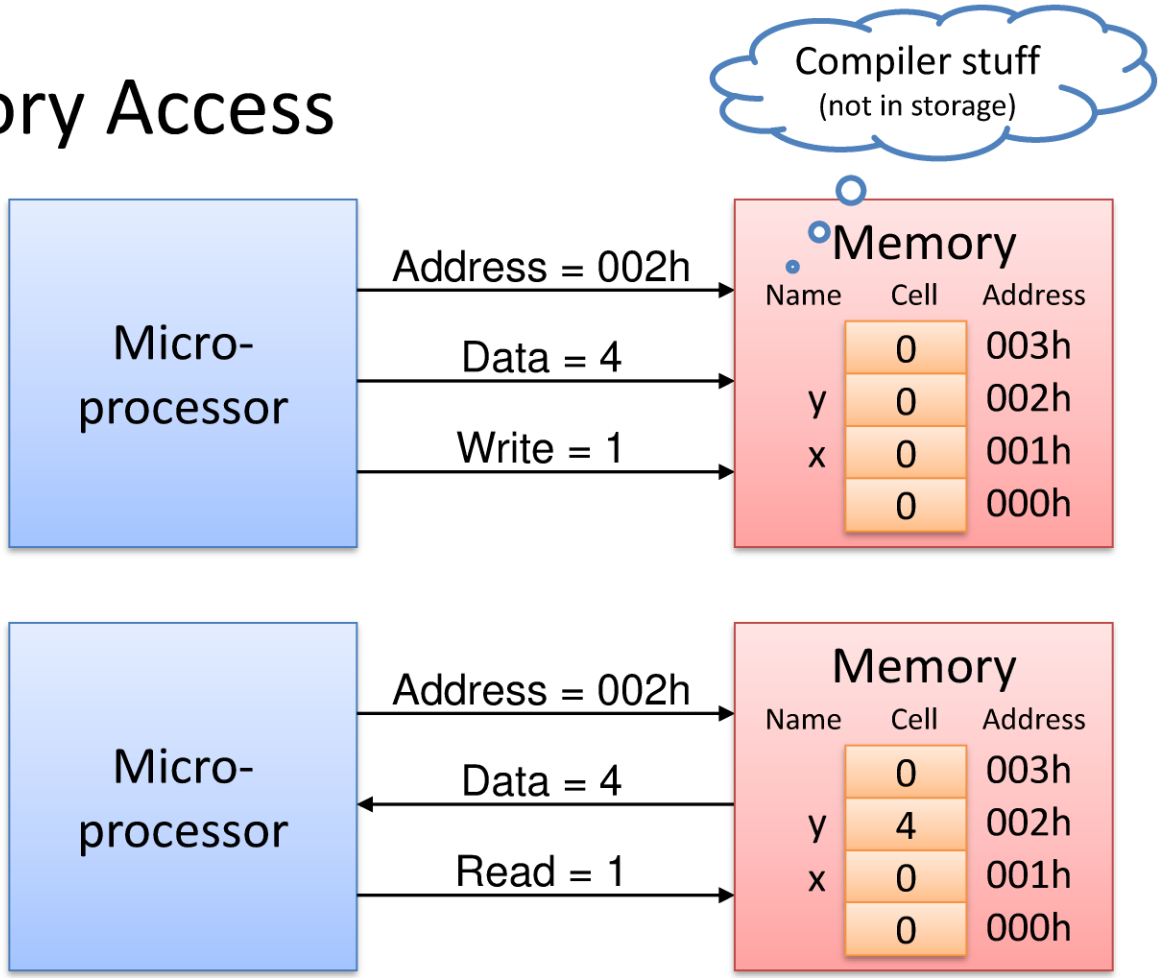
Components (4)

- Information Flow



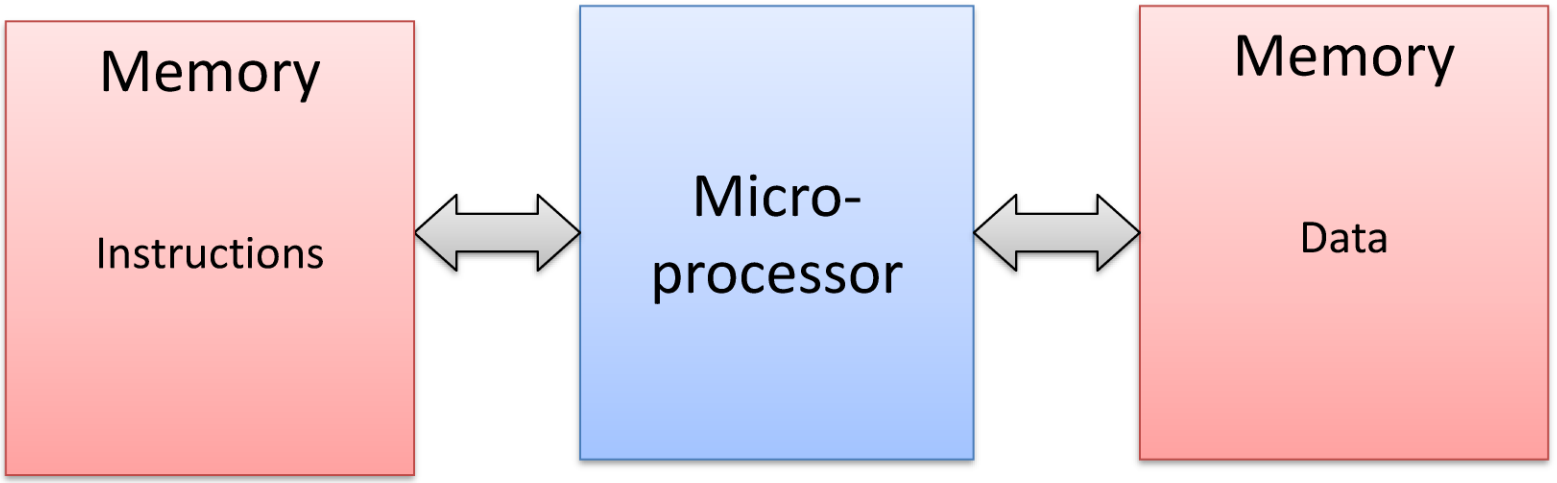
Memory (1)

- Memory Access



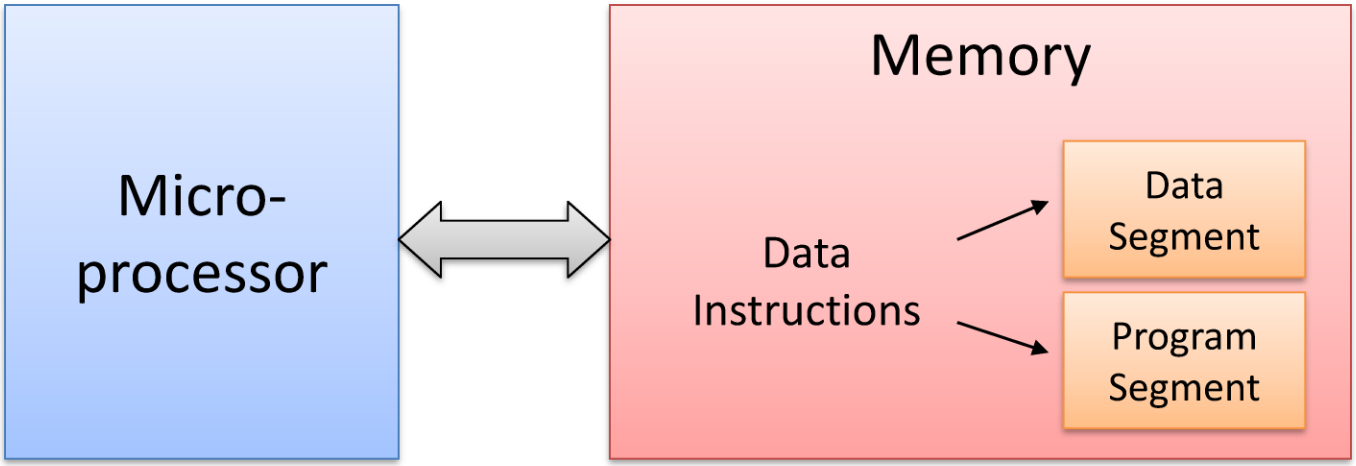
Memory (2)

- Harvard Architecture
  - One storage for instructions
  - Another storage for data



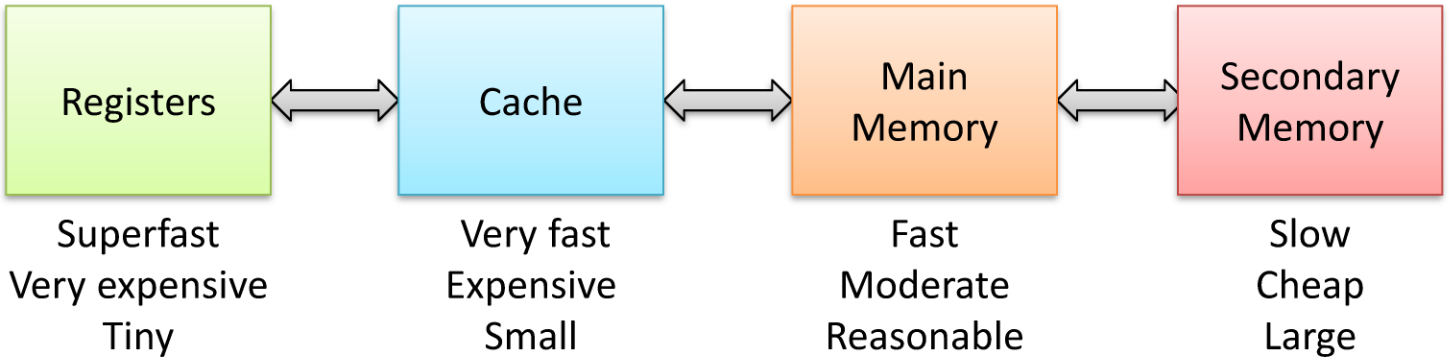
Memory (3)

- Von Neumann Architecture
  - Common storage for instructions and data
  - Sometimes segmented



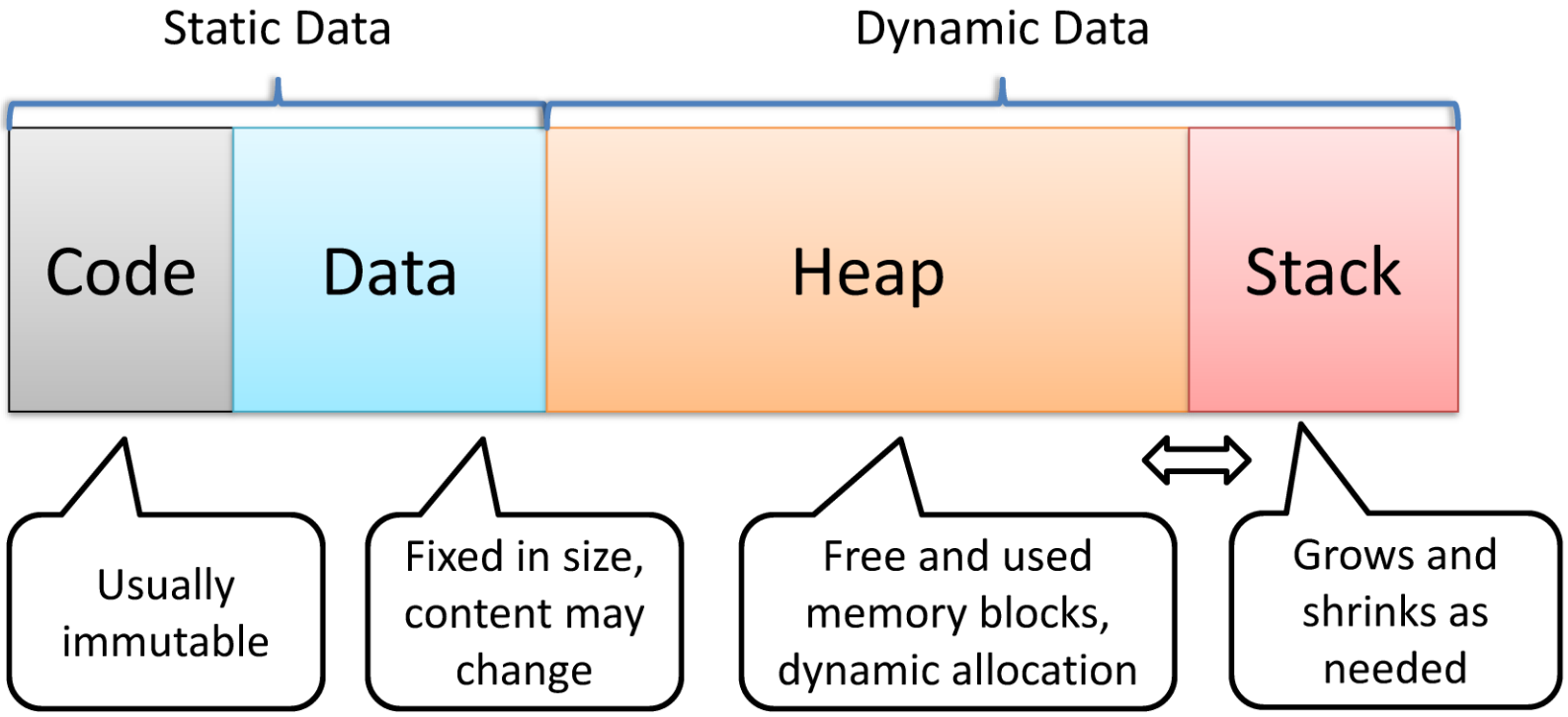
Memory (4)

- Memory Hierarchy
  - Motto: the faster the smaller
  - Data is copied between different hierarchies
  - Heavily used data is close to the microprocessor



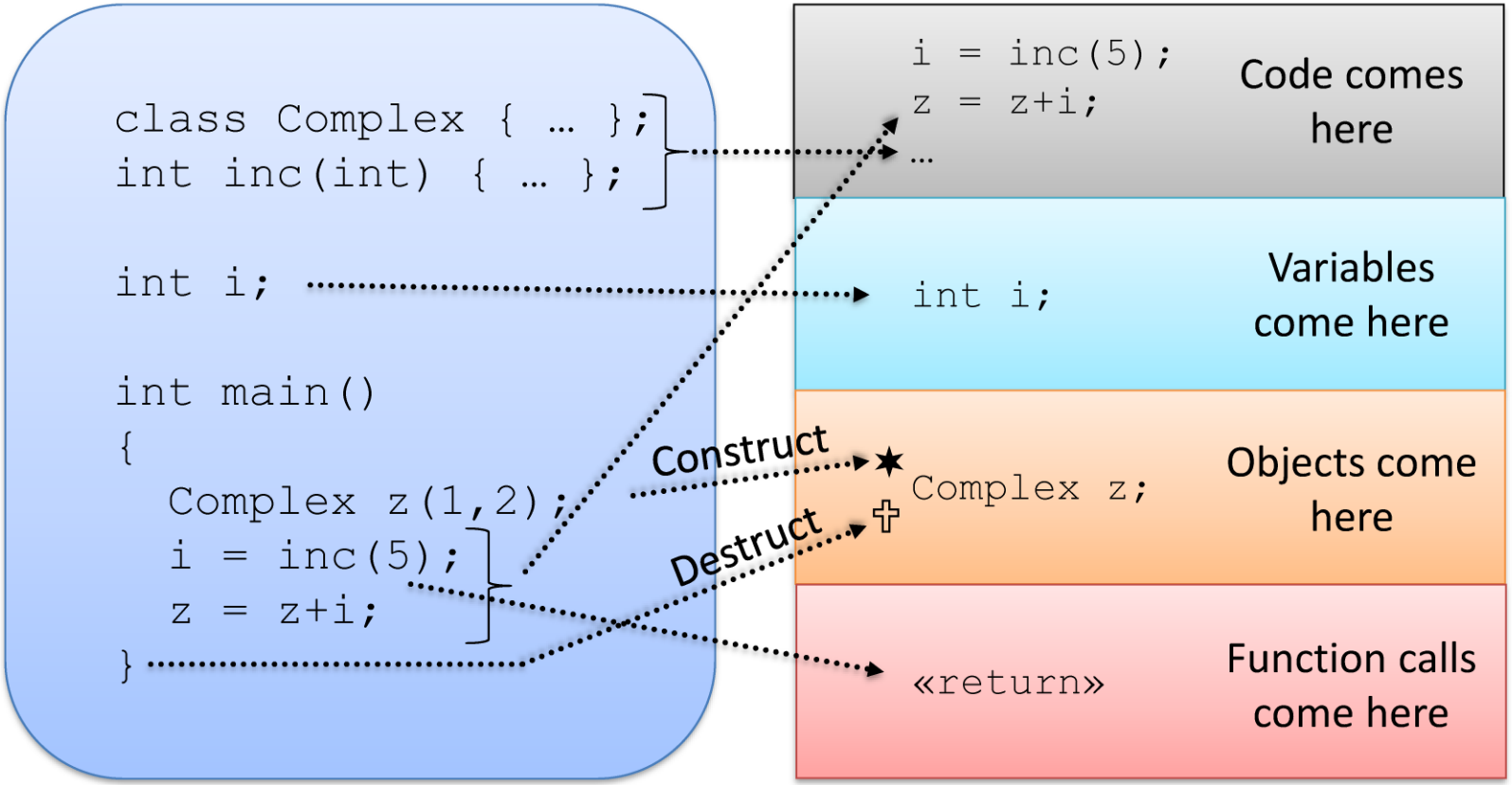
Memory (5)

- Memory Layout



Memory (6)

- Loading a program



Peripherals (1)

- Examples
  - Computers
    - Storage: hard disk drive, SSD
    - Input devices: keyboard, mouse
    - Output devices: monitor, printer, speaker

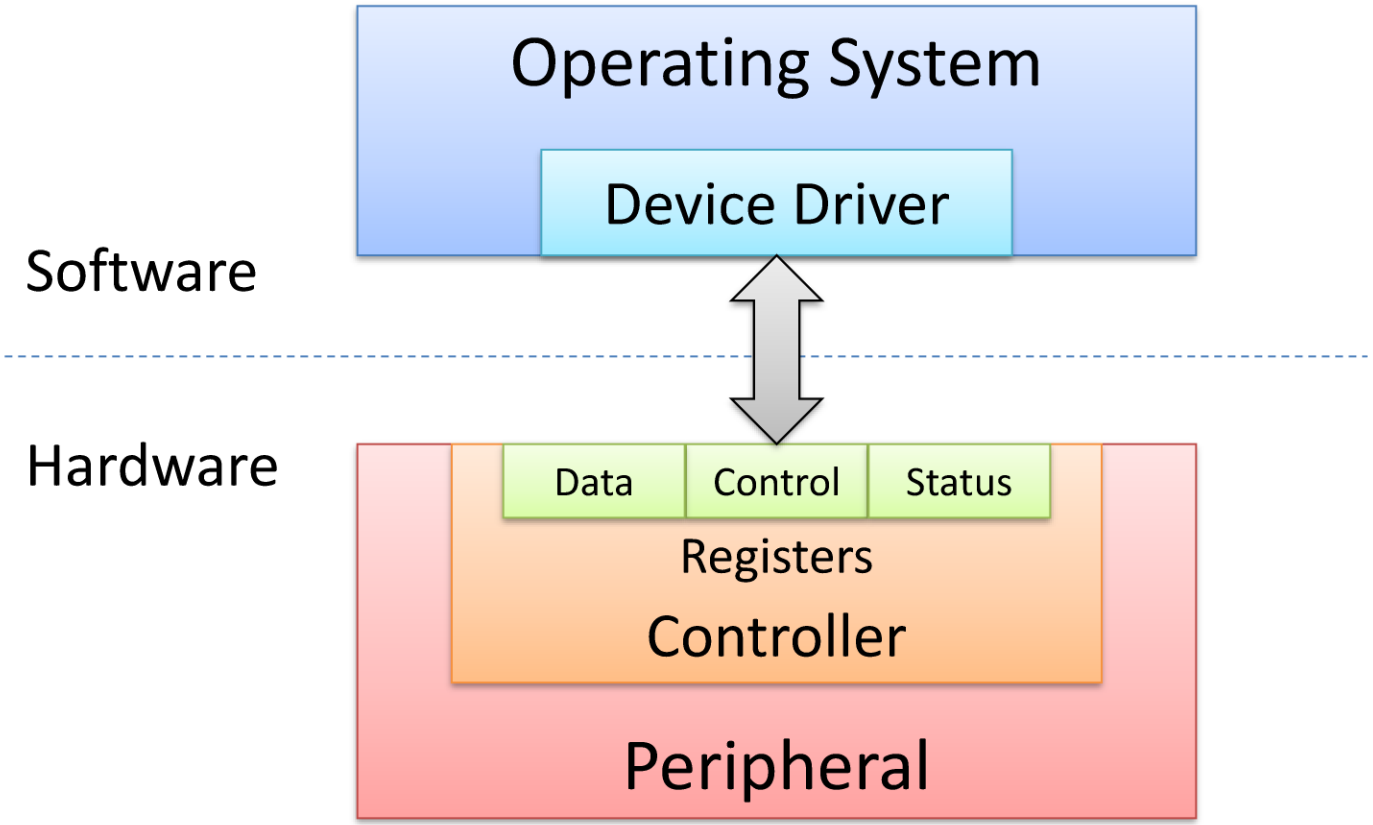
  - Mobile Phone
    - Storage: flash, SD memory card
    - Input devices: touch screen, camera
    - Further devices: accelerometer, GPS

Peripherals (2)

- Characteristics
  - Independent devices
    - Have their own controller
    - Have their own register set
  - Data exchange necessary
    - Host/Device connection
    - Connected via interface
  - Operate asynchronously
    - Device acts independently from host

Peripherals (3)

- Architecture



Peripherals (4)

- Register Set
  - Data Register
    - Used to transfer data to and from the device
      Example: the text a printer should print
  - Control Register
    - Tells the device what to do
      Example: print out a color copy, for example
  - Status Register
    - Reports what the device is doing
      Example: printer has stopped as it is out of paper

Interfaces (1)

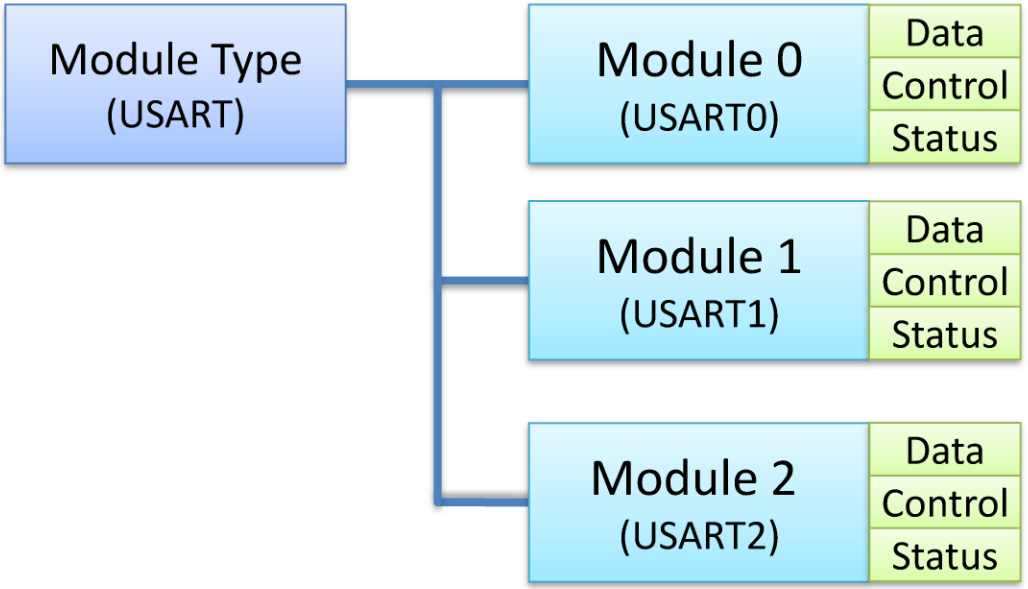
- Definitions
  - Port: Pins used by the interface
  - Module: Hardware that implements the interface
- Examples
  - Digital Ports: GPIO (module 4.2.1)
  - Analog Ports: ADC, DAC (module 4.2.6)
  - Serial Ports: UART, SPI, I^2C, CAN, USB, Ethernet, … (modules 4.2.6 and 5.2.4)

Interfaces (2)

- Modules
  - Microcontrollers have multiple modules
    - ATmega1284: 4×GPIO, 8×ADC, 2×USART, 1×SPI, …
    - ATmega4809 : 6×GPIO, 16×ADC, 4×USART, 1×SPI, …
    - ATxmega128A1: 11×GPIO, 16×ADC, 8×USART, 4×SPI, …
  - Labeling the individual modules
    - Enumeration by numbers: 0, 1, 2, 3, …
    - Enumeration by letters: A, B, C, D, …

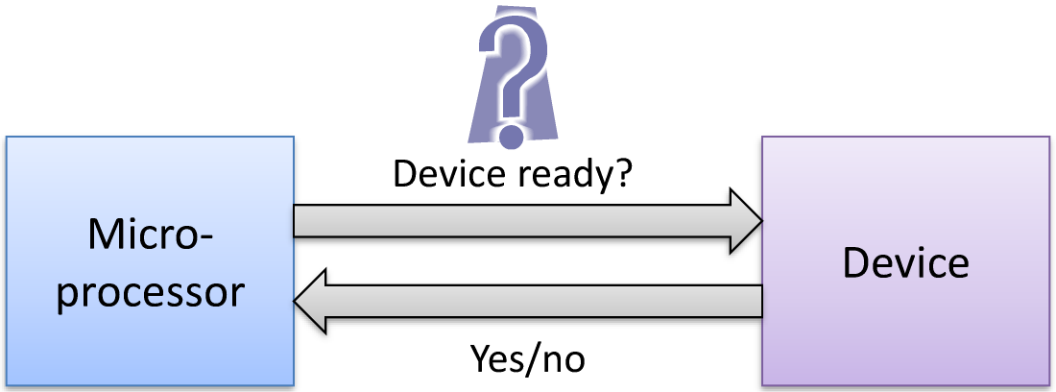
Interfaces (3)

- Modules (continued)



Interfaces (4)

- Communication
  - Polling
    - Device is polled if it is ready to receive data
    - Device is polled if new data is available



Interfaces (5)

- Communication (continued)
  - Interrupt
    - Device indicates that it is ready receive data
    - Device indicates that new data is available