

1. Embedded Computing



- ⌘ What are embedded computing systems?
- ⌘ Challenges in embedded computing system design.
- ⌘ Design methodologies.

Introduction



⌘ Microprocessors are so common

⌘ Used for

- ☑ Control

- ☑ User interface

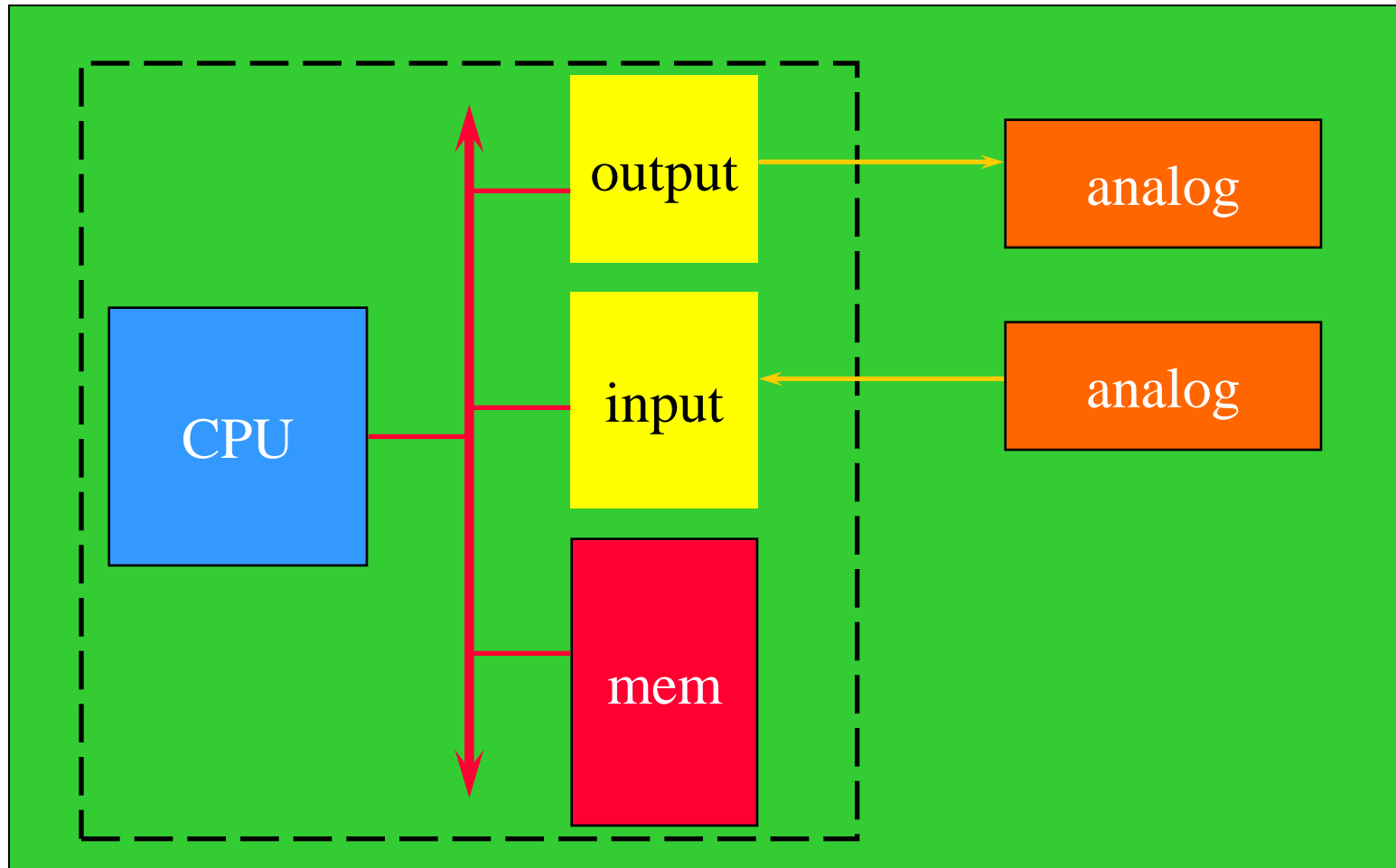
- ☑ Signal processing

Definition

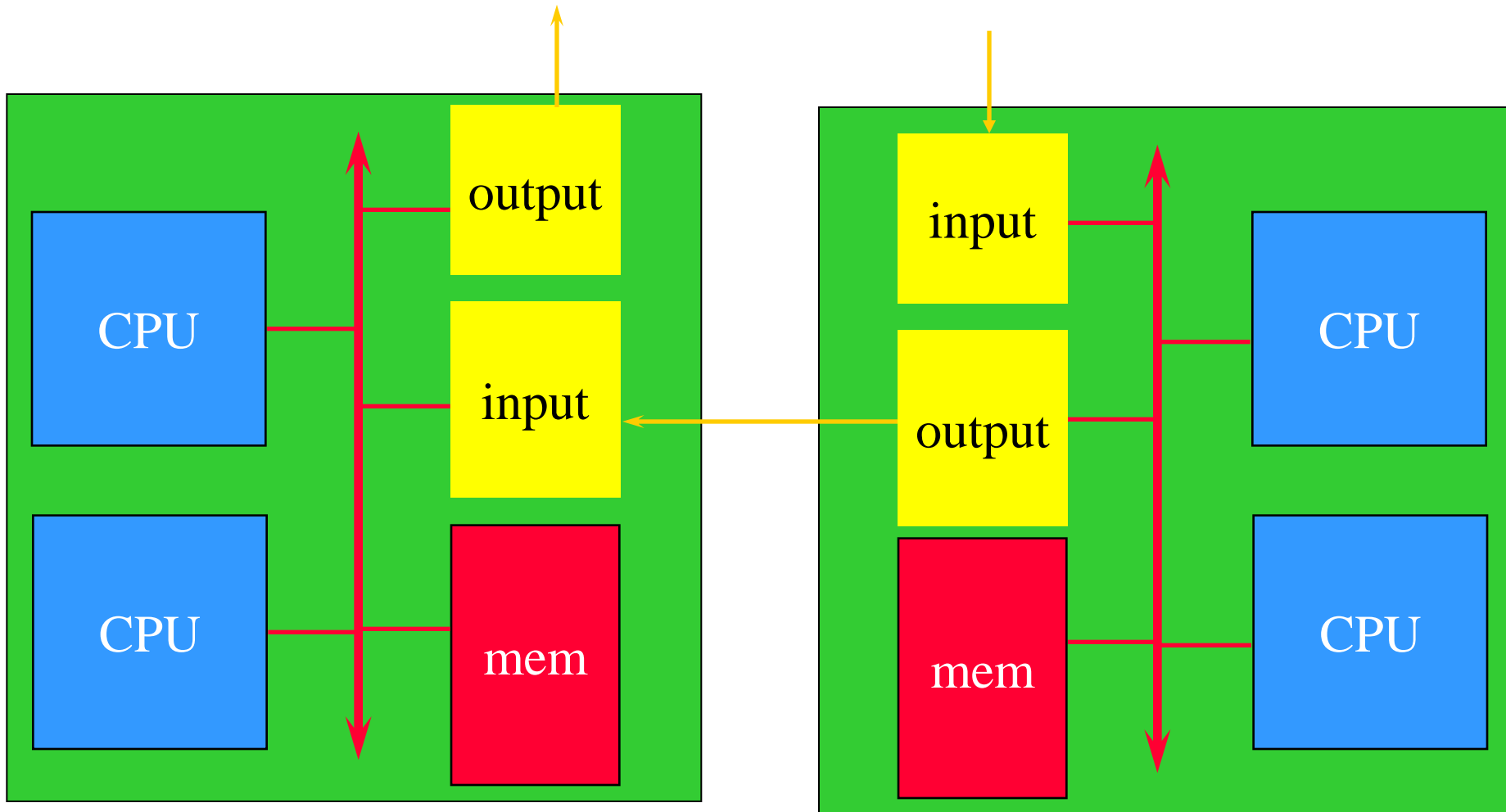


- ⌘ **Embedded computing system**: any device that includes a programmable computer but is not itself a general-purpose computer.
- ⌘ Take advantage of application characteristics to optimize the design:
 - ☑ don't need all the general-purpose bells and whistles.

Embedding a computer



Embedding multiple CPUs



Examples



- ⌘ Cell phone.
- ⌘ Printer.
- ⌘ Automobile: engine, brakes, dash, etc.
- ⌘ Airplane: engine, flight controls, nav/comm.
- ⌘ Digital television.
- ⌘ Household appliances.

Early history



- ⌘ Late 1940's: MIT Whirlwind computer was designed for real-time operations.
 - ☑ Originally designed to control an aircraft simulator.
- ⌘ First microprocessor was Intel 4004 in early 1970's.
- ⌘ HP-35 calculator used several chips to implement a microprocessor in 1972.

Early history, cont'd.



- ⌘ Automobiles used microprocessor-based engine controllers starting in 1970's.
 - ☑ Control fuel/air mixture, engine timing, etc.
 - ☑ Multiple modes of operation: warm-up, cruise, hill climbing, etc.
 - ☑ Provides lower emissions, better fuel efficiency.

Microprocessor varieties



- ⌘ **Microcontroller:** includes I/O devices, on-board memory.
- ⌘ **Digital signal processor (DSP):** microprocessor optimized for digital signal processing.
- ⌘ **Typical embedded word sizes:** 8-bit, 16-bit, 32-bit.

Application examples



- ⌘ Simple control: front panel of microwave oven, etc.
- ⌘ Canon EOS 3 has three microprocessors.
 - ☒ 32-bit RISC CPU runs autofocus and eye control systems.
- ⌘ Digital TV: programmable CPUs + hardwired logic for video/audio decode, menus, etc.

Automotive embedded systems



- ⌘ Today's high-end automobile may have 100 microprocessors:
 - ☑ 4-bit microcontroller checks seat belt;
 - ☑ microcontrollers run dashboard devices;
 - ☑ 16/32-bit microprocessor controls engine.

BMW 850i brake and stability control system

- ⌘ Anti-lock brake system (ABS): pumps brakes to reduce skidding.
- ⌘ Automatic stability control (ASC+T): controls engine to improve stability.
- ⌘ ABS and ASC+T communicate.
 - ☑ ABS was introduced first---needed to interface to existing ABS module.

BMW 850i, cont'd.

