Microprocessor System Design

EHB432E

Lecture -2

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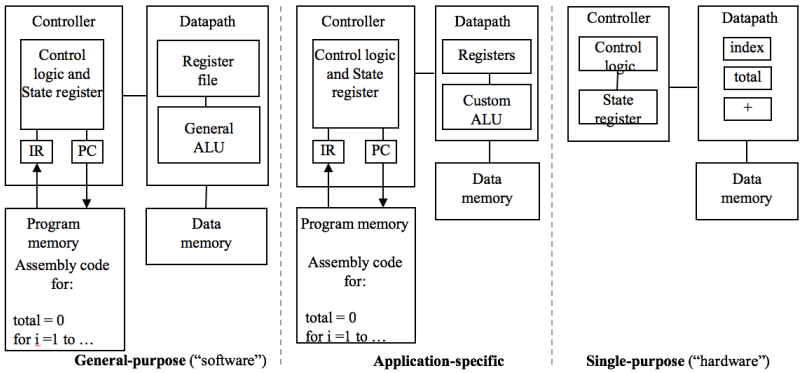
Three key technologies for embedded systems

- Processor technology
- IC technology
- Design technology



The architecture of the computation engine used to implement a system's desired

Processor

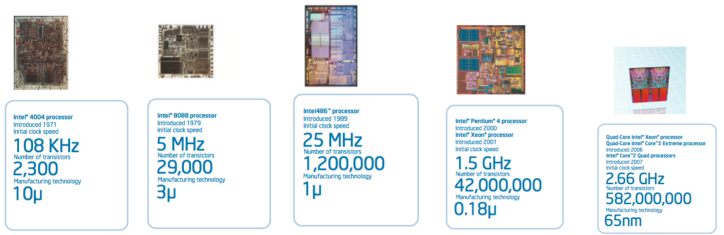
A processor is a digital circuit designed to perform computational tasks.
A processor consists of

- a datapath: storing and manipulating data
- a controller: moving data through the datapath

A general-purpose proc. can carry out a wide variety of computational task.
A single-purpose proc. can only carry out particular computational task.

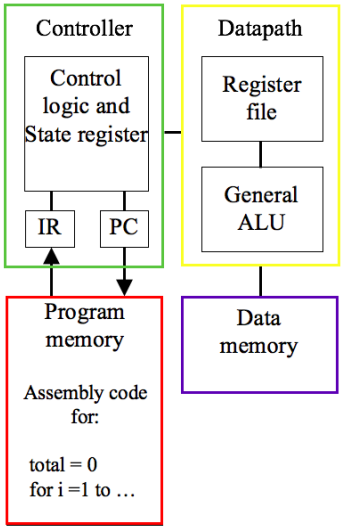
General-purpose processors

- Programmable device used in a variety of applications ("microprocessor")
- Features
  - Program memory
  - General datapath with large register file and general ALU
- User benefits
  - Low time-to-market and NRE costs
  - High flexibility



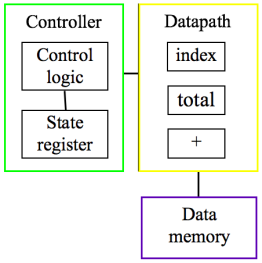
Link

General-purpose processors



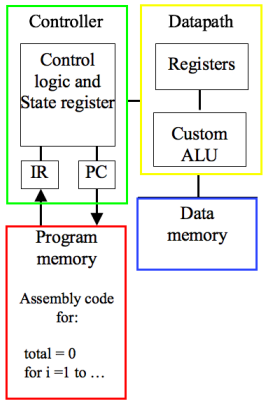
Single-purpose processors

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



Application-specific processors

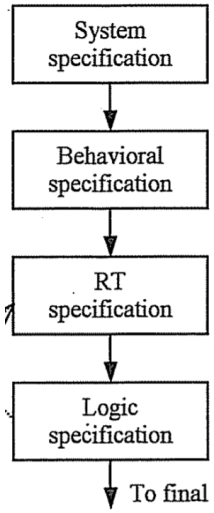
- Programmable processor optimized for a particular class of applications having common characteristics
- Features
  - Program memory
  - Optimized datapath
  - Special functional units
- Benefits
  - Some flexibility
  - good performance
  - size and power



IC technology

- Full-custom/VLSI :
  - Excellent performance, small size, low power
  - High NRE cost (e.g., $300k), long time-to-market
- Semi-custom ASIC
  - Good performance, good size, less NRE cost than a full-custom implementation (perhaps $10k to $100k)
  - Still require weeks to months to develop
- Programmable Logic Device
  - Low NRE costs, almost instant IC availability
  - Bigger, expensive (perhaps $30 per unit), power hungry, slower

Design Technology



Design Technology

The system specification:

At the system level, the designer describes the desired functionality in some language, often a natural language like English, but preferably an executable language !

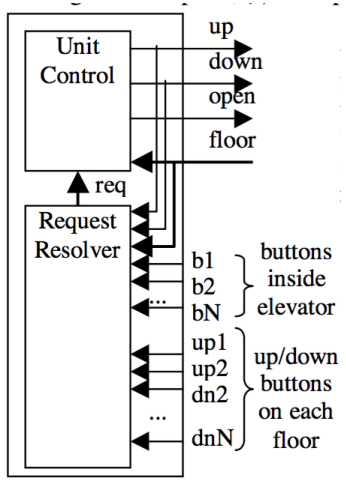
Designers must spend much time and effort simply understanding and describing the desired behaviour of a system, and some studies have found that most system bugs come from mistakes made describing the desired behaviour rather than from mistakes in implementing that behaviour.

D. Gajski, F. Vahid, S. Narayan and J. Gong, "Specification an Design of embedded systems," page 10 - 13.

System description (English)

Example :
"Move the elevator either up or down to reach the target floor. Once at the target floor, open the door for at least 10 seconds, and keep it open until the target floor changes. Ensure the door is never open while moving. Don't change directions unless there are no higher requests when moving up or no lower requests when moving down."

Block-box diagram

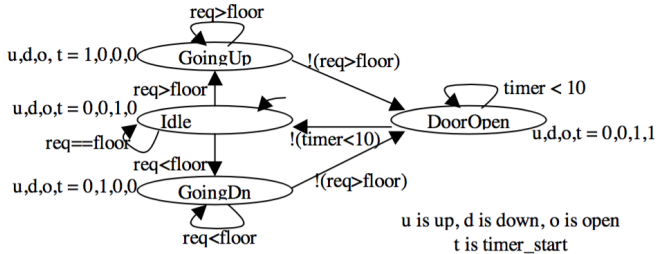


```
Inputs:  int floor; bit b1..bN; up1..upN-1; dn2..dnN;
Outputs:  bit up, down, open;
Global variables:  int req;

void main() {
Call concurrently:  UnitControl() and RequestResolver()
}
void UnitControl() {
up = down = 0; open = 1;
while (1) {
while (req == floor); open = 0;
if (req > floor) { up = 1;} else {down = 1;}
while (req != floor); open = 1;
delay(10);
}}
}
void RequestResolver() {
while (1)
...
req = ...
...
```


Behavioural Specification

A behavioral synthesis converts a sequential program into finite-state machines and register transfers.



Register Transfer (RT) specification

The designer refines Behavioural Specifications into register-transfer (RT) specifications

- by converting behavior on general-purpose processors to assembly code,
- by converting behavior on single-purpose processors to a connection of register-transfer components and state machines.