Embedded Systems Architecture

Session #2

Embedding Systems

- General purpose computer systems
- Application specific embedded systems

General Purpose Computer Systems

- CPU
- Memory: cache, RAM, hard disk
- Communications: serial, parallel, Ethernet, wireless
- Data entry: keyboard, mouse, touch screen
- Multimedia support
- Software: OS, user applications

Application Specific Embedded Systems

- Can have many of the same basic features as the general purpose computer system but hardware and/or software are tailored to meet the requirements of a specific application.
- Usually Real-Time in nature.

Real-Time

- Possesses operational deadlines from event to system response.

Embedded Systems Application Considerations

- Portability
- Scalability
- Costs
- Market

Portability

- Portability of high level code like C or HDL.

Scalability

- Migration path for larger / faster / better subsequent designs.

Costs

- Cost of development
- Cost of production
- Per unit cost

Market

- Features needed.
- Market window.
- Cost target.
- Profit margin.

Hardware / Software Considerations

- Dedicated resources.
- Shared resources.
- Performance balance.

Dedicated Resources

- Single function.
- Very fast.
- Cannot be shared or time sliced.
- Hardware like MACs (Multipliers-Accumulators), communication channels, & DDS (Direct Digital Synthesis) devices.

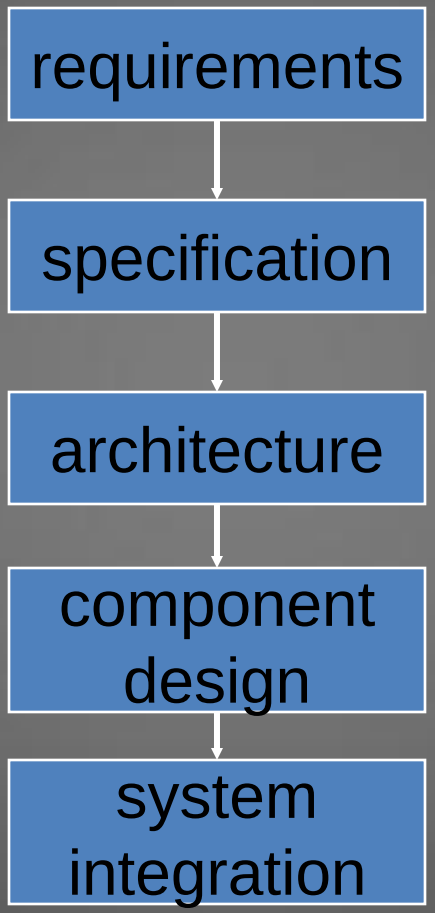
Shared Resources

- Generic function.
- Time sliced.
- Hardware like processors & memory.

Performance Balance

- Any function that software performs could also be implemented using only hardware, but at what cost?
- Time slicing hardware using software instructions reduces the total amount of hardware required, but at what cost?
- Use hardware for functions that software could not perform “fast enough”.

The Embedded System Design Process



Requirements

- Plain language description of what the user wants and expects to get.
- May be developed in several ways:
  - talking directly to customers;
  - talking to marketing representatives;
  - providing prototypes to users for comment.

Specification

- A more precise description of the system:
  - should not imply a particular architecture;
  - provides input to the architecture design process.
- Includes I/O interface requirements.
- Includes performance requirements.

Architecture

- Defines function blocks and their connectivity.
- Hardware components:
  - CPUs, peripherals, etc.
- Software components:
  - Operating system, kernel, or RTOS.
  - Application specific program(s).
- Function block may hierarchically contain smaller function blocks.

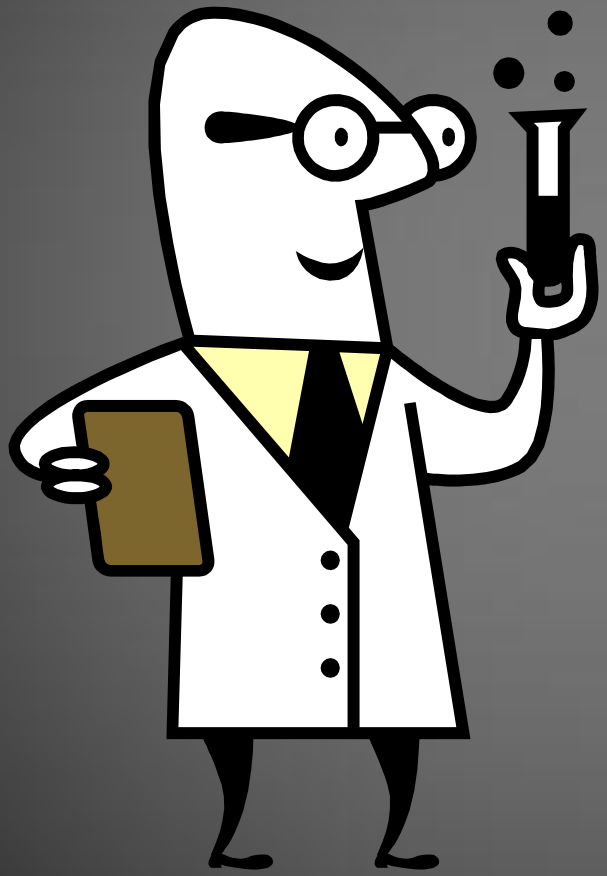
Component Design

- Selection of hardware and software components (both purchased and designed in-house).
- Creating schematics.
- Writing software code.
- Writing HDL code (if any).

System Integration

- Put together the components.
  - Many bugs appear only at this stage.
  - Major function blocks should be tested stand alone.
- Should be performed incrementally.

Lab Session #2



- Data Flow Diagrams

Data Flow Diagrams (DFD)

- Graphical Elements
- Process Specification (PSPEC)
- DFD Hierarchy
- Data Context Diagram

Graphical Elements

- Process
- Data Flow
- Data Store
- Terminator

Process

- Definition
  - “A process indicates the transformation of incoming flows into outgoing flows.”
- Symbol
  - “A circle with a name and a number.”
- Naming Convention
  - “..should include a verb acting on a specific group object or group of objects.”

Data Flow

- Definition
  - “A data flow is a pipeline through which information, material, or energy of known composition flows.”
- Symbol
  - A named unidirectional or bi-directional vector.
- Naming Convention
  - No verbs, only nouns and adjectives.

Data Store

- Definition
  - “A store is simply data, material, or energy retained for later use, possibly in a sequence that is different than their order of arrival.”
- Symbol
  - “Parallel lines with the name of the stored data, material, or energy.”
- Naming same as data flow.

Terminator

- Definition
  - External entities to the system that sink or source data, material, or energy.
- Symbol
  - A named square or rectangle.
- Naming convention same as data flow.

Process Specification (PSPEC)

- A process is defined by either a child DFD or a PSPEC.
- A PSPEC describes how the outputs are generated from the inputs.
- It has the same name and number as the process that it describes.
- It may be defined either graphically or textually.

DFD Hierarchy

- Complex processes can be broken into finer detail using hierarchy.
- Balance must be maintained between levels with regard to inputs and outputs.

Data Context Diagram

- Top level DFD with a single process for the system itself and terminators indicating system boundaries.