The Softening of Hardware

By: Frank Vahid
Presented By: Kelly Stephenson
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Quick History of "Software"

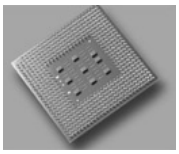
- 1940s – software and hardware are viewed as one
- Computers became stable, programs grew
- 1958 – "software" term used, fields separate
- Present – hardware is softening partially due to Embedded Systems

Presentation Outline

- Embedded Systems Elements
  - Understand how embedded systems part
- Softer Hardware
  - How is hardware softening?
- Merging Design Tools
  - How design tools are blurring the line

Element 1: Processor

- Digital design that executes an algorithm
- Contains controller to configure data path
- Contains data path to store and manipulate data



Choosing A Processor

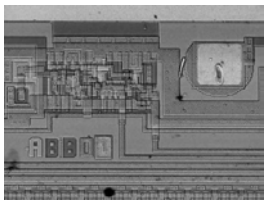
- General Purpose Processors
  - Execute any application, requires fast compilers
  - Immediately available, low cost, simple design flow
  - Easily reprogrammable
- Custom Processors
  - Match requirements perfectly
  - Exact fit makes better solution

Semi Custom Processors

- In the middle of processors
- Represented by microcontrollers and DSP
- Optimized for particular classes of programs

Element 2: IC Fabrics

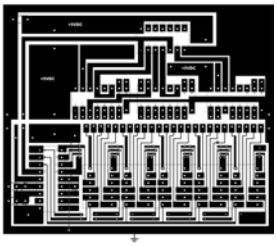
- Interconnection of transistors following a certain pattern



Choosing A Fabric

- Fully custom
  - Custom compose transistors to implement components exactly, send to chip fabrication plant
  - Performance, power, size, cost
- Programmable
  - Build a set of interconnected modules and program each set
  - FPGA
  - Available, flexible, simple design flow

Semi Custom IC Fabrics



- Use logic components from libraries
  - Reduce design effort
- Gate array IC fabric
  - Reduces design effort further, just connect gates
- Many others exist and evolving

Element 3: Chips

- Thumbnail size piece of silicon that physically implements IC fabrics.
- ASIC – chips implementing custom processors
- Microprocessor core – a microprocessor on a chip with other processors

Putting the Elements Together

- Designers map processes to IC fabrics
- Designers map fabrics to chips

Softer Hardware

- Software: the instructions to be executed on programmable hardware processors
- Software: soft bits that configure the system to realize a specific application
  - Soft bits can represent more than instructions; mapping

Software/Hardware Blurring

- Soft bits represent processors being mapped being mapped onto fabrics
- Reconfigurable computing: application can swap processors to perform computations
- Turnable architectures: systems with additional configurable features, can reduce system requirements by configuring system

Design Tools History

- 1950s – assemblers were used to program computers
- 1960s – compilers
- 1960s – physical design tools convert transistor circuits
- 1970s – logic synthesis tools convert state machines and equations
- 1990s – behavioral synthesis tools convert sequential programs

Design Tools

- Hardware design tools make hardware design look like software design
  - Use higher abstraction levels to describe designs
- Future step is to to describe hardware and software the same

Hardware/Software Codesign

- Simultaneously design software and custom processors that make up the system
- Simultaneously design software program and the programmable processor that will run the program
- Eventually designer specifies a desired application and then synthesizes an embedded system