When Girls Design CPUs!

An overview on one of the world's most famous CPU cores: ARM

Once Upon a Time…

- There was a company in UK
  - Acorn
- This company was the competitor to
  - IBM
  - Apple
- They were creating personal computers and selling them
- BBC company signed a contract with Acorn
  - To create a computer for BBC

BBC Micro

- Used a processor
  - MOS Technology 6502
- BBC advertised for BBC Micro widely
- All of the schools in UK used BBC Micro for education
- Also some universities
- And research laboratories
- Acorn was thinking about the next product
  - They needed a better CPU
  - CPU should be owned by themselves

Acorn's own CPU!

- Acorn decided to have its own CPU
- But how?
  - It required a great background
  - Acorn has nothing as the background to perform this task
- At same time at Berkley
  - A team of graduate students
  - Designed a new purely RISC cpu
  - They published some papers
  - CPU was competitive to CPUs on the market that time
- Acorn found the papers!
- It was a great starting point!

The journey to the west!

- Acorn decided to send some of its engineers to learn required info about creating CPUs
- Selected engineers
  - Sophie Wilson
  - Steve Furber
- They travelled to Western Design Center
- They learned
  - Creating a new CPU is not that much difficult!

Designing the CPU

- Sophie Wilson
  - Began to develop the ***instruction set*** for the new CPU
  - She also developed the basic new CPU structure
- She talked to Acorn CEO
  - Convinced them the new design is good
- A team of engineers
  - Helped Wilson to create CPU circuits
- VLSI technology was selected to build the CPU

The CPU by Wilson

- The new CPU
  - Had a very simple architecture
- No cache memory!
- No DMA controller!
- No Memory protection mechanism!
- No multiple register banks!
- No delayed branches!
- No Single cycle execution of all instructions!
- …
- Nothing!!!!

Acorn's first CPU

- Designers omitted every risky part of CPU
- Just kept simplest sections
- Result: a very simple CPU
  - And so : its power consumption was very small
  - And this was the revolution!

Acorn RISC Machines

- Acorn had now a better name
  - Acorn RISC Machines
- April 1985
  - Acorn RISC Machine introduced their first CPU
  - ARM1
- Using ARM1 machine Wilson developed “BBC Basic”
  - BBC Basic was developed for ARM1
  - Used to create CAD software required for development of ARM2
- 1986
  - ARM2 was in the market!

ARM2 Processor

- 32Bits data bus
- 26Bits address space
- 16 Registers 32Bits
- ARM2 was simplest 32Bits processor of the world
- Transistor count: 30,000
- Intel 80286 transistor count was: 134,000
- ARM2's performance was better than 80286
- ARM2's power consumption was much lower
- Transistor count growth for arm
  - Very slow
  - ARM6 was 35,000 transistors

Advanced RISC Machines

- In 1990
- Apple, Acorn and VLSI Technologies joint to further enhance ARM architecture
- A new company created
  - Spin off from Acorn
  - Advanced RISC Machines
- ARM company then began its existence

ARM6

- 1992
  - ARM6 : The result of effort by ARM and Apple
  - ARM610 CPU used by Apple in PDAs
- DEC company licensed ARM6 core
  - It enhanced ARM6 architecture and created StrongARM
- StrongARM was then given to Intel
  - Intel implemented a high performance implementation of StrongARM
  - Intel called it : Xscale
  - Intel sold Xscale to Marvell

What is a core?

- A core is a ready to use design
  - Hardware
    - A piece of ready to use silicon (transistors and wires)
    - A circuit consisting gates and their connections
      - Should be converted into Silicon
  - Software
    - Source code of the core in a hardware description language
- You purchase the core
  - You put the ready-to-use core into your design directly

ARM Cores

- ARM company
  - Does not sell chips
  - Sells CPU cores
- ARM licenses CPU cores to other companies
- They use the core to build their own chip
  - Microprocessor
  - Microcontroller
- They add their own peripherals to the chip
- They sell their chips
  - One part of obtained money : will go back to ARM company

ARM Financial Status

- In 2005
  - ARM sold 1.6 billion cores
- In 2006
  - 2.45 billion cores were sold
  - Income :
    - Royalties: $ 164.1 million
    - Licensing revenues: $ 119.5 million (65 Licenses signed)
- In 2011
  - Predication: ARM will sell 5 billion ARM cores
- In 2007
  - 98% of mobiles phones contained some sort of ARM core
- In 2009
  - 90% of 32Bits embedded systems were based on ARM

ARM core Families & Architectures

Family	Architecture
ARM1	ARMv1
ARM2	ARMv2, ARMv2a
ARM3	ARMv2a + cache
ARM6	ARMv3 + coprocessor bus + 32bit memory space
ARM7	ARMv3
ARM7T	ARMv4T (Thumb instruction set)
ARM7J	ARMv5J (Java support)
ARM8	ARMv4 (branch prediction, better memory controller)
ARM9	ARMv4
ARM9E	ARMv5 (Enhanced DSP)
ARM10	ARMv5 (higher speed- deeper pipeline)
ARM11	ARMv6 (higher speed, floating point, DSP, …)
ARM-CORTEX	ARMv7-A, ARMv7-R, ARMv7-M