Hardware Specialization
The Age of Dark and Bespoke Silicon

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Dark Silicon

• What: Silicon that is not used all the time or at its full frequency

• Why: Transistor energy efficiency improves at a slower rate than the improvements of native transistor speeds and transistor density

• Dark Silicon on chip is exponentially increasing
  • PANIC ------- THE APOCALYPSE APPROACHES
The Four Horsemen of the Apocalypse
The Shrinking Horseman

- Building smaller chips
- Price:Size ratio goes higher the smaller the chips get
- Same goes for Temperature
- Most pessimistic Horseman
The Dim Horseman

- Manipulates:
  - Voltage
  - Frequency
  - Duty cycles

To manage power

- Implemented:
  - Turbo Boost 1.0
  - NTV Processors
  - Bigger caches
The Specialized Horseman

- Power and clock-gate unused cores
- reduce the amount of capacitance per particular operation

👍 for coprocessors
👎 for general-purpose
The Specialized Horseman

👍 for coprocessors
👎 for general-purpose

⇒ Tower of Babel Problem
The Deus Ex Machina Horseman

- Hope for a breakthrough in semiconductor devices
  - MOSFET-imposed limits
  - Currently at a bottleneck imposed by the laws of physics
- Alternatives to MOSFET transistors
  - Tunnel Field-Effect Transistors (TFETs)
  - Nanoelectromechanical System (NEMS)
- Beyond-CMOS approaches
  - Electron-Spin Memory (C-SPIN)
  - Statistics Models: Nondeterministic (SONIC)
So what?

- Decrease sharing
  - Expensive control logic
  - Additional energy consumption
- Reduce pipelining
  - Increases duty cycle and increases capacitance
  - Increases gap between processing and memory
Bitcoin

• International Cryptocurrency (Began Jan 3rd, 2009)
• Account that allows you to make or receive payments
• System maintains a global, distributed cryptographic ledger of transactions called the blockchain
  • Maintained by computers running a consensus algorithm across the world
  • Algorithm is called mining- integrates transactions into the blockchain
  • Each transaction becomes the new head block and is posted to the blockchain
Why Mine

• Each block the miner adds to the block chain:
  • Block Reward (Started at 50 BTC, halved every 210,000 blocks)
  • BTC cannot exceed 21 million
  • In 2032, 99% will be issues

• Rewarded transaction fees attached to the block
  • The higher the transaction fee the faster the transaction is completed
  • Incentivizes paying to use the service
Why Use Bitcoin

• Can be used internationally
• Known upper limit to amount of BTC that can be mined
• Users are mostly anonymous and transactions are secure but public to everyone
  • Can still be traced and subjected to law enforcement
Bitcoin Trend

- Difficulty of mining is dynamically increased as more machines mine to avoid saturating the amount of currency created per day.
Bitcoin Stats: May 14th 2017

• 1 BTC = 1,825.40 Dollars
• Current Block Reward = 12 BTC = 21,904.80 Dollars
• Bitcoin Mined = 77.76%
• Total BTC in circulation: 16,330,450
• Total BTC left to mine: 4,669,550

Sources
• http://www.coindesk.com/price/
• http://www.bitcoinblockhalf.com/
Bitcoin, Bespoke and Dark Silicon

• Cost of cooling and energy is what holds back miners
• Bespoke Silicon
  • Best if the specialized implementation is much smaller than the general purpose case and computation exhibits weak scaling
  • The power of homebrew and crowdsourcing
Thanks for Listening!
Article Sources