Future Challenges for Computer Architecture
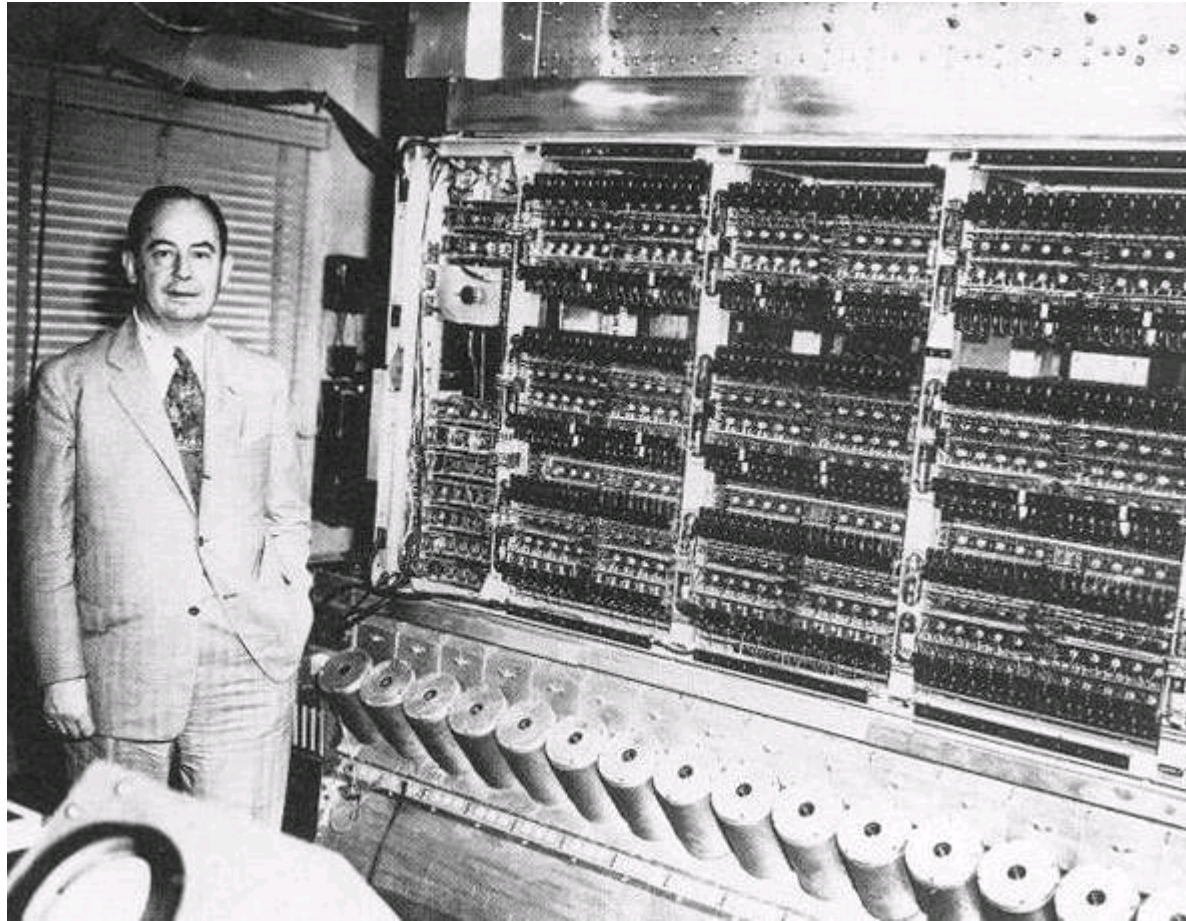
Bill Dally

March 21, 2006

10 Year Forecast

- Major breakthroughs by 2016
  - Parallelism becomes mainstream
  - Embedded devices (e.g., modems) become programmable
  - Power efficiency without voltage scaling
- Open Questions in 2016
  - Managing locality
  - Power

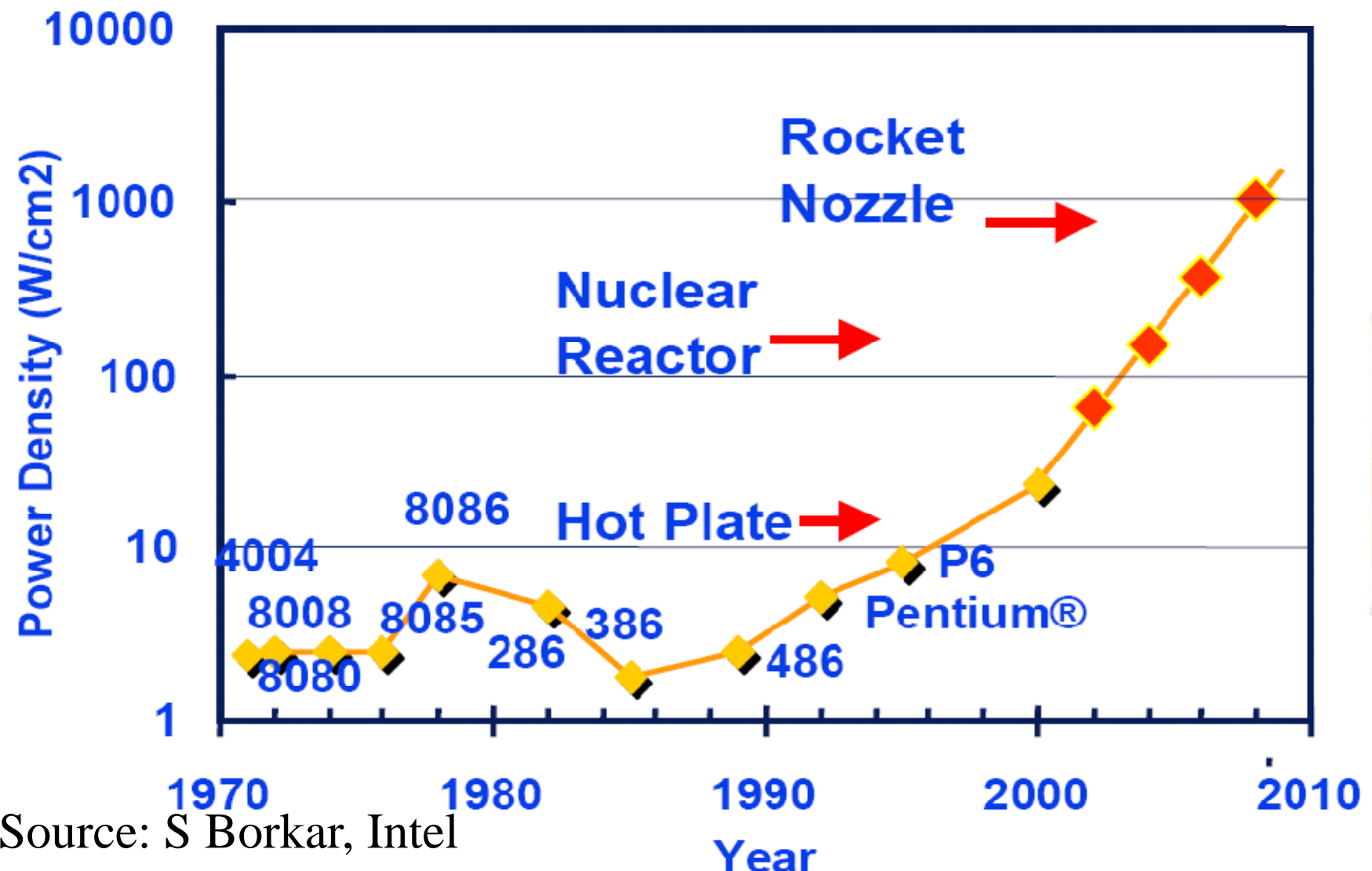# 60 years of Von Neumann Architecture is at an end

Scalar performance is no longer scaling
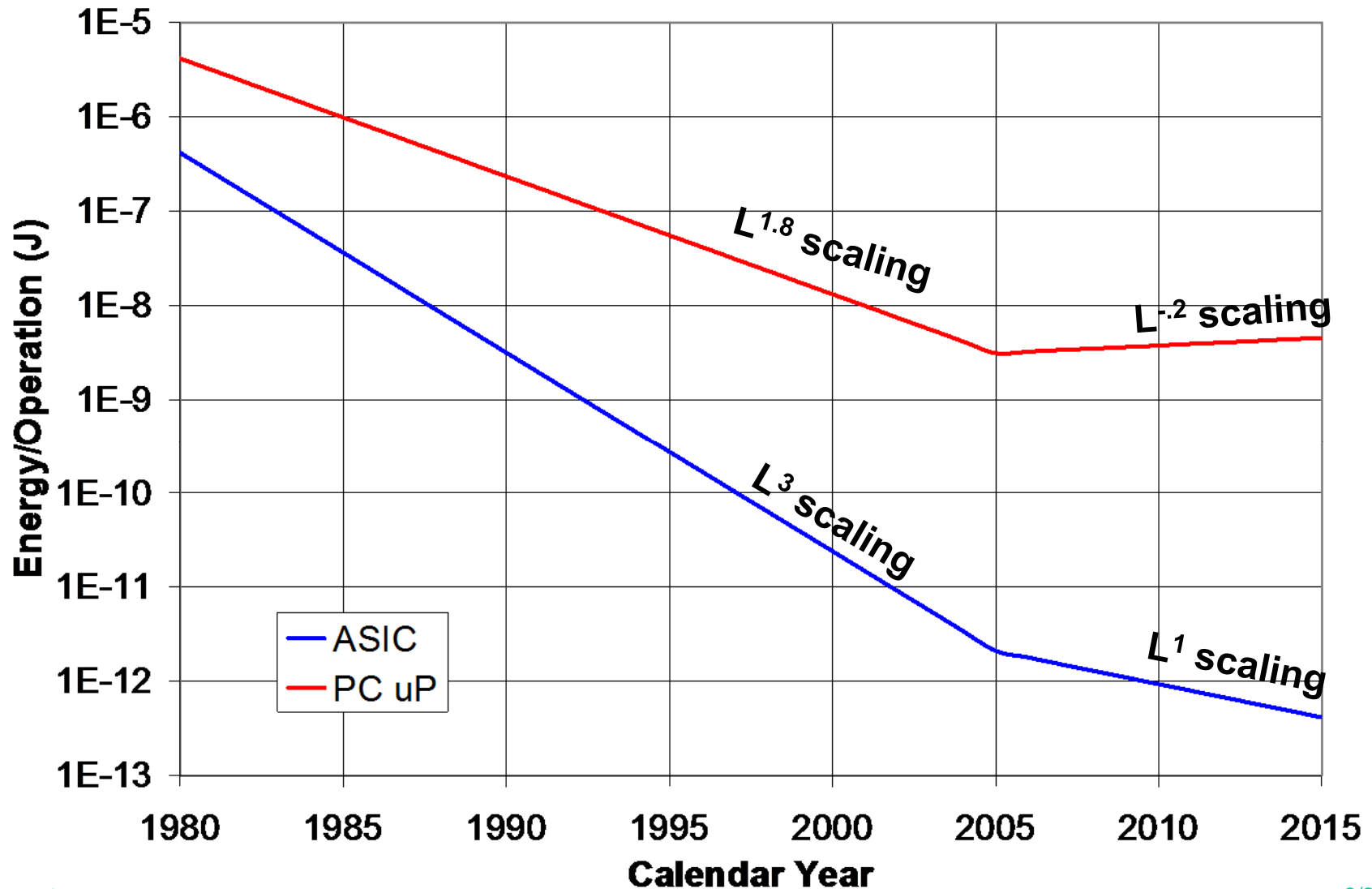
- This is the only way to continue scaling performance
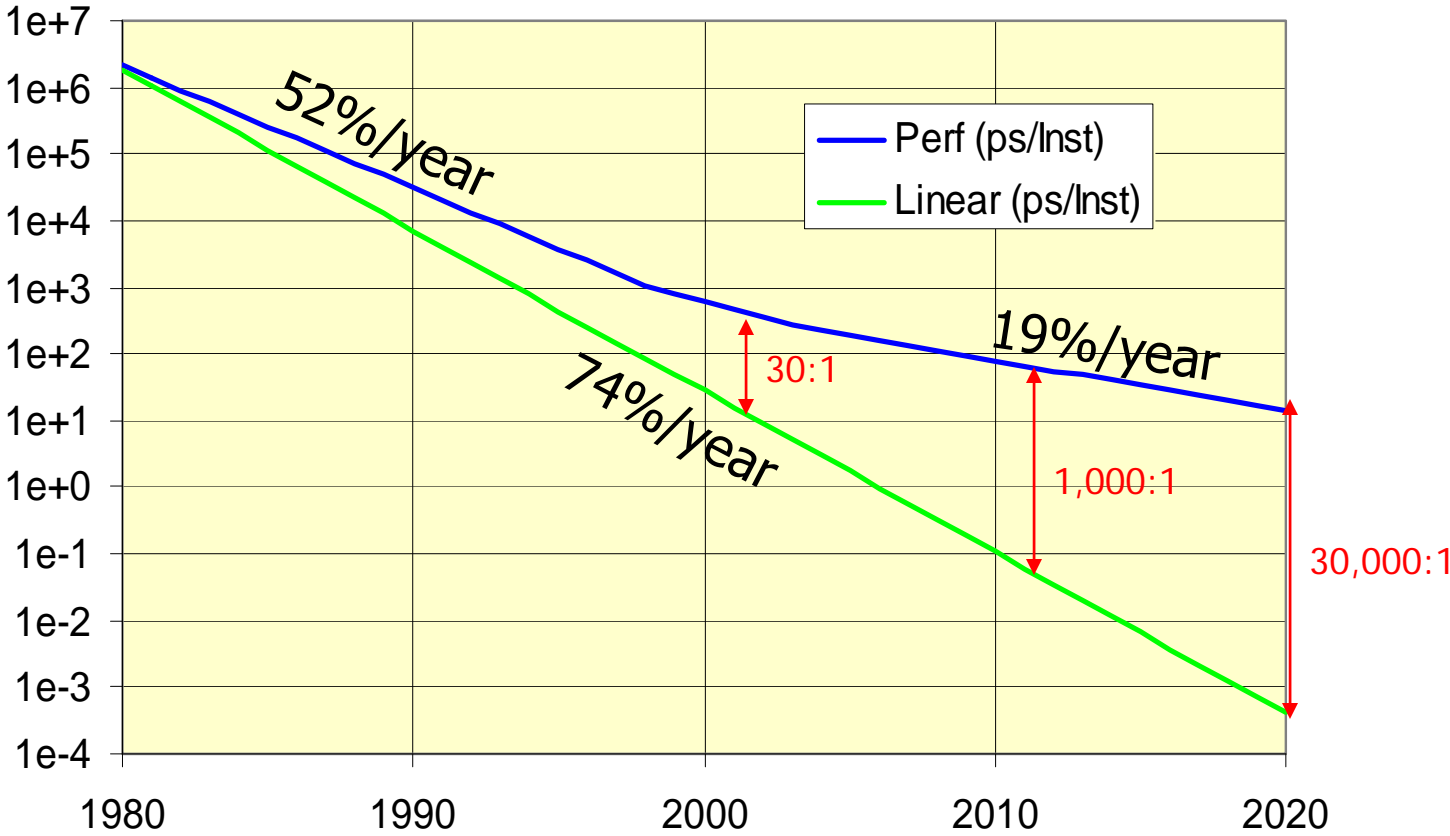
Computers are power limited

Source: S Borkar, Intel

Voltage, and hence power is no longer scaling with device length

Scalar architectures don't meet the needs of emerging embedded applications

- Intensive functions today are hard-wired
  - Cell phone modems
  - DTV codecs, deinterlacers, etc...
- This is done for efficiency
  - 30-100x vs a DSP or microprocessor
- Hard-wired computing is getting harder
  - Standards & algorithms evolving rapidly
  - ASIC design/tooling getting more expensive

- Architecture must close the gap
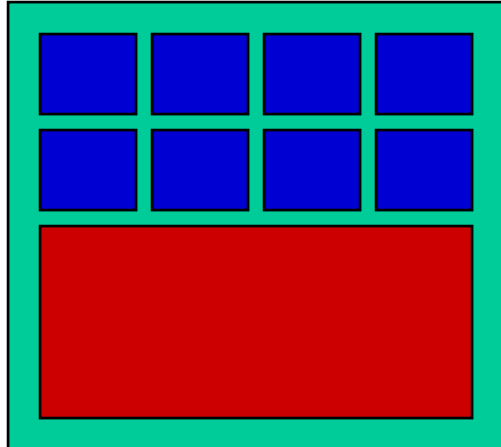 - We need efficient, programmable architectures

A Revolution in Computer architecture is at hand

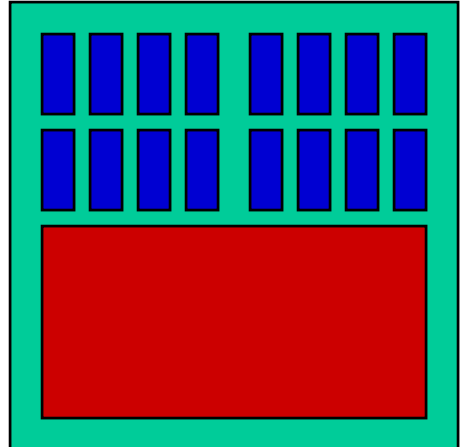Motivated by: performance scaling, power, and embedded applications
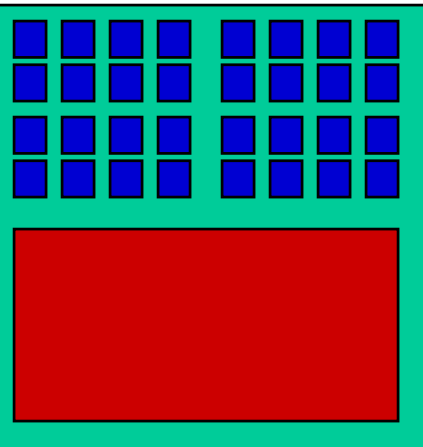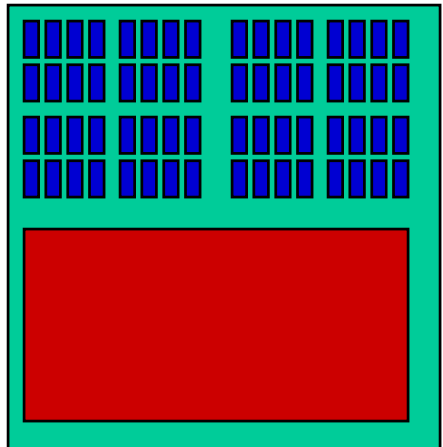
Cores/chip will double every 18 months
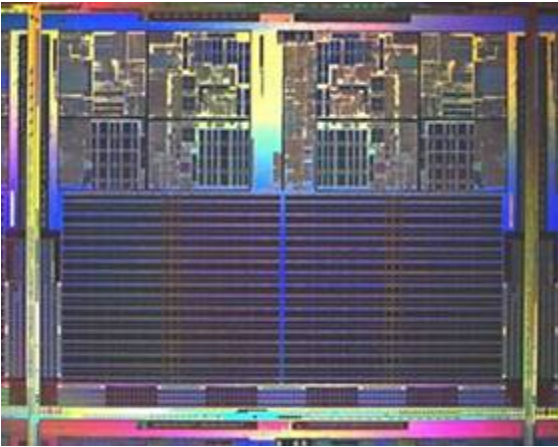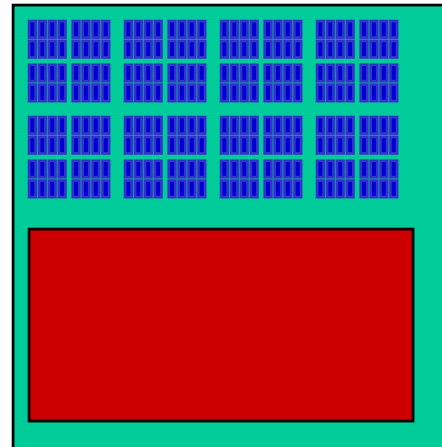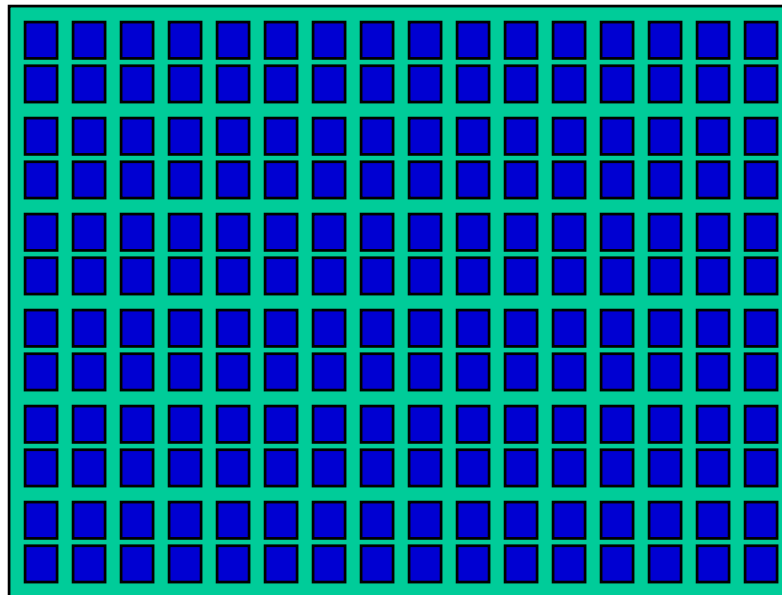

2006

2007.5

2009

2010.5

2012

2013.5

2015

Software will evolve to exploit multiple threads

- Lots of parallelism in most demanding applications

- Challenge is legacy code

Managing Locality

- Data movement, not arithmetic is the critical function
- Architectures must expose data location
- Software must place and stage data and schedule data movement

Computer Architecture is at the Crossroads

- Pervasive parallelism

- Programmable embedded functions

- Power efficiency through optimized data movement

- The next 10 years will be very exciting