Physical System Simulation and Verification

Combining Pre- and Post- Silicon Verification

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Physical System Simulation

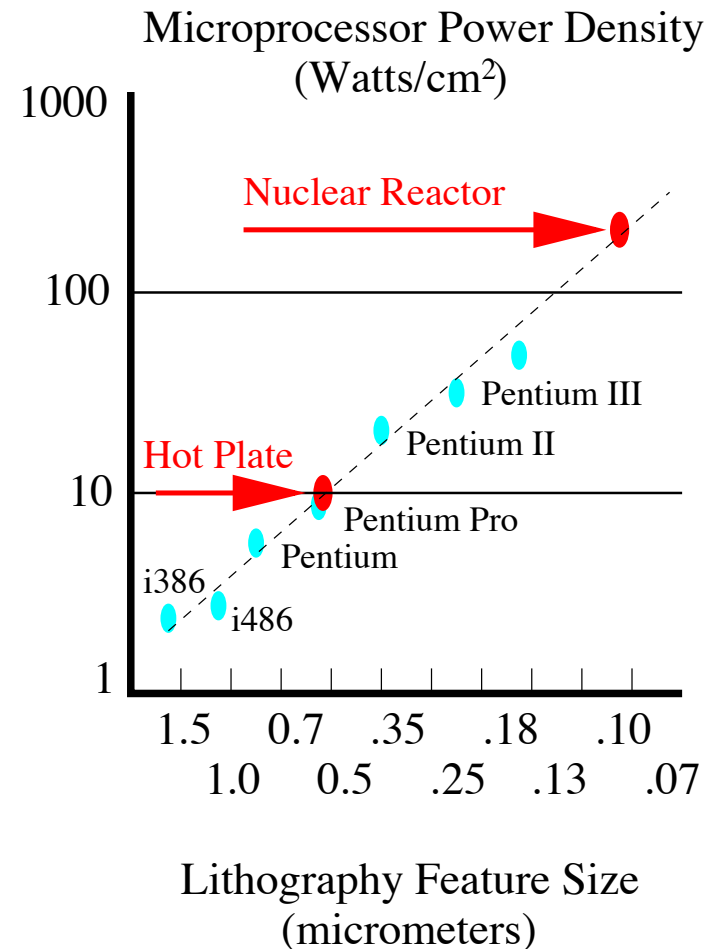In the future, deep design exploration will need to occur on actual parts.

- The number of configurations is growing exponentially.
  - Simulators will not scale with design complextity.
  - To "warm up" the state, will require trillions of steps.

- Can we perform design exploration from specific reached states?
  - Pre- and post-silicon verification approaches need to be combined.
  - We need on-chip mechanisms to enable physical co-simulation with symbolic simulation.

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Future Systems (e.g., UT TRIPS Architecture)
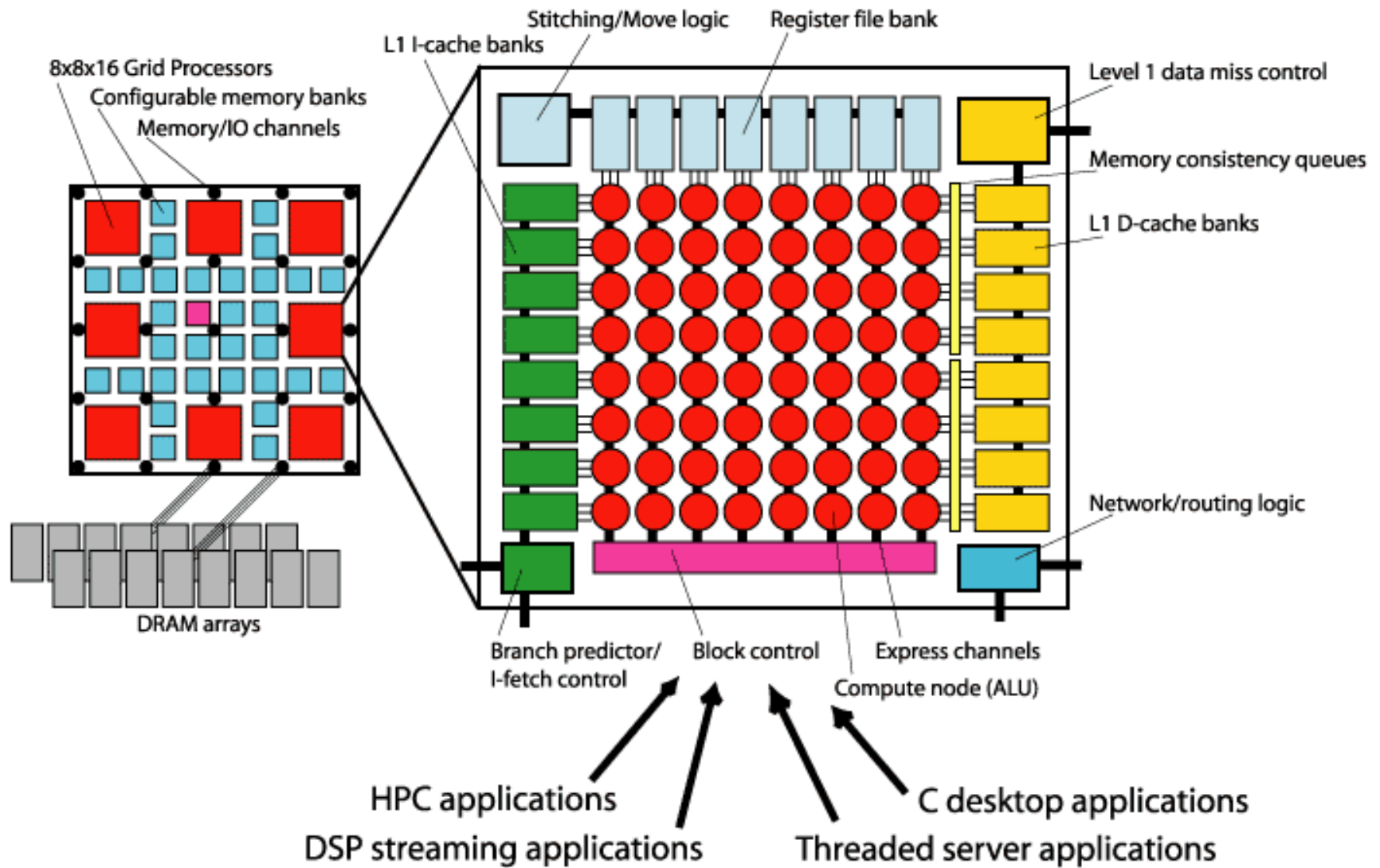
Combined Power & Functional Specifications

- The power density of microprocessors (as well as ASICs, FPGAs) is now first-order problem.

- There are ways to trade power for performance.

  – Equivalent circuits that require different numbers of clock cycles

  – Different circuits can be selected based on the current voltage.

- Future HDLs must combine functional and power specifications into a single language.

- Future functional verification will require knowing circuit parameters, such voltages, as well as the netlist.

Microprocessor Power Density (Watts/cm^2)

Nuclear Reactor

Hot Plate

Pentium III

Pentium II

Pentium Pro

Pentium

i386

i486

1000
100
10
1

1.5   0.7   .35   .18   .10
1.0   0.5   .25   .13   .07

Lithography Feature Size (micrometers)

Source: F. Pollack, Intel, New Microprocessor Challenges in Coming Generations of CMOS Technologies, Micro32

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Our Vision

We would like computing systems to be specified by a *formula manual*, a complete precise set of formulas that exactly specifies computings systems (whether hardware, software, or both).

- A formula manual unambigously describes the functionality being offered.

- A formula manual defines the abstract specification for its concrete implementation.

- A formula manual can be used as the concrete specification for something built on top of it.

We want mathematically specified, mechanically checked computing systems.

- This is a long-term and evolving goal.

  – Systems are increasing in complexity faster than our ability to manage them or control them.

  – If we are aggressive, maybe we can achieve this vision on small commercial designs, e.g, cell telephones, pagers, routers, etc.

- Our ability to field secure systems is based our our ability to specify and validate our computing, networking, and control systems.

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