Getting to Work with OpenPiton

Princeton University

http://openpiton.org

Princeton Parallel Research Group

- Redesigning the Data Center of the Future
  - Chip Architecture
  - Operating Systems and Runtimes
  - Power and Cooling Optimization
- Biodegradable Computing (Materials)

- 11 PhD Students
- 3 Undergraduates

Winter 2016 Ski Trip

Support

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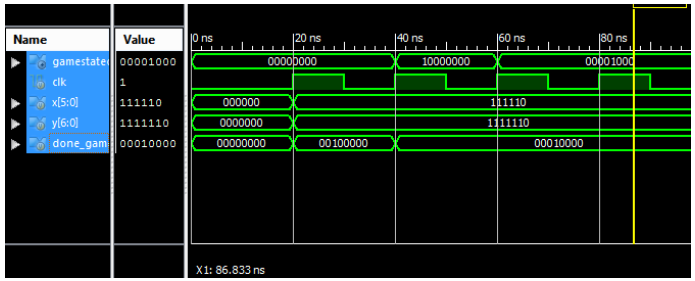
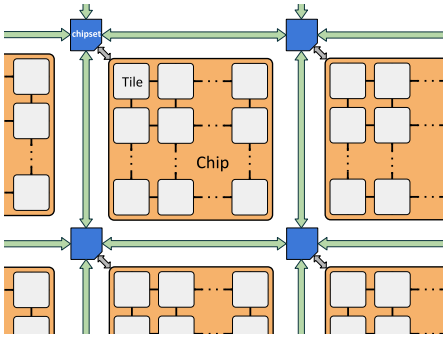
The world's first open source, general purpose, multithreaded manycore processor

- Open source (GPL core, BSD uncore) manycore
- Written in Verilog RTL
- Scales to ½ billion cores
- Configurable core, uncore
- Includes synthesis and back-end flow
- ASIC & FPGA verified
- Runs full stack multi-user Debian Linux
- Great for Architecture, Programming Language, Compilers, Operating Systems, Security, EDA research

GPL BSD



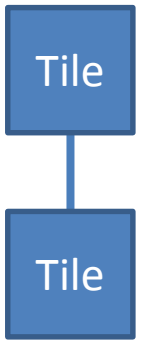


debian

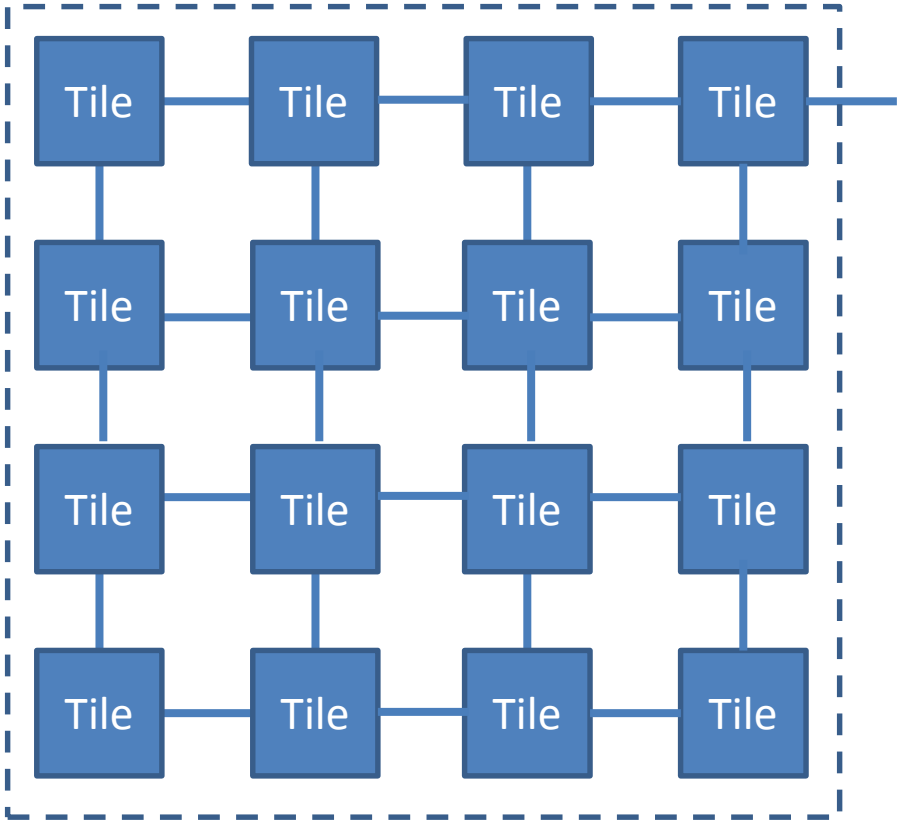
XILINX®

OpenPiton System Overview

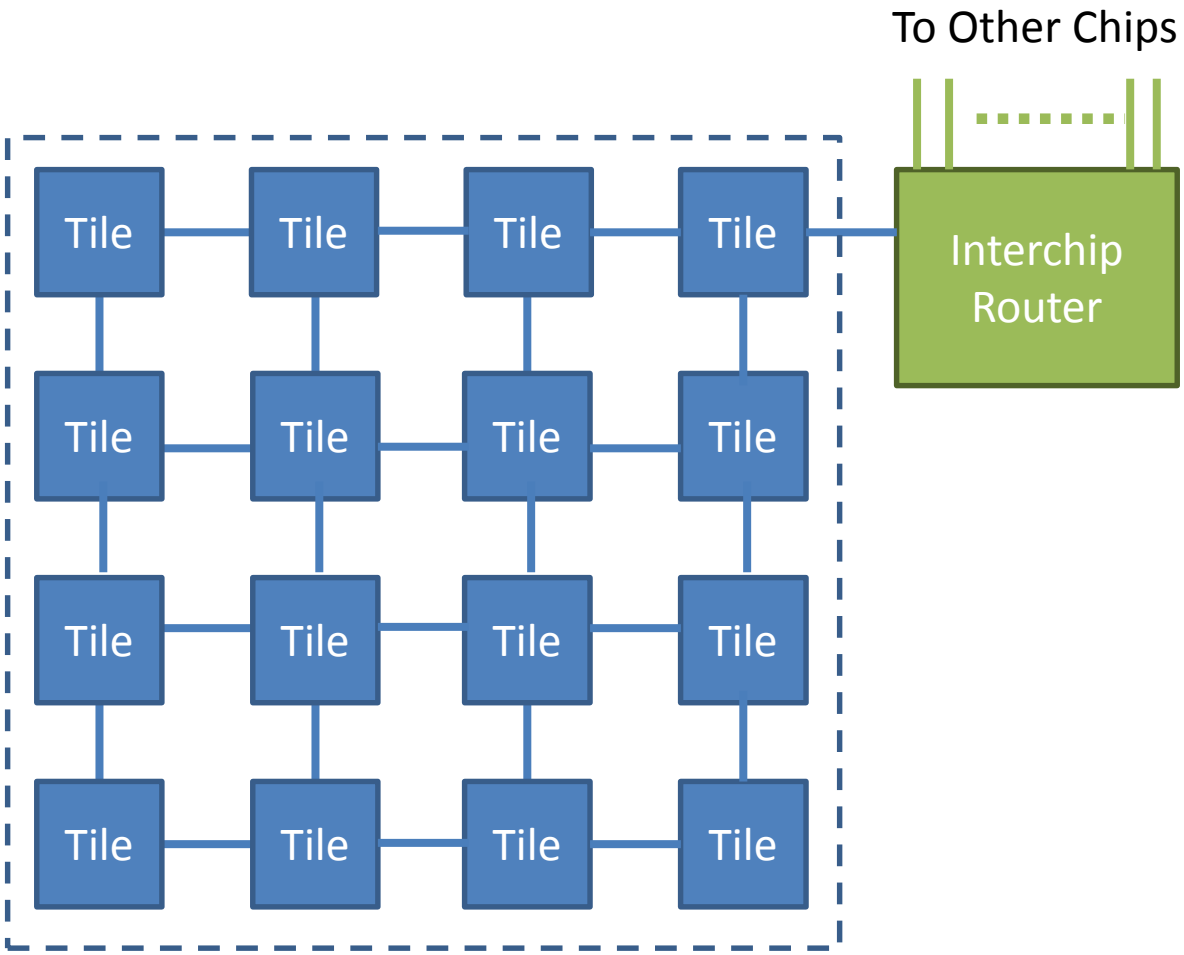
OpenPiton System Overview



OpenPiton System Overview



OpenPiton System Overview



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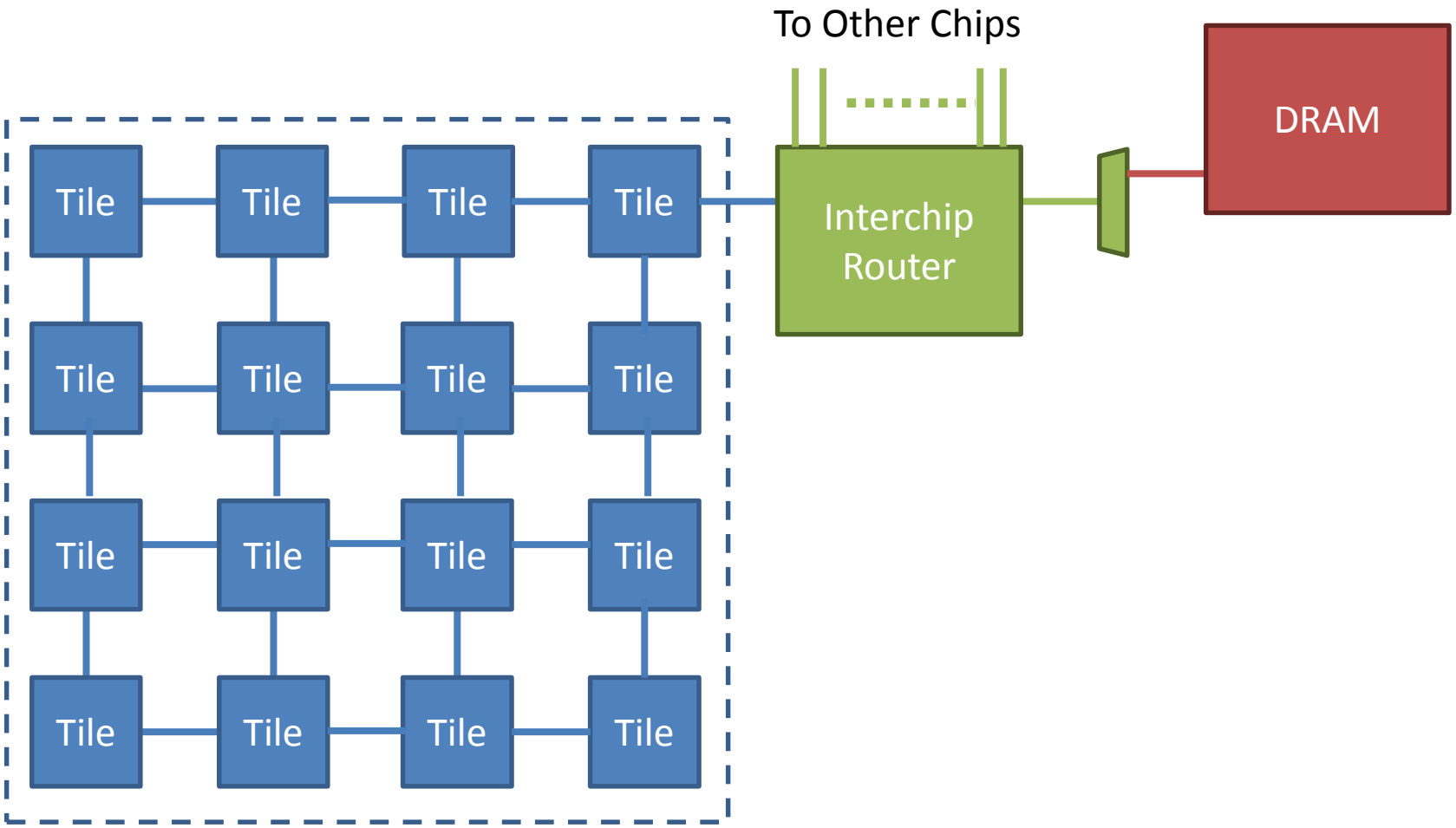

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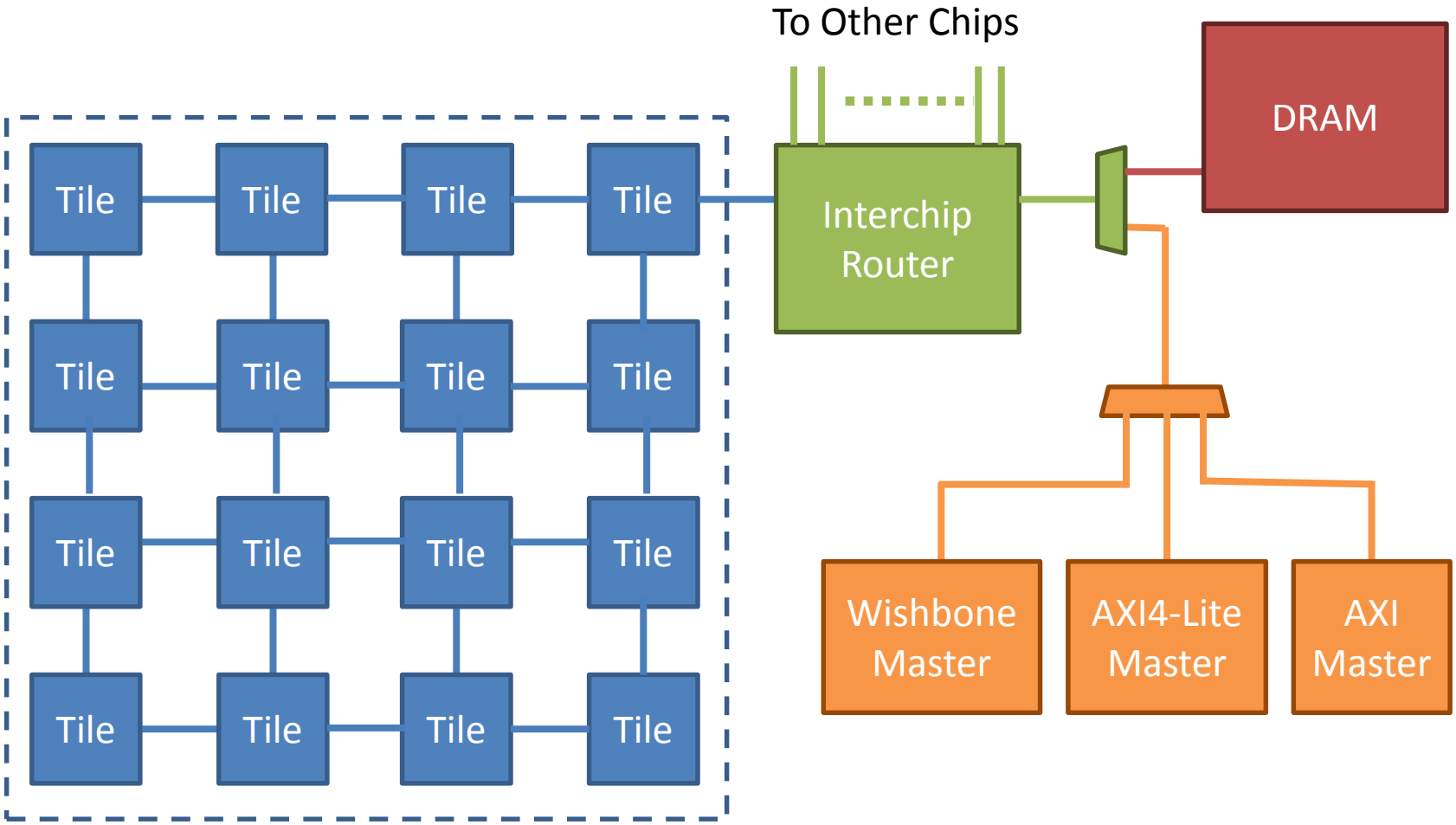
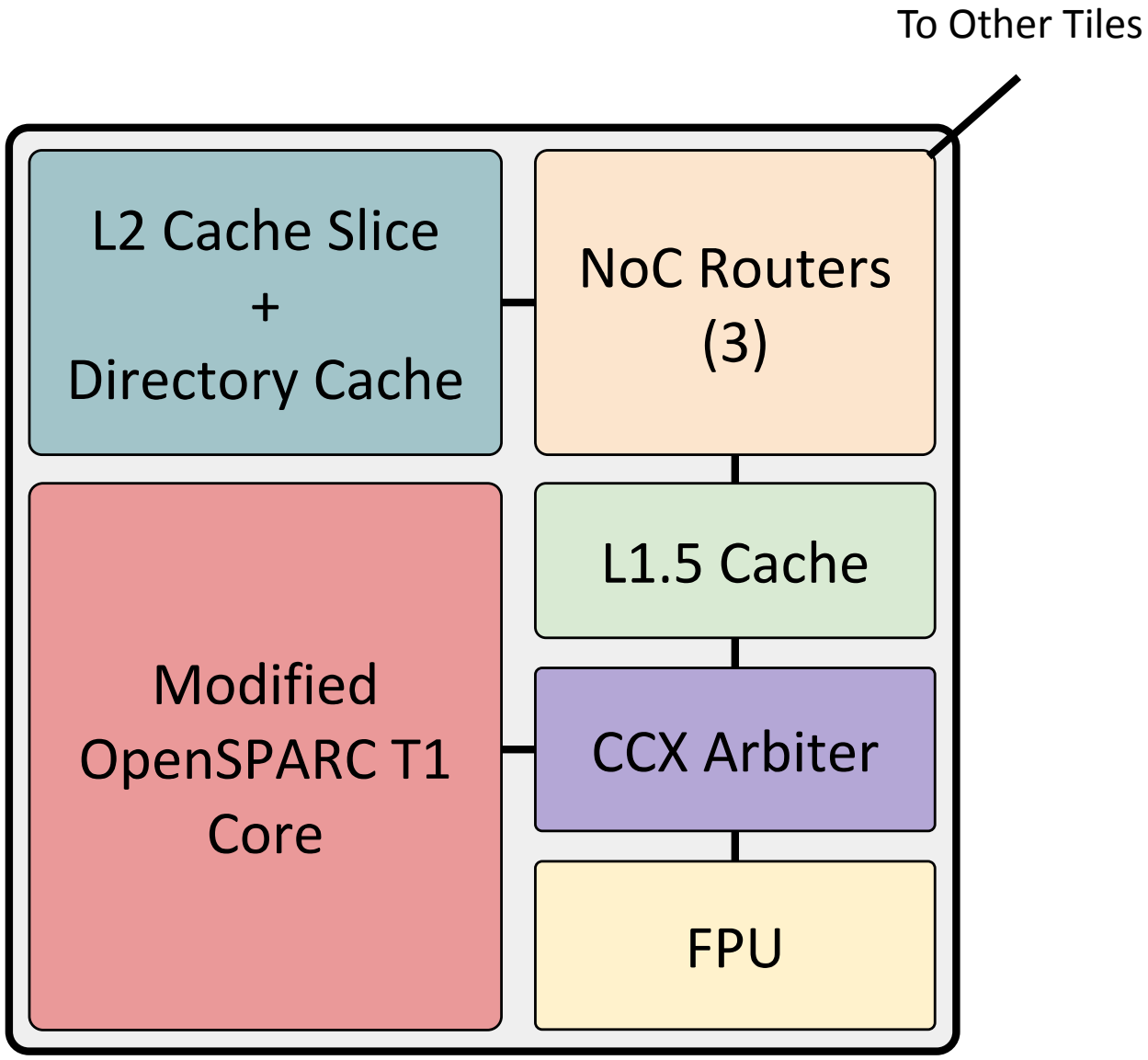
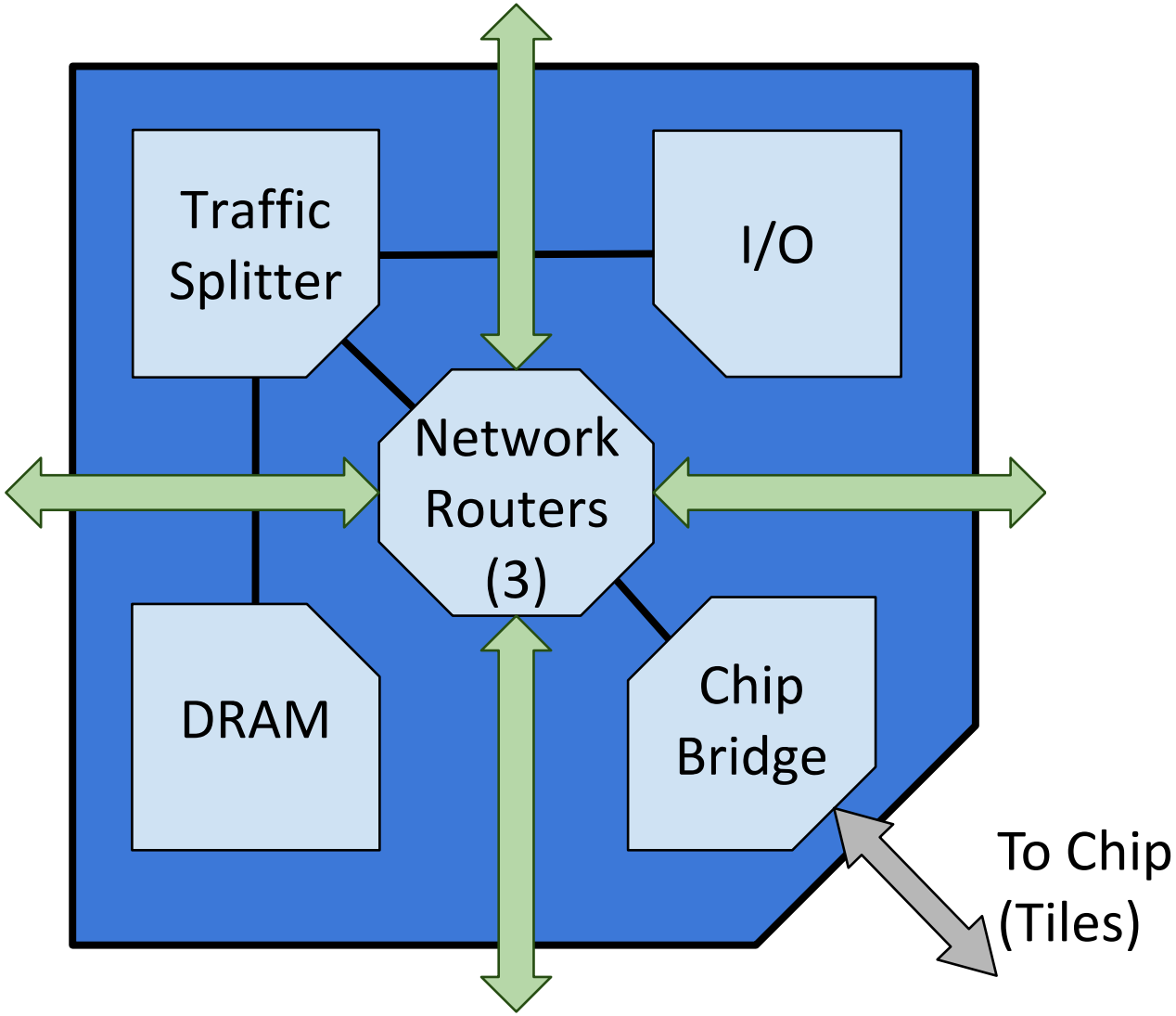


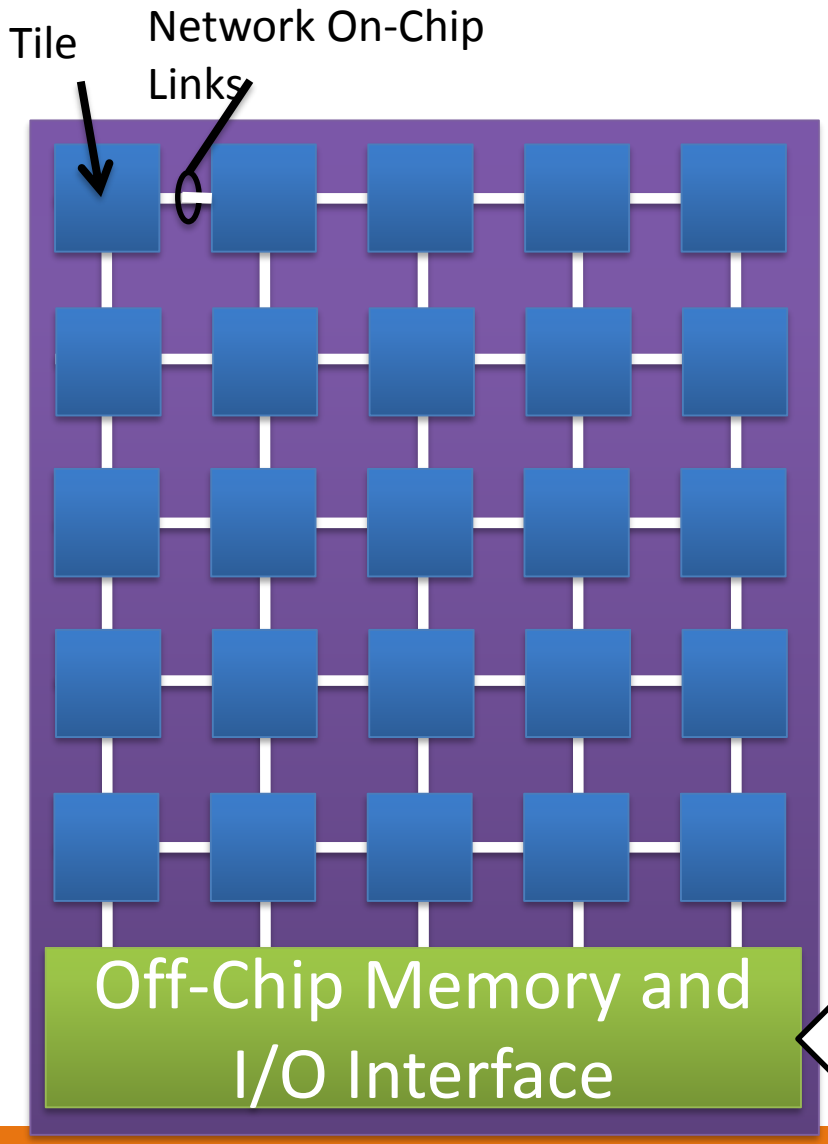
Tile Overview



Chipset Overview

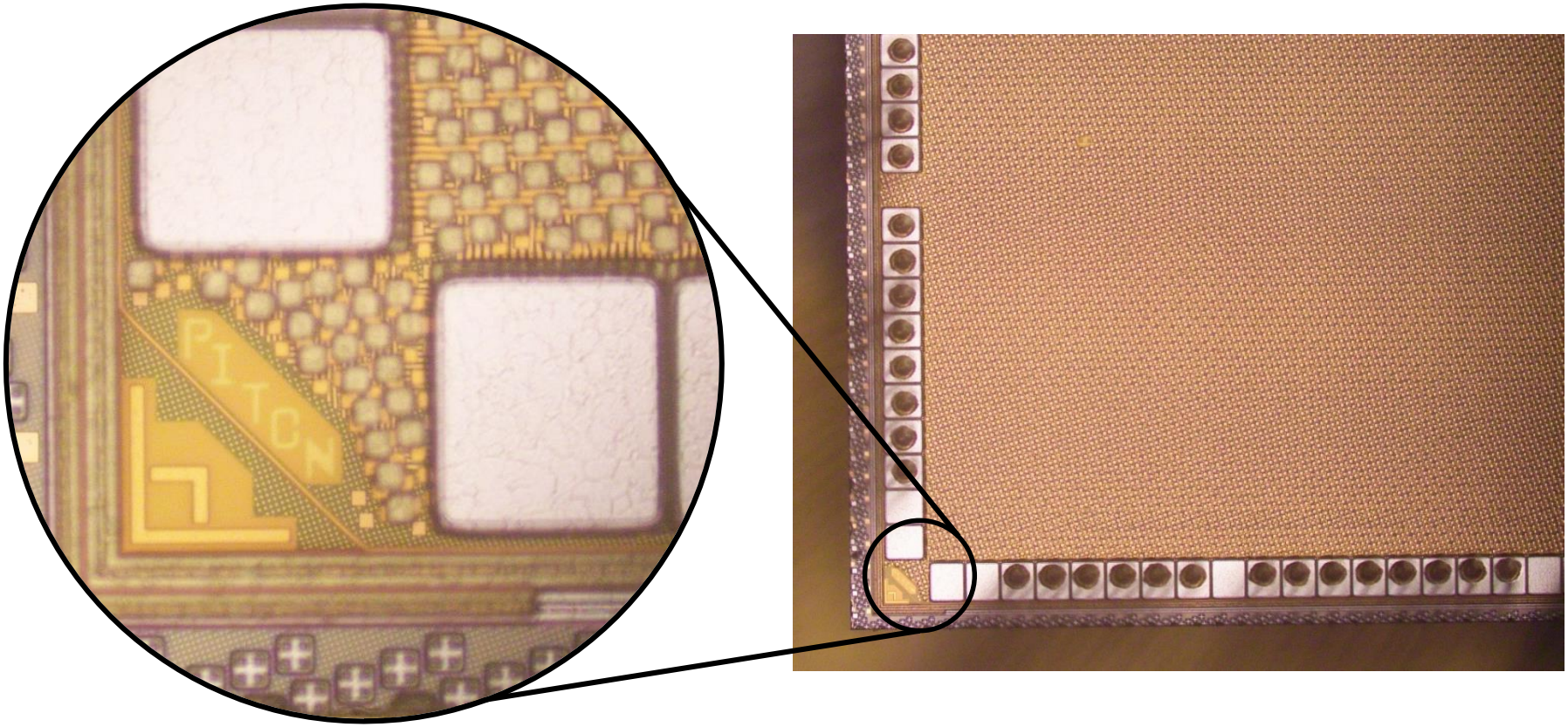


Piton Chip Block Diagram



- 25-core
  - 2 Threads per core
  - 64-bit Architecture
  - Modified OpenSPARC T1 Core
- 3 NoCs
  - 64-bit, 2D Mesh
  - Extend off-chip enabling multichip systems
- Directory-Based Cache System
  - 64KB L2 Cache per core (Shared)
  - 8KB L1.5 Data Cache
  - 8KB L1 Data Cache
  - 16KB L1 Instruction Cache
- IBM 32nm SOI Process
  - 6mm x 6mm
  - 460 Million Transistors
- Target: 1GHz Clock @ 900mV
- 208 Pin CQFP Package

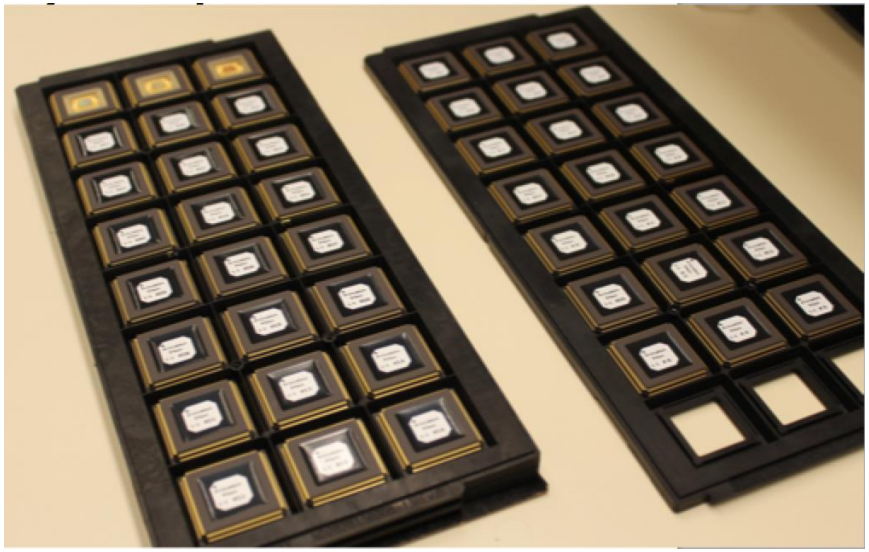
Piton Chip

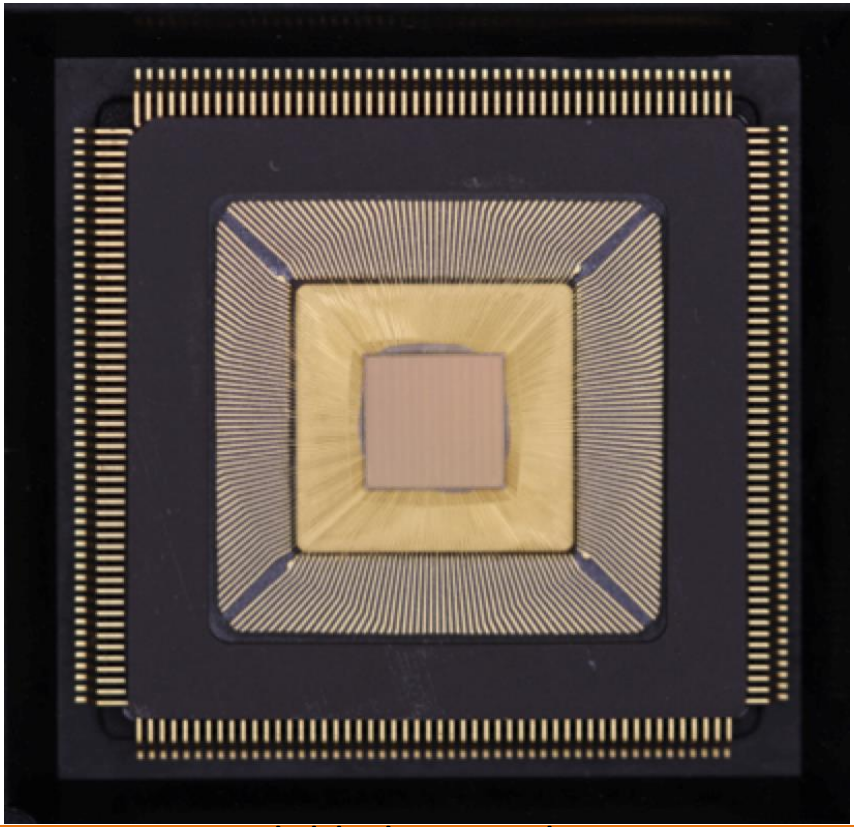


- Among largest chips ever built in academia
- Received silicon and has been tested working in lab

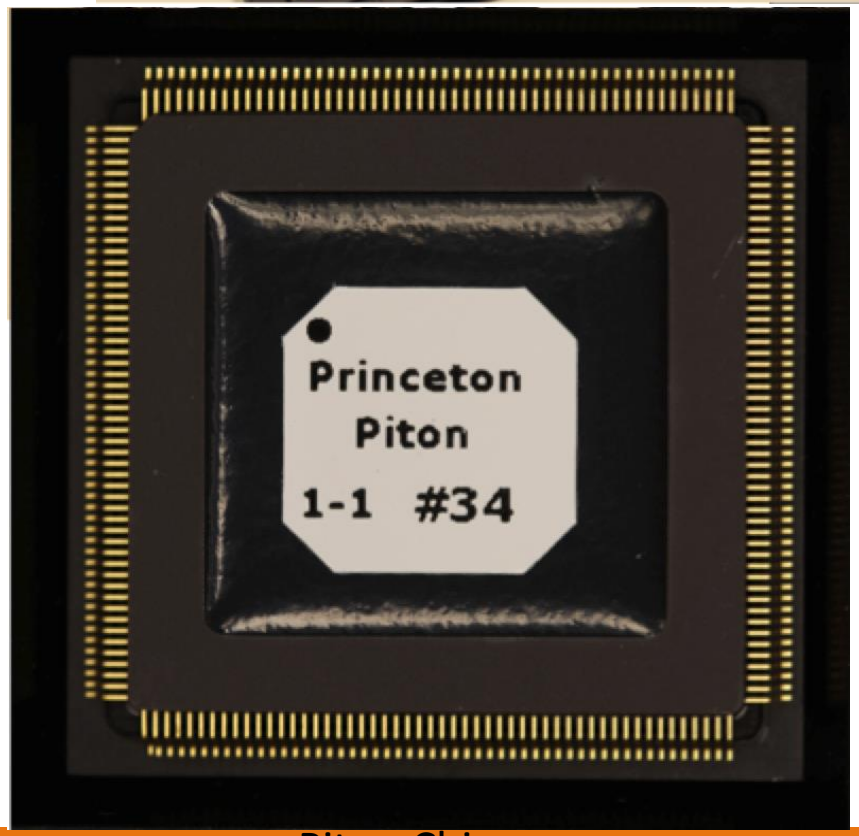
Piton Chip

- Piton Processor packaged in 208-pin Ceramic Quad Flat Pack (CQFP)
- Received ~100 die from IBM



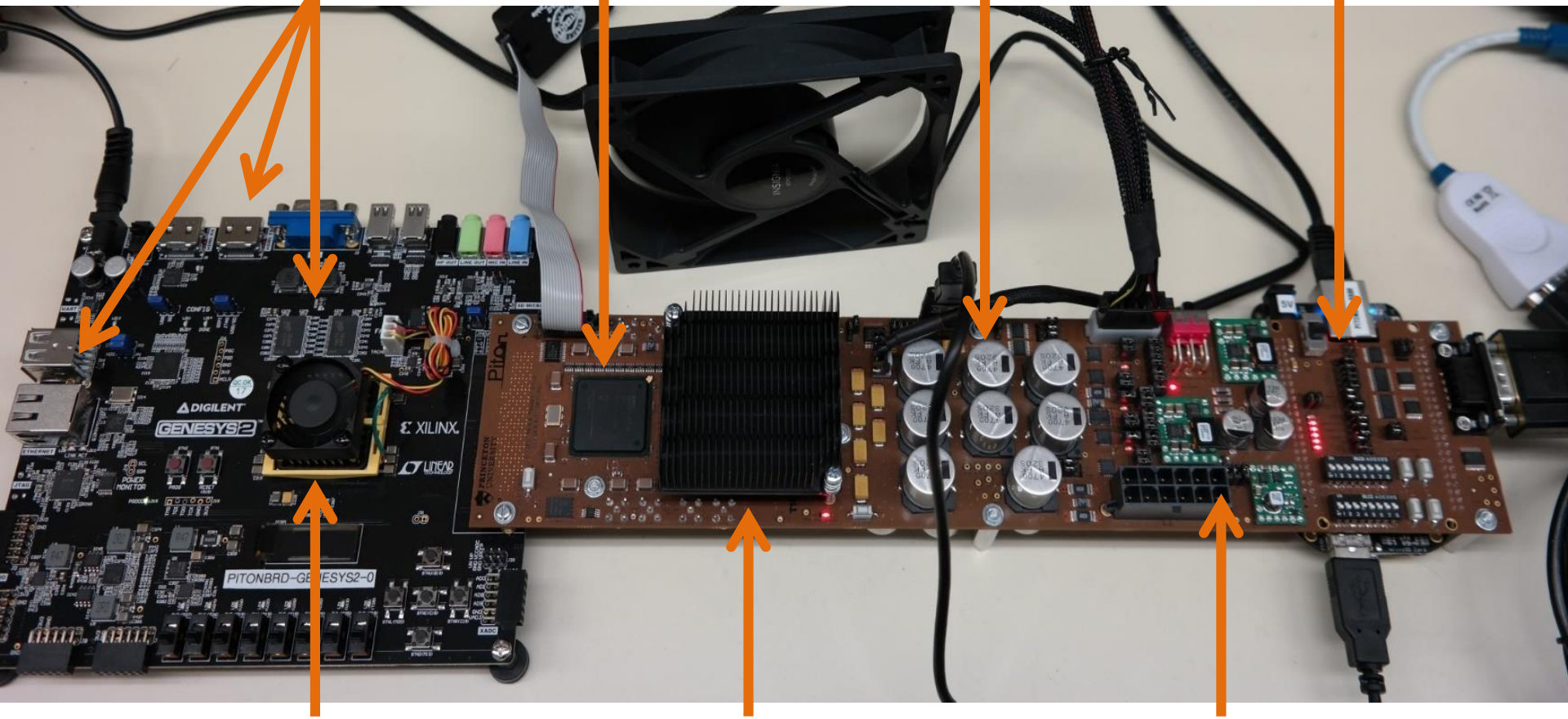


Unlidded Piton Chip



Piton Chip

Piton Test Setup



[McKeown et al, HotChips 2016]

Tetris on Debian Linux on Piton

From Michael McKeown <mmckeown@PRINCETON.EDU>
Subject **Tetris on Piton!!**
To ee-parallel@Princeton.EDU <ee-parallel@Princeton.EDU>

Reply | Reply All | Forward | Archive | Junk | Delete | More

10/11/16, 5:44 PM

Piton boots Linux and we can play tetris!

Solution was to use another chip :).

Mike

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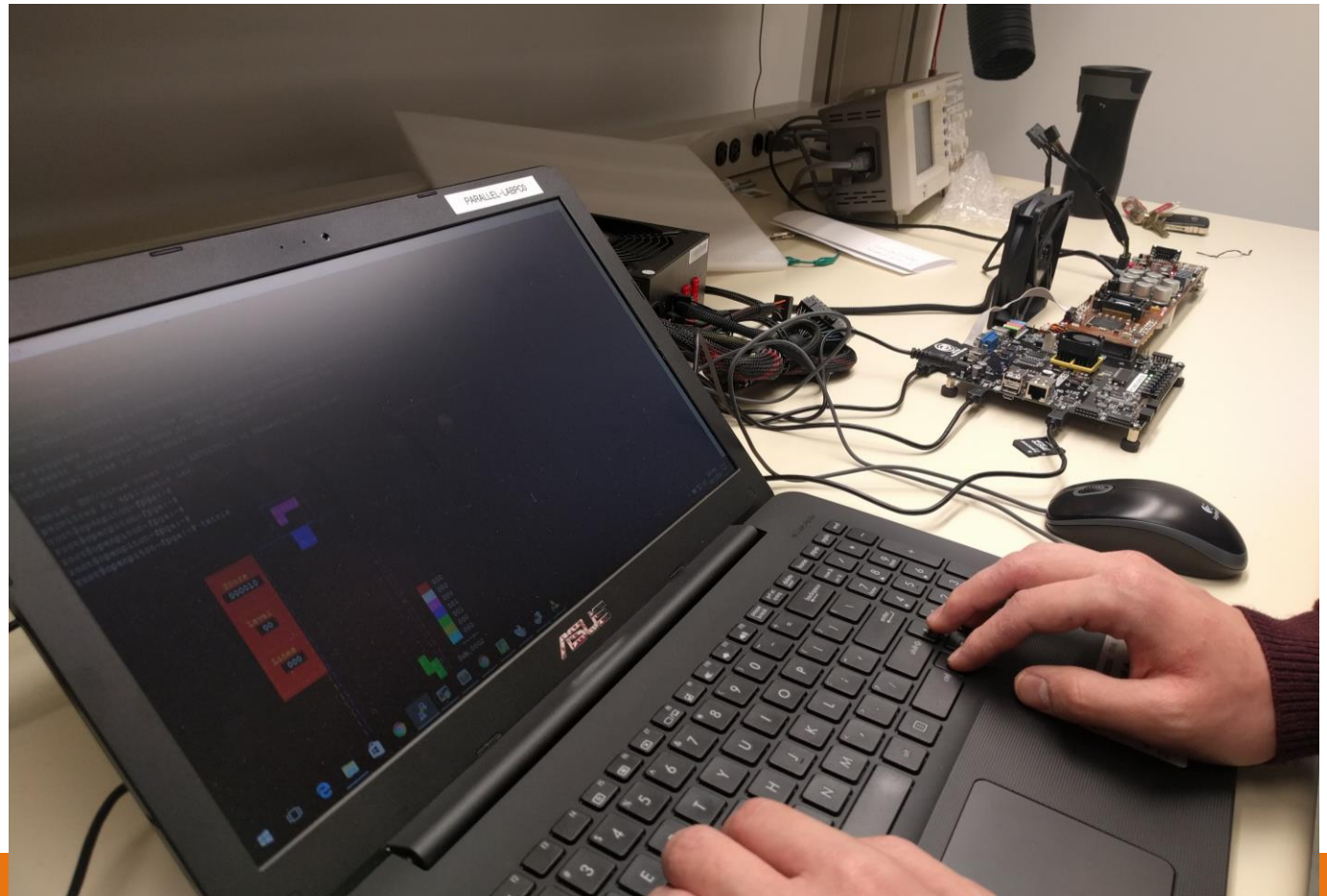


FPGA Targets

Board	Frequency (1 Core)	Cores	Academic Price
Xilinx VC707	67MHz	4	$3495
Xilinx ML605	18MHz	2	$1995
Digilent Genesys 2	60MHz	2	$600
Digilent Nexys Video	30MHz	1	$250
Digilent Nexys 4 DDR	29MHz	1	$160

OpenPiton Philosophy

- Focus/Value is in the Uncore
  - Not religious about ISA
  - Provide whole working system
- We are practical
  - Use Verilog
  - Industry standard tools
  - Use the best tool for job (including commercial CAD tools)
- Primarily for research, but welcome industry also
- Licensing
  - All our code is BSD-like
  - Linux, Hypervisor, T1 core (GPL or LGPL)
- Scalability (Million Core)

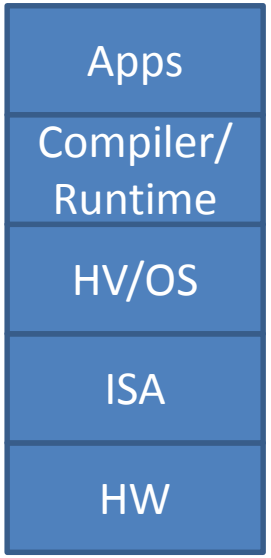
OpenPiton Community

- Building a community
  - Welcome community contributions
  - Over 1500 Downloads
- Google Group

- Visit http://openpiton.org
- openpiton@princeton.edu

Doing Research with OpenPiton

- Software
  - Install on Debian, test scalability
- Operating System
  - Recompile kernel, rebuild SW, run
- Hardware/Software Co-design
  - Add new instructions, change compiler/HV/OS/SW
- Architecture
  - Change parameters, rebuild HW, run



Enabled Research

- Coherence Domain Restriction
  - Fu et al. MICRO 2015
- Execution Drafting
  - McKeown et al. MICRO 2014
- Memory Inter-arrival Time Traffic Shaper
  - Zhou et al. ISCA 2016
- Oblivious RAM
  - Fletcher et al. ASPLOS 2015
- DVFS modelling