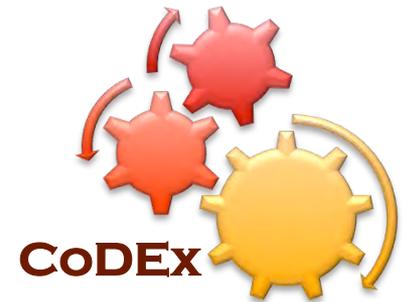# OpenSoC Fabric

An open source, parameterized, network generation tool

Farzad Fatollahi-Fard, Dave Donofrio, George Michelogiannakis, John Shalf

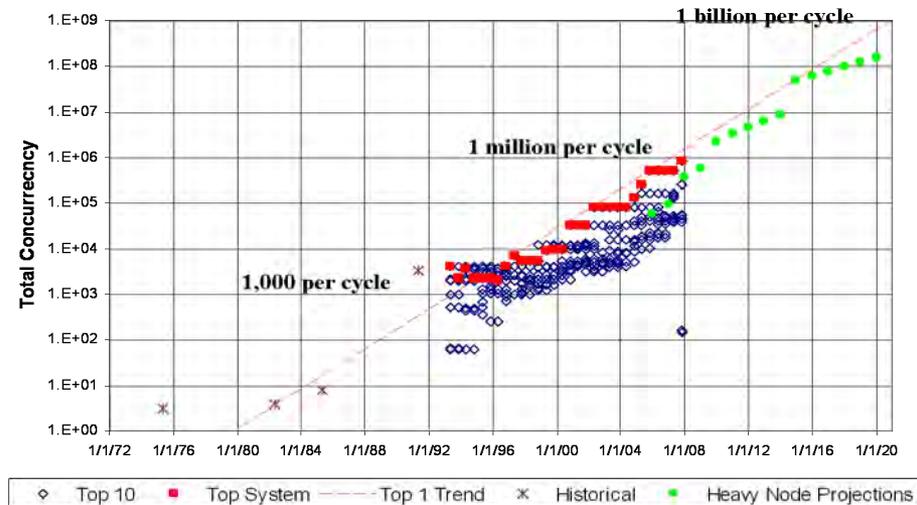Webinar: Embedded Technologies
September 25, 2014.

CoDEx

COMPUTER ARCHITECTURE LABORATORY

EXASCALE DESIGN SPACE EXPLORATION

Motivation

How best to influence and predict performance of future architectures?

▸ **Clock frequencies leveling off**

▸ **Chip density continues to increase**

▸ **Parallelism increasing exponentially**

Inspiration from the Embedded Market

‣ **Have most of the IP and experience with for low-power technology**

‣ **Have sophisticated tools for rapid turn-around of designs**

‣ **Vibrant commodity market in IP components**

- *Change your notion of "commodity"!*

- *It's commodity IP on the chip (not the chip itself!)*

‣ **Convergence with HPC requirements**

- Need better computational efficiency and lower power

- Now we both must face parallelism

Integration is Key

What if we had method of quickly integrating the IP that is readily available for the embedded market?

Embracing Integration
What happens when you stop caring about core power

‣ **Future chips will have 1000's of cores**

- Power per core will drop to mW

- Power / performance of on-chip SRAM, networks and IO will be dominant

‣ **Integrated IP will differentiate processors**

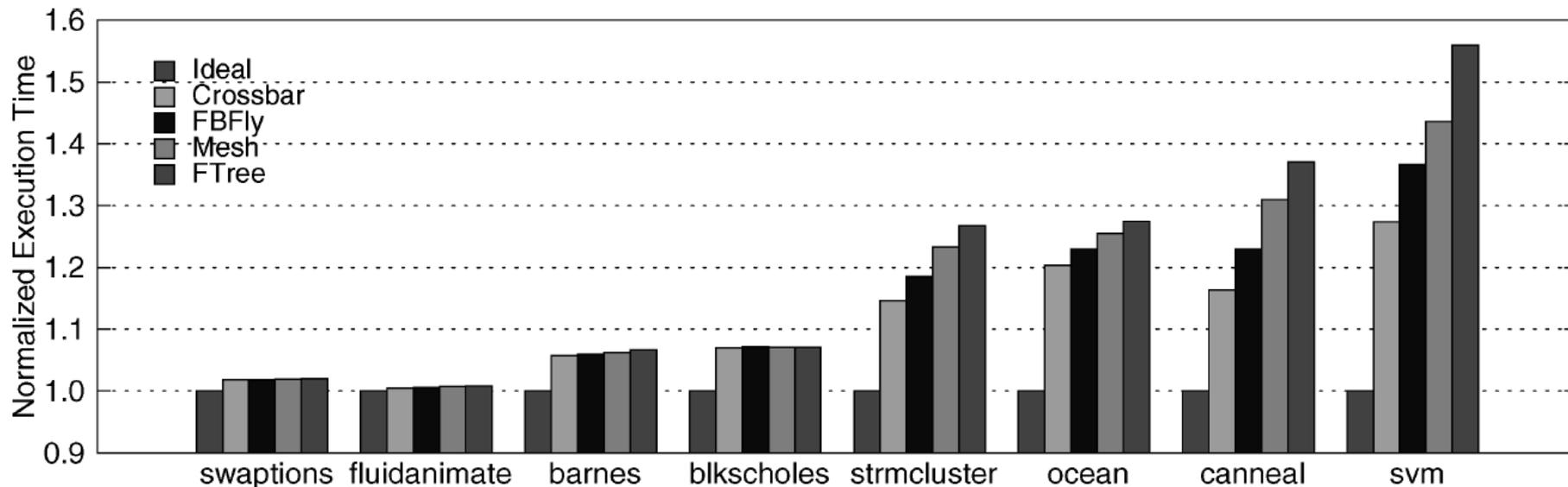‣ **Need powerful networks to connect cores to memory(s), external IO and each other**

SoC - Interconnect Examples

Some common topologies
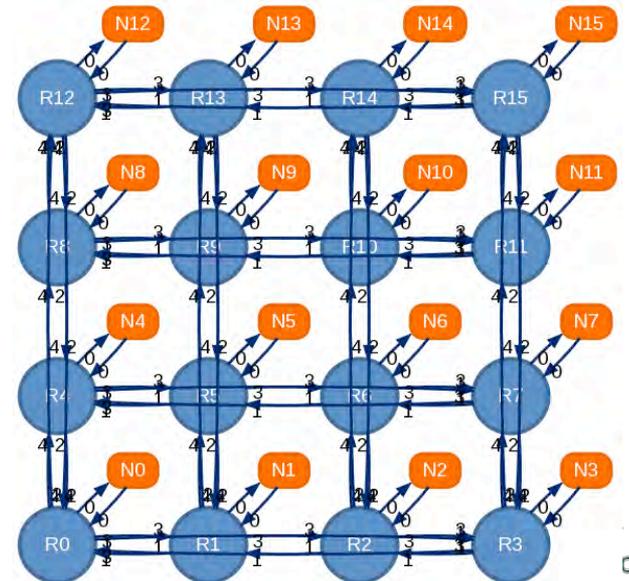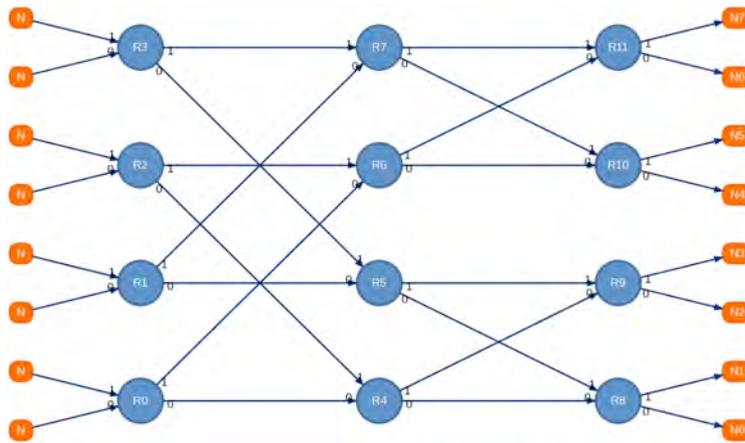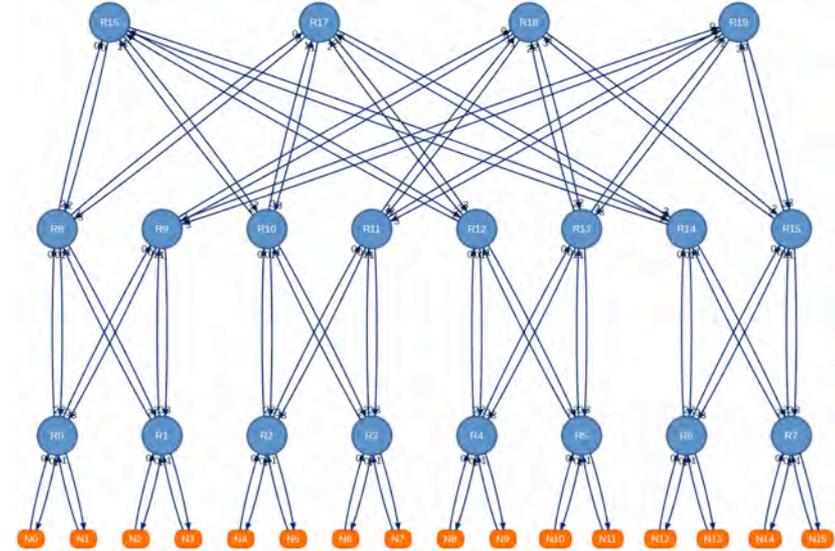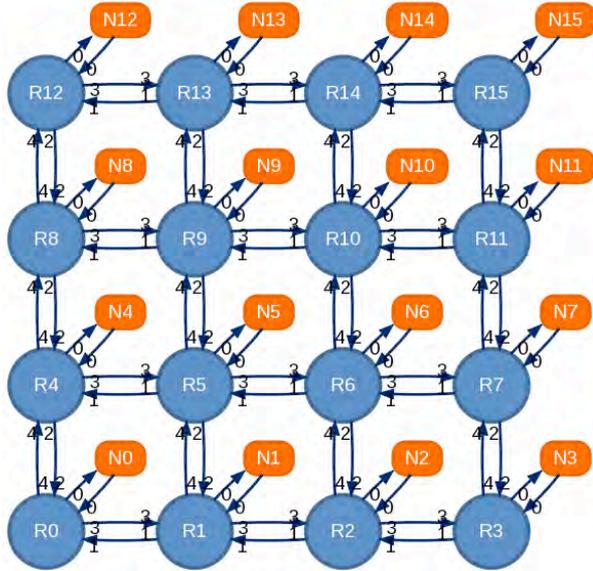
The Importance of Network Topology
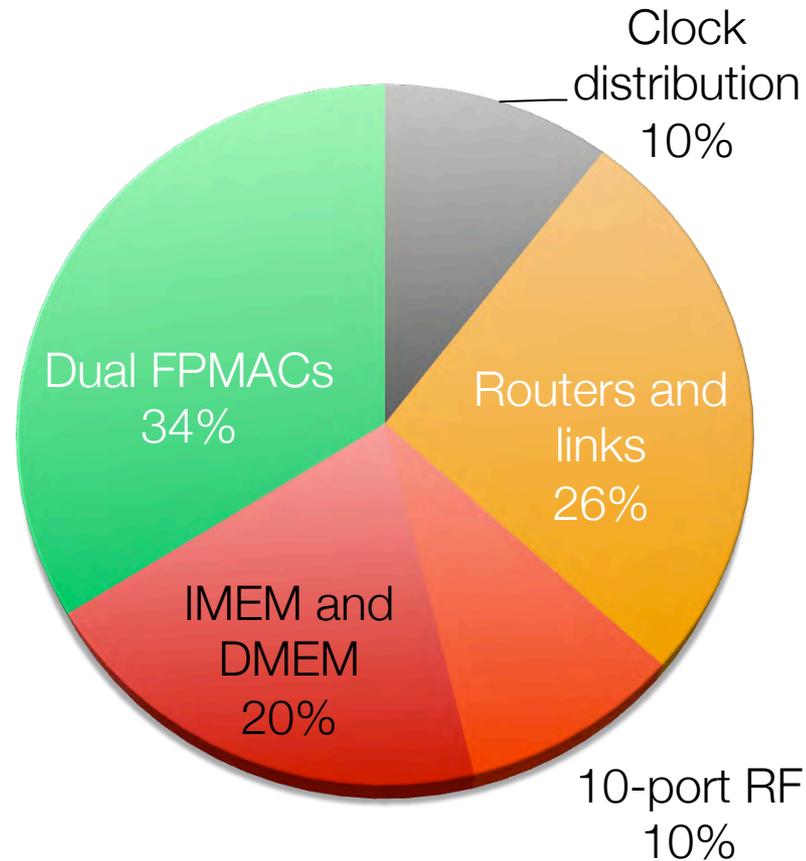
Topology wars may be coming…

An analysis of on-chip interconnection networks for large-scale chip multiprocessors
ACM Transactions on computer architecture and code optimization (TACO), April 2010

▸ **Network topology can greatly influence application performance**

The Importance of Networks

Networks consume a large fraction of total chip power...

A 5-GHz Mesh Interconnect for a Teraflops Processor.
IEEE Micro. 2007

What Interconnect Provides the Best Power / Performance Ratio?
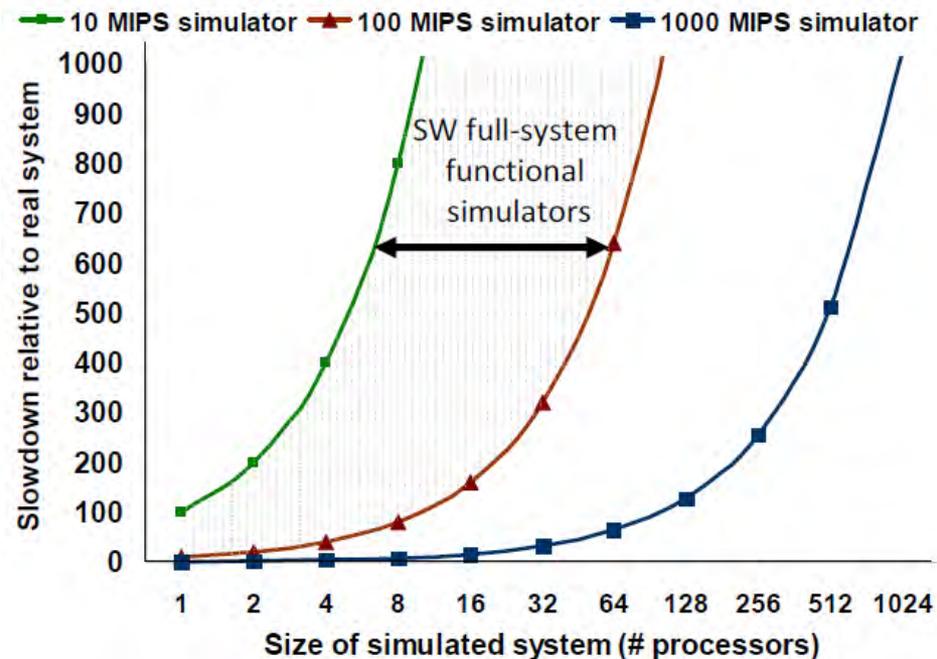What tools exist to answer this question?

What tools exist for SoC research

What tools do we have to evaluate large, complex networks of cores?

‣ **Software models**

  • Fast to create, but plagued by long runtimes as system size increases

‣ **Hardware emulation**

  • Fast, accurate evaluate that scales with system size but suffers from long development time

Chisel: A New Hardware DSL

Using Scala to construct Verilog and C++ descriptions

- **Chisel provides both software and hardware models from the same codebase**

- **Object-oriented hardware development**
  - Allows definition of structs and other high-level constructs

- **Powerful libraries and components ready to use**

- **Working processors fabricated using chisel**
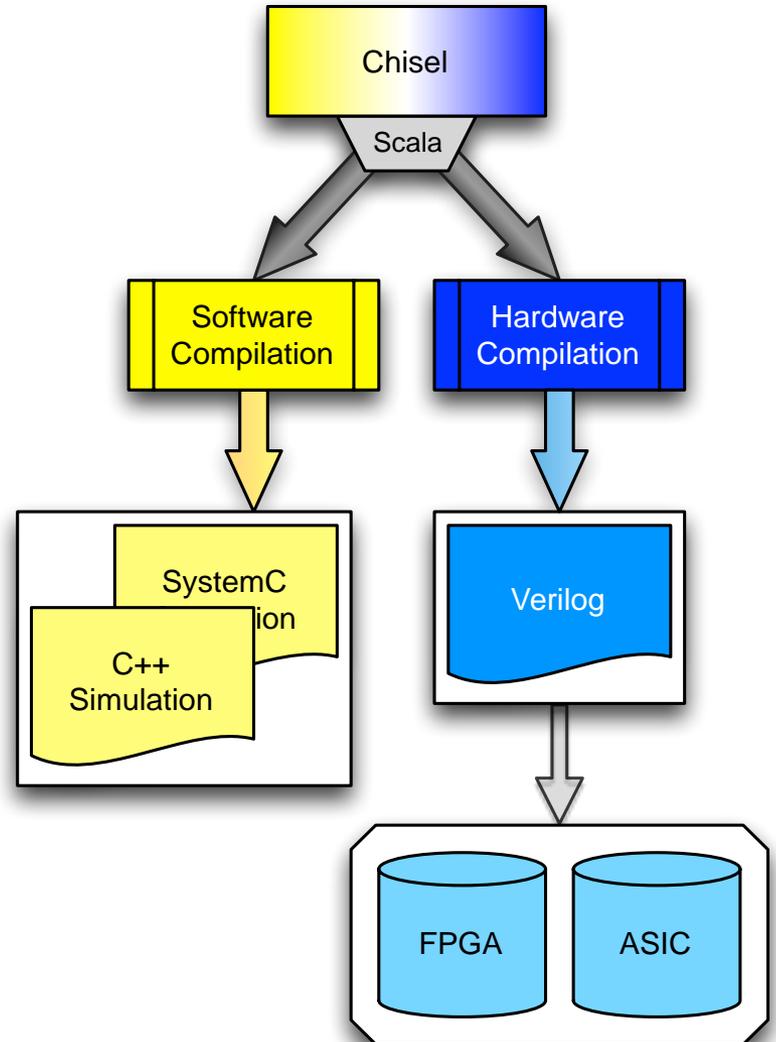
OpenSoC Fabric

An open source, flexible, parameterized, NoC generator

- **Based on Chisel**

- **Dimensions, topology, VCs all configurable**

- **Fast functional C++ model for functional validation**

  - SystemC ready

- **Verilog based description for FPGA or ASIC**

- **AXI Based endpoints**

  - Ready for ARM integration

OpenSoC Fabric

An open source, flexible, parameterized, NoC generator
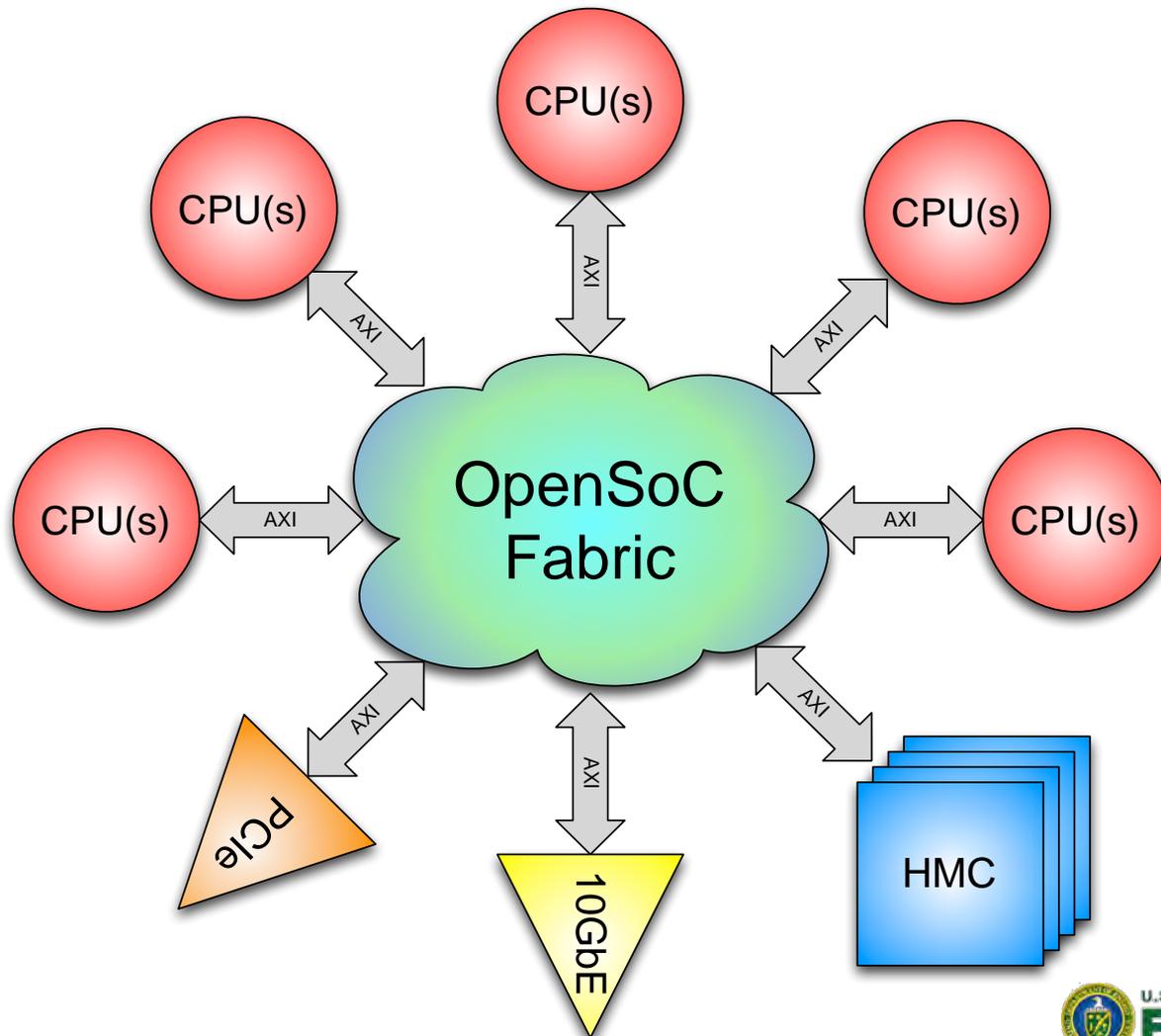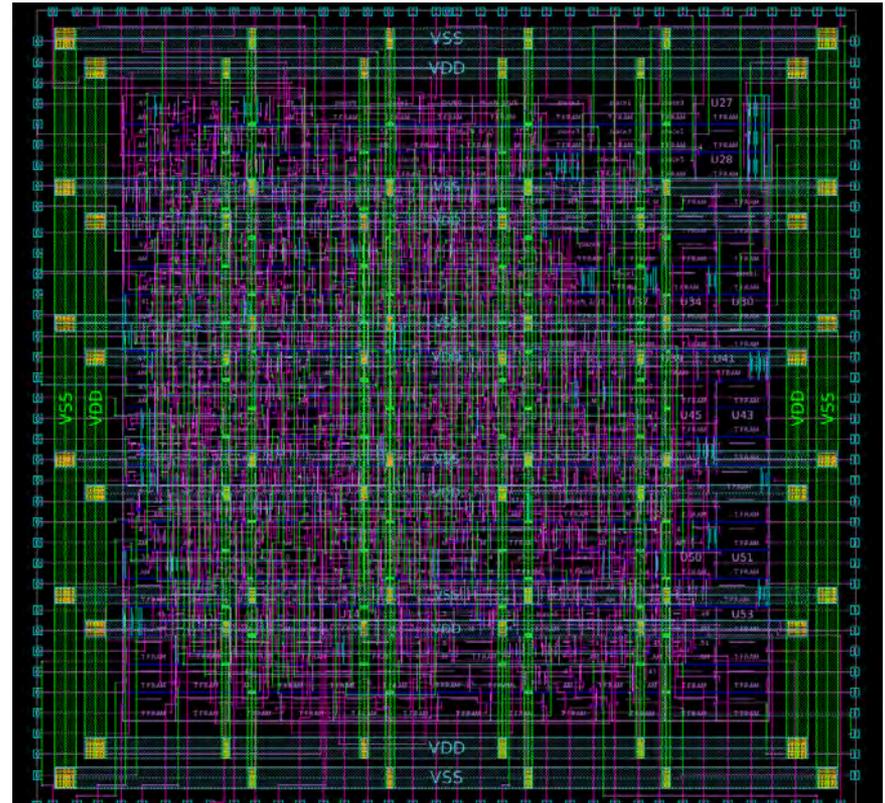
OpenSoC: Current Status

Projected v1.0 release date of October 1st

▸ **Available now:**

- 2-D mesh or Flattened Butterfly network of arbitrary size

- Wormhole routing

▸ **In Development**

- Virtual Channels

- AXI Interface

Future additions

Towards a full set of features

- ▶ **Photonics and circuit switched networks**

- ▶ **A collection of topologies and routing functions**

- ▶ **An easy way to adjust router pipeline stages**

- ▶ **Validation against other RTL or simulators**

- ▶ **Standardized (AXI) interfaces at the endpoints**

- ▶ **More powerful synthetic traffic and trace replay support**

- ▶ **Power modeling in the C++ model**

Summary

‣ **Embrace the embedded market for energy efficiency**

‣ **Integration of commercial IP for semi custom chip designs**

‣ **OpenSoC Fabric**

  • Emerging tools and techniques enable the development of novel manycore architectures

Acknowledgements

- **UCB Chisel**

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- **Berkeley Wireless Research Center**

More Information

http://www.opensocfabric.org