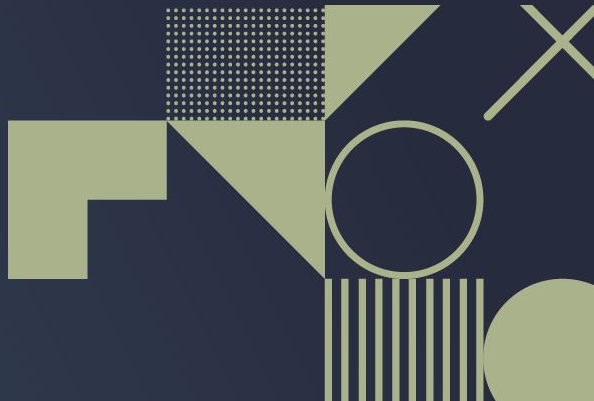
Ookami – The first year of a computing technology testbed

Eva Siegmann, Robert Harrison

IACS, Stony Brook University

HPCSysPros21 Workshop, 14 November 2021



Ookami - 狼

- A computer technology testbed supported by NSF
- Available for researchers worldwide

  (excluding ITAR prohibited countries & restricted parties on the EAR entity list)
- Usage is free for non-commercial and limited commercial purposes

Fugaku #1
Fastest computer in the world

First machine to be fastest in

all 5 major benchmarks:

- Green-500
- Top-500 – 415 PFLOP/s in double precision – nearly 3x Summit!
- HPCG
- HPL-AI
- Graph-500

- 432 racks
- 158,976 nodes
- 7,630,848 cores
- 440 PF/s dp (880 sp; 1,760 hp)
- 32 Gbyte memory per node
- 1 Tbyte/s memory bandwidth/node
- Tofu-2 interconnect

https://www.r-ccs.riken.jp/en/fugaku

Ookami

Node	
Processor	A64FX
#Cores	48
Peak DP	2.76 TOP/s
Memory	32GB@**1TB/s**
System	
#Nodes	176
Peak DP	486 TOP/s
Peak INT8	3886 TOP/s
Memory	5.6 TB
Disk	0.8 PB Lustre
Comms	IB HDR-100

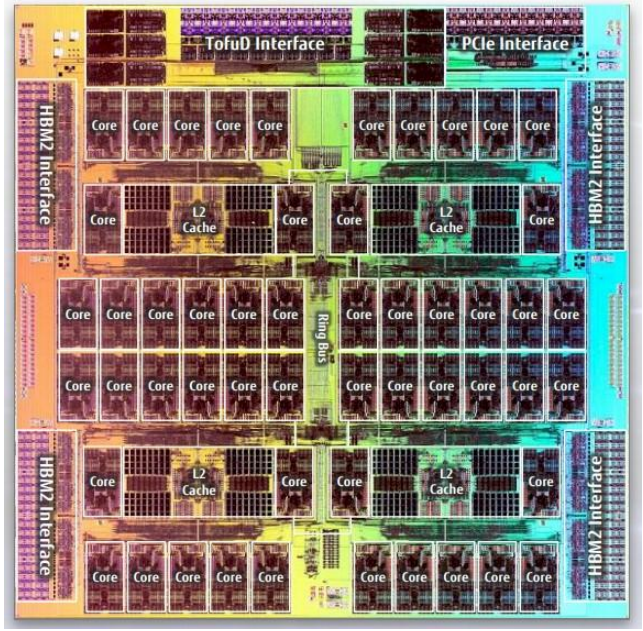
What is Ookami

- 176 1.8Ghz **A64FX** compute nodes each with 32GB of high-bandwidth memory and a 512 GB SSD
  - Same as in currently fastest machine worldwide, Fugaku
  - First open deployment outside Japan
  - HPE/Cray Apollo 80

- Ookami also includes:
  - 1 node with dual socket AMD Milan (64 cores) with 512 GB memory and 2 NVIDIA V100 GPUs
  - 2 nodes with dual socket Thunder X2 (64 cores) each with 256 GB memory
  - 1 node with dual socket Intel Skylake (36 cores) with 192 GB memory
- Delivers ~1.5M node hours per year

A64FX NUMA Node Architecture

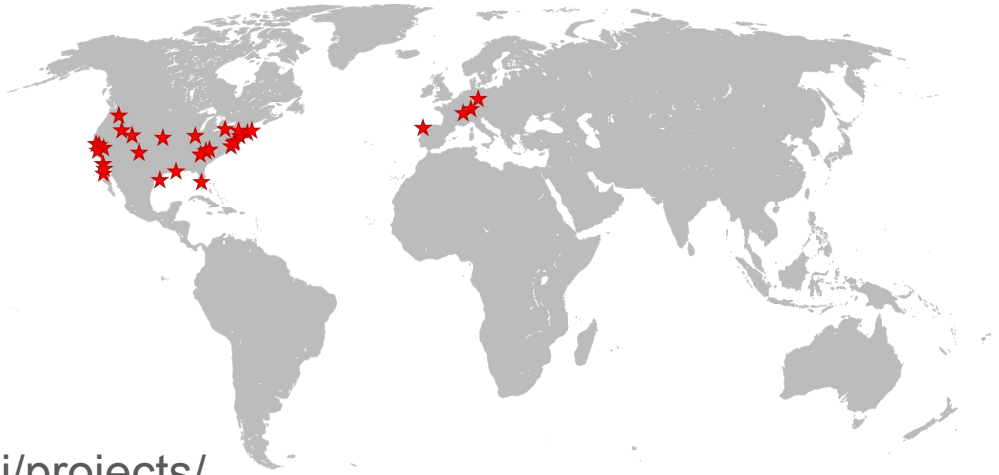
- Arm V8-64bit
- Supports high calculation performance and low power consumption
- Supports Scalable Vector Extensions (SVE) with 512-bit vector length
- **4 Core Memory Groups (CMGs)**
  - 12 cores (13 in the FX1000)
  - 64KB L1$ per core - 256b cache line
  - 8MB L2$ shared between all cores - 256b cache line
  - Zero L3$
- 32 (4x8) GB HBM @ 1 TB/s
- PCIe 3 (+ Tofu-3) network



Projects

- Total: 191 users & 64 projects
- 92.2% projects from within the US
- 7.8% from Europe
- 93.75% from academia
- Complete list of projects:

  https://www.stonybrook.edu/ookami/projects/



User Support

- Enable users to make effective use of the resource
  - E.g., switching from serial implementation to a fully-pipelined, vectorized, and threaded version → up to 100x speedup
  - E.g. switching compilers → 2 - 10x speedup
- Slack channel
- Ticketing system handled by the HPC support team
- Virtual office hours twice a week (Tue and Thu, each 2 hrs)
- Regular webinars
  - Arm vectorization hackathon, TAU, XDMoD, OSACA & likwid, etc.

Key Findings

- Compiler plays a major role in achieving good performance
- Most science codes need optimization to fully utilize A64FX and give the best performance
- GNU tool chain
  - Can generate very high performance vectorized and OpenMP code, but
  - No current path for an SVE capable vector math library
  - Most users want to start and finish with this tool chain, but many science applications need to switch tool chains to obtain high performance
- Fujitsu and Cray tool chains
  - Highest performance, but no support for recent language standards (e.g., only C++14)
- Arm tool chain
  - Mostly good to high performance, and being based on LLVM 11 supports modern C++
- MPI memory usage, latency, multithreaded performance
  - Working with developers to address limitations

Get in Contact

Acknowledgement:

- The whole Ookami team
- NSF (grant OAC 1927880)

www.stonybrook.edu/ookami

eva.siegmann@stonybrook.edu