

HPC User Forum Update

Arm in the UK: Catalyst and Isambard

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IN THIS UPDATE

The HPC User Forum was established in 1999 to promote the health of the global HPC industry and address issues of common concern to users. In October 2019, the 74th HPC User Forum took place in Edinburgh, Scotland. This update summarizes a presentation from that meeting, entitled *Arm in the UK: Catalyst and Isambard*, given by Simon Burbidge from the University of Bristol.

Burbidge's talk described performance results from two Arm-based supercomputers in the UK, the Catalyst system from HPE and the Isambard system from Cray. With both systems based on ThunderX2 Arm processors from Marvell, Burbidge characterized the system usability, single-node performance, and scalability in comparison to conventional Intel processors on a suite of four HPC benchmarks.



 University of
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ARM in the UK Catalyst and Isambard

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Source: University of Bristol and Hyperion Research, 2019

PRESENTATION: ARM IN THE UK: CATALYST AND ISAMBARD

Simon Burbidge from the University of Bristol described performance results from Arm-based supercomputers built by Cray and HPE. Funded under two separate programs, the ground-breaking projects put Arm to the test in a real-world academic workload environment.

Burbidge began his talk with a brief summary of HPC at Bristol's Advanced Computing Group, which supports three key activities across the University: HPC, Research Data Storage, and Research Software Engineering (RSE). The University has a long history of using different processors for HPC, and their staff was intrigued by the possibilities of using a new Arm CPU.

FIGURE 1

ARM at Bristol

- UoB was excited by prospect of a new CPU
- Isambard Project, PI Simon McIntosh-Smith. £3M EPSRC funded project with Cray to deliver ARM based Supercomputer
- Catalyst UK Programme, Collaboration between HPE, ARM and 3 UK Universities to demonstrate ARM based supercomputing in a real world environment

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Source: University of Bristol and Hyperion Research, 2019

Burbidge then discussed the specifics for the two Arm projects:

- Under Principle Investigator (PI) Simon McIntosh-Smith, the Isambard supercomputer from Cray was one of the first Arm supercomputers deployed worldwide. Isambard uses Marvell ThunderX2 32 core, 2.1GHz processors and has a total of 10,752 Armv8 cores (168 x 2 x 32) connected by the high-speed Aries interconnect. The system runs the Cray HPC optimized software stack.
- Under PI Simon Burbidge, the Catalyst system from HPE comprises three 30kW systems, each consisting of 64 HPE Apollo 70 servers equipped with two 32-core Marvell ThunderX2 processors, 128GB of memory, and Mellanox InfiniBand interconnects.

FIGURE 2

| Processor | Cores | Clock speed GHz | TDP Watts | FP64 TFLOP/s | Bandwidth GB/s |
|------------------|--------|--------------------|--------------|-----------------|-------------------|
| Broadwell | 2 × 22 | 2.2 | 145 | 1.55 | 154 |
| Skylake Gold | 2 × 20 | 2.4 | 150 | 3.07 | 256 |
| Skylake Platinum | 2 × 28 | 2.1 | 165 | 3.76 | 256 |
| ThunderX2 | 2 × 32 | 2.1 (2.5) | 175 | 1.28 | 320 |

BDW 22c Intel Broadwell E5-2699 v4, **\$4,560** each (near top-bin)
SKL 20c Intel Skylake Gold Skylake Platinum 86148, **\$3,078** each
SKL 28c Intel 176, **\$8,719** each (near top-bin)
TX2 32c Cavium ThunderX2, **\$1,795** each (near top-bin)

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Source: University of Bristol and Hyperion Research, 2019

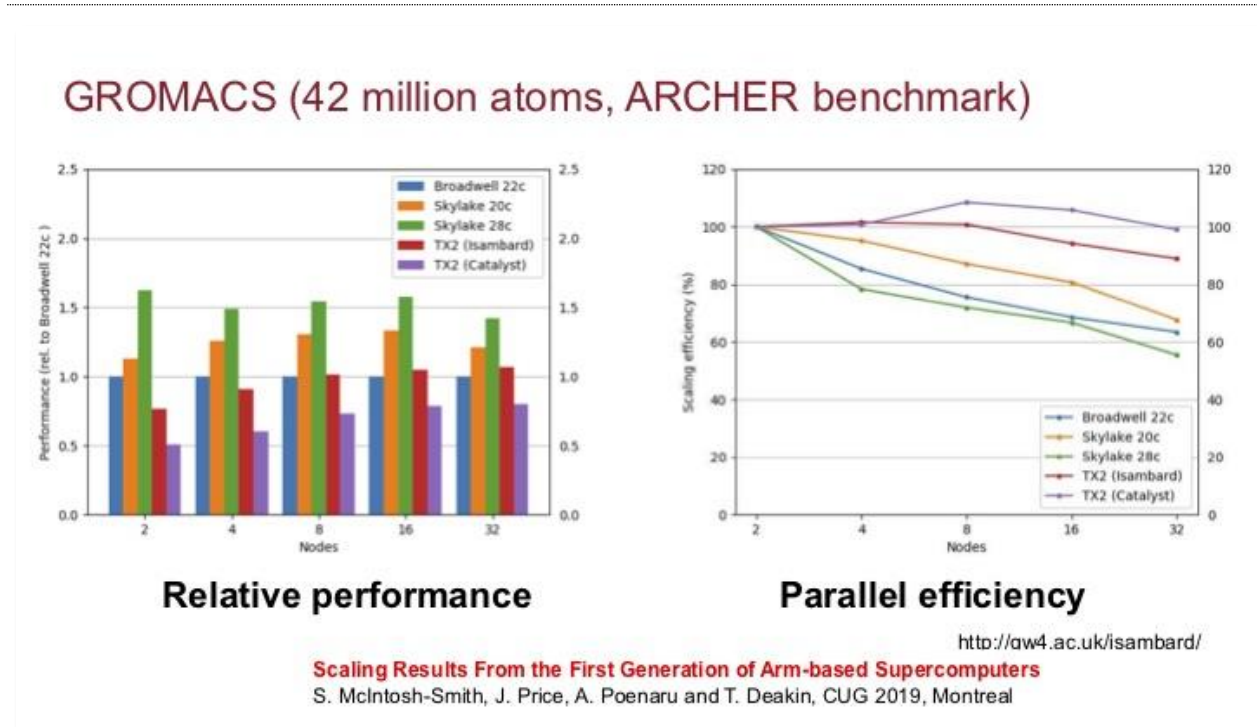
In Figure 2, Burbidge showed how the Marvell ThunderX2 processor compares with traditional HPC processors from Intel in terms of number of cores, clock speed, power consumption, FP64 FLOPS, and memory bandwidth.

“When we were doing comparisons, we wanted to make sure that we picked the best-of-breed that we could. The clock speeds are a little bit lower than some of Intel’s best, but the performance per node seems to be pretty comparable.”

Highlights:

- Although the ThunderX2 has a slightly slower clock speed at 2.1 GHz than Intel’s best offerings, it has higher memory bandwidth due to having four memory channels per processor, versus three for the Intel Xeon processors.
- Burbidge noted that for these tests, the price of the ThunderX2 is significantly less than the Intel processors, as seen in Figure 2.
- In terms of the software environment, Burbidge indicated that the Linux tools and libraries look and behave the same as with any typical x86 supercomputer system.
- In terms of system stability, Burbidge describes the drivers, disks, networks, etc. as robust for a first-generation system architecture and usable for a production environment.

FIGURE 3



Source: University of Bristol and Hyperion Research, 2019

Burbidge characterized the systems' single-node performance and scalability in comparison with conventional Intel processors on a number of heavily used benchmark codes in the UK academic area:

- GROMACS (molecular dynamics, particularly biomolecules)
- OpenSBLI (finite difference, Navier Stokes)
- VASP (atomic scale materials modeling)
- Open FOAM (computational fluid dynamics)

Figure 3 shows the relative performance of the Arm processors on Isambard and Catalyst for the GROMACS code, with Intel Broadwell rated at 1.0. Note that this is single-node performance. Burbidge characterized this as acceptable performance for HPC, especially after considering processor cost.

In Figure 3 on the right-hand side, parallel efficiency is shown when for scaling up to 16 or 32 nodes. Burbidge highlighted that the Arm processors displayed better parallel efficiency due to their higher memory bandwidth.

While the four codes used in this comparison have vastly different application profiles, the results Burbidge noted showed comparable, or at least acceptable, single node performance and scalability for Arm vs. Intel processors.

FIGURE 4

Conclusions

- ARM is capable of doing HPC
- Real world runs, decent performance
- Two proven example system types
- Results are correct
- Looks like the major CPU supplier may have some competition!

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Source: University of Bristol and Hyperion Research, 2019

Conclusions and Plans Going Forward:

- Burbidge concluded that not only are Arm processors capable of doing HPC, they are able to do production supercomputing in real-world work environments, producing correct answers with decent performance.
- Results from two system vendors with different interconnects show that Arm has the bandwidth and scalability to provide real competition to the Intel-dominated market for HPC systems.
- The University of Bristol is seeking to demonstrate more applications on Arm, and they welcome enquiries from research groups.
- The University is especially interested in working with industry, commerce, and ISVs to bring more code to Arm and to expand the ecosystem.

For more information or to view this and other presentations given at HPC User Forums dating back to 2008, visit www.hpcuserforum.com.

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