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Status and performance of two Arm supercomputers: the Cray Isambard Tier-2 service and HPE Catalyst

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Isambard system specification

- **10,752** Armv8 cores (168n x 2s x 32c)
  - **Marvell ThunderX2 32 core 2.1→2.5GHz**
  - **256 GB RAM per node, bandwidth >240 GB/s**
- Cray XC50 'Scout' form factor
- High-speed **Aries** interconnect
- Cray HPC optimised software stack
  - CCE, Cray MPI, math libraries, CrayPAT, …
- **Phase 2 (the Arm part):**
  - Installed in November 2018, accepted in 1 week!
  - Upgraded silicon (to B2), firmware and stack Mar19
  - Now have 185 registered users, 63 are external
  - **PRODUCTION SERVICE opened to all users May 2019**
    - **First Arm-based production service in the world!**


Isambard
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Pioneering research and skills
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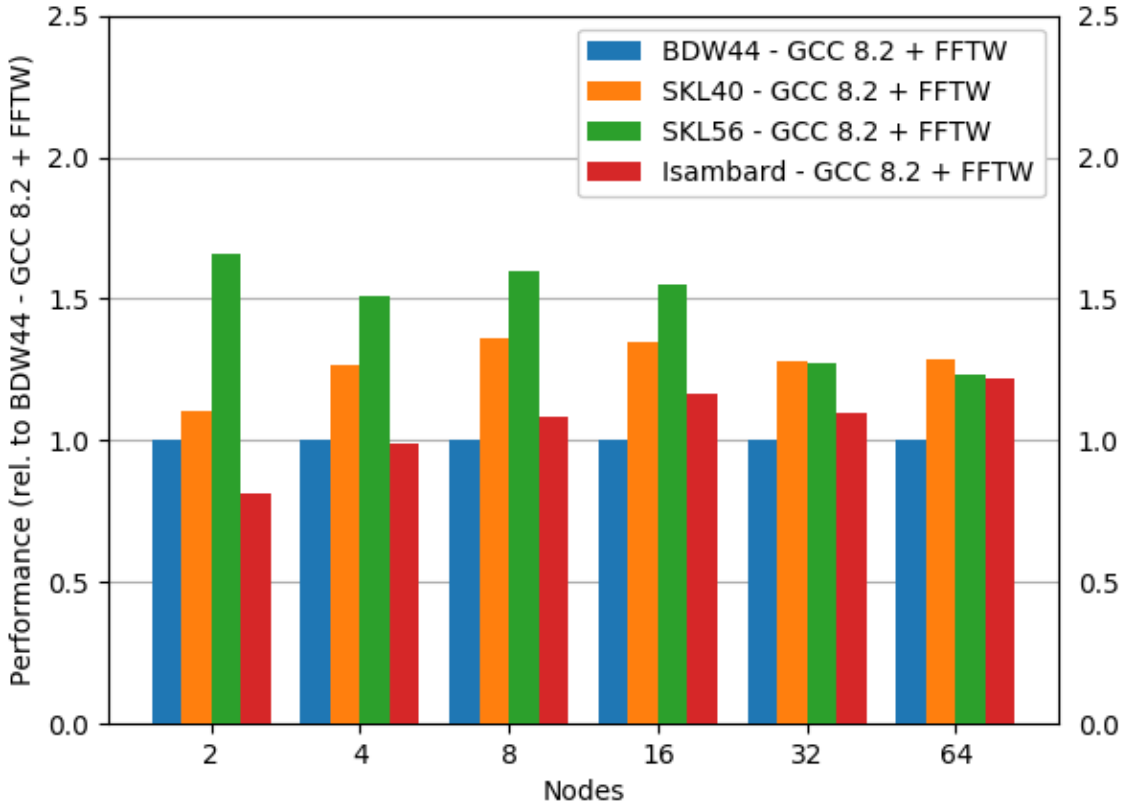
CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD
UNIVERSITY OF EXETER
Met Office
CRAY

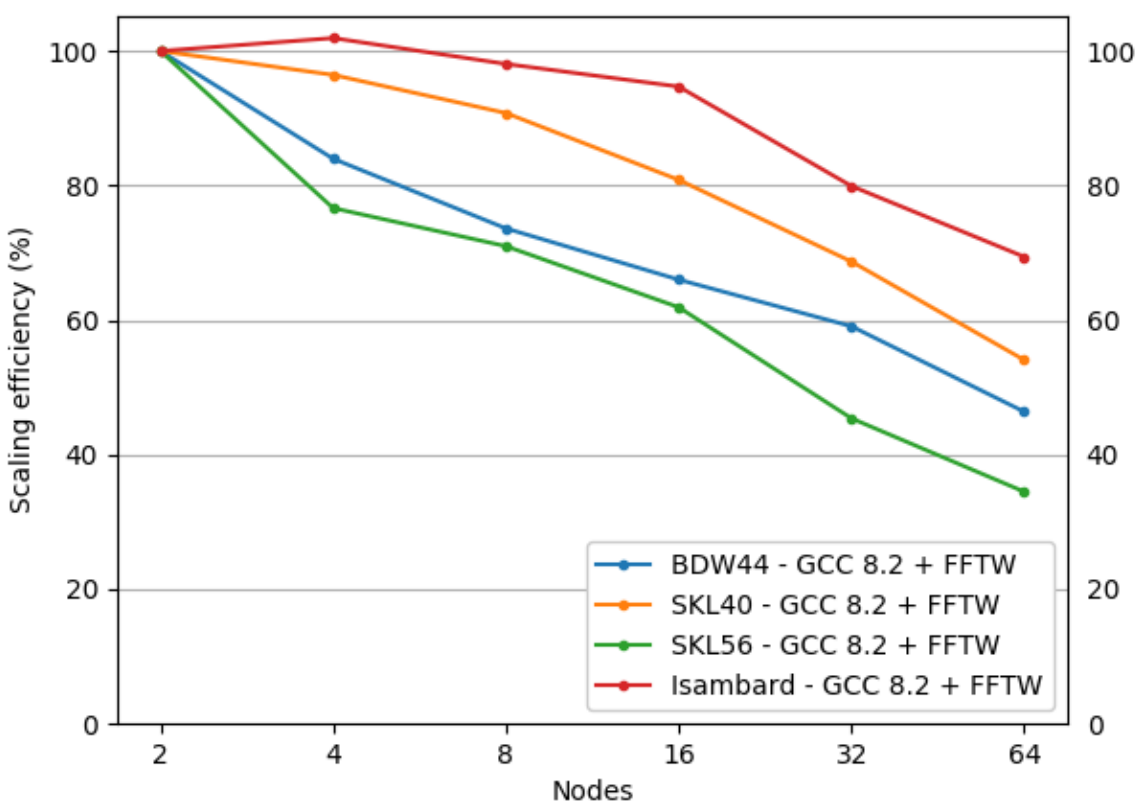
Scalability comparisons between x86 and Arm

- We explore relative performance and scaling efficiency
- We've compared against three x86-based XC50 systems:
  - Swan using Intel Broadwell E5-2699 22-core CPUs at 2.2GHz
  - Horizon using Intel Skylake Gold 6148 20-core CPUs at 2.4GHz
  - Swan using Intel Skylake Platinum 8176 28-core CPUs at 2.1GHz
- All the results are for **strong scaling**, up to 64 nodes
- All of these systems use the same interconnect (Cray's Aries) and the same O/S and MPI library, so this is a good test of whether Arm-based ThunderX2 scales as well as x86

GROMACS (42 million atoms, ARCHER benchmark)

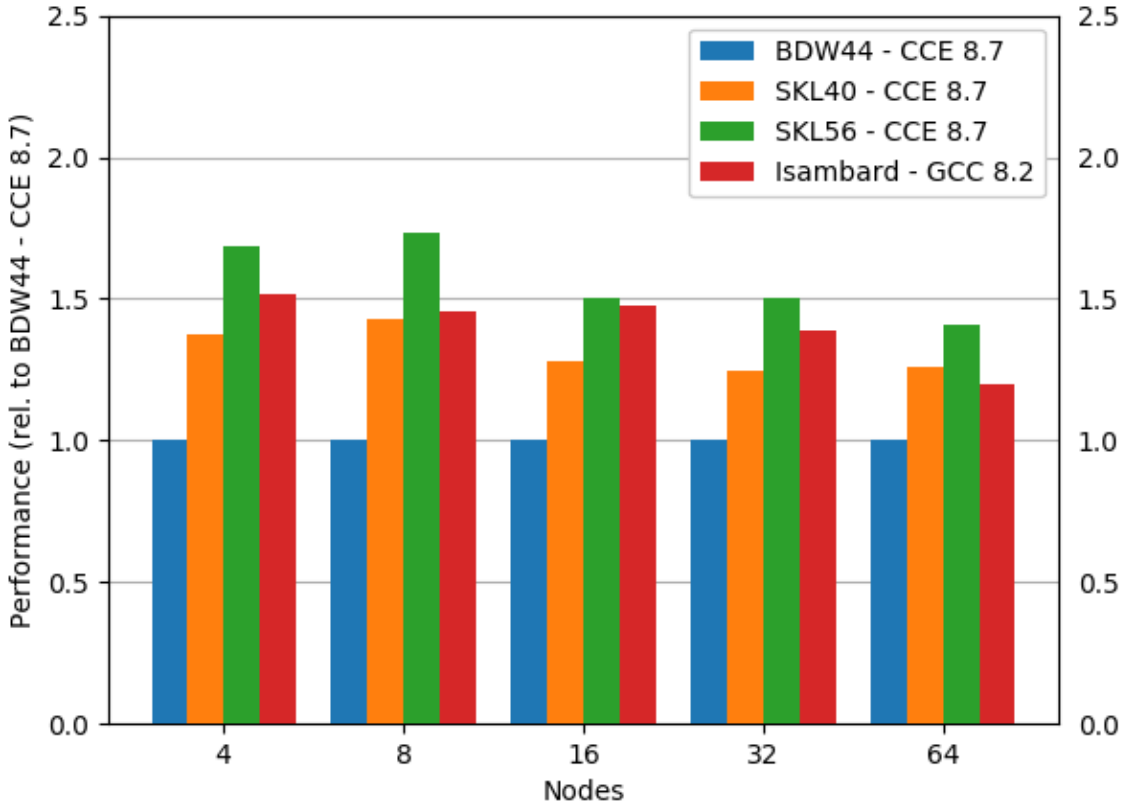


Relative performance

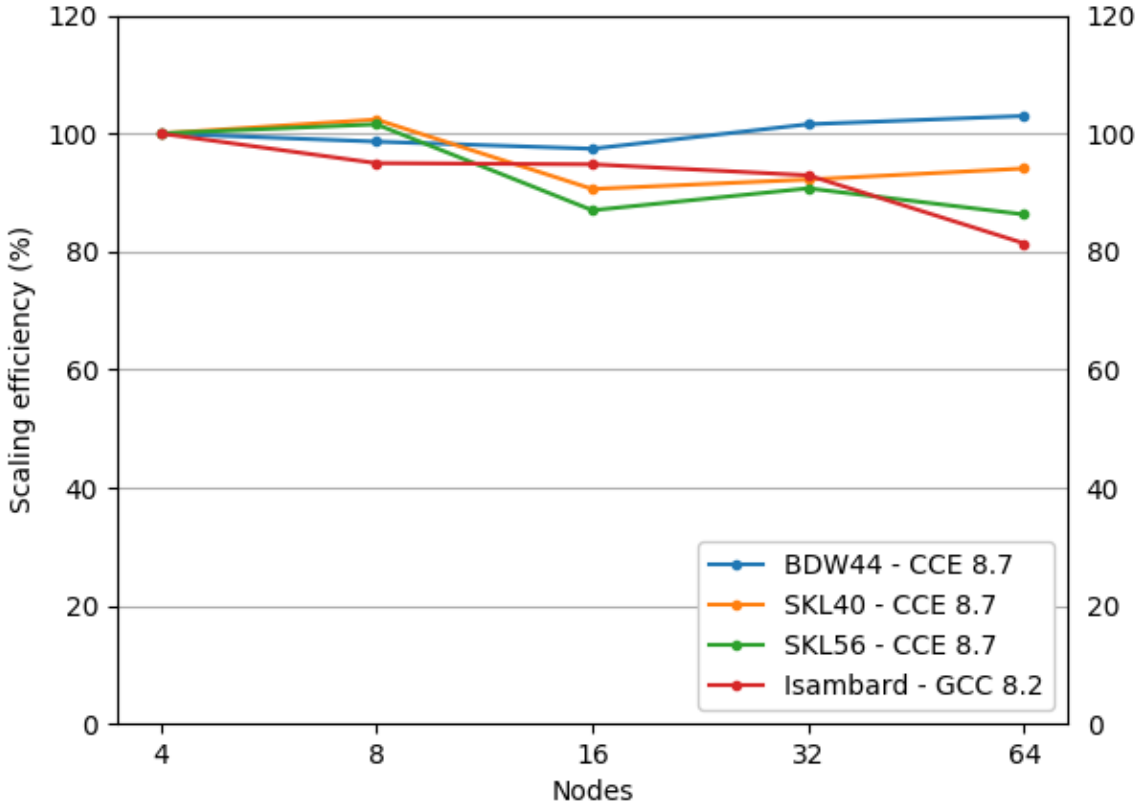


Parallel efficiency

OpenSBLI (1024^3, ARCHER benchmark)

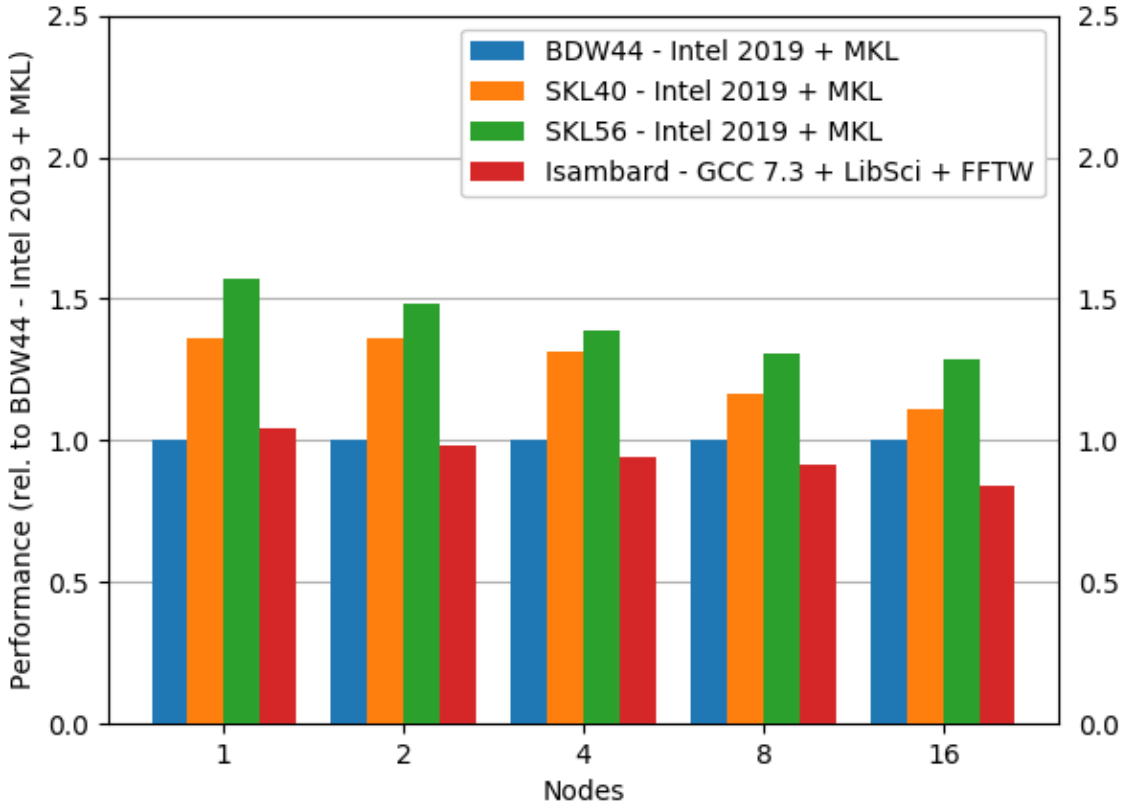


Relative performance

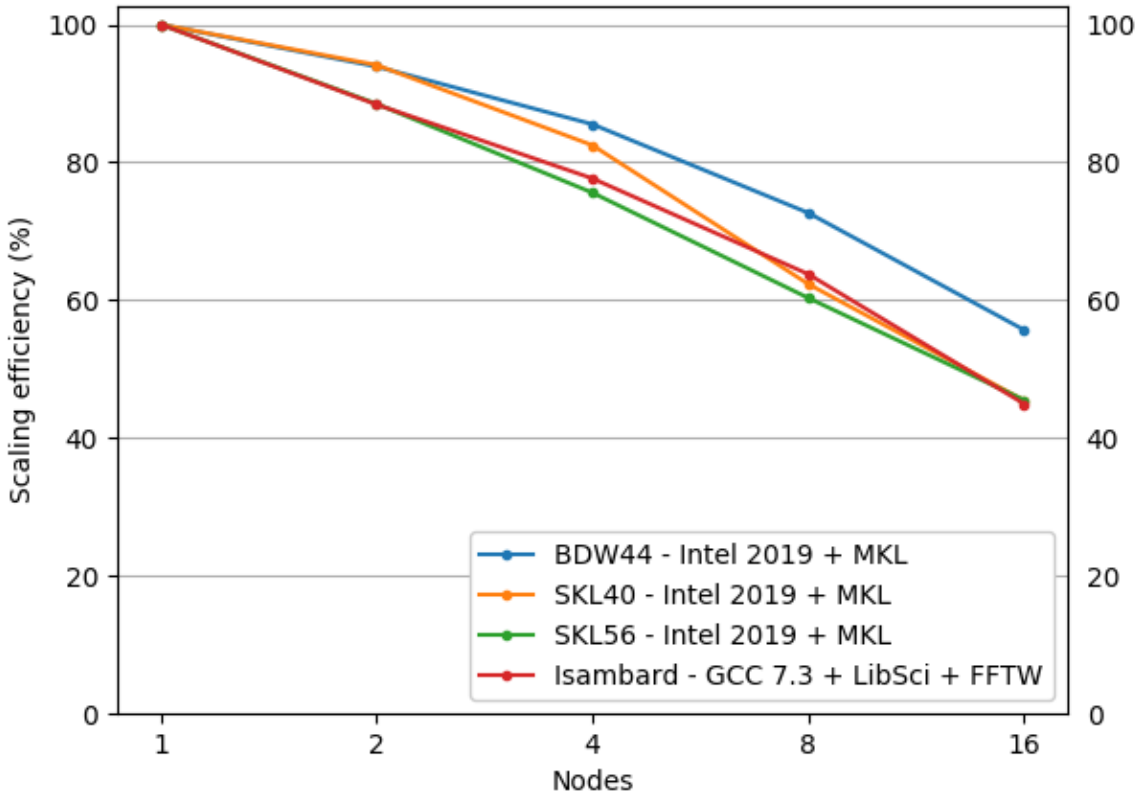


Parallel efficiency

VASP (PdO, 1392 atoms)



Relative performance



Parallel efficiency

Isambard scaling summary

- **Arm-based systems appear to scale just as well as x86 ones**

- **For certain codes that were compute- or bandwidth-bound at low scale, these became network bound at 'real' scale, levelling the playing field**

- **We're seeing an issue with scaling in a few cases; appears to be in the MPI implementation** (currently investigating with Cray)

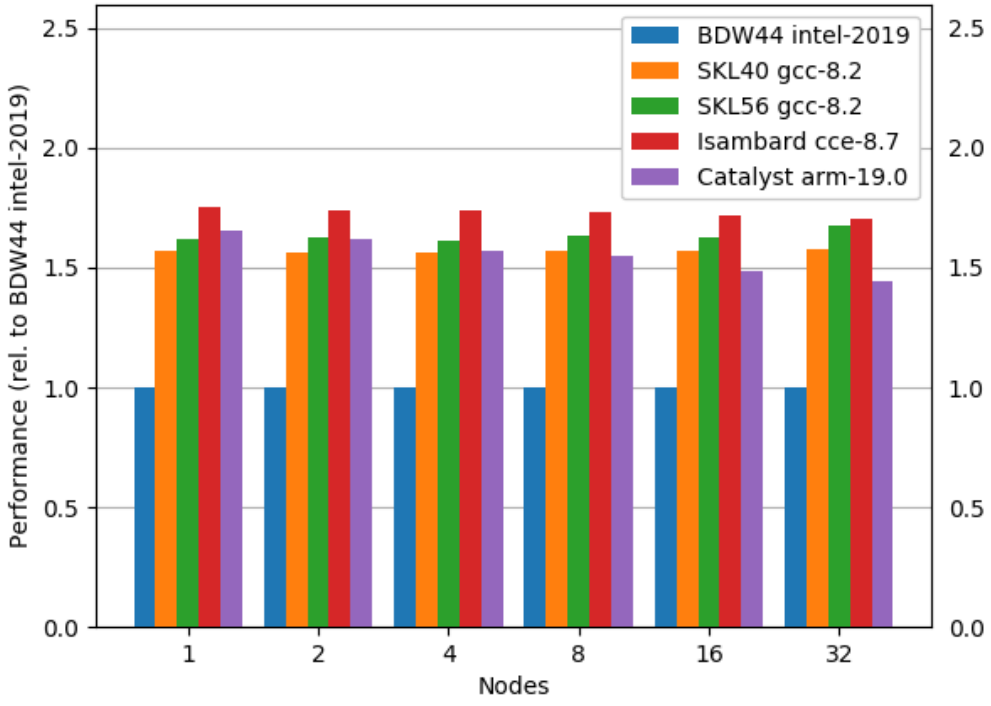
Comparing between multiple Arm-based supercomputers

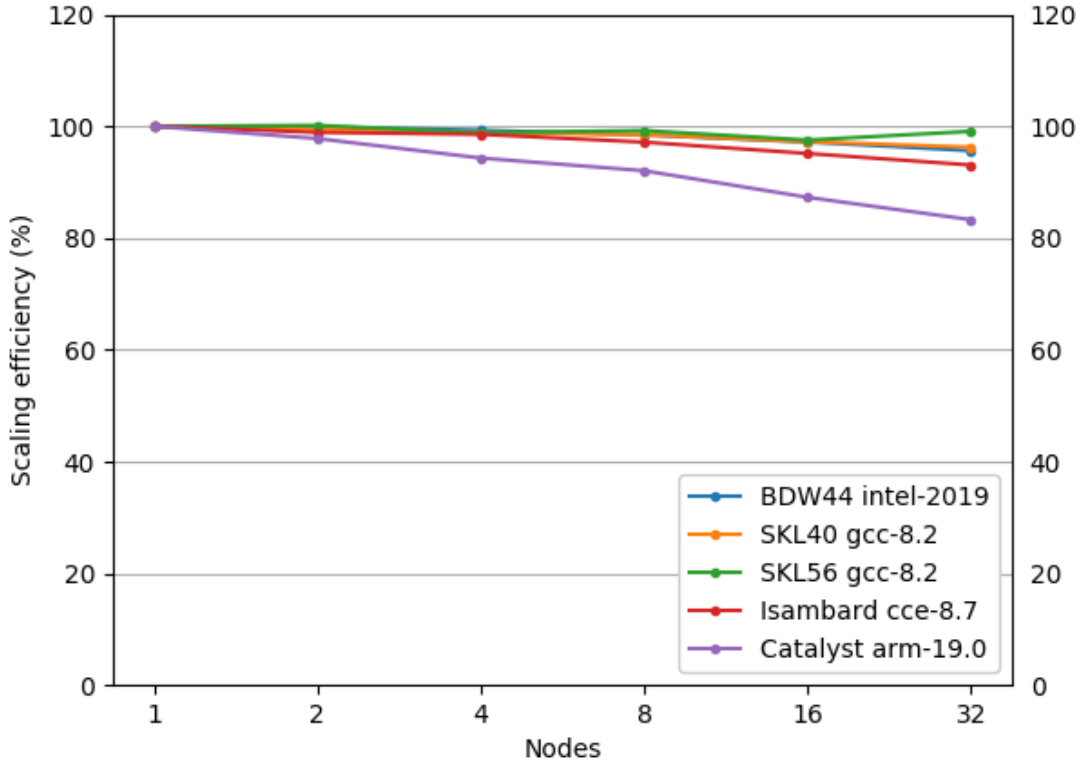
- **Bristol** is one of the few sites in the world with multiple different Arm-based supercomputers
  - Added an HPE Catalyst system in 1Q2019
    - 64-node Apollo70 system, 4,096 cores, ThunderX2 CPUs

- **Isambard** and **Catalyst** together enable us to compare across:
  - **Networks**: Cray Aries vs Mellanox IB
  - **Software stacks**: open source vs Cray

- The following charts have never been shown in public before…

CloverLeaf – system comparison





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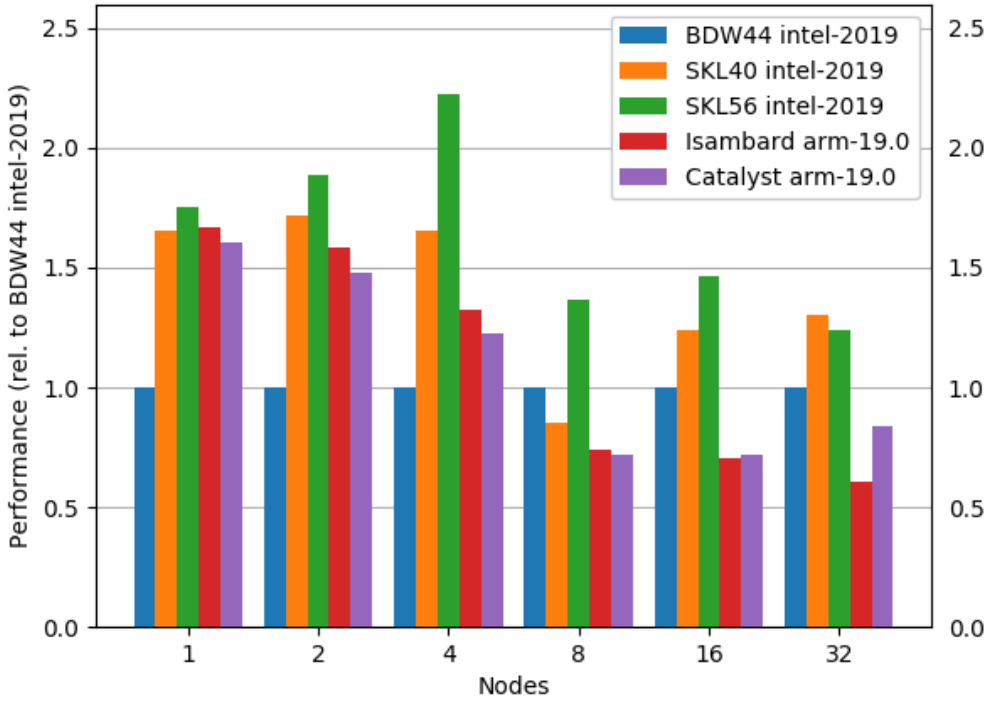
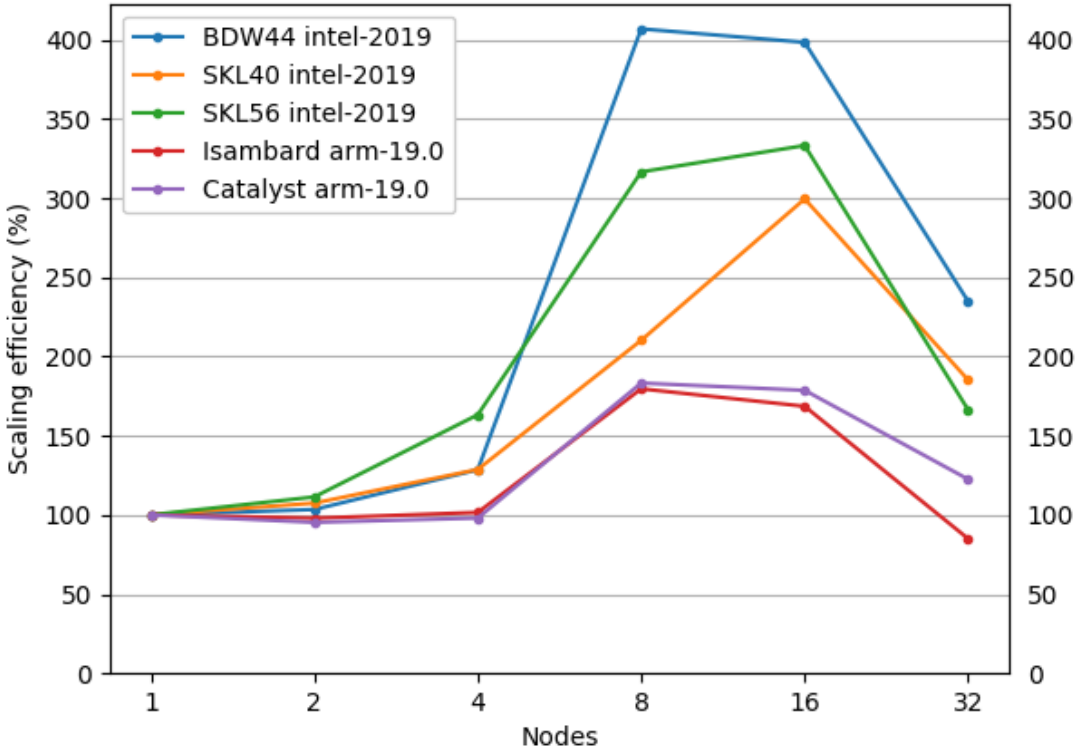
TeaLeaf – system comparison





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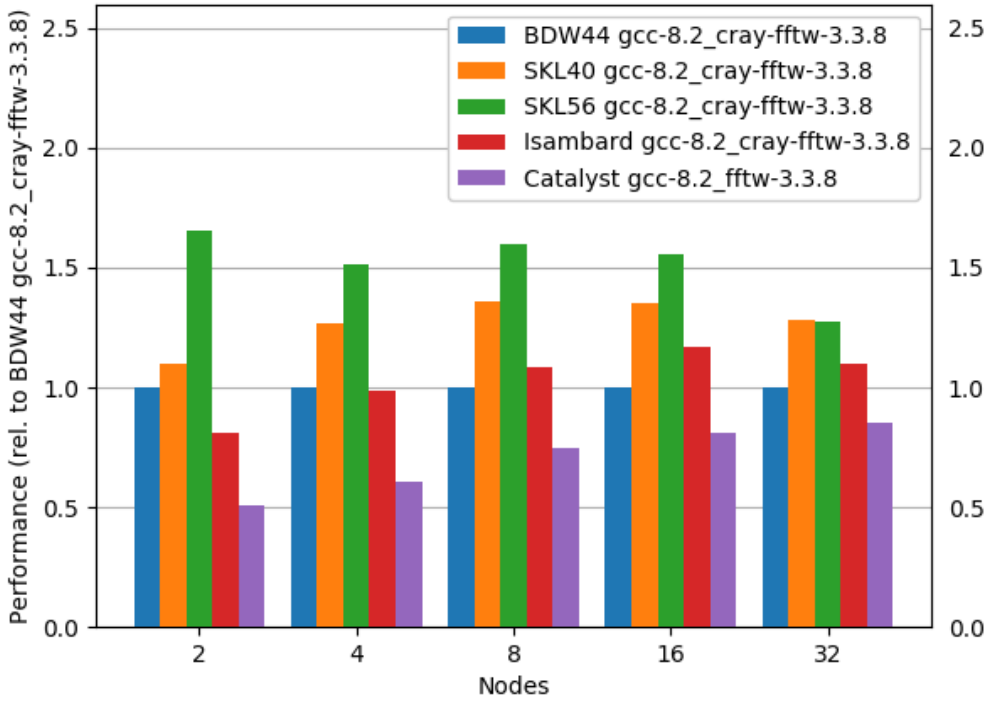
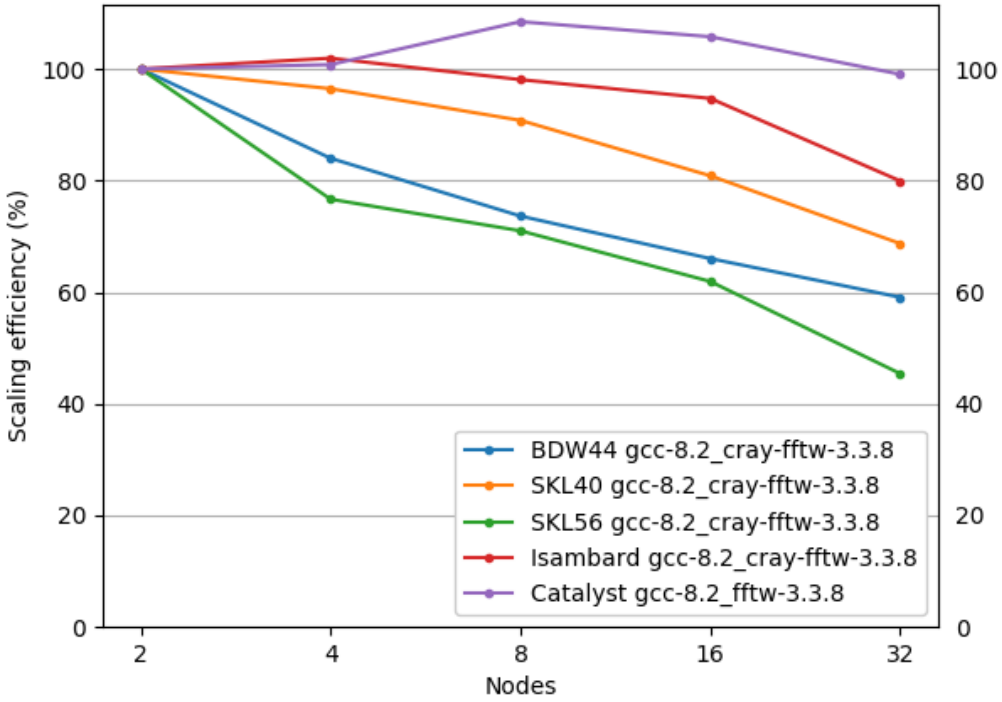
GROMACS – system comparison





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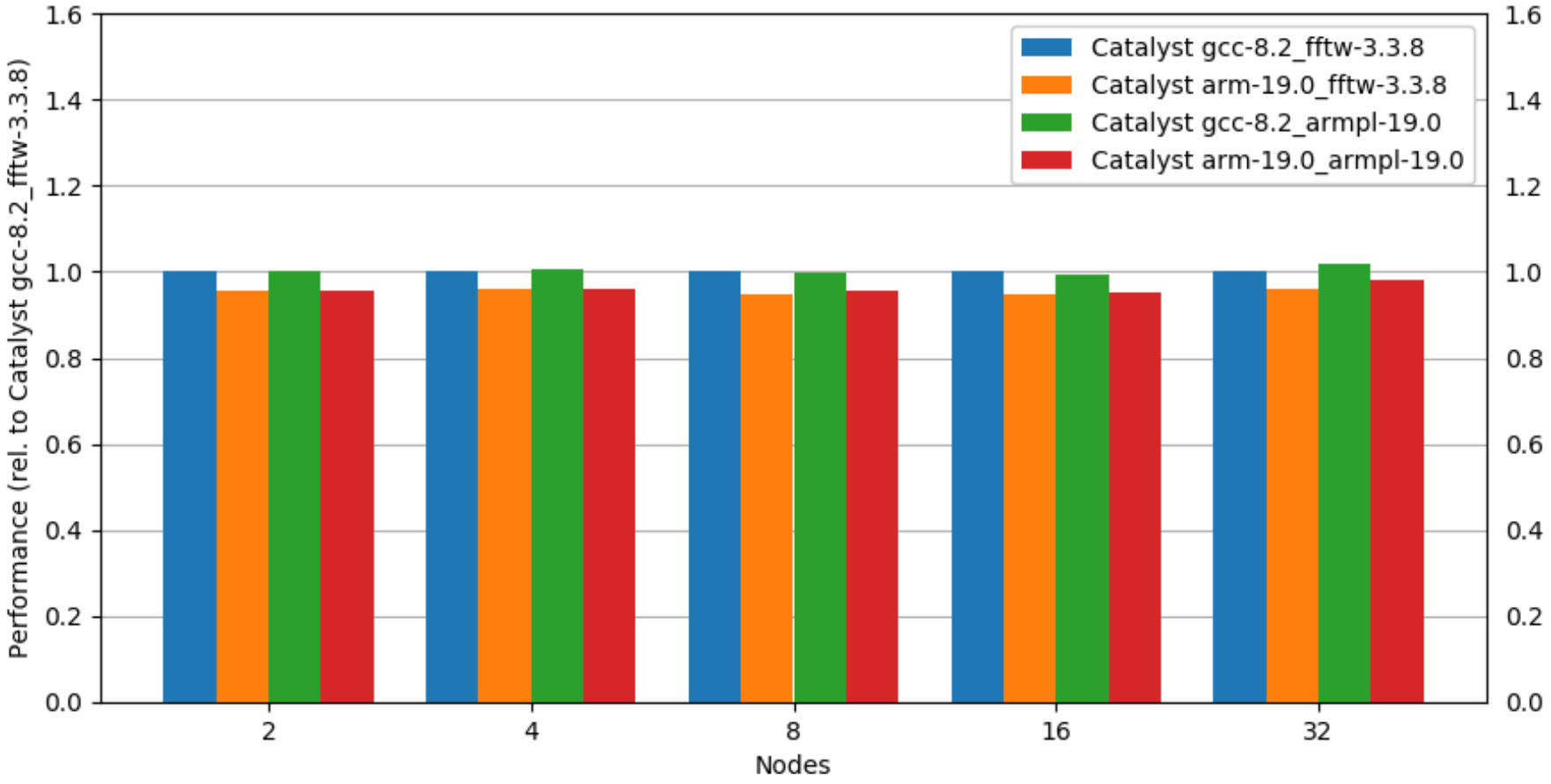
GROMACS - toolchains



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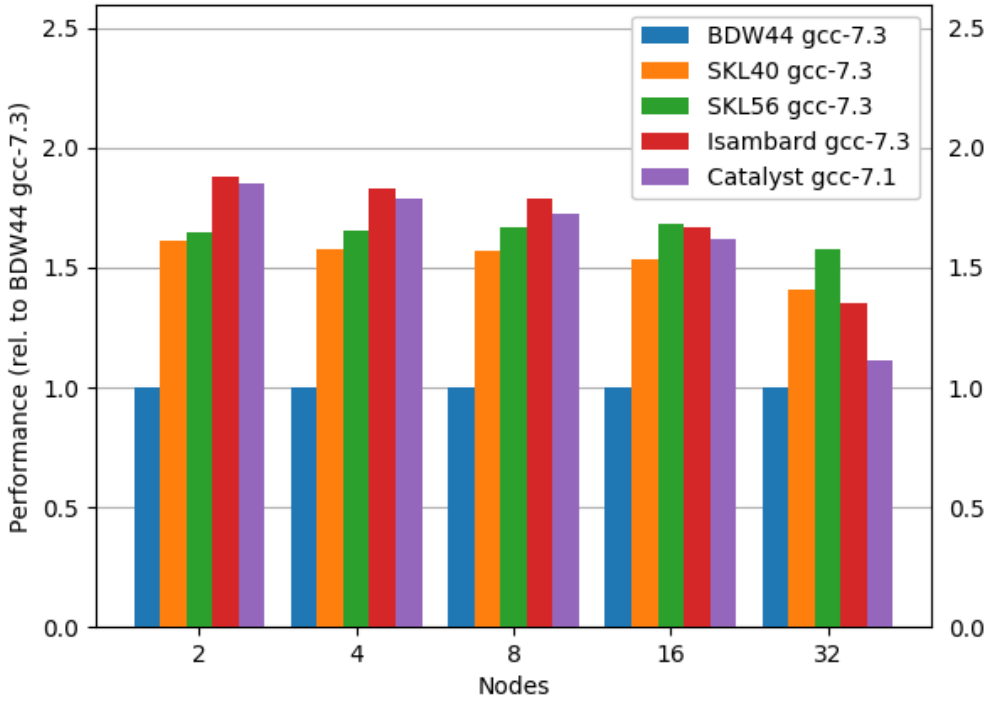
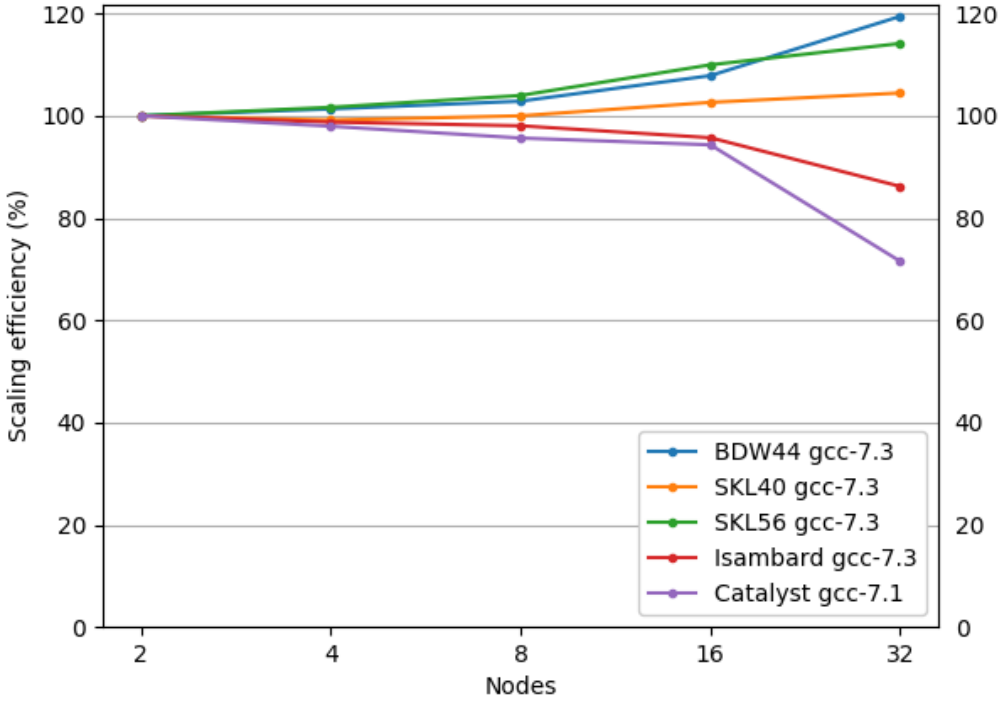
OpenFOAM – system comparison





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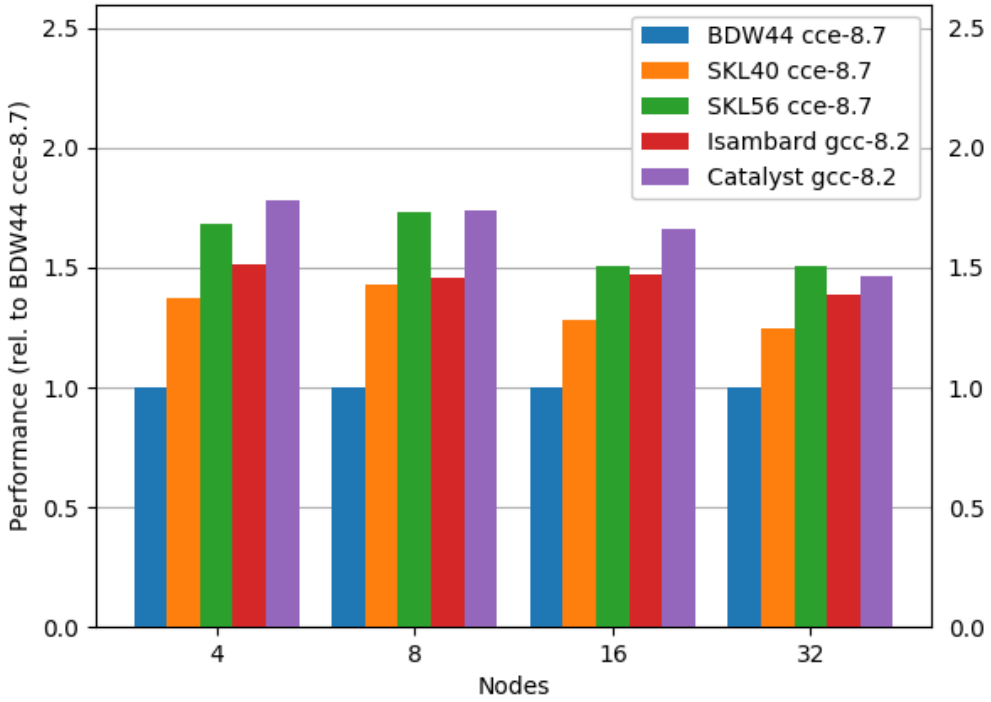
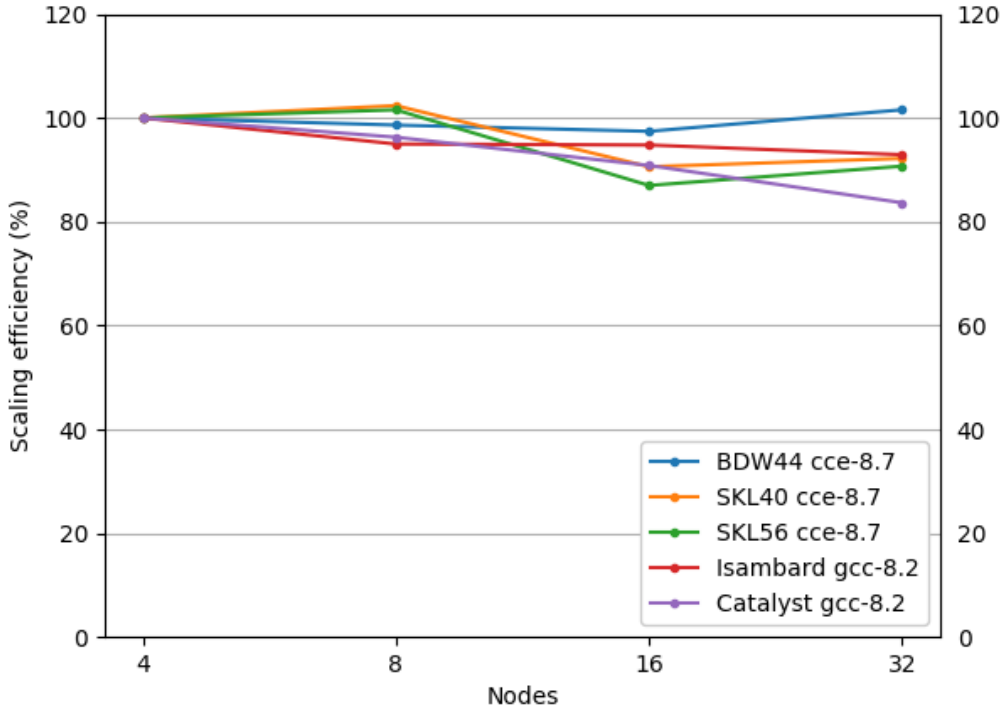
OpenSBLI – system comparison





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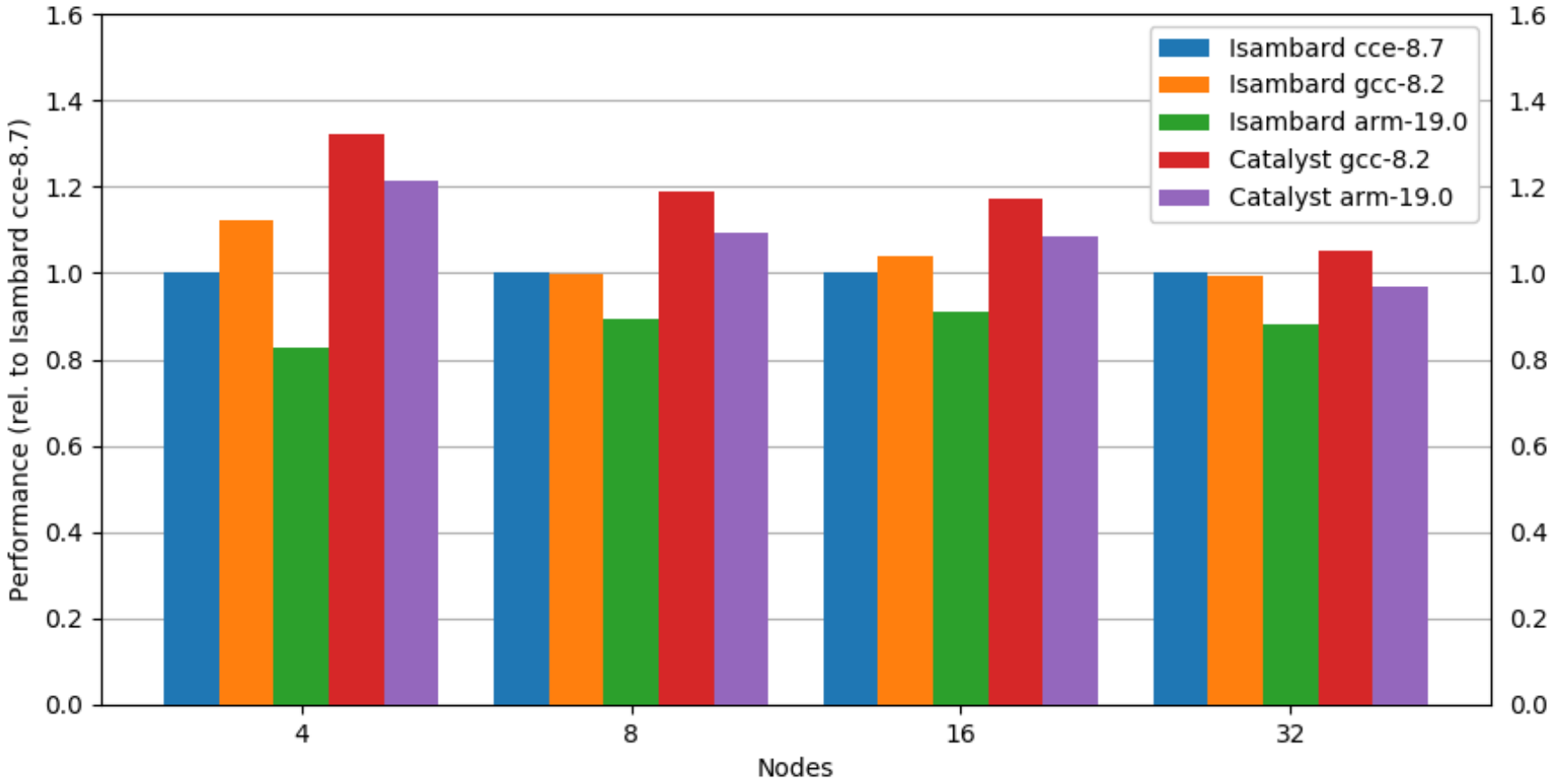
OpenSBLI - toolchains



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Conclusions

- Arm-based supercomputers are now **in production**, doing real science
- Available from multiple vendors
- **Solid, robust software toolchains from multiple vendors**
  - Both open source and proprietary
- Arm-based systems scale just as well as x86 ones
- Now have evidence that **Arm-based systems are real alternatives for HPC,** reintroducing much needed ***competition*** to the market

For more information

Scaling Results From the First Generation of Arm-based Supercomputers

S. McIntosh-Smith, J. Price, A. Poenaru and T. Deakin, CUG 2019, Montreal

http://uob-hpc.github.io/2019/06/07/CUG19.html

Bristol HPC group: https://uob-hpc.github.io/

Isambard: http://gw4.ac.uk/isambard/

Build and run scripts: https://github.com/UoB-HPC/benchmarks