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Isambard PI

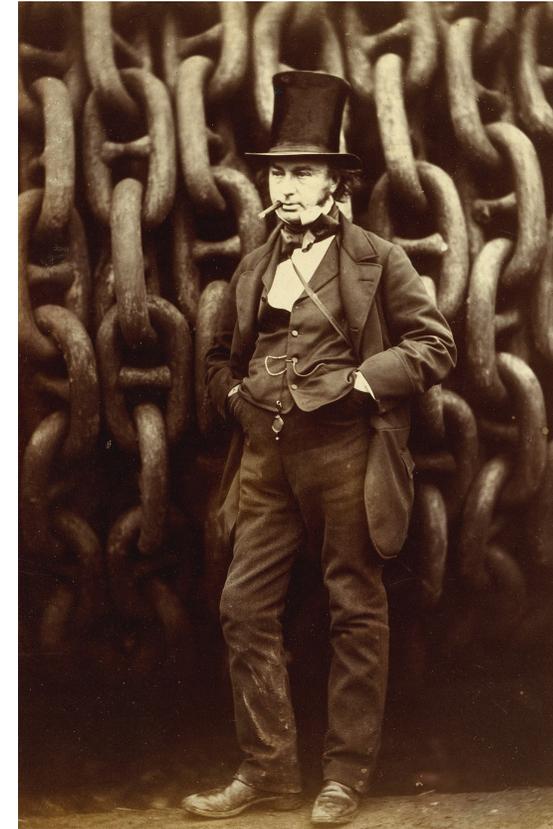
University of Bristol /

GW4 Alliance



Isambard / Catalyst at scale testing results

Isambard is a UK Tier 2 HPC service from GW4 and the world's first, Arm-based production supercomputer



Isambard Kingdom Brunel
1804-1859



Isambard system specification

- **10,752** Armv8 cores (168n x 2s x 32c)
 - **Marvell ThunderX2 32core 2.1→2.5GHz**
- Cray XC50 'Scout' form factor
- High-speed **Aries** interconnect
- Cray HPC optimised software stack
- **Phase 2 (the Arm part):**
 - **In production since May 28th 2019**
- **>300 registered users**, >100 of whom are from outside the consortium



HPE Catalyst system specification

- **4,096** Armv8 cores (64n x 2s x 32c)
 - **Marvell ThunderX2 32core 2.2GHz**
- HPE Apollo 70 form factor
- 100Gbps Infiniband interconnect
- Open Source software stack
 - **Compilers from Arm, GNU**
- Most users from Bristol today

Up to 4 servers in 2U



Isambard's core mission: enabling Arm for production HPC

Initial focus on most heavily used codes on Archer, (#1 in UK)

- VASP, CASTEP, GROMACS, CP2K, UM, HYDRA, NAMD, Oasis, SBLI, NEMO
- Note: most of these codes are written in FORTRAN

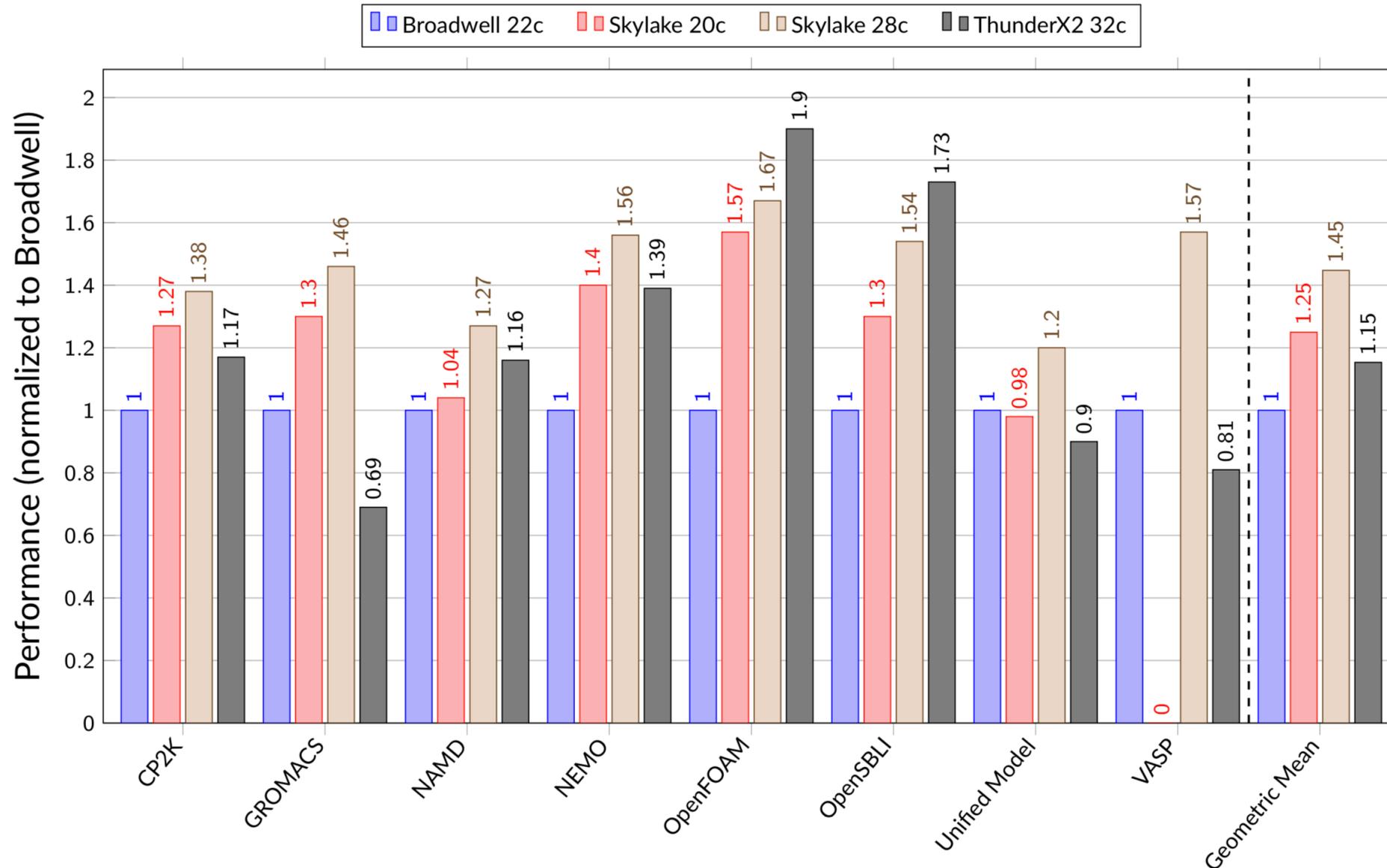
Additional important codes for project partners:

- OpenFOAM, OpenIFS, WRF, CASINO, LAMMPS, ...

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 6148, **\$3,078** each
- SKL 28c** Intel Skylake Platinum 8176, **\$8,719** each (near top-bin)
- TX2 32c** Cavium ThunderX2, **\$1,795 each** (near top-bin)

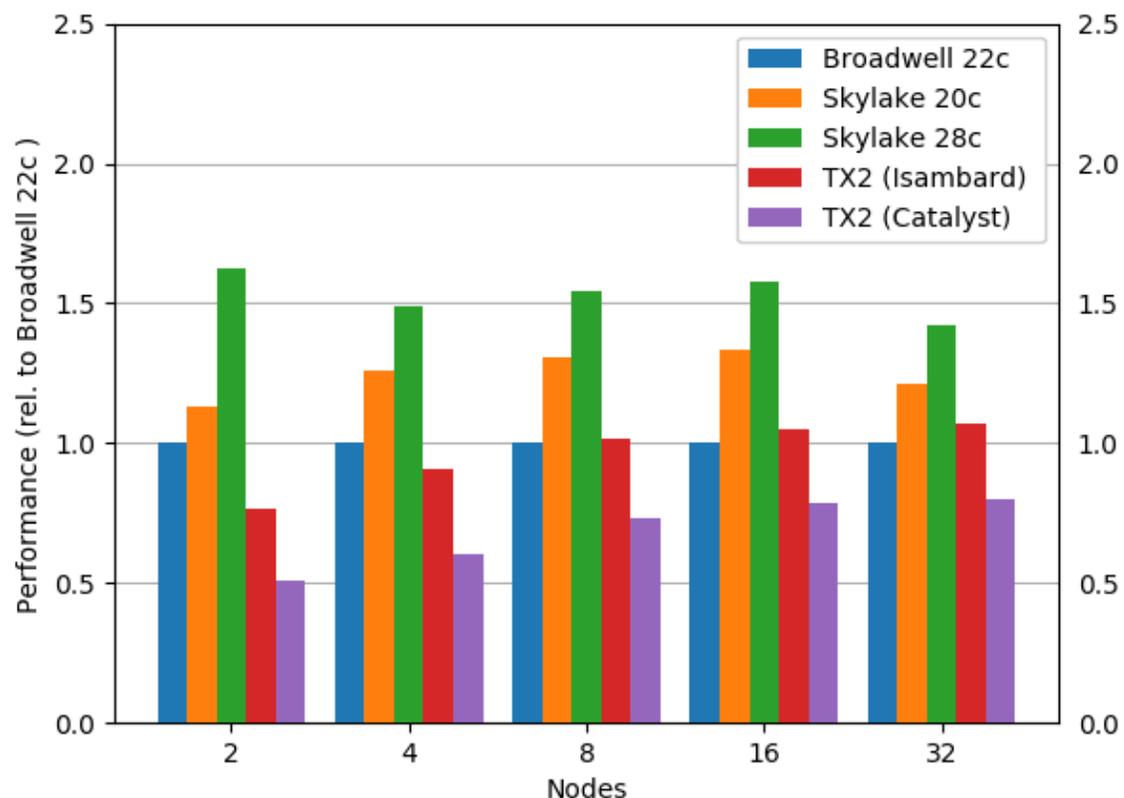
Single node performance comparisons



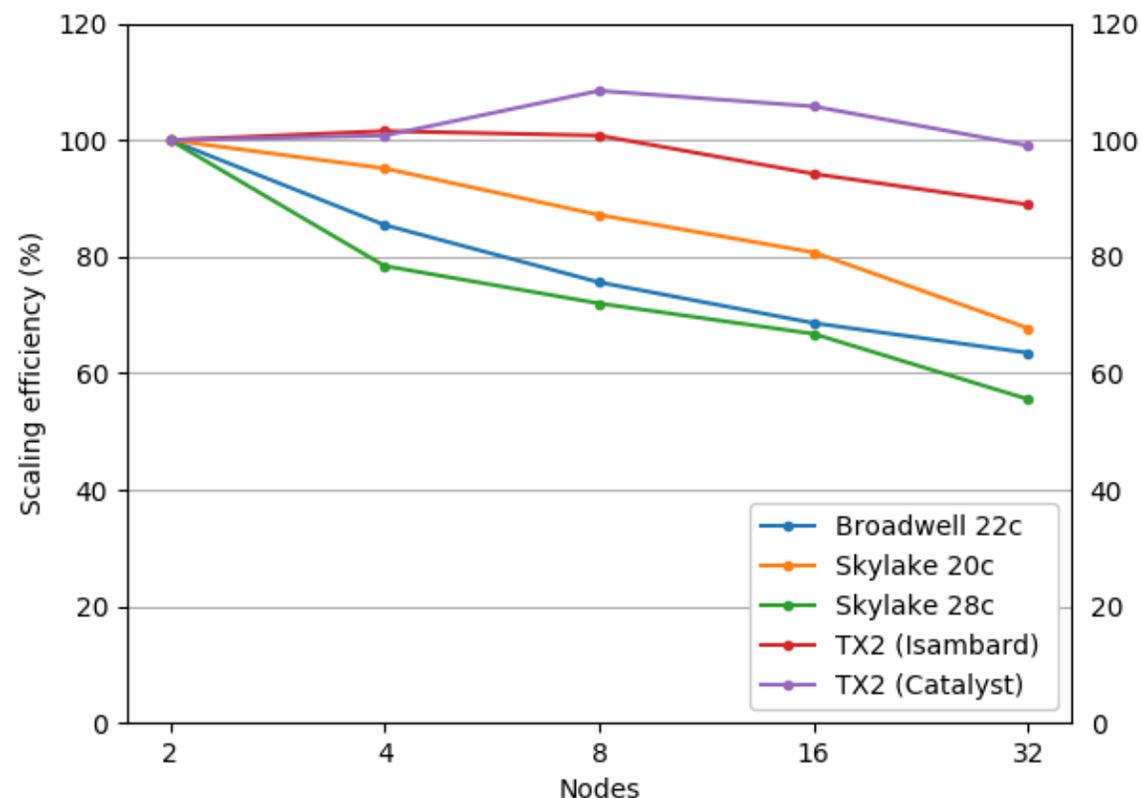
Comparative Benchmarking of the First Generation of HPC-Optimised Arm Processors on Isambard

S. McIntosh-Smith, J. Price, T. Deakin and A. Poenaru, CUG 2018, Stockholm

GROMACS (42 million atoms, ARCHER benchmark)

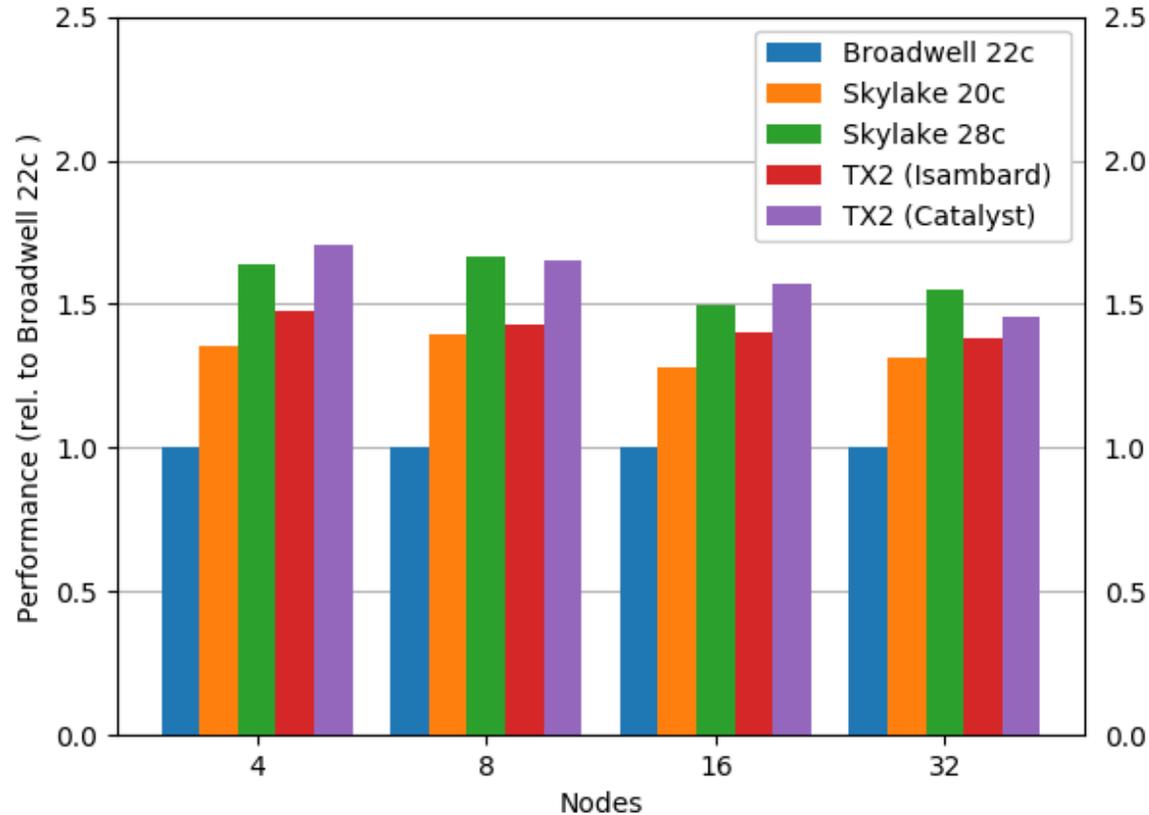


Relative performance

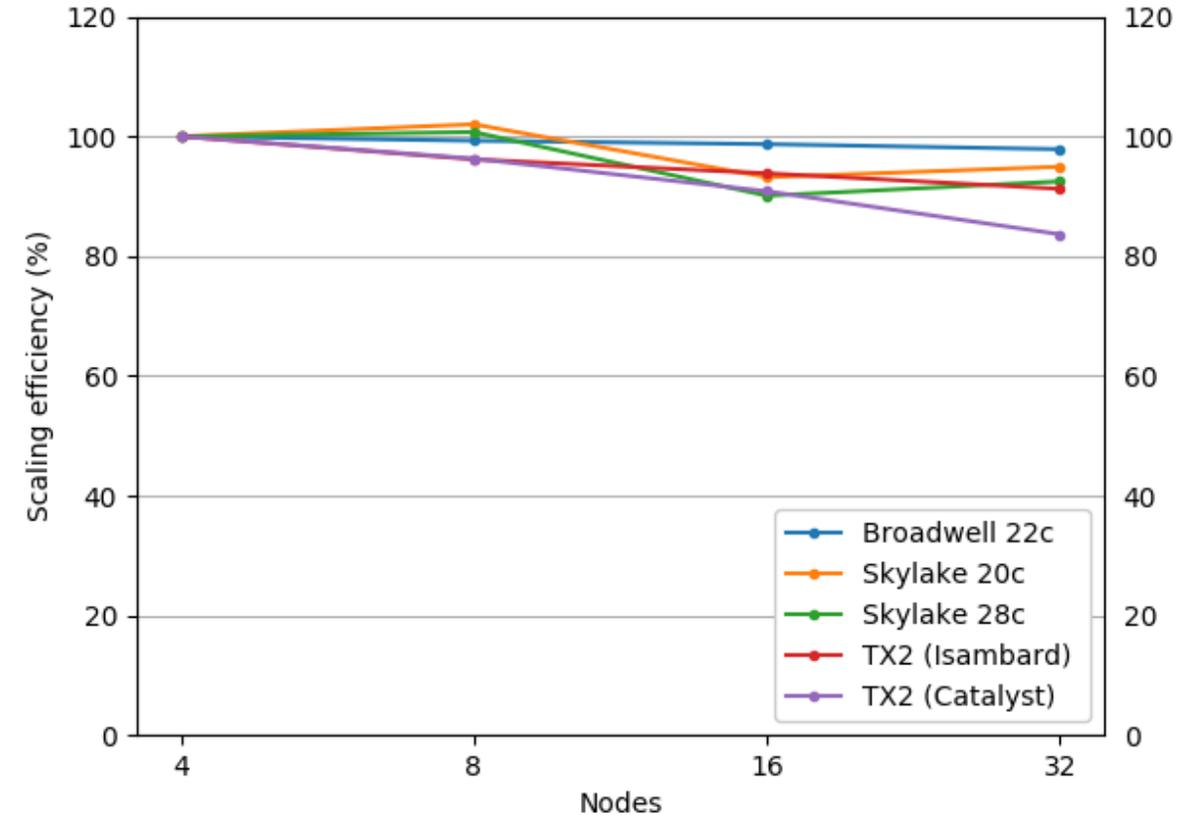


Parallel efficiency

OpenSBLI (1024³, ARCHER benchmark)

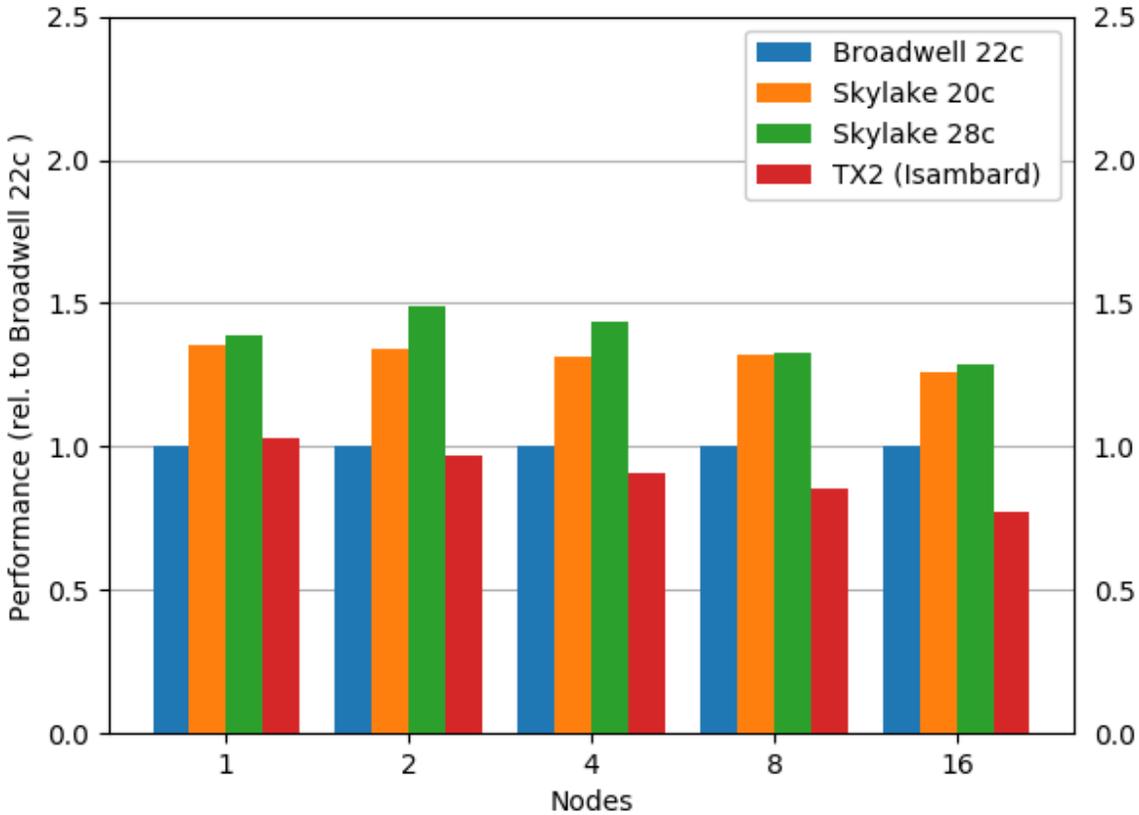


Relative performance

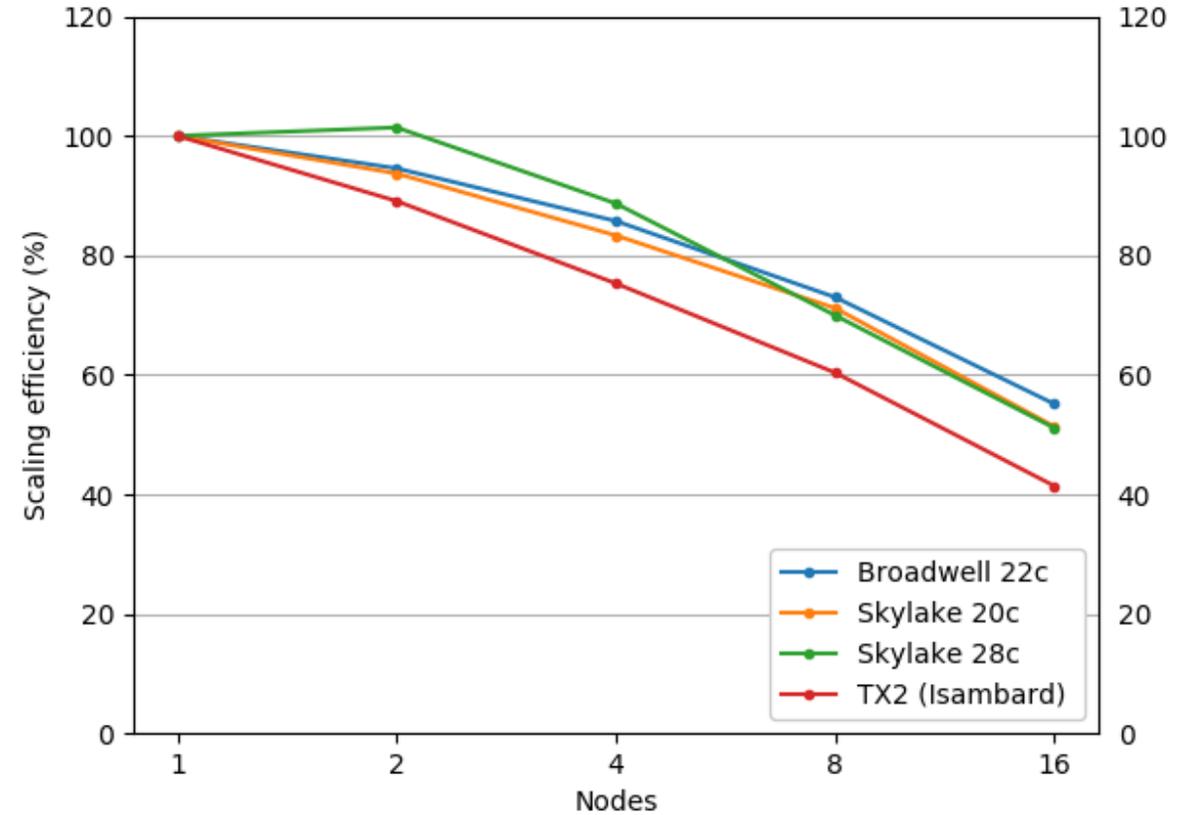


Parallel efficiency

VASP (PdO, 1392 atoms)

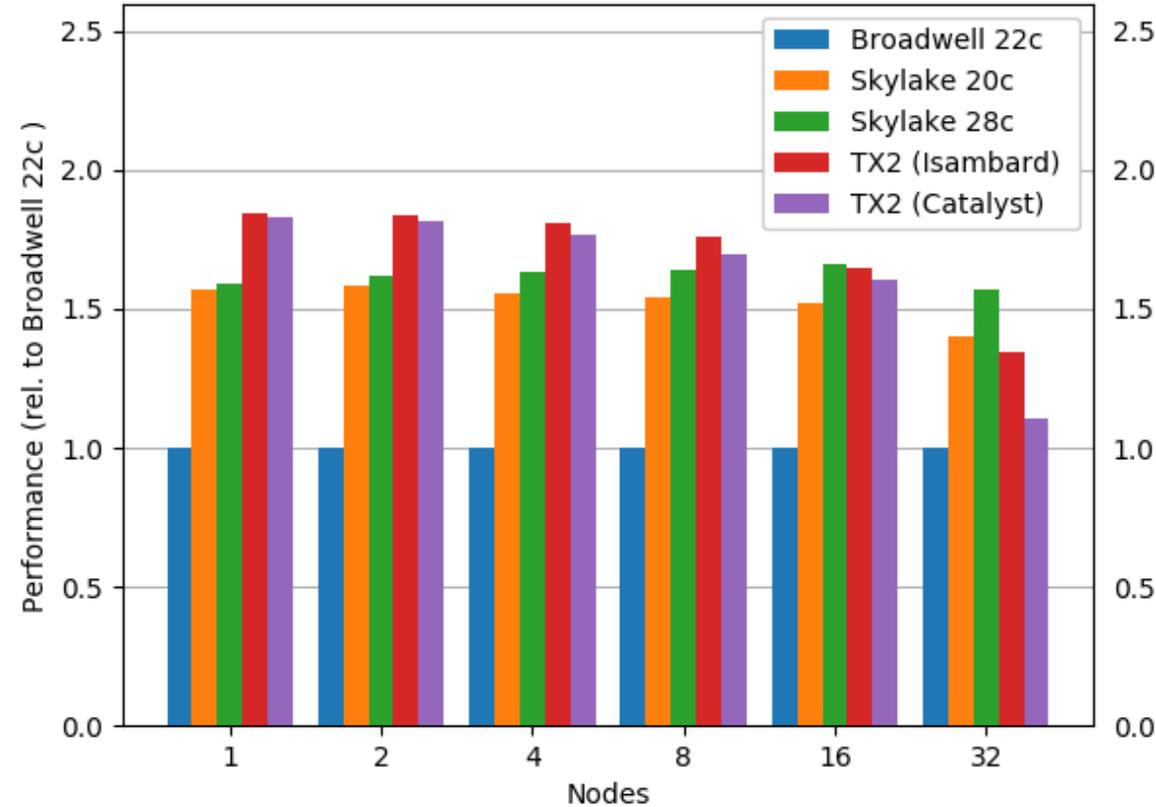


Relative performance

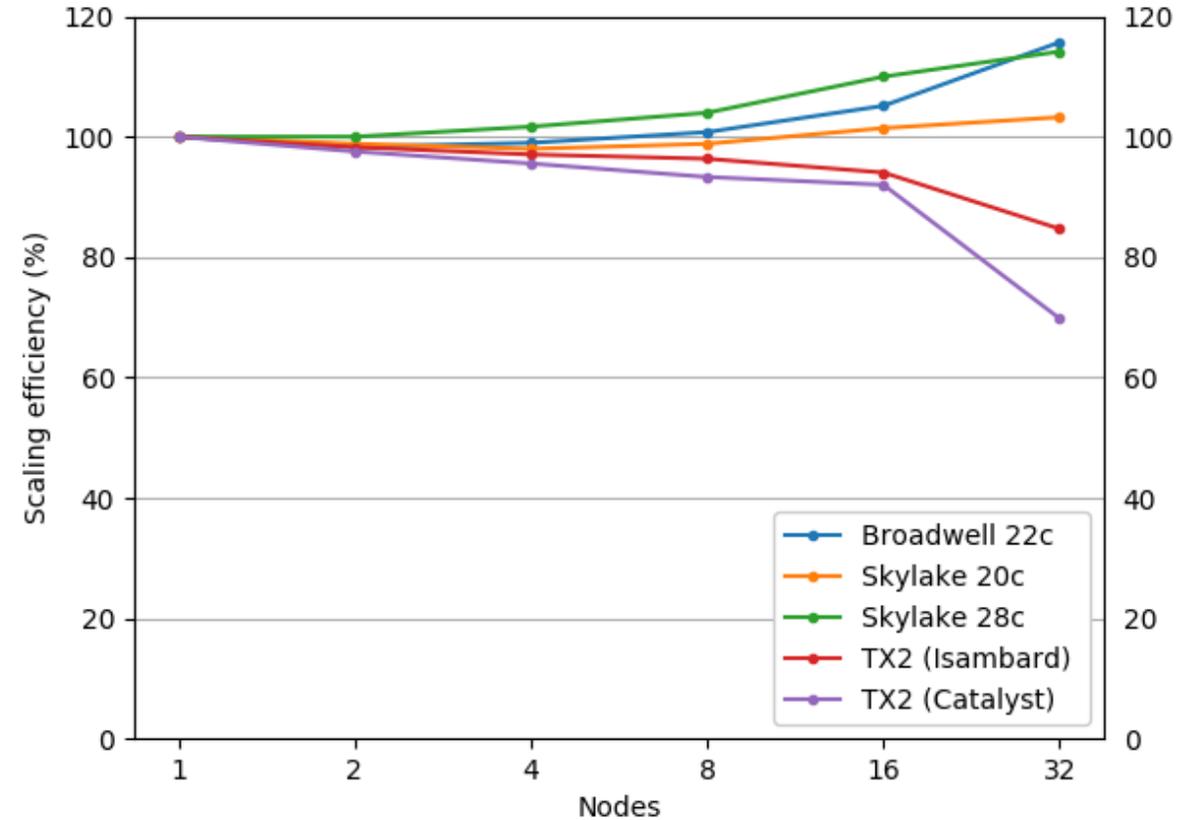


Parallel efficiency

OpenFOAM (RANS DrivAer, ~64 million cells)



Relative performance



Parallel efficiency

**Which
compiler
was fastest*
on each
code?**

Benchmark	Broadwell	Skylake	Isambard	Catalyst
CloverLeaf	Intel 2019	Intel 2019	CCE 9.0	Arm 19.0
TeaLeaf	Intel 2019	Intel 2019	GCC 8.3	Arm 19.0
SNAP	Intel 2019	Intel 2019	CCE 9.0	GCC 8.2
GROMACS	GCC 8.3	GCC 8.3	Arm 19.2	GCC 8.2
OpenFOAM	GCC 7.3	GCC 7.3	GCC 7.3	GCC 7.1
OpenSBLI	CCE 9.0	GCC 8.3	GCC 8.3	GCC 8.2
VASP	Intel 2019	Intel 2019	GCC 7.3	-

* Fastest when running across 32 nodes using all cores.

Comparison of compilers on Isambard

	GCC 8.3	Arm 19.2	CCE 9.0
CloverLeaf	88%	92%	100%
TeaLeaf	100%	91%	87%
SNAP	58%	CRASH	100%
GROMACS	96%	100%	88%
OpenFOAM	100%*	79%	BUILD
OpenSBLI	100%	91%	96%
VASP	100%*	BUILD	BUILD

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 commercial
- Arm-based systems scale just as well as x86 ones
- **Arm-based systems are real alternatives for HPC**, reintroducing much needed competition to the market

Two more things ... early SVE results

Isambard 2

We're in the planning stages for Isambard 2 for 2020:

- Expands the current XC50 Marvell production system
- Adds the latest Arm technologies, such as A64fx
- Updates the Multi Architecture Comparison System:
 - Latest CPUs from AMD, Intel, Marvell
 - Latest GPUs from NVIDIA, AMD, Intel
 - Enabling scientifically rigorous performance comparisons
- Watch this space!

For more information

Benchmarking the first generation of production quality Arm-based supercomputers

S. McIntosh-Smith, J. Price, A. Poenaru and T. Deakin, CC:PE, Nov 2019, DOI: 10.1002/cpe.5110

Scaling Results From the First Generation of Arm-based Supercomputers

S. McIntosh-Smith, J. Price, A. Poenaru and T. Deakin, CUG 2019, Montreal (**Best Paper**)

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

Comparative Benchmarking of the First Generation of HPC-Optimised Arm Processors on Isambard

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<http://uob-hpc.github.io/2018/05/23/CUG18.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>