University of BRISTOL

ARM in the UK Catalyst and Isambard

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University of Bristol

- Founded 1876
- 18,000 undergraduate students
- 6,043 postgraduate students
- 4,600 full time staff
- £606m annual income

Located in the West Country of England

- Russell Group University
- Research Intensive

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ACRC

- Advanced Computing Group supports 3 key activities:
- High Performance Computing (HPC)
  - Advanced computing and simulation used across the University. Currently 1279 users/479 projects.
  - Used for research and teaching.
- Research Data Storage (RDS)
  - Central storage facility for University research data.
  - Currently storing 1.6PB of data, with 900 projects/3000 users.
- Research Software Engineering (RSE)
  - Team of 5 providing research consultancy in software engineering.
  - Providing training in software engineering and best practice.

Computer Science HPC Group

- Lead by Prof Simon McIntosh-Smith
  http://uob-hpc.github.io/SimonMS/
- Undergraduate and Masters teaching in HPC
- Post graduate HPC research group
- PI of Isambard

Synergy between groups

- Close collaboration between the ACRC and the HPC group
- Two Simons
- Simon McIntosh-Smith is chair of HPC Executive, academic oversight of ACRC

Processors in HPC

- History of many different processors being used in HPC
- Originally each vendor had their own, Control Data, Cray, IBM,Amdahl, DEC (VAX), Convex, transputer, NEC FX and many more
- Later on, processors manufactured separately, SPARC, IBM Power, MIPS, Intel, AMD
- Now: Intel
  maybe a bit of AMD, maybe a bit of Power, the Japanese vendors (NEC, Fujitsu, Hitachi) trying hard with vector and other special processors
- But vast majority is Intel. Until …

ARM 64 bit

- ARM design processors
- Others license design and then manufacture processors
- Very widespread use of ARM designed processors – how many do you have?
- Newer 64 Bit design enables use for HPC

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

Validation

- Both projects have had running systems since January 2019
- Systems are running well and running real user workloads
- The Linux OS works fine on ARM! Looks no different to an X86 system.
- Storage works – SATA, SAS, SSD, Disk, Arrays, PCI
- Interconnects work, Mellanox IB, Cray Aries, Ethernets

Validation 2

- Software works
- Compilers (ARM, GNU, Cray, LLVM, clang, flang)
- Debuggers, tools, utilities, all work
- Code just recompiles out of the box
- The generated executables run, and give the right answers

Performance

- Thunder X2 processor (Cavium now Marvell)
- 32 cores per socket, 2 sockets per node, 4 memory channels
- Clock speeds lower than Intel’s best (2.0 to 2.5GHz), but performance per node very comparable
- Tech specs:

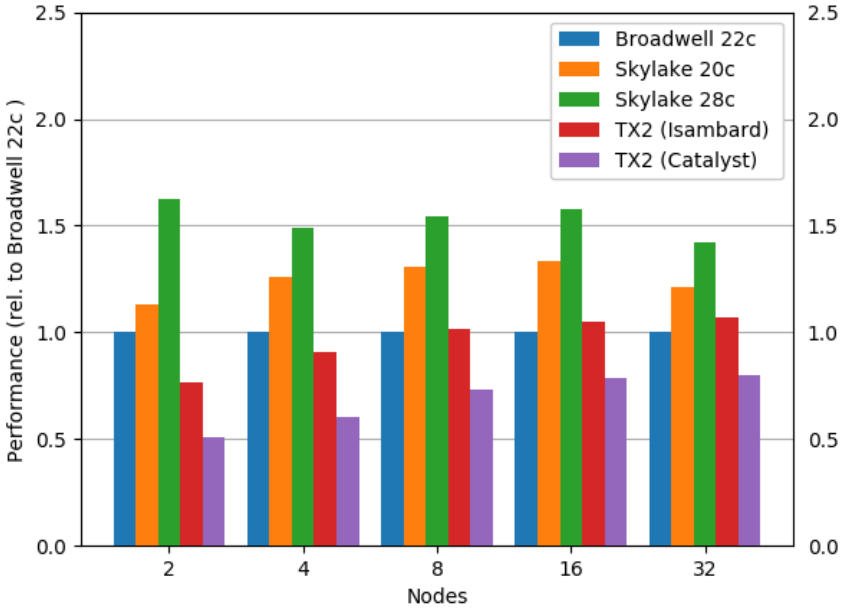
Processor	Cores	Clock speed GHz	TDP Watts	FP64 TFLOP/s	Bandwidth GB/s
Broadwell	2×22	2.2	145	1.55	154
Skylake Gold	2×20	2.4	150	3.07	256
Skylake Platinum	2×28	2.1	165	3.76	256
ThunderX2	2×32	2.1 (2.5)	175	1.28	320

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)

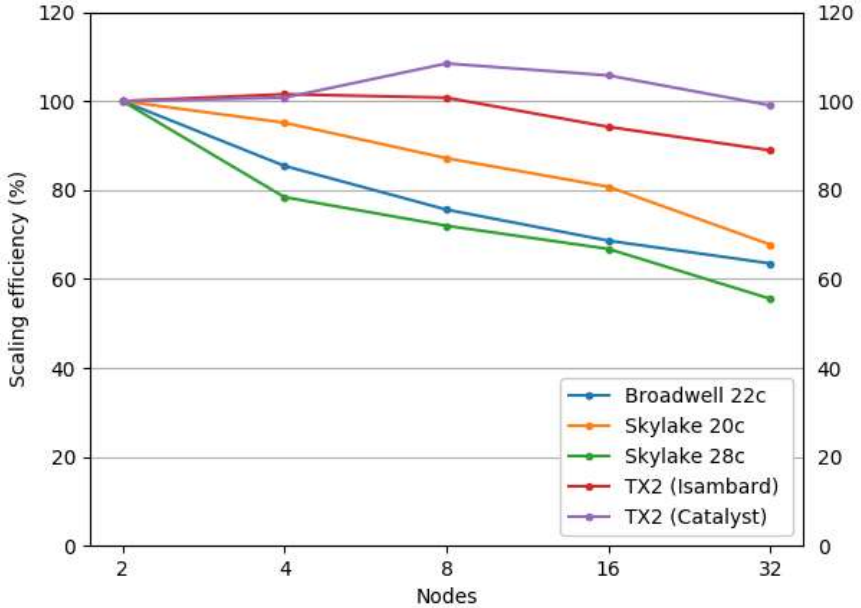
Performance

- Benchmarks have been run on a number of heavily used codes in the UK academic area:
- GROMACS (molecular dynamics, particularly biomolecules)
- OpenSBLI (finite difference, Navier Stokes)
- VASP (atomic scale materials modelling)
- OpenFOAM (Computational Fluid Dynamics)

GROMACS (42 million atoms, ARCHER benchmark)



Relative performance



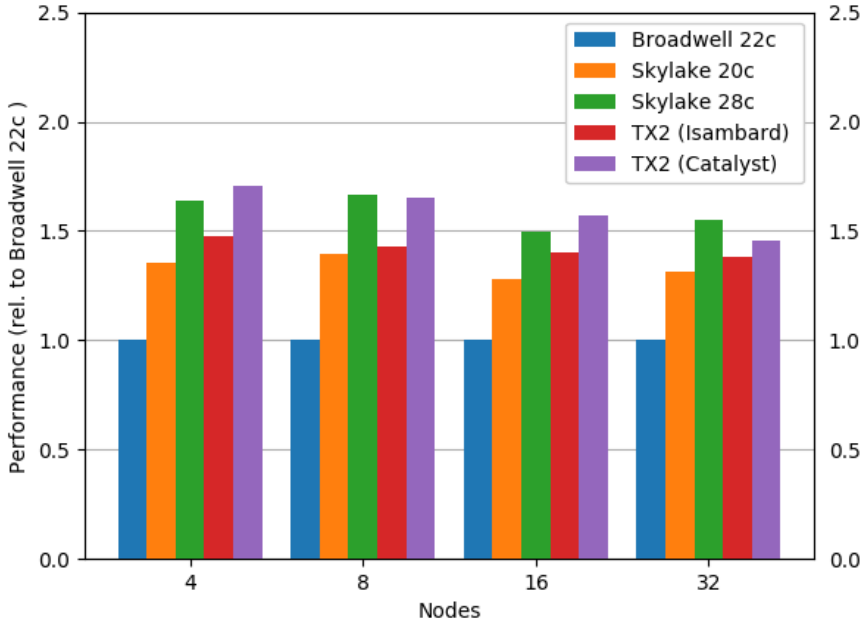
Parallel efficiency

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

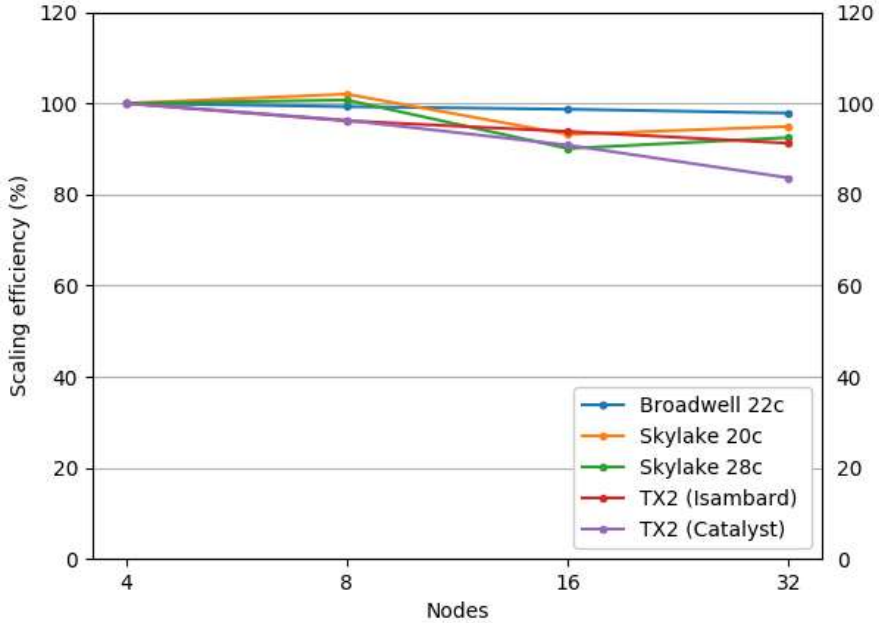
Scaling Results From the First Generation of Arm-based Supercomputers

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

OpenSBLI (1024^3, ARCHER benchmark)



Relative performance



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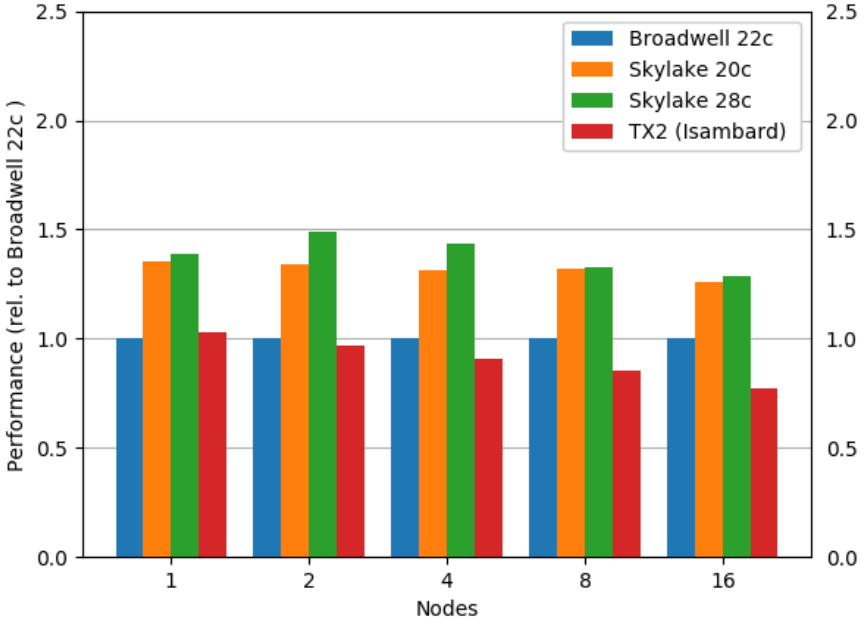
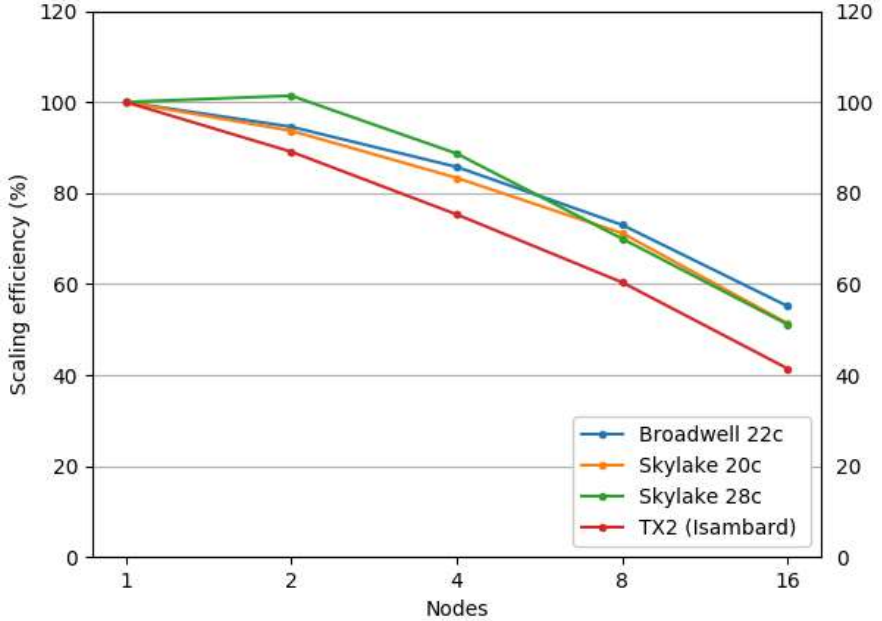
VASP (PdO, 1392 atoms)



Relative performance



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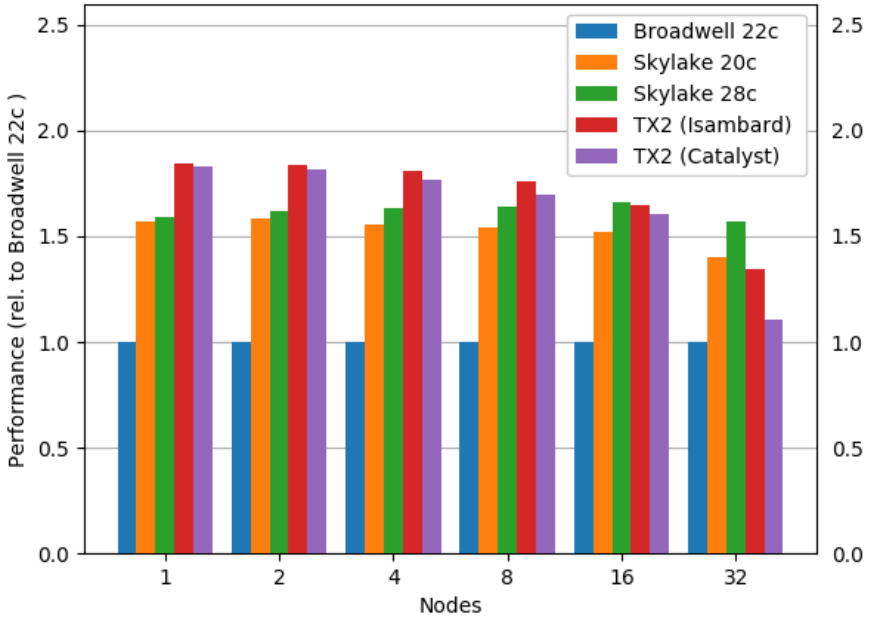
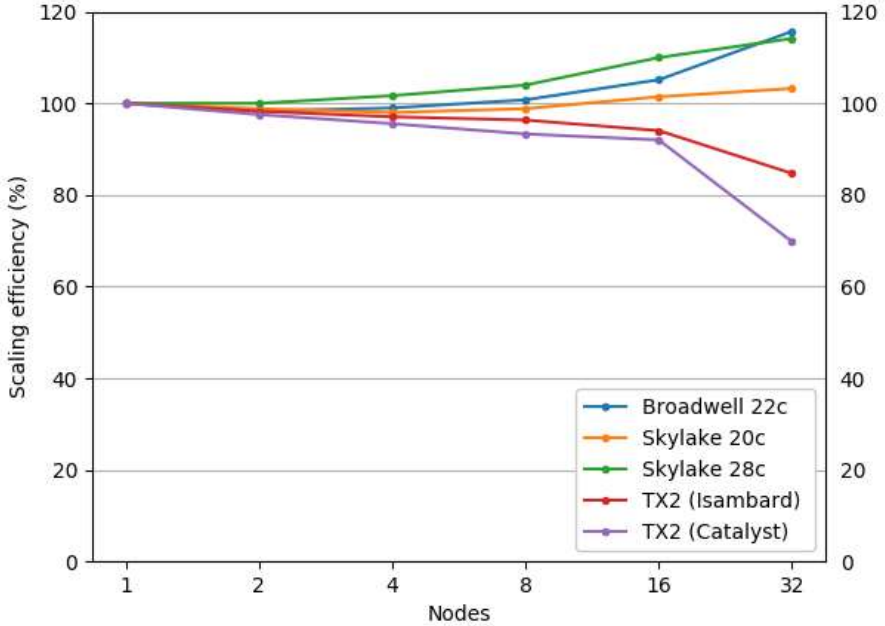
OpenFOAM (RANS DrivAer, ~64 million cells)



Relative performance



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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!

Moving on

- Seeking to demonstrate more applications on ARM
- Welcome enquiries from research groups
- Especially interested in working with Industry, Commerce and ISVs to bring more code to ARM and to expand the ecosystem
- Isambard, Catalyst (Bristol, Edinburgh, Leicester)
- Stay tuned !!!

Thank You

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