

ARM HPC Ecosystem

ARM

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ARM Collaboration for Exascale Programs

United States

ARM is currently a participant in two Department of Energy funded pre-Exascale projects: Data Movement Dominates and Fast Forward 2.

European Union

Through FP7 and Horizon 2020, ARM has been involved in several funded pre-Exascale projects including the Mont Blanc program which deployed one of the first ARM prototype HPC systems.



Japan

Fujitsu and RIKEN announced that the Post-K system targeted at Exascale will be based on ARMv8 with new **Scalable Vector Extensions**.

China

James Lin, vice director for the Center of HPC at Shanghai Jiao Tong University claims China will build three pre-Exascale prototypes to select the architecture for their Exascale system. The three prototypes are based on AMD, SunWei TaihuLight, and ARMv8.

ARM HPC deployments starting in 2H2017

Two recent announcements about ARM in HPC in Europe:





Bull Atos to Build HPC Prototype for Mont-Blanc Project using Cavium ThunderX2 Processor

January 16, 2017 by [staff](#)

Today the [Mont-Blanc European project](#) announced it has selected Cavium's ThunderX2 ARM server processor to power its new HPC prototype.

The new Mont-Blanc prototype will be built by [Atos](#), the coordinator of phase 3 of Mont-Blanc, using its Bull expertise and products. The platform will leverage the infrastructure of the Bull sequana pre-exascale supercomputer range for network, management, cooling, and power. Atos and Cavium signed an agreement to collaborate to develop this new platform, thus making Mont-Blanc an Alpha-site for ThunderX2.




January 17th 2017

Announcing the **GW4 Tier 2 HPC service, 'Isambard'**: named after Isambard Kingdom Brunel

System specs:

- Cray CS-400 system
- **10,000+** ARMv8 cores
- HPC optimised software stack
- Technology comparison:
 - x86, KNL, Pascal
- To be installed March-Dec 2017
- £4.7m total project cost over 3 years



I.K.Brunel 1804-1859

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bristol.ac.uk

Japan Exascale

Post-K: Fujitsu HPC CPU to Support ARM v8



Post-K fully utilizes Fujitsu proven supercomputer microarchitecture

Fujitsu, as a lead partner of ARM HPC extension development, is working to realize ARM Powered® supercomputer w/ high application performance

ARM v8 brings out the real strength of Fujitsu's microarchitecture

HPC apps acceleration feature	Post-K	FX100	FX10	K computer
FMA: Floating Multiply and Add	✓	✓	✓	✓
Math. acceleration primitives*	✓Enhanced	✓	✓	✓
Inter core barrier	✓	✓	✓	✓
Sector cache	✓Enhanced	✓	✓	✓
Hardware prefetch assist	✓Enhanced	✓	✓	✓
Tofu interconnect	✓Integrated	✓Integrated	✓	✓

* Mathematical acceleration primitives include trigonometric functions, sine & cosines, and exponential...

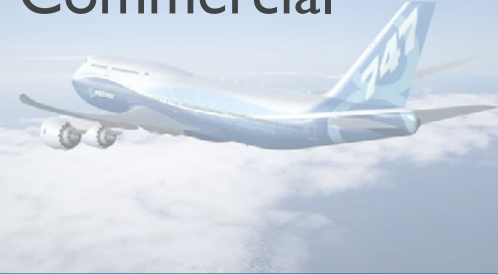


slides from Fujitsu at ISC'16

Foundational SW Ecosystem for HPC

- Linux OS's – RedHat, SUSE, CENTOS, UBUNTU,...
- Compilers – ARM, GNU, LLVM,...
- Libraries – ARM, OpenBLAS, BLIS, ATLAS, FFTW...
- Parallelism – OpenMP, OpenMPI, MVAPICH2,...
- Debugging – Allinea, RW Totalview, GDB,...
- Analysis – ARM, Allinea, HPCToolkit, TAU,...
- Job schedulers – LSF, PBS Pro, SLURM,...
- Cluster mgmt – Bright, CMU, wawulf,...

Commercial



Open-source



Predictable Baseline

openHPC — now on ARM

OpenHPC defines a baseline. It is a community effort to provide a common, verified set of open source packages for HPC deployments

ARM's participation:

- Silver member of OpenHPC
- ARM is on the OpenHPC Technical Steering Committee in order to drive ARM architecture build support

Status (April 2017):

- 1.3.0 release out now
- All packages built on ARMv8 for both CentOS and SUSE
- ARM-based machines are being used for builds in the OpenHPC build infrastructure at TACC
- <https://github.com/arm-hpc/ohpc/>

Functional Areas	Supported packages / components
Base OS	RHEL/CentOS 7.1, SLES 12
Administrative Tools	Conman, Ganglia, Lmod, LosF, ORCM, Nagios, pdsh, prun
Provisioning	Warewulf
Resource Mgmt.	SLURM, Munge, Altair PBS Pro
I/O Services	Lustre client (community version)
Numerical, Scientific Libraries	Boost, GSL, FFTW, Metis, PETSc, Trilinos, Hypre, SuperLU, Mumps
I/O Libraries	HDF5 (pHDF5), NetCDF (including C++ and Fortran interfaces), Adios
Compiler Families	GNU (gcc, g++, gfortran)
MPI Families	OpenMPI, MVAPICH2
Development Tools	Autotools (autoconf, automake, libtool), Valgrind, R, SciPy/NumPy
Performance Tools	PAPI, Intel IMB, mpiP, pdtoolkit TAU

ARM HPC tools commercial portfolio

ARM C/C++ Compiler

COMMERCIALLY SUPPORTED
FOR HPC APPLICATIONS

ARM Performance Libraries

BLAS, LAPACK and FFT
MICRO-ARCHITECTURALLY TUNED

ARM Code Advisor

ACTIONABLE ADVICE TO
OPTIMIZE YOUR CODE

ARM SVE C/C++ Compiler

COMPILER SUPPORT FOR
ARM SCALABLE VECTOR EXTENSION

ARM Instruction Emulator

DEVELOP SOFTWARE FOR
TOMORROW'S HARDWARE TODAY

Allinea Forge (DDT+MAP)

CODE DEBUGGING and PROFILING
TOOLS for HPC APPLICATIONS

Allinea Performance Reports

MONITOR AND TUNE APPLICATION
PERFORMANCE IN THE FIELD

ARM Compiler

Commercially supported C/C++ compiler for Linux user-space HPC applications

LLVM-based

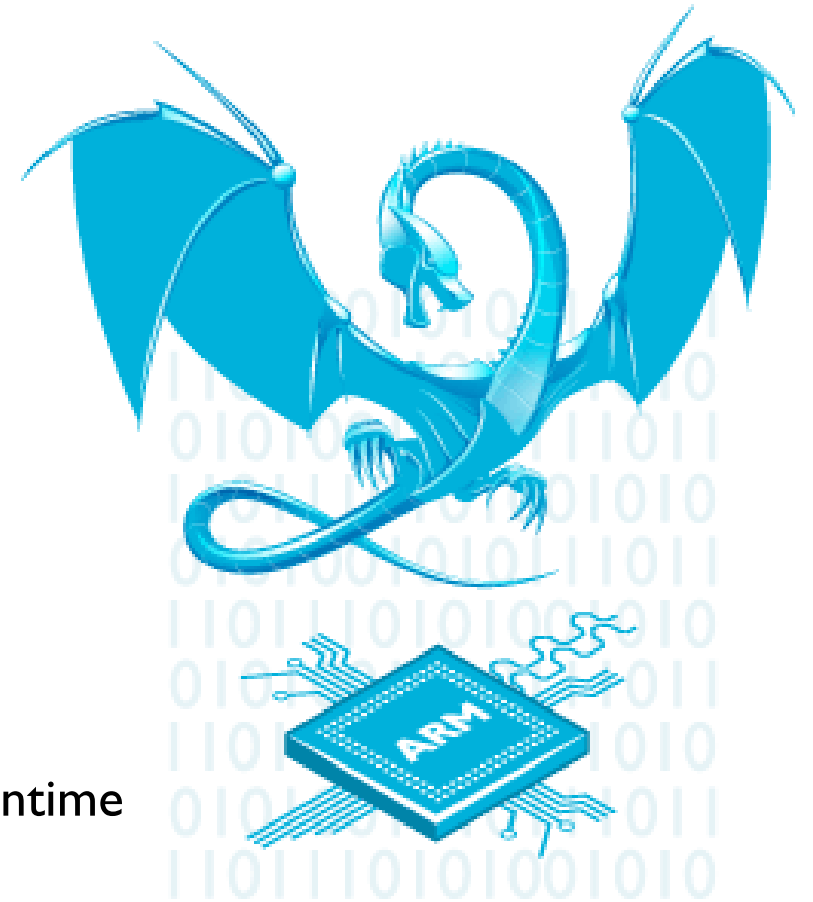
- LLVM-based
- ARM-on-ARM compiler
- For application development (not bare-metal/embedded)

Fortran in the works

- Leveraging on-going PGI FLANG collaboration

OpenMP

- Uses latest open source (now ARM-optimized) LLVM OpenMP runtime



ARM Performance Libraries

Optimized BLAS, LAPACK and FFT

Commercial 64-bit ARMv8 math libraries

- Commonly used low-level math routines - BLAS, LAPACK and FFT.
- Validated with NAG's test suite, a de-facto standard.

Best-in-class performance with commercial support

- Tuned by ARM for Cortex-A72, Cortex-A57 and Cortex-A53.
- Maintained and Supported by ARM for a wide range of ARM-based SoCs.
- Regular benchmarking against open source alternatives.

Silicon partners can provide tuned micro-kernels for their SoCs

- Partners can collaborate directly working with our source-code and test suite.
- Alternatively they can contribute through open source route.



Performance on par
with best-in-class math libraries



Commercially Supported
by ARM



Validated with
NAG test suite

Open source in the ARM HPC ecosystem

- Many open-source applications have been ported to ARMv8 for a variety of HPC sectors:

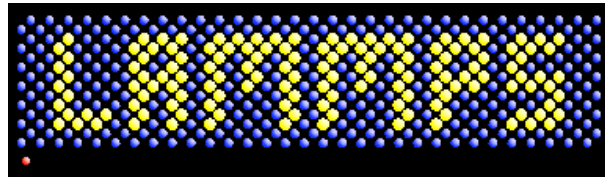
OpenFOAM

NAMD
Scalable Molecular Dynamics

GROMACS
FAST.
FLEXIBLE.
FREE.

QUANTUM ESPRESSO

Geant 4



WRF

Further reading:

www.arm.com/hpc

<https://www.nextplatform.com/2017/03/15/arm-antes-hpc-software-stack/>

Server OS support solidifies for ARM in 2016

- **SUSE (SLES 12)** providing first commercial enterprise Linux distribution optimized for ARM-based 64-bit servers - <https://www.suse.com/products/arm>
- **Red Hat** Enterprise Linux Server for ARM (RHLSA) 7.3 release with single-host virtualization based on KVM, Ceph for prototyping and deploying and initial support for Red Hat Developer Toolset (latest stable open source C and C++) <http://red.ht/2flVOH7>
- **CentOS 7.3** for ARM64 released with greatly improved support for Cavium ThunderX SoC family <https://lists.centos.org/pipermail/centos-announce/2017-January/022193.html>
- **Canonical** and ARM collaborate on commercial Ubuntu OpenStack and Ceph for ARMv8 servers: <https://insights.ubuntu.com/2016/10/17/canonical-and-arm-collaborate-on-openstack/>
- **FreeBSD 11** released - ARM joins x86 as primary architectures supported - <https://www.freebsdoundation.org/blog/freebsd-takes-open-source-to-11-with-latest-release/> and <https://www.freebsd.org/releases/11.0R/relnotes.html>
- **Xen** hypervisor 4.8 released - Updates focus on ARM server enhancements, security hardening and quality code: <http://www.marketwired.com/press-release/xen-project-hypervisor-continues-to-expand-into-embedded-use-cases-in-latest-release-2181499.htm>