

# An Introduction to HPC @ Linaro

Accelerating deployment of Arm-based solutions  
for Supercomputers

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78%

of companies  
run on open source

Source: Black Duck Software & North Bridge

Most of us know  
the benefits of using  
open source software  
to develop and  
deploy our products

So what  
value does  
Linaro add?



Focus on  
Differentiation



Faster Time  
to Market



Better  
Security



Reliability  
& Quality



Freedom  
of Choice



?



?



?



?

# Laying the foundations upon which to innovate

## Collaborate on the essentials

Linaro provides a collaborative forum where industry and community work together on open source software to **solve common problems**

## Focus on differentiation

There is **no need to differentiate on the basics**. Solving common problems together once and for all allows you to focus on your value add.

## See tangible results

Solving problems doesn't just mean developing strategy. It means **actual engineering solutions** are delivered by Linaro and member engineers.

## Work with Arm software experts

Linaro co-maintains the Arm ecosystem, providing the tools, security and Linux kernel quality needed for a solid base to differentiate on. **Arm software is our expertise.**

Linaro co-maintains the Arm ecosystem. We work with members to consolidate fragmented Arm code bases in the ecosystem as a whole as well as specific market segments.

# Enabling markets on Arm architecture since 2010

## 2010

Arm code bases are fragmented.

**Linaro is formed** to consolidate and improve the way open source software is used.



Open Source Tools for Arm

## 2012-2018

Responding to demand, Linaro creates groups tasked with addressing fragmentation in specific segments.



Data Center & Cloud



High Performance Computing



Consumer (Mobile & Android)



Edge & Fog Computing



IoT & Embedded

Open Source Security

Multimedia on Arm

## Today

New and exciting technologies continue to emerge which require collaboration. Collaborative engineering drives innovation.



Artificial Intelligence



Autonomous Vehicles

Linux Kernel Quality

# LDCG

## Datacenter & Cloud Segment Group

Arm64 Server Architecture

Cloud Orchestration

Big Data & Data Science



CI Community

Continuously tested and available as part of the Developer Cloud



Developer Cloud

Member Servers hosted In London, UK. Publicly available

## LDCG Special Interest Groups

HPC SIG



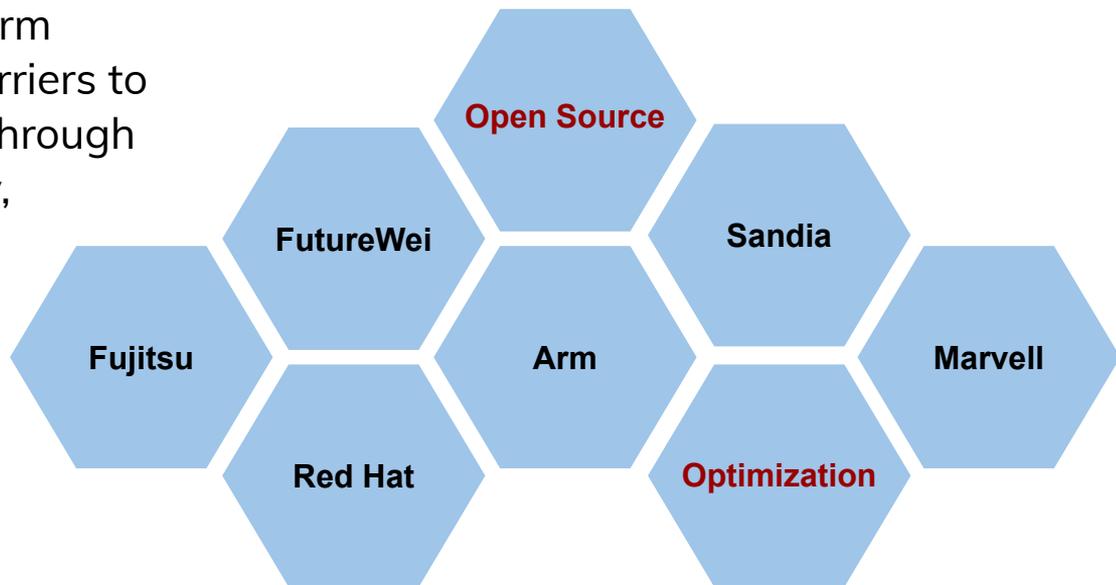
## Key Projects & Workloads



# Linaro High Performance Computing Special Interest Group



The **Linaro HPC SIG** drives open source software development for the Arm architecture. It aims to lower barriers to deployment and management through standardisation, interoperability, orchestration and use case development.



# HPC-SIG Achievements and New Initiatives

Built a lab infrastructure to reliably work on ecosystems, toolchains and libraries.

Upstreamed SVE in GCC.

Supporting SVE Enablement in LLVM.

Contributions to OpenBLAS to leverage the full power of the servers' microarchitectures.

Testing and providing feedback for the full enablement of Lustre Server on ARM.

Release testing of OpenHPC as well as development of a framework to easily provide Cloud based as well as bare-metal ARM HPC solutions.

Convergence of Datacenter workloads in Supercomputers

# HPC-SIG Focus areas

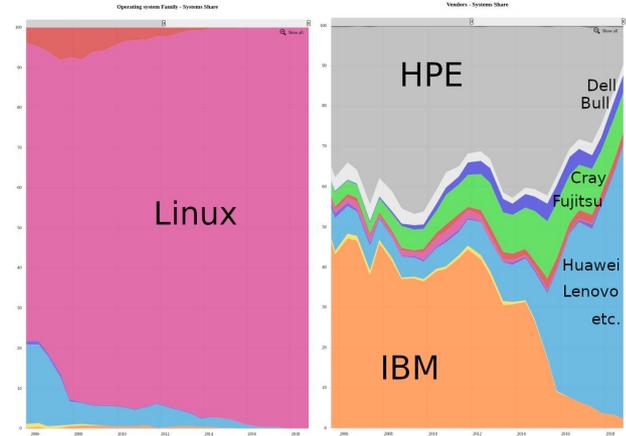
1. **Ecosystem stability**, including base Linux, HPC services (Lustre, MPI, OMP), hardware reliability and speed (cross-vendor, infiniband). OpenHPC is a means to that end, not the end itself.
2. **Toolchain usability and performance**, more specifically LLVM. It needs to be on par with GCC on Arm first, but ultimately, the aim is to compete with ICC on x86\_64.
3. **Library suitability and performance**, to cover the huge gap of hand-optimisation for SSE/AVX that doesn't yet exist in NEON/SVE, and all the unknown assumptions of the x86 architecture. This includes distributed filesystems.

# Current HPC ecosystem

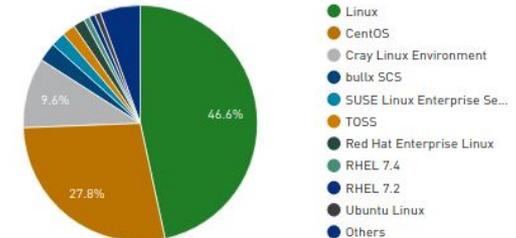
- Top500 list
  - All of them running **Linux**
  - **96.2%** based commodity **Intel** (up from 89% in 2015)
  - **Many** vendors / integrators

Striking contrast in software vs. integration?

- The Linux ecosystem, however, is also diverse
  - 46.6% “Linux” (custom)
  - 31.6% OSS distros (CentOS, Scientific, Ubuntu, TOSS)
  - 21.8% Commercial (Cray, Bull, SUSE, RedHat)



Operating System System Share



# Server Architecture Standards

- Standards Compliant (SBSA/SBBR/UEFI/ACPI/IPMI)
  - UEFI/ACPI/IPMI/SMBIOS already mature standards in x86
  - SBSA/SBBR define how to apply these to ARM to make all machines predictable
  - Use [Arm Server Architecture Compliance Suite](#) for out-of-the-box experience.
- Leverage existing knowledge and development (with x86)
  - Platforms look familiar and use same monitoring/debug tools
  - RAS Reporting is the same across all Arm vendors
- Standardised OS-to-Firmware interfaces
  - Allows old distributions to function on new hardware
  - Allows hardware to be generic to OS (Linux distros / Windows Server / etc)
- Linaro's work
  - **2859** patches over last 2 years accepted into Linux and **878** in EDK2

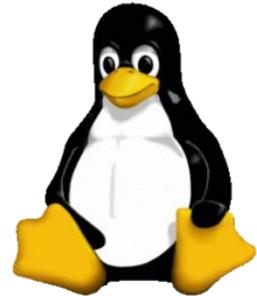


# Linux ecosystem

- Upstream out-of-the-box experience expected
  - Linux has to work on any new hardware
  - Standards on hardware and software needed
- Arm vendors provide unique solutions
  - All need *the same* base Arm support
  - The *only* way to collaborate is upstream
- Linaro has been working on that for 8+ years
  - We're on top Linux committer/reviewer list since 2013



debian



Linux 2017 Report Linaro's Contributions		
commits	4th	5.6%
reviews	4th	7.9%

# Toolchains

- System toolchains
  - The system toolchain, used to build kernel and packages, is generally the distro's GCC
  - Modern GCC is a *solid* toolchain for most uses
  - HPC: Benefits greatly from *special* (versus *generic*) build options
- Application toolchains can be (and often are) *special*
  - Used to compile libraries (math, distributed, etc) and applications
  - Potentially extended by vendors (optimised libraries, for example)
- Clang/LLVM is a good alternative
  - Consistent efforts for server side and Arm performance
  - Multiple existing products on top of LLVM
  - But the base **must** be *solid*
  - Linaro has over 1000 patches on Arm support, core changes, stability
  - We also participate actively in HPC/performance changes' design



# HPC SIG History

The HPC SIG was officially launched at Linaro Connect Las Vegas in September 2016 to drive the adoption of ARM in HPC through the creation of a data center ecosystem.

It is a collaborative project comprised of members and an advisory board.

Current members include ARM, Fujitsu, FutureWei, Marvell, Red Hat, Sandia. CERN and Riken are on the advisory board.

# HPC SIG Mission

Leverage server class infrastructure, multi-gigabit interconnect support and Scalable Vector Extensions on an Arm software ecosystem to build exascale HPC deployments based on Arm Server Standards.

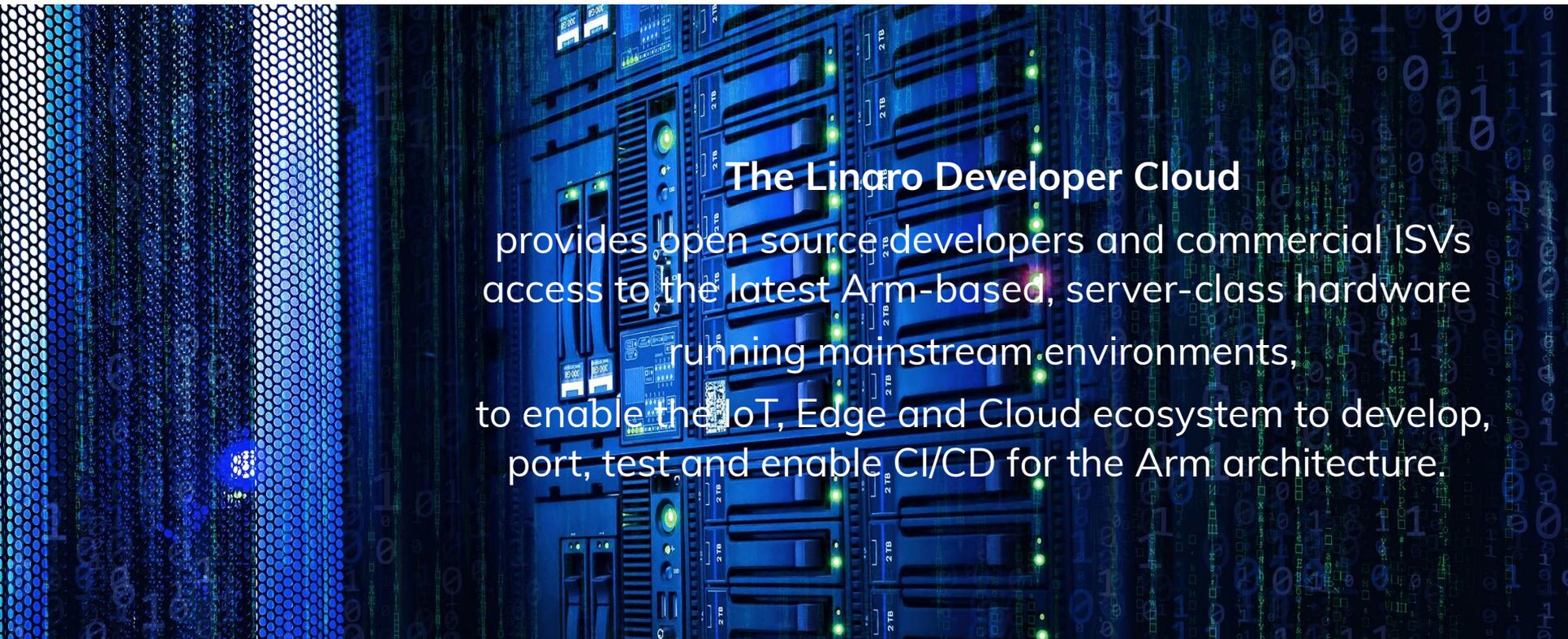
# Accelerate Deployment of ARM into Data Centers



POWERED



DeveloperCloud  
[www.linaro.cloud](http://www.linaro.cloud)

The background of the slide is a photograph of a server rack in a data center. The server units are blue and have various components like fans and lights. The lighting is dim, with some green indicator lights glowing. The overall color palette is dark blue and black.

**The Linaro Developer Cloud**  
provides open source developers and commercial ISVs access to the latest Arm-based, server-class hardware running mainstream environments, to enable the IoT, Edge and Cloud ecosystem to develop, port, test and enable CI/CD for the Arm architecture.

Let's Collaborate!

# Thank you

Join Linaro to accelerate deployment of your  
Arm-based solutions through collaboration

[contact@linaro.org](mailto:contact@linaro.org)

