



Kokkos – Sustaining Performance Portability for the Exascale Era



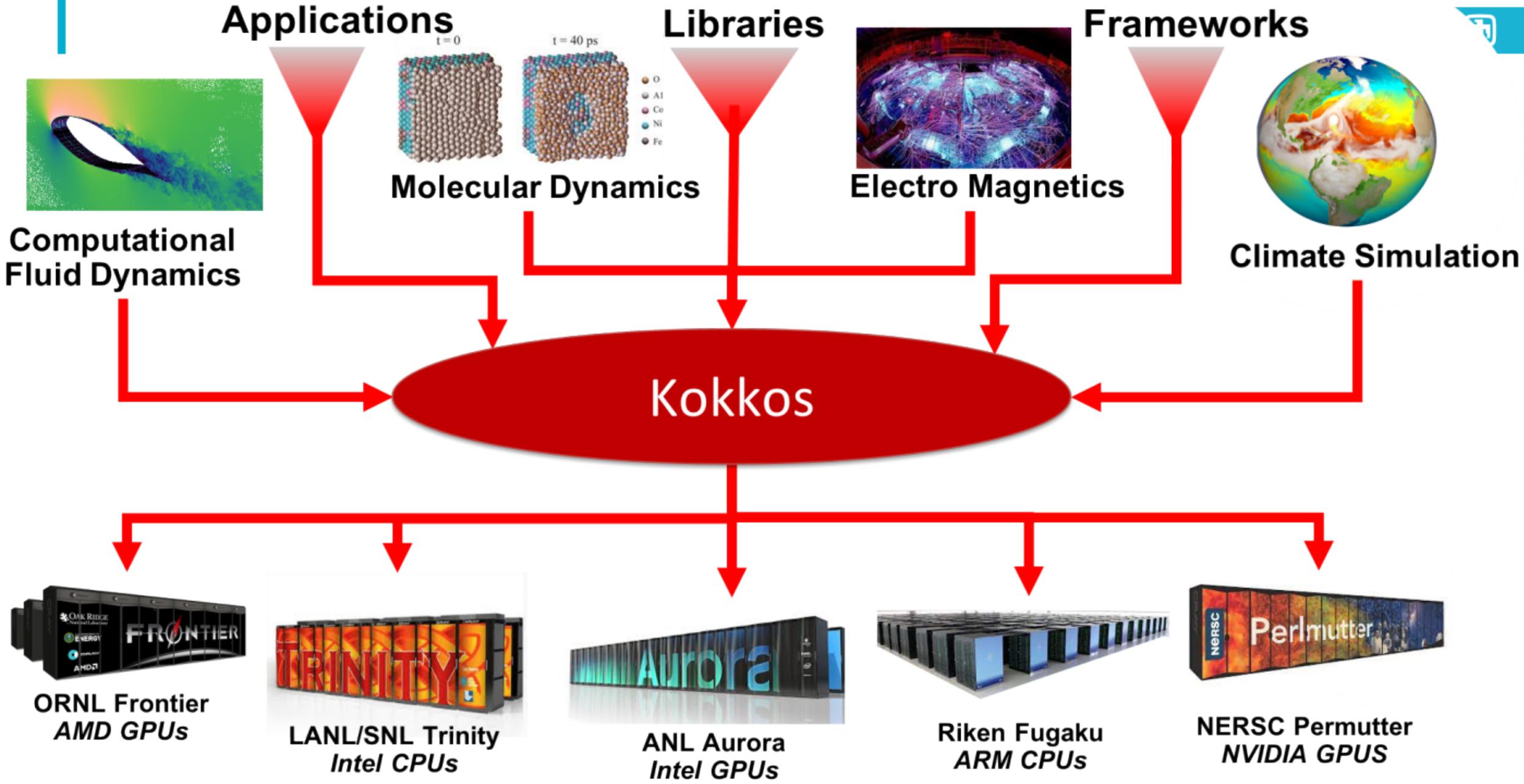
kokkos

Christian Trott

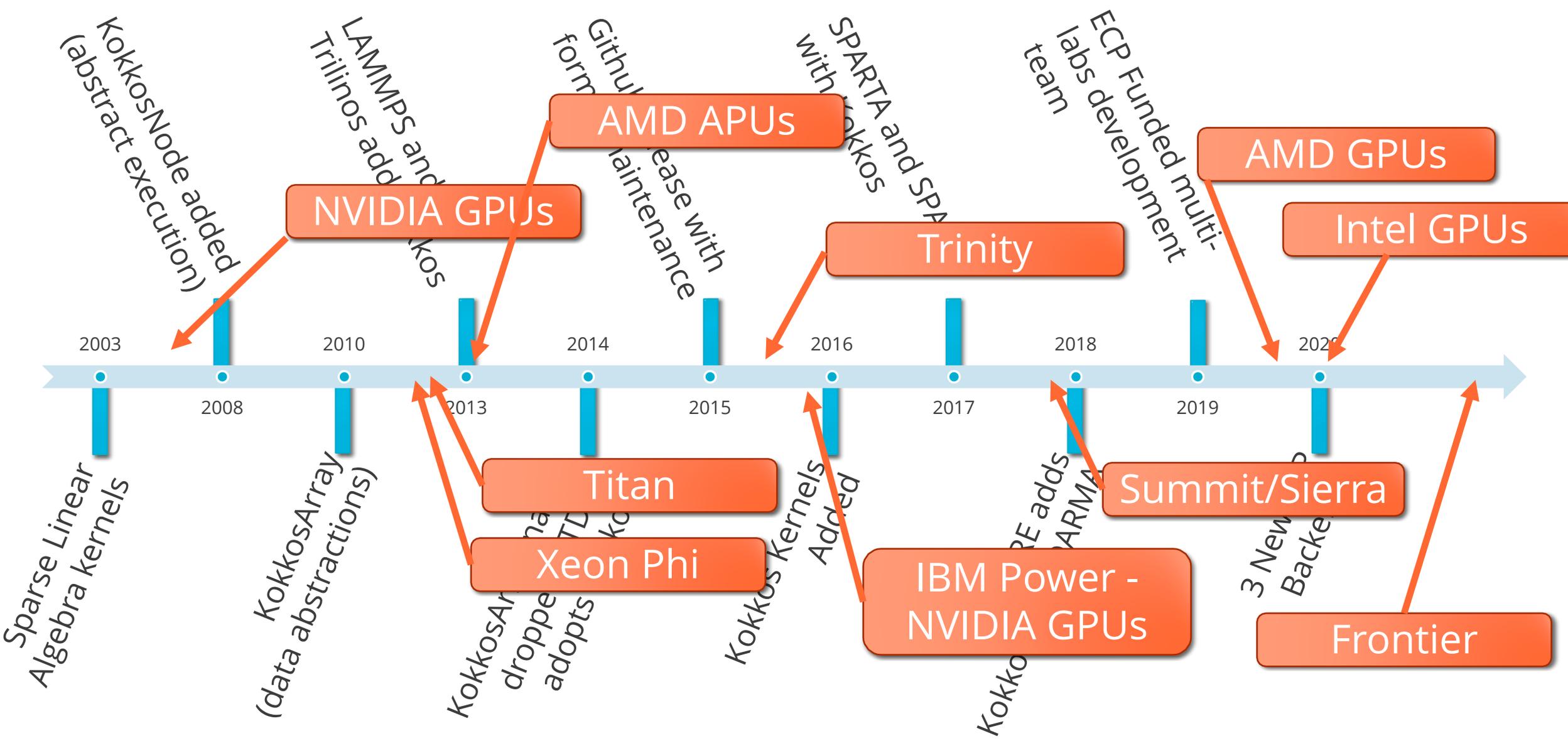
Sandia National Laboratories, Center for Computing Research



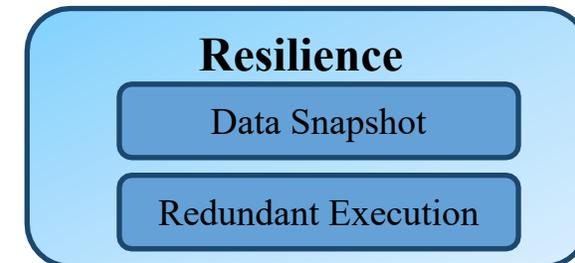
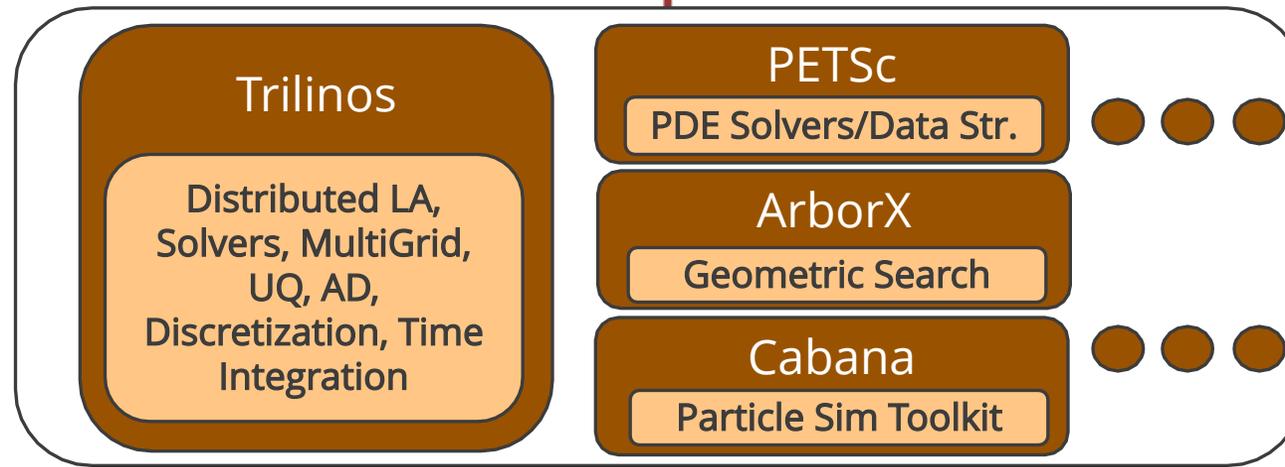
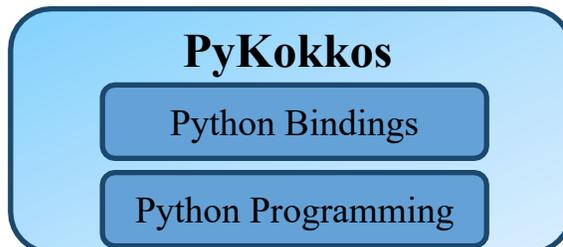
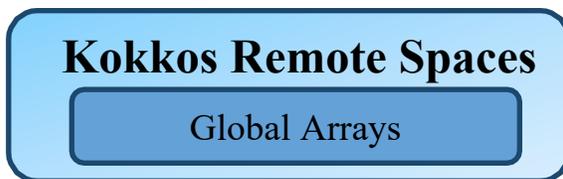
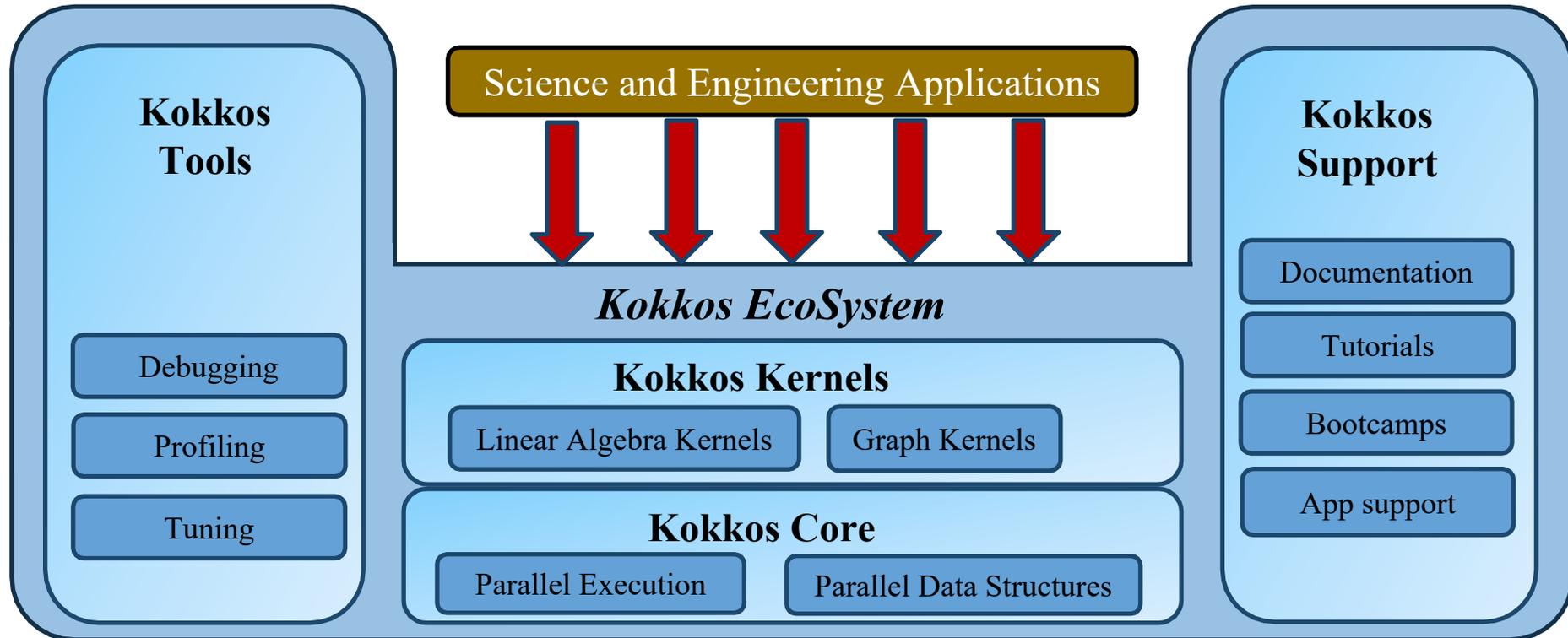
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Kokkos Timeline



The Kokkos EcoSystem - Today



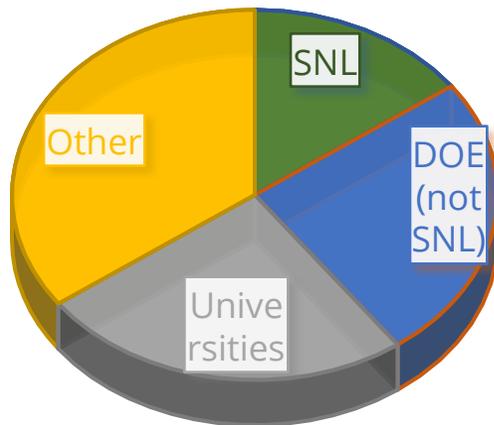
Kokkos Community



Kokkos Slack

<https://kokkosteam.slack.com>

- >1200 Registered Users
- >150 Institutions
 - Including 34 European



Kokkos Developers



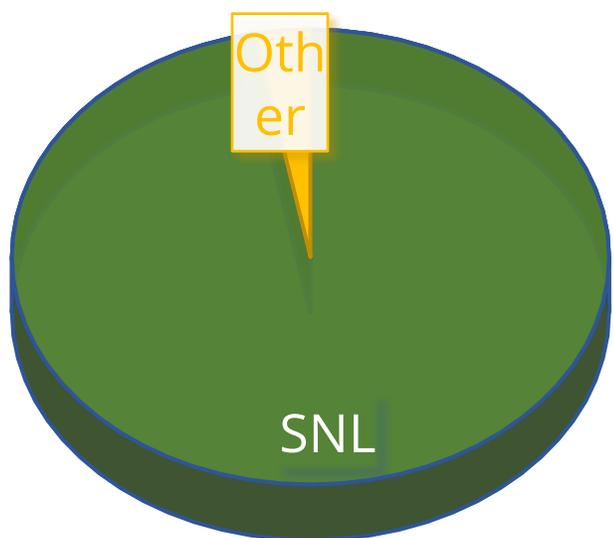
- Kokkos-Core Project: ~12 Developers
- Kokkos-Kernels Project: ~8 Developers
- Other Kokkos Ecosystem projects: ~6 Developers

Applications and Libraries

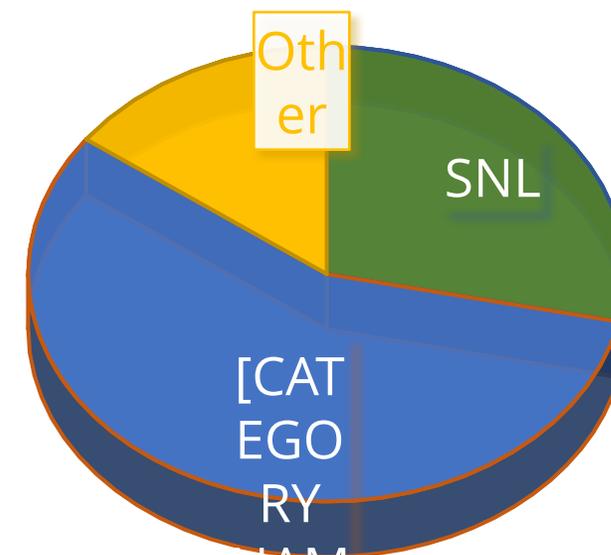
- Estimated 150-300 HPC projects using Kokkos
- On the order of three-dozen apps run science and engineering production runs with Kokkos
 - Many apps use multiple Kokkos based libraries
- Similar distribution as the Slack User

2015-2017

2021-2023



ECP-Funding



- Most of Kokkos-Tools and Kokkos-Kernels development still at Sandia
- ISO C++ Contribution well distributed over labs

Kokkos – How Library Solution Helps Sustainability



The Kokkos EcoSystem is using a library approach to achieve sustainability

- **Use optimized vendor toolchains on every platform**
 - Users/facilities can ask vendors for toolchain fixes for the vendors hardware
 - You can use Kokkos immediately on new hardware – don't have to wait for addition of hardware support to some third party toolchain
 - Vendor toolchains expose new hardware capabilities (CUDAgraphs, TensorCores, ...)
- **Work with vendors under NDA before platform is public**
 - Kokkos can easily be adopted for new C++ toolchains, enables working with new comers as soon as they can run any C++ code
 - Allows day-1 readiness for new systems
- **Full interoperability with vendor specific libraries**
 - Can leverage raw CUDA/HIP/SYCL/OpenMP libraries from within Kokkos code
- **Wider developer pool**
 - There are more developers who have expertise in writing libraries on top of CUDA/HIP/SYCL/OpenMP etc. than there are developers familiar with compiler work
 - => if Damien and I disappear there are enough people at the labs who could take over

Long term sustainment via integration of Kokkos features into ISO C++ standard

Getting something into ISO C++

- Requires a lot of effort
 - mdspan was 9 years, but we didn't know what we were doing
 - linalg likely 5 years to get into draft
- Requires prototype and usage experience
 - Need to be able to show successful use in field by sizeable community

Kokkos as the HPCs proving ground

- Large enough community
- More agile development of new features possible
- Kokkos team has gained trust of ISO C++ community as well as standard library implementers

In the standard

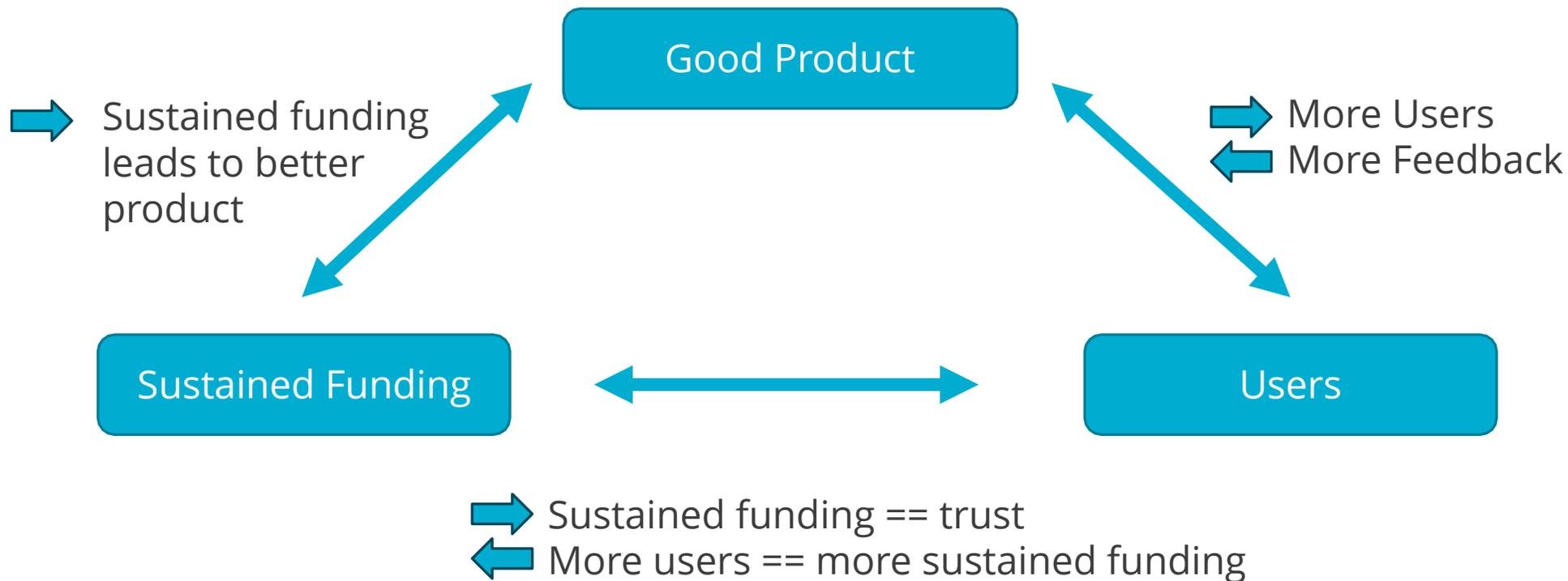
- "this" capture C++17
- atomic_ref C++20
- mdspan C++23

In flight for 26

- linalg – BLAS with extensions – *design approved*
- batched_linalg
- mdarray
- submdspan – *in draft*
- More accessors and layouts
- simd
- senders/receivers

We need long term engagement with ISO C++ as integral part of Kokkos effort.

Sustainment: A self reinforcing Cycle?



There is strength in numbers: collaboration on core product good for everyone!

Pillars for Long Term Sustainment



Open Source

- Enable wider set of contributor
- Risk mitigation for partner institutions – no one can just take the project away, worst case scenario is institutional fork with internal continued development
- Permissive license critical for industry participation

Core Funding

- Need a group of institutions to sustain core development team
 - **NNSA – Sandia National Laboratories** (+ *Los Alamos National Laboratory?*)
 - **DOE – ASCR Facilities – Oak Ridge Leadership Computing Facility** (+ *NERSC?, ALCF?*)
 - *DOE – Sustainability (Direction and size not clear yet)*
 - CEA starting now – good initial meeting last week

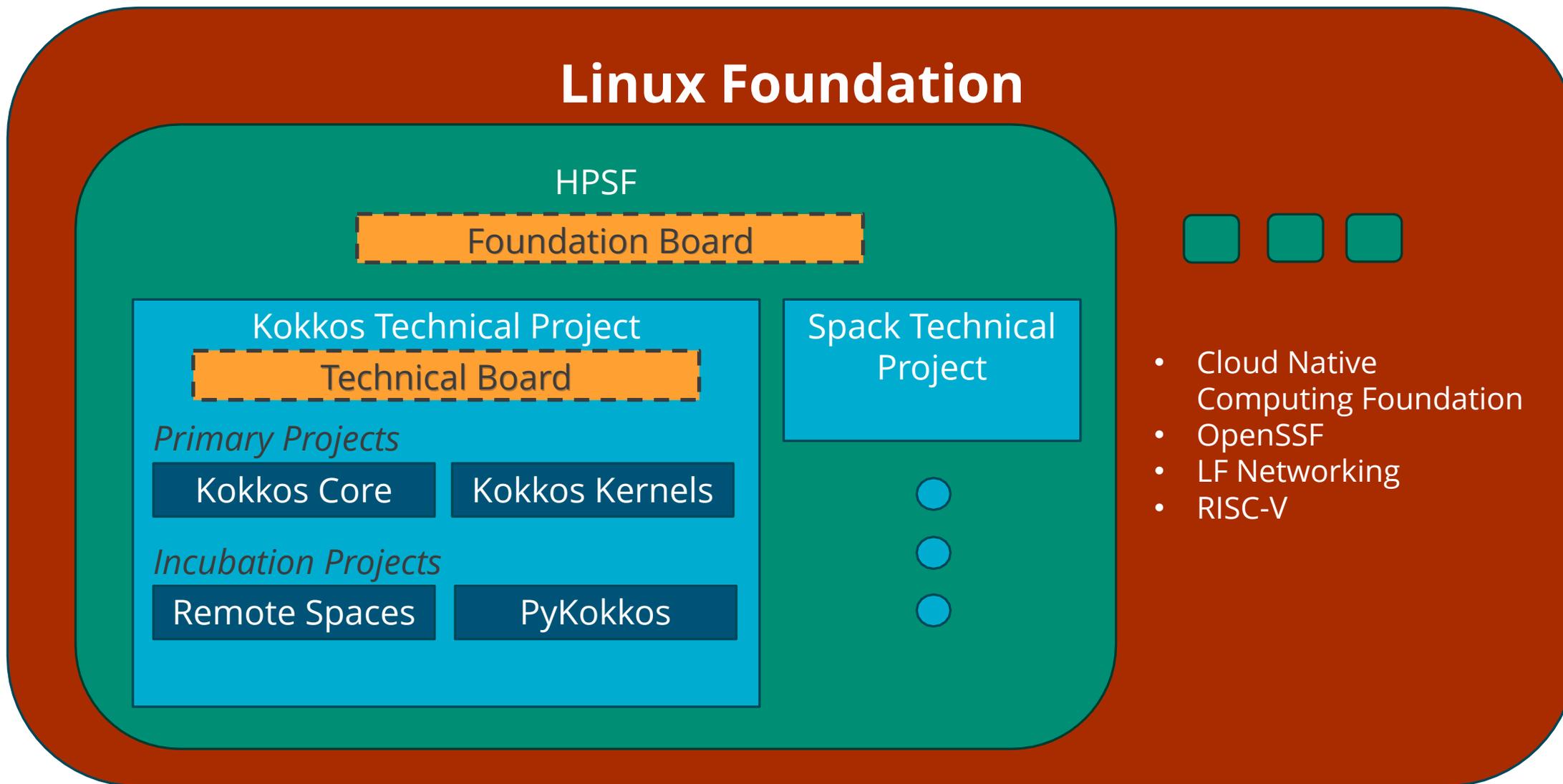
Open Governance

- Encourage participation of institutions by enabling say in direction
 - Enable path for new core funding teams to enter
- Exploring joining Linux Foundation

High Performance Software Foundation



Primary Goal for Kokkos: *Enable true partnerships on Kokkos via open governance.*



A few more foundation details



Primary Organizers: Todd Gamblin (Spack) and Christian Trott (Kokkos)

Sponsors:

- *US Labs:* SNL, LLNL, working on ORNL, LBL, LANL and ANL (i.e. hoping to get all big US National Labs on board)
- *Tentative Industry:* HPE, Amazon, NVIDIA, talking also to AMD and Intel
- *Others:* CEA?, maybe Rieken, CSCS, AWE? Open to other interested parties

Scope:

- Help sustain critical software technologies for HPC and related areas

What does it do:

- Guarantees Open Governances (e.g. <https://github.com/kokkos> will be owned by LF)
- Help organize and pay for meetings and workshops
- Help finance and organize project infrastructure (e.g. Slack)

Foundation Timeline



October 2023: Spack and Kokkos become "Unfunded technical projects" in Linux Foundation

- Sets up Open Governance
- Transfer assets (github organization, trademark, URLs)
- Copyright stays with contributing organizations!
- No change in license

November 2023 SC: Announcement for intend to launch foundation

- Describes goals and initial partners
- Invitation for interested partners to participate in finalization of foundation charter
- Potentially add more initial technical projects

March 2024: Foundation is up and running

- Enables donations to go reach this effort

Kokkos Ecosystem Organization



Technical Oversight Committee

- Representative of each participating organization
- Super-majority votes for decisions – but votes should be exceedingly rare

Primary Projects: initially Kokkos Core, Kokkos Kernels

- Work on all EcoSystem supported platforms
- Strong user-support, stable developer base
- Subject to full open-governance process

Secondary Projects: initially Kokkos Tools, Remote Spaces

- Best effort to work on all EcoSystem supported platforms
- Working towards strong user-support, generally smaller developer base
- Subject to full open-governance process

Associated/Incubation Projects: e.g. PyKokkos

- May only work on some platforms yet
- More geared towards friendly users, generally smaller developer base
- Open governance encouraged but not required

The Kokkos team is committed to collaborative community development!

- We actively seek more contributors and are willing to invest in productive collaborations.
- We are joining the Linux Foundation to create level playing field for partnerships.
- *But: community is **not** a substitute for sustained core funding!*

