VANGUARD

DOE NNSA Vanguard Program

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CCR
Center for Computing Research

U.S. DEPARTMENT OF ENERGY

NNSA
National Nuclear Security Administration
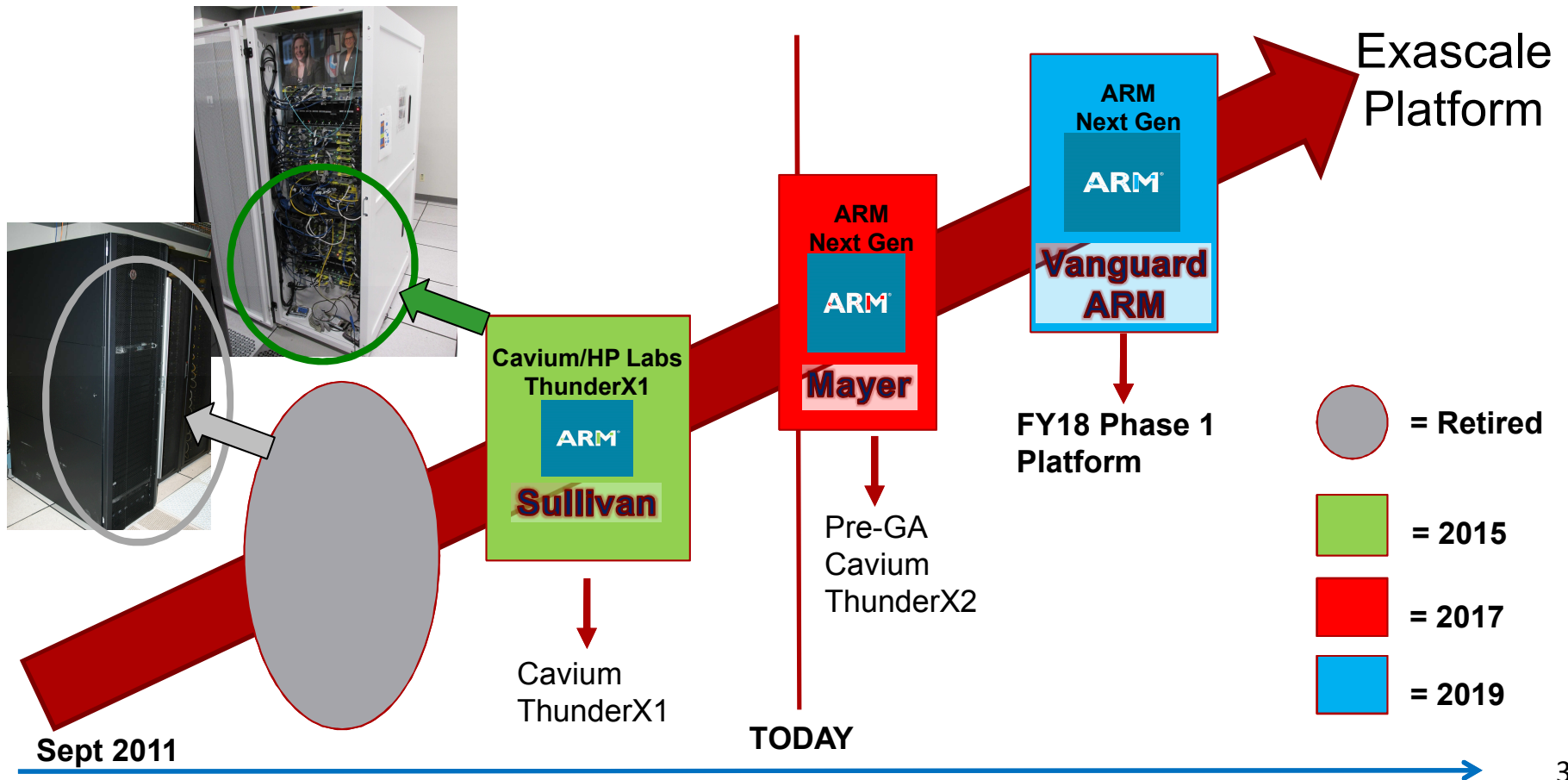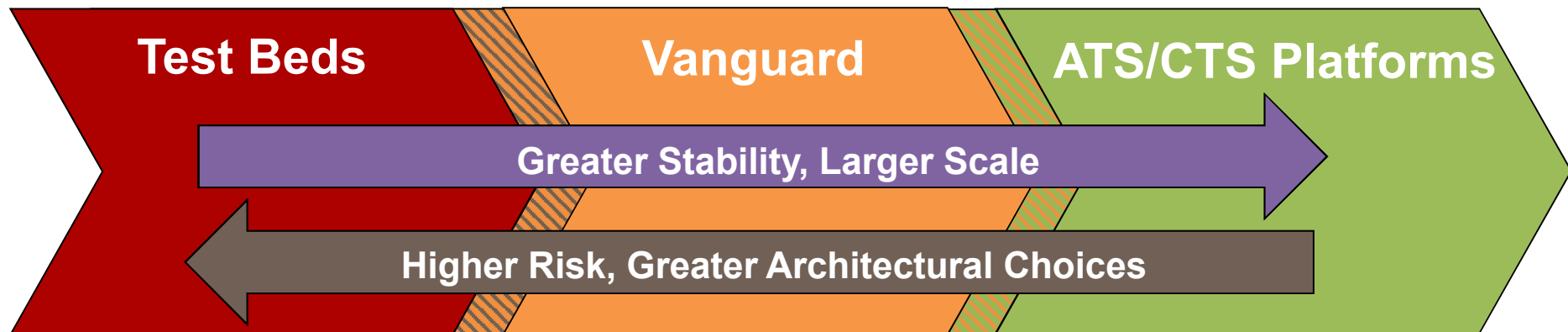
Vanguard Program: Prototype Systems for Advanced Architectures

- Expand the HPC ecosystem by developing emerging, yet-to-be-proven, technologies
  - Is technology viable for future ATS/CTS platforms supporting ASC integrated codes?
- Address hardware and software technologies together
  - If hardware technology is new, gaps in software stack are certain
- Buy down risk before commitment on capability/capacity class investment
  - Ability to accept higher risk allows for more/faster technology advancement
  - Lowers/eliminates mission risk and significantly reduces investment

Sandia's NNSA/ASC ARM Platforms

Exascale Platform

ARM Next Gen

ARM

Vanguard ARM

ARM Next Gen

ARM

Mayer

Cavium/HP Labs ThunderX1

ARM

Sulllvan

FY18 Phase 1 Platform

Pre-GA Cavium ThunderX2

Cavium ThunderX1

TODAY

Sept 2011

⬭ = Retired

🟩 = 2015

🟥 = 2017

🟦 = 2019

3

Where Vanguard Fits

Test Beds	Vanguard	ATS/CTS Platforms

Greater Stability, Larger Scale →

← **Higher Risk, Greater Architectural Choices**

- Small testbeds (~10-100 nodes)
- Breadth of architectures Key
- Brave users

- Larger-scale experimental systems
- Focused efforts to mature new technologies
- Broader user-base
- Not targeted for production use

- Leadership-class systems (Petascale, Exascale, ...)
- Advanced technologies, sometimes first-of-kind
- Broad user-base
- PRODUCTION USE

Vanguard ARM Project

Phase 1 - 2018

- 2018: Field early ARM based (petascale) prototype platform
  - Target 64-bit HPC relevant processor
  - Close gaps in software stack
    - OS
    - Compilers
    - Scalable MPI, runtime, systems management
    - Development and debugging tools
    - IO
  - Prove viability of supporting NNSA mission applications
    - AT SCALE
    - Tied to software stack
    - First run then optimize

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Vanguard ARM Project

Phase 2 (2019-2020)

- Upgrade, augment, field follow on ARM technologies
  - Potential targets
    - Next generation ARM processor
    - Advanced network technologies
    - On-package memory
- Technology trends remain VERY uncertain
- Make Phase 2 decision when options are more clear
  - By end of FY2018

Vanguard Tri-Lab Software Effort

- Accelerate maturity of ARM ecosystem for ASC computing
  - Proving the viability of NNSA integrated codes depends on a capable software stack
- Need an integrated software stack for the 2019 ARM platform to enable application development and optimization
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  - Low-level OS (optimized Linux, I/O, network, containers + VMs, PowerAPI, …)
  - Job scheduling and management (WLM, app launcher, user tools, …)
  - System management (boot, system monitoring, image mgt., …)
- Focus areas
  - Integration and robustness, overall user experience
  - Address known areas of weakness: compilers, libs and tools
  - Increase modularization and openness of system software stack
    - Be able to plugin externally developed components (e.g. libs, tools, OS)

Vanguard Tri-Lab Software Effort (cont.)

Responsibilities

- Vendor
    - Deliver and support core elements of the software environment necessary for viable integrated system (called for in RFP)
    - Expect different levels of completeness depending on selected vendor
- Sandia and Tri-lab team
    - Integrate system into our computing environment
    - Identify and resolve SW issues in collaboration with system vendor
    - Contribute tools and other capabilities to fill gaps and improve the overall computing environment
    - Regardless of selected vendor, ultimately use the Tri-lab developed SW stack to demonstrate applications

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Compiler Dashboard

Early ThunderX2, Various compilers

Workload	GCC	Vendor A	Vendor B
STREAM		OpenMP issue	
GUPS	-13%	-20%	
MiniFE	-7% for WAXPY -17% for SpMV	+2% for WAXPY **-52% for SpMV**	
Pennant	-22%	**-200%**	
Sweep3D	-2%		-16%
LULESH	-15%	**-65%**	
OpenMPI 2.1.2			
Kokkos Kernels			
Trilinos			
NaluCFD			

Results from Si Hammond @ Sandia

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Schedule – Past and Projected

- ~~September 22nd – 2nd Draft RFI released~~
  - Note: We are releasing the RFI via the procurement vehicle more frequently, possibly weekly, to maintain equality in the communication process.
- ~~Week of September 25th – Prime F2F presentations~~
- RFP release no later than January 12th
  - Possibly before Christmas holidays
- RFP responses due no later than February 8th
  - Hopefully worse case scenario
- RFP responses distributed to technical team members February 9th
- February 21st – Technical review (SNL Albuquerque)
- February 21st – Source Selection (with Tri-lab members to minimize travel)
- February 22nd – Follow on Source Selection only if necessary
- February/March 2018 – Negotiations and SOW development
- March/April 2018 – SOW development and contract placement
- July/August 2018 – Phase 1 platform delivery begins

Status: 725-East -HPC Computing Facility Construction

- Institutionally Funded
- Design/Build Contract Awarded
- All Permits Received – Site Preparation underway
- Groundbreaking Event 9/28/17
- 40% and 90% Design Reviews Completed
- 100% Design Review by 12/8/17
- Completion Data 7/15/18
- Will feature 90% liquid cooling 10% air cooling
- Thermosyphons & Air-Side Economization for Water/Energy Savings
- Solar Farm for LEED Certification
- Non-load-bearing, movable west wall for expansion (14,000 – 20,000sf)
- 7 MW power expandable to 15 MW