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# Alliance for Computing at Extreme Scale (ACES)

CEA Meeting, France

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# Outline

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- NNSA Complex Transformation
- Consolidation to two capability sites (ACES, LLNL)
- Programmatic Needs, ASC Roadmap
- LANL & SNL partnership
- Alliance for Computing at Extreme Scale (ACES)
- ACES Design Team
- Next ASC production capability platform in 2010
- Zia RFP development
- Summary

## Vision of the Future Complex

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- A smaller, safer, more secure and less expensive enterprise that leverages the scientific and technical capabilities of our workforce, and meets national security requirements
- Eliminate redundancies and improve efficiencies by consolidating missions and capabilities
- Many changes at all NNSA sites
- NNSA preferred alternative: Two capability supercomputing sites:
  - ACES
  - LLNL
- SNL continues to site NNSA capacity computers, other platforms

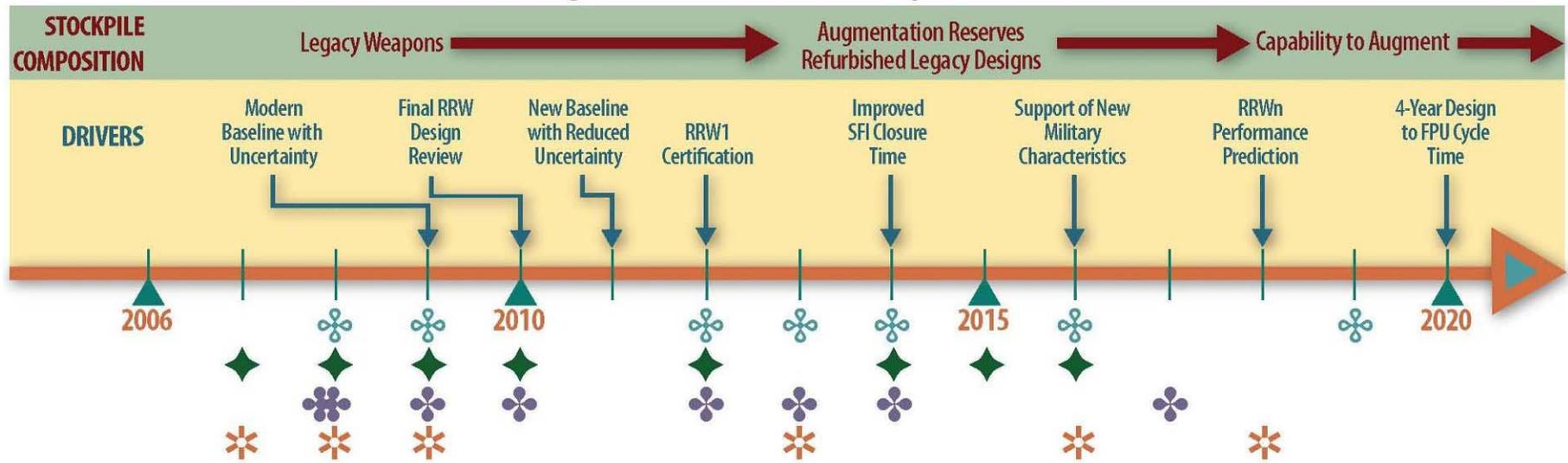
# Programmatic Needs

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- ASC roadmap:
  - 2009: Petascale
  - 2016: 100x Petascale
  - 2018: Exascale
- Driven by need for higher fidelity physics
  - To support stockpile needs & enable complex transformation
  - Desired state: Confidence in science-based simulation exceeds our confidence in simulations calibrated by underground test data
  - Reduction in cumulative uncertainty in “un-tuned” scientific models: *Validation replaces calibration*

# ASC Roadmap

## Computational Weapons Science and Simulation: Targets to address Nuclear Weapons Issues



## ASC Targets

### FOCUS AREA 1: ADDRESS NATIONAL SECURITY SIMULATION NEEDS

- ❖ 2008: National code strategy
- ❖ 2009: Modular physics and engineering packages for national weapons codes
- ❖ 2012: Tested capability to address emerging threats, effects, and attribution
- ❖ 2013: 50% improvement in setup-to-solution time for SFI simulations (with respect to 2006)
- ❖ 2014: Full-system engineering and physics simulation capability
- ❖ 2016: Capability to certify fire safety for an unfielded weapon
- ❖ 2019: 50% improvement in setup-to-solution time for SFI simulations (with respect to 2013)

### FOCUS AREA 2: ESTABLISH A VALIDATED PREDICTIVE CAPABILITY FOR KEY PHYSICAL PHENOMENA

- ❖ 2007: Launch Thermonuclear Burn Initiative (TBI) collaboration
- ❖ 2008: Realistic plutonium aging simulations
- ❖ 2009: Science-based replacement for Knob #1
- ❖ 2010: Science-based models for neutron tube simulations
- ❖ 2012: Validated science-based replacement for Knob #2
- ❖ 2014: NIF-validated simulations supporting replacement of knob #3
- ❖ 2015: Science-based models for fire excitation simulations
- ❖ 2016: Predictive model for Knob #4

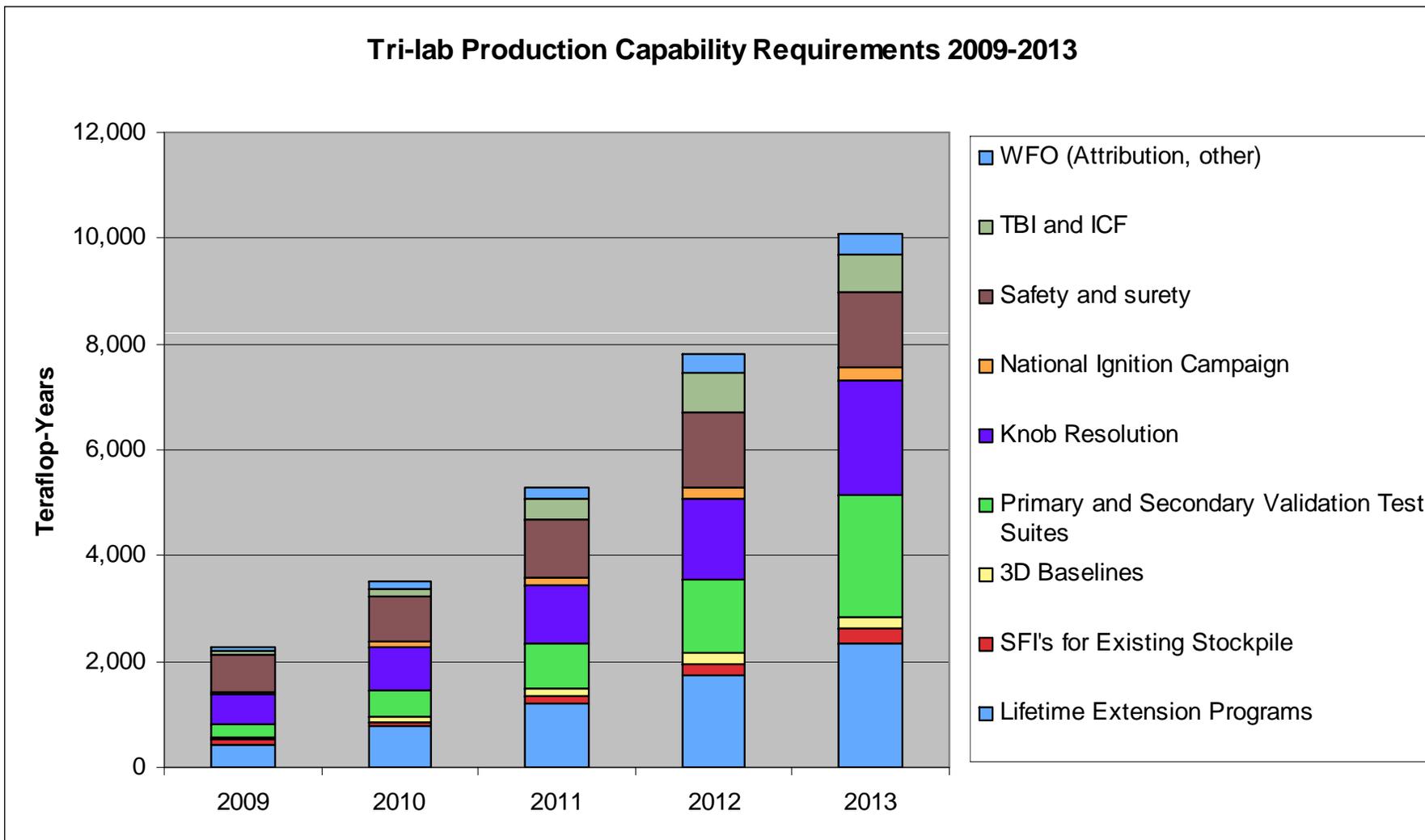
### FOCUS AREA 3: QUANTIFY AND AGGREGATE UNCERTAINTIES IN SIMULATION TOOLS

- ❖ 2008: National verification & validation strategy
- ❖ 2008: Assessment of major simulation uncertainties
- ❖ 2009: Shared weapons physical databases
- ❖ 2010: Uncertainty Quantification (UQ) methodology for QMU
- ❖ 2012: 20% reduction in overall prediction error bars (with respect to 2006)
- ❖ 2013: Re-assessment of major simulation uncertainties
- ❖ 2014: Demonstrated uncertainty aggregation for QMU
- ❖ 2017: 20% Reduction in overall prediction error bars (with respect to 2012)

### FOCUS AREA 4: PROVIDE MISSION-RESPONSIVE COMPUTATIONAL ENVIRONMENTS

- ❖ 2007: Initiate new National User Facility model for capability supercomputing
- ❖ 2008: Seamless user environments for capability computing
- ❖ 2009: Petascale computing
- ❖ 2013: Seamless user environments for capability computing
- ❖ 2016: 100x petascale computing
- ❖ 2018: Exascale computing

### Tri-lab Production Capability Requirements 2009-2013



## LANL & SNL Partnership

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- 3/2008: LANL & SNL Memorandum of Understanding
- **ACES: The NNSA New Mexico Alliance for Computing at Extreme Scale**
  - Joint design, architecture, development, deployment and operation of production capability systems for NNSA
- Driven by mission needs
- Commitment to the development and use of world class computing
- Continued leadership in high performance computing
- Sharing intellectual capabilities of both laboratories
- Controlled release of information

# ACES Alliance Organization Chart



## Senior Executives:

Charlie McMillian, LANL / ADWP  
Rick Stulen, SNL / CTO & VP-STE

## NNSA Defense Programs



## Governance Board:

James Peery, SNL / CCIM & ASC  
Rob Leland, SNL / 9300  
Andy White, LANL / ADTSC  
John Hopson, LANL / ASC

## ASC Headquarters:

Bob Meisner, ASC Program Director



Los Alamos



Sandia

## Co-Directors:

John Morrison, LANL / HPC  
Sudip Dosanjh, SNL / CCIM

## Advisory Board (TBD)



## Computer Architecture Office

Sited at Sandia  
SNL Office Leader (TBD)  
LANL Deputy Leader (TBD)  
Joint SNL & LANL team members

## Deployment and Operations Office

Sited at Los Alamos  
LANL Office Leader (TBD)  
Sandia Deputy Leader (TBD)  
Joint LANL & SNL team members



## User Requirements Office Code Teams



## ACES Design Team

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- Established by Sudip Dosanjh (SNL) and Karl-Heinz Winkler (LANL)
- Approximately 10 participants from each laboratory
- Developed a LANL/SNL platform strategy document
- Numerous meetings and discussions on
  - RFP for a 2010 petascale production capability platform
  - Areas for technology development
  - 2014 production capability platform for predictivity
- Half-day to full day meetings with:
  - AMD, Cisco, Open MPI, Corning, Cray, HP, IBM, Intel, Luxtera, Myricom, Panasas, Qlogic, Seagate, SGI, Sun

# ACES Strategy

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- Align with and influence industry roadmaps
- Co-architect platforms, applications and algorithms recognizing that new architectures are likely to influence applications and algorithms
- Ensure pragmatic migration of ASC codes to new platforms with significant performance gains
- Encourage and foster credible competition in the supercomputing industry (procurements will be open and competitive)
- Actively promote public standards
- Focus on a broad range of applications
- Impact the supercomputing industry through market acceptance of designs and component technologies
- Be driven by cost, risk and benefit analyses
- Partner with the DOE's Office of Advanced Scientific Computing Research and other government agencies (notably DARPA and other DoD agencies)

# The next ASC capability platform: Zia

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- ASC Purple
  - Deployed at LLNL in 2005
  - 92.781 TF/s peak, Linpack Rmax 75.760 TF/s
  - Will be 5 years old in 2010
- ASC Red Storm
  - Deployed at SNL in 2005, upgraded in 2007
  - 127.531 TF/s peak, Linpack Rmax 102.200 TF/s
  - Will be 5 years old in 2010
- Need for Purple replacement & capability increase in 2010
  - ACES Design Team developing RFP for Zia
  - Capability production in 2010

## Zia Goals

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- Production capability
  - Capable of running a single application across the entire machine
- Petascale
- RFP will specify minimum peak, aggregate memory bandwidth and interconnect bandwidth
- Large memory per core (minimum: 2 GB/core)
- Easy migration of existing codes with reasonable increase in performance
- Key challenges: Power, reliability, scalability, usability

# High-Level Design Targets for Zia

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Zia Performance Targets	Specification	Specification <sup>(c)</sup>
Peak Floating Point (double precision)	> 2 PF	> 1.25 PF
Total Memory	> 0.5 PB	> 200 TB
Aggregate <sup>(a)</sup> Memory BW	> 1 PB/s	> 600 TB/s
Aggregate Interconnect BW	> 1 PB/s	> 600 TB/s
Aggregate Bisection BW <sup>(b)</sup>	> 80 TB/s	> 50 TB/s
Aggregate Message Injection Rate	> 100 GMsgs/s	> 60 GMsgs/s
Aggregate I/O BW	> 1 TB/s	> 400 GB/s
Disk Capacity	> 30 PB	> 10 PB
System Power	< 8 MW	< 8 MW
Floor Space	< 8000 ft <sup>2</sup>	< 8000 ft <sup>2</sup>
Full System Job MTTI	> 25 hours	> 1 day
System MTBI	> 200 hours	> 1 week

<sup>(a)</sup> Total peak bidirectional rate for all nodes.

<sup>(b)</sup> For an N-dimensional mesh/torus this is defined as the sum of the bandwidths

<sup>(c)</sup> For a 2PF option, these non-facility performance specs scale accordingly



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# Questions?

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## Abstract

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- In support of the NNSA complex transformation, LANL and SNL have created The Alliance for Computing at Extreme Scale (ACES). The ACES effort is driven by mission needs, sharing intellectual capabilities of both laboratories, and continued leadership in high performance computing. The initial goals of ACES partnership include the design and deployment of Zia, the next ASC production capability platform.