On Democratizing HPC: An update on the Missing Middle

MARC³ Symposium
June 6, 2011

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The Missing Middle

USERS

Traditional Computer Users

Opportunity: the "Missing Middle"

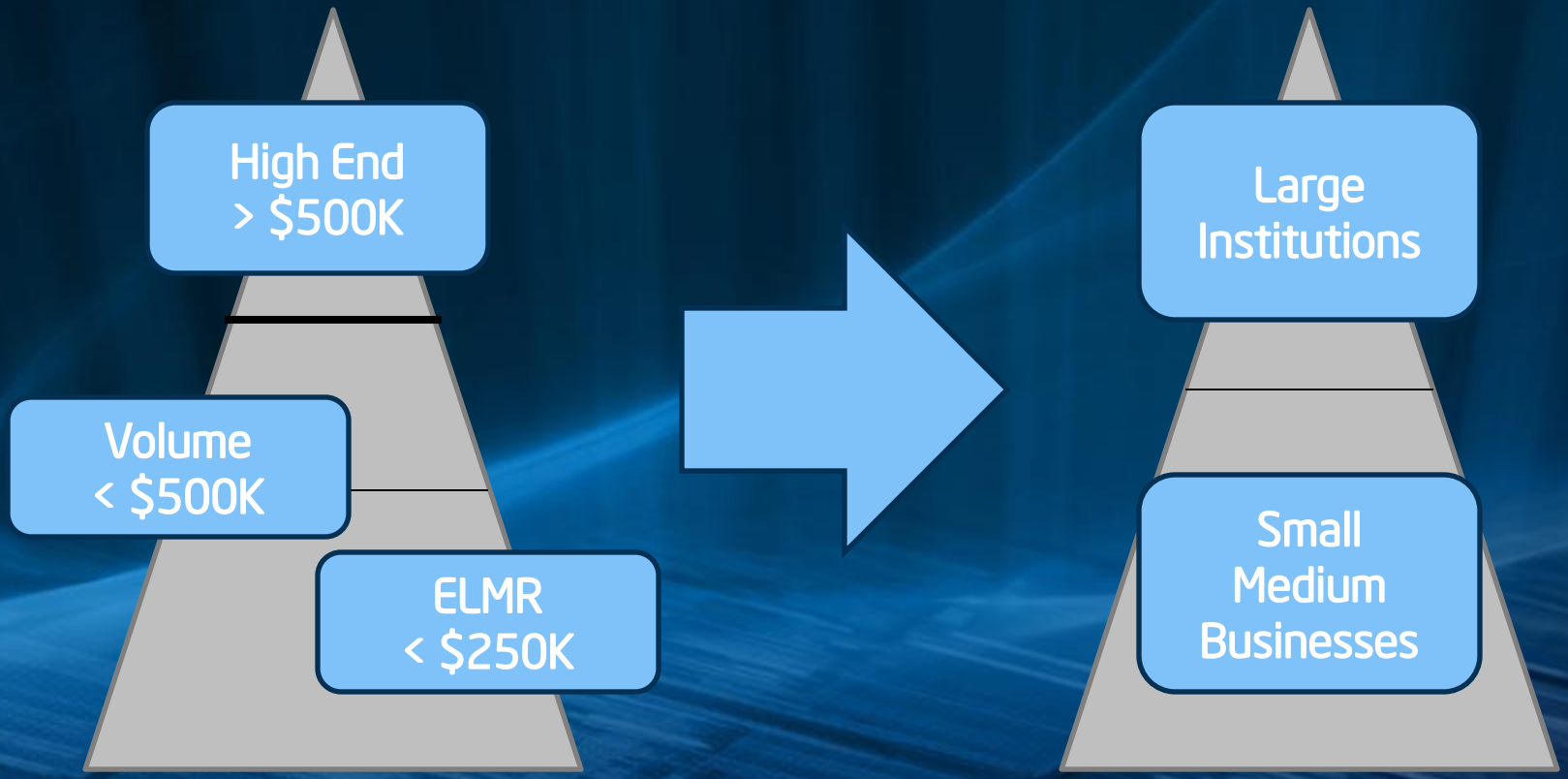
High-End Users

TASK COMPLEXITY

From ncms.org

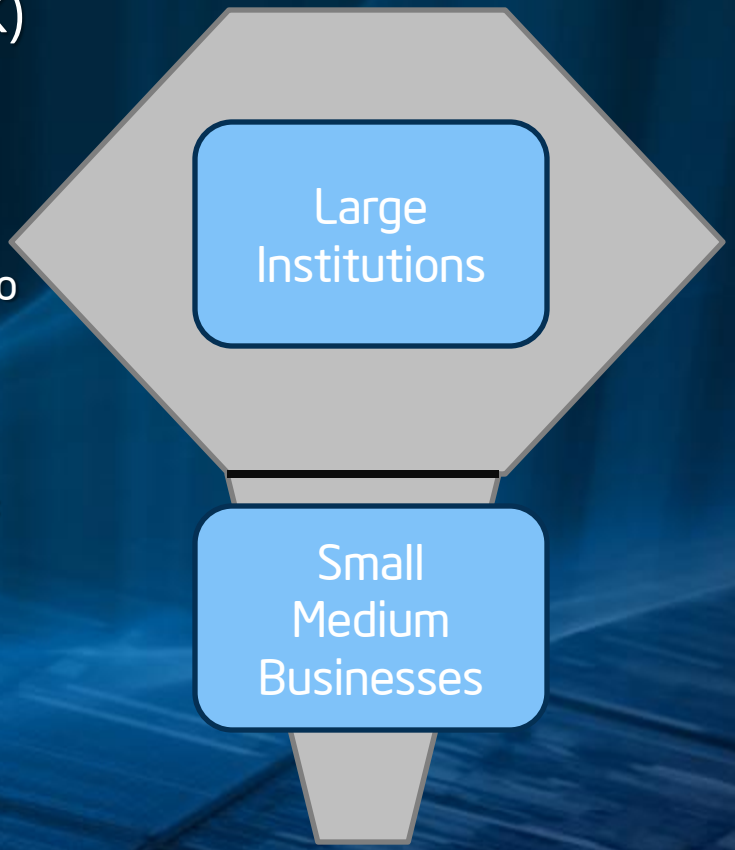
intel

Implied Perspectives



Reality?

- About two-thirds of ELMR-sized (<$250K) systems are upgrades or add-ons to larger systems[1]
- InterSect360 measures that:
  - Of true ELMR systems, 20-25% go to users who also have larger (high-end) systems.
  - so, only 10-15% of said systems go to ELMR users[2]
- IDC sees something similar, with 70%[3] of the <$500K going to the Workgroup, Department, Divisional segments.
  - Needs further visibility/corroboration



1 – Source: InterSect360 Research, HPC User Site Census: Lifecycles, 2009.
2 – Source: InterSect360 Research, custom user study, 2009.
3 – Source: IDC, personal comms, 2010

Key Barriers

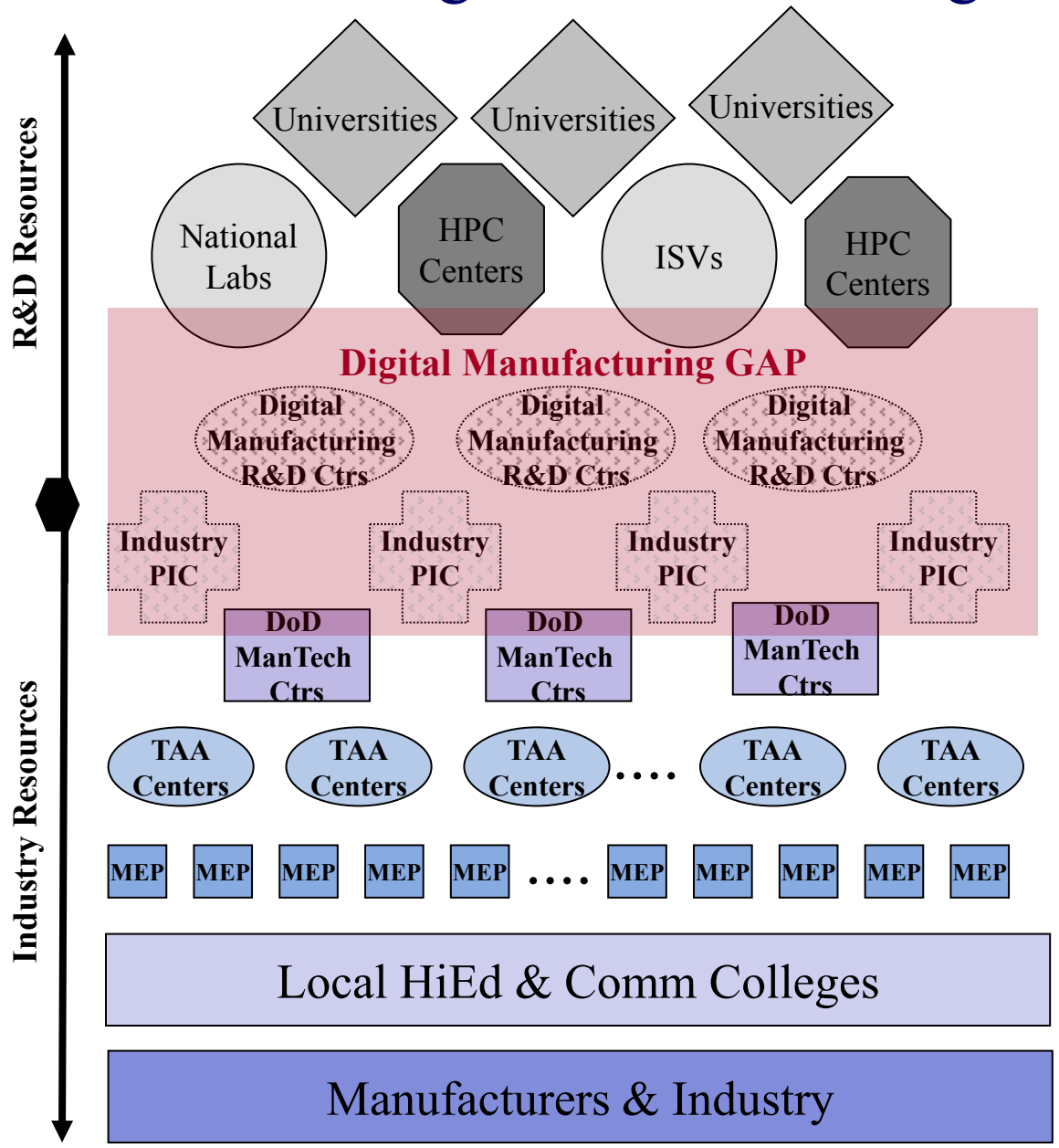
- The COC/IDC Reveal[1] report concluded that there are three major system barriers stalling HPC adoption:
  - Lack of Application Software
  - Lack of Sufficient Talent
  - Cost constraints
- They noted that these were the same constraints identified four years prior[1,2]
- InterSect360[3] had a similar perspective; that cost is not the top barrier.
  - "You could give companies free HW and SW, and it wouldn't solve these problems:
    - Political will to change a workflow and to build faith in simulation to supplement physical testing.
    - Expertise and knowledge for using scalable systems, and
    - Creation of digital models."

1 – Source: CoC/IDC Reveal report, 2008.
2 – Source: CoC Study of US Industrial HPC Users, July 2004
3 – Source: Addison Snell, InterSect360

Alliance for High Performance Digital Manufacturing

- >45 entities working towards reaching the Missing Middle
  - Industry, ISVs, Academia, and National Labs
  - Many represented here today
- The motivation:
  - Facilitating innovation and economic growth
  - A rising tide that benefits all of the ecosystem
- Membership
  - Open and easily accessible
- Further info at www.digitalmanufacturing.org

National Digital Manufacturing Strategy Vision



Existing R&D Expertise

- Universities
- National Labs
- DoE Labs
- HPC Centers (i.e. OSC, NCSA, etc.)

Proposed National Manufacturing Innovation Network

- Digital Manufacturing R&D Centers
- (academic focus)
- Industry Predictive Innovation Collaboration Centers (non-profit e.g. NCMS)

Trade Adjustment Assistance Centers (TAAC)

- Approx. 14 National Centers
- Expand mission beyond trade impacted companies

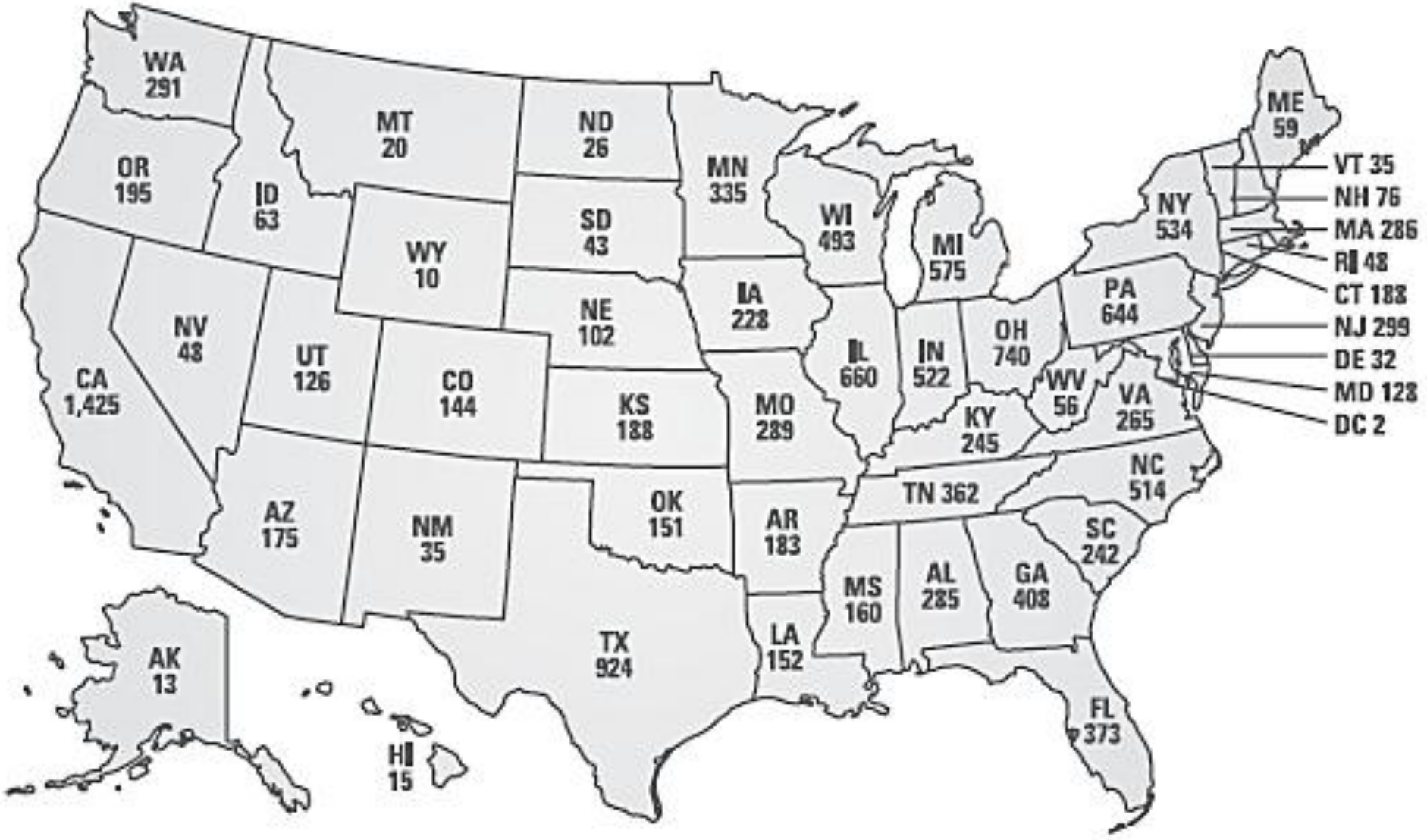
MEP's (NIST)

- 60+ National Centers
- New focus on Digital Manufacturing

Focused Digital Manufacturing Training

- Community colleges, NAM, Manufacturing web portals

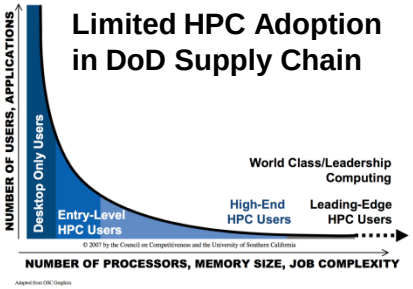
Manufacturing Jobs (1000's of workers)



Source: U.S. Bureau of Labor Statistics, 2008

HPC-ISP PILOTS: Case studies to evaluate whether manufacturing SMBs would see real benefits if they could obtain HPC access

STATUS QUO

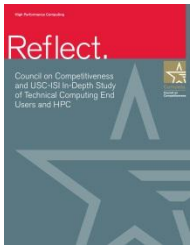


- *The limited industrial user adoption of HPC is eroding the competitiveness of critical DoD suppliers and the country's industrial and military capability.*

NEW INSIGHTS

Phase 1 Case Studies Found:

- *HPC is often **perceived** as an ultra high-end technology appropriate only for government or academia.*
- *There is a lack of understanding of the business value (**ROI**) of simulation and analysis with HPC.*
- *Access to talent, lack of software, and initial capital cost are all barriers.*

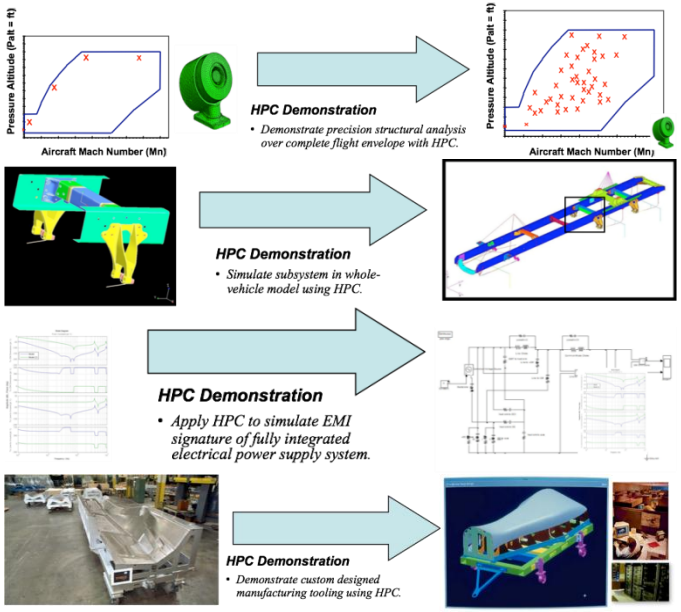


Technical Approach:

- Demonstrate the business and competitive value of product simulation and analysis with HPC for U.S. manufacturing.
- Motivate usage of this innovation-accelerating technology throughout the DoD supply chain supplier base.
- Identify technologies and partners that can help support an HPC infrastructure for the DoD supply chain base.

Deliverables

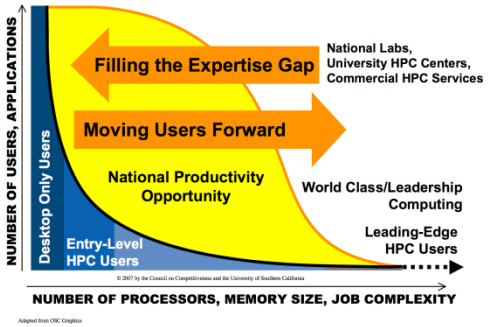
- Conduct four 12-month HPC pilot demonstrations with DoD supply chain "desktop-only" companies.
- The Council will deliver 10 HPC user case studies.



QUANTITATIVE IMPACT

Success Stories:

- Successful examples of accelerated innovation, new discoveries, new product development, shortened time to market, cost savings.
- The Pratt & Whitney supply chain pilot will be measured in terms of value achieved/saved through a product value stream analysis.



END-OF-PHASE GOAL

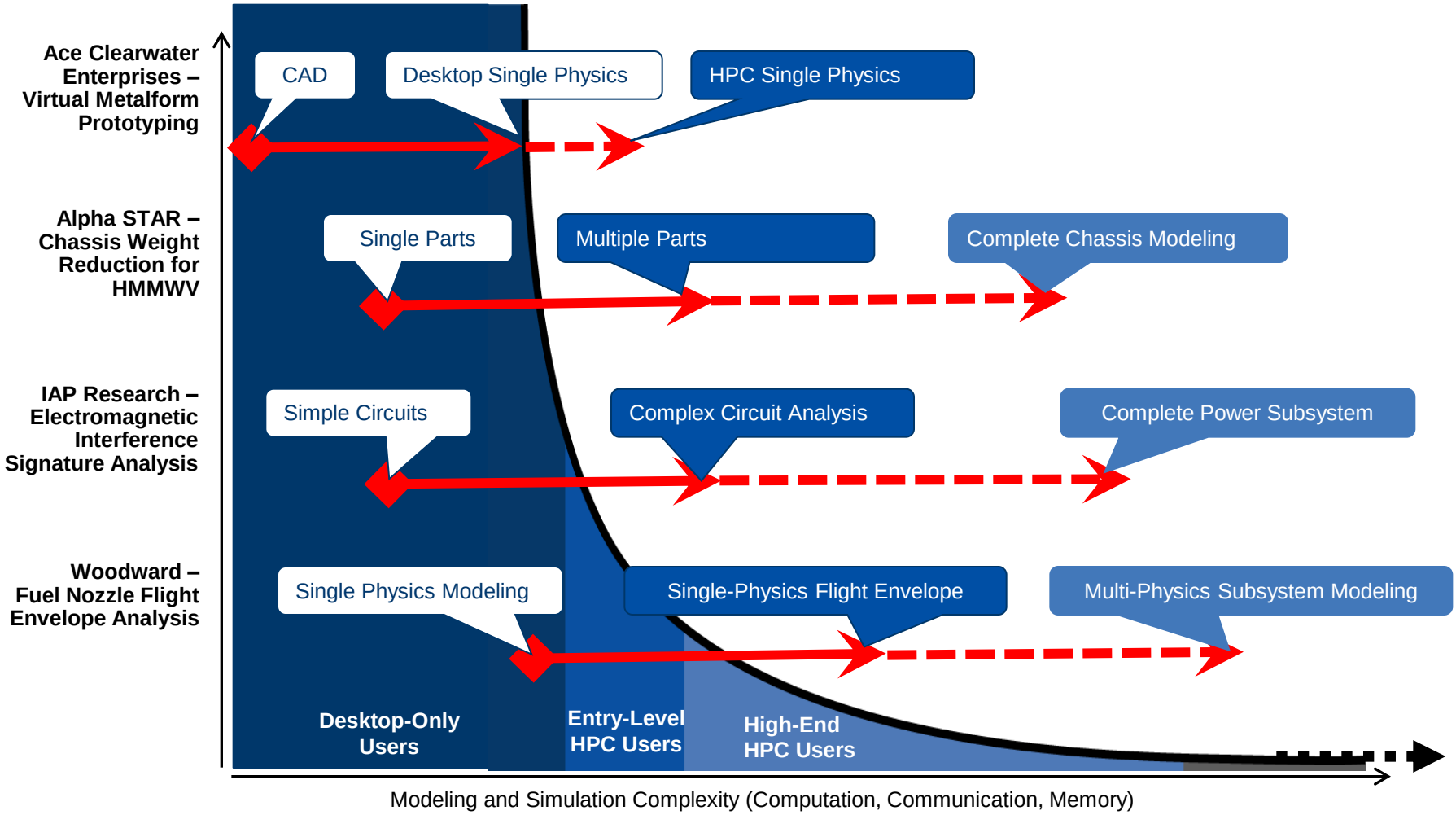
Strengthen the DoD's Supply Chain

- *Provide real world industry examples of the value of simulation and analysis with HPC that will stimulate usage through DoD's supply chain for greater supply chain reliability, product innovation, and cost savings.*

ISP=Innovation Service Portal

Drive HPC Usage Throughout the DoD Supply Chain

Pilots intersecting different entry points



ISI worked with an SMB engineering firm to leverage HPC

WOODWARD

Fuel injection component supplier

Information Sciences Institute

HPC resource and expertise provider

- 200 employees
- 3 computational engineers

PRATT & WHITNEY
DEPENDABLE ENGINES

Jet engine supplier

Military aircraft

Baseline goal: Simulate nozzle behavior at many more points within the flight envelope

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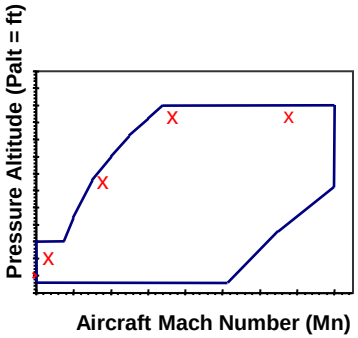
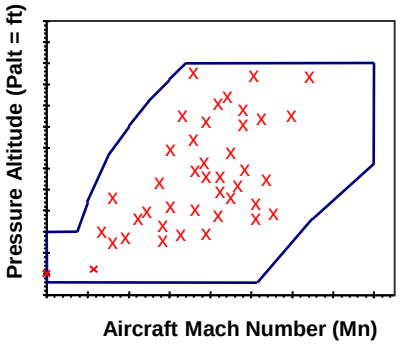
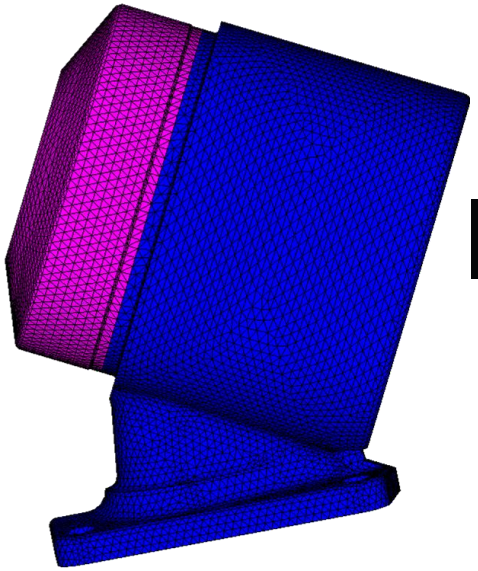


Eliminate the “desktop-only” bottleneck.

GOAL



Simulation problem: transient thermal + static structural analysis



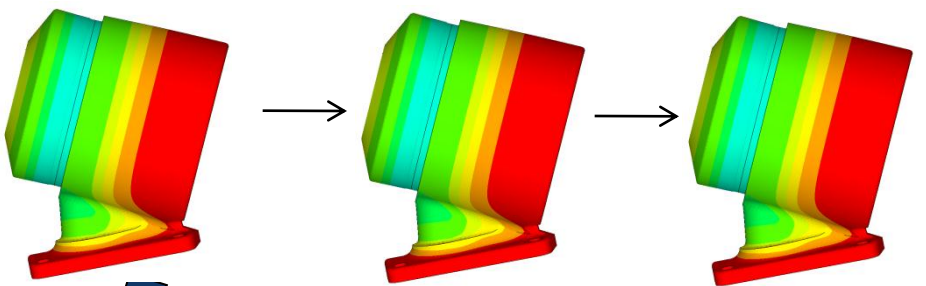
Model size increase: 4MDOF -> 6MDOF

#1. Do thermal analysis to compute temperature using time-varying heat convection loads as inputs

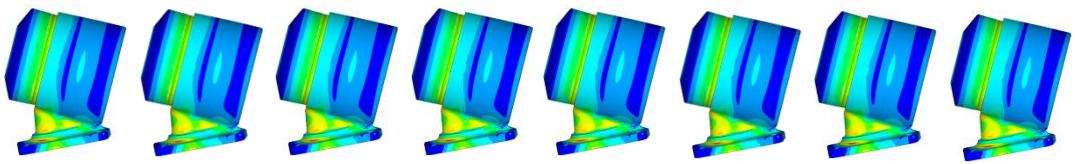
ANSYS

Color shows temperature

time



#2. Do structural analysis at different time points, using thermal loads calculated from thermal analysis

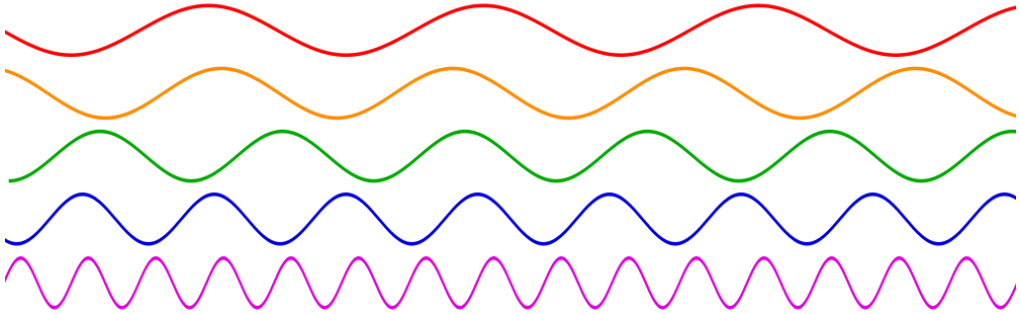


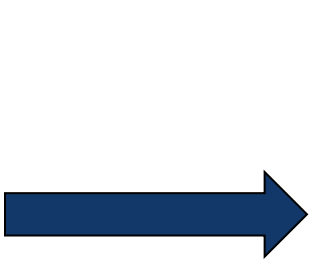
Color shows first principal stress

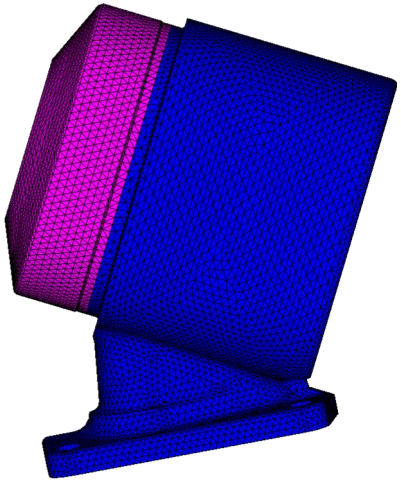
# of points increase: 4 -> 81

~480 MDOF total: 120X increase

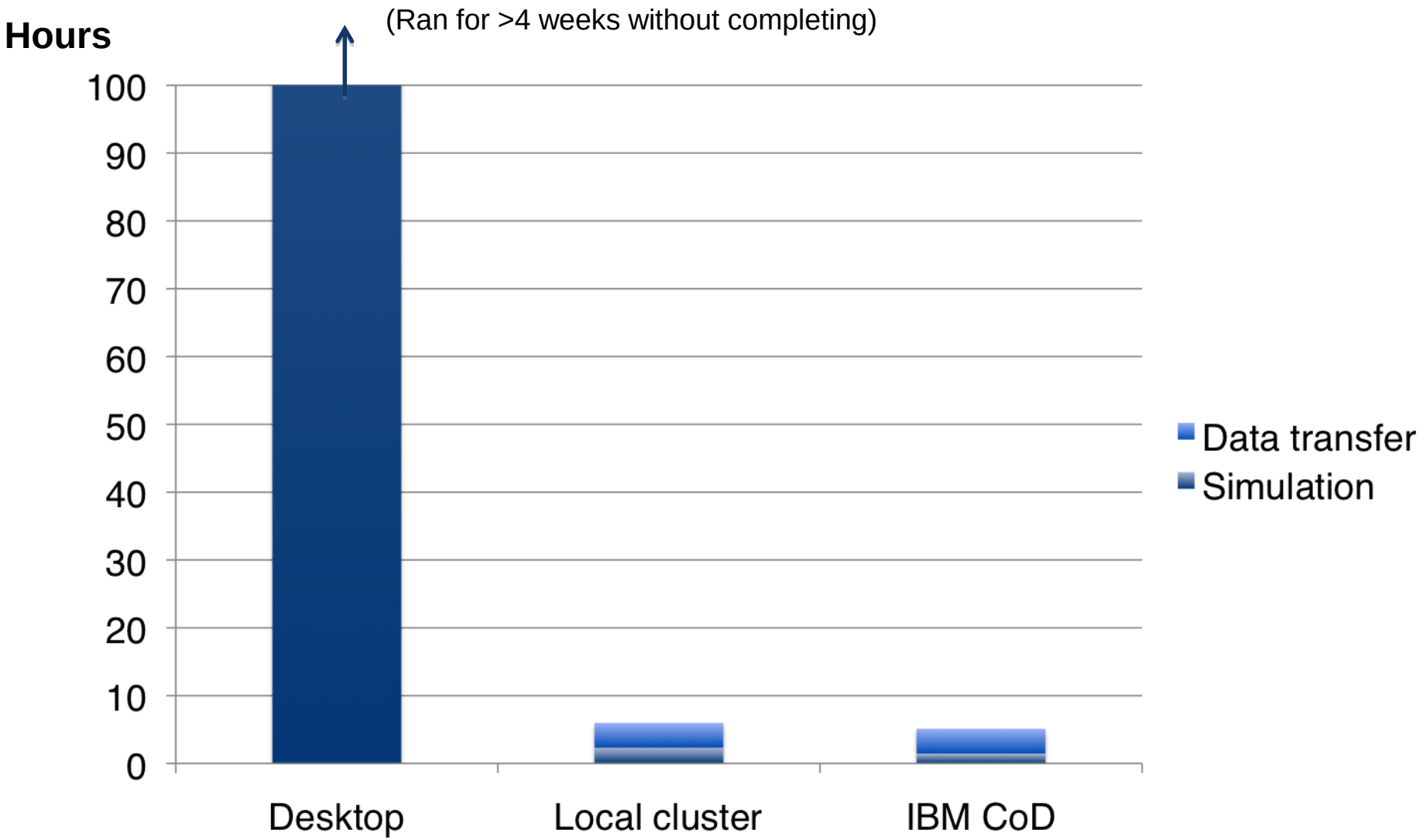
Stretch goal: Harmonic analysis, would never attempt on desktop with large model





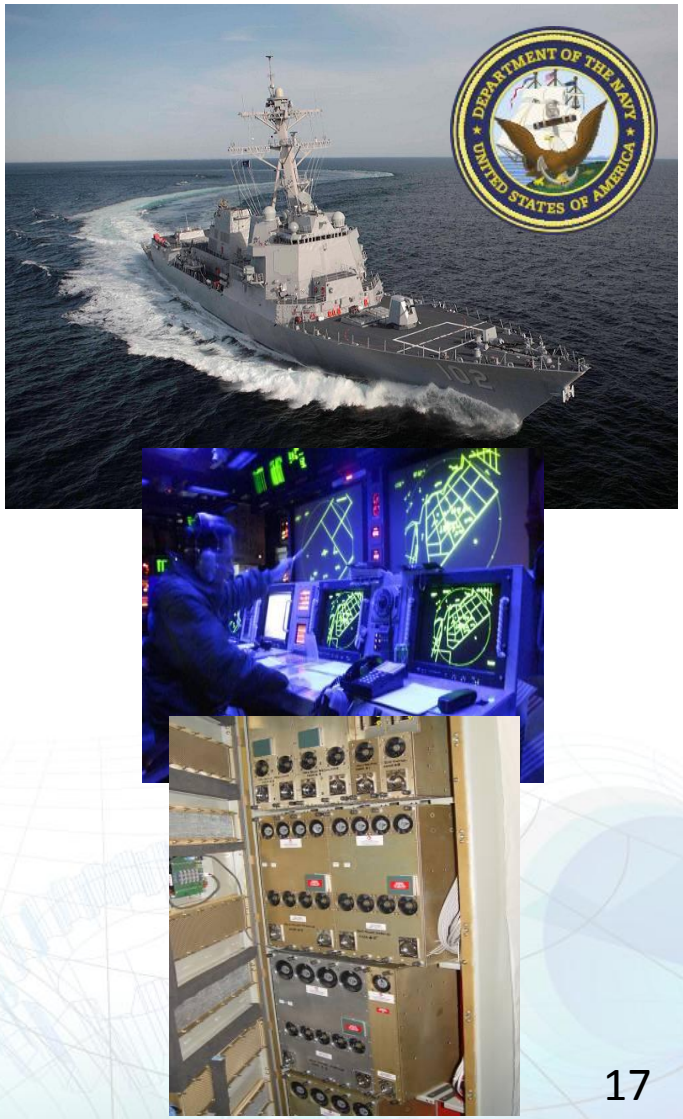


Harmonic analysis ran only on HPC



Background

- Power switching device for next generation US Navy ships
- New technology provides miniaturization
  - Increased power density
  - Increased ***conductive*** EMI
- Traditional EMI solution is ~30% over target cost and weight
- Current solution uses experience and iterative testing/evaluation



ALTASIM TECHNOLOGIES
REALIZING TOMORROW'S TECHNOLOGY

Future Business Impact

- NGIPS roadmap indicates 60MW required for future “all electric” ship
- Power processed by solid state power switching devices
- For 60MW power output:
  - Development saving: ~$105M per platform
  - Development time saving: Decades
  - Procurement saving : ~$34M-3M per ship
  - Associated structure saving: ~$3.5M-600K per ship

Total cost saving: >$100M per platform
Total cost saving: >$30M per ship

ALTASIM TECHNOLOGIES
REALIZING TOMORROW'S TECHNOLOGY

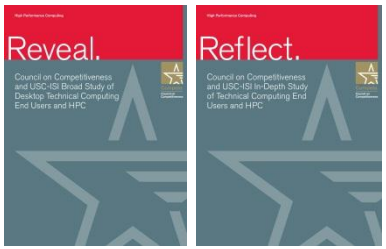
HPC-ISP-PILOTS: Summary of results

STATUS QUO

Limited HPC Adoption in DoD Supply Chain

- *The limited industrial user adoption of HPC is eroding the competitiveness of critical DoD suppliers and the country's industrial and military capability.*

NEW INSIGHTS

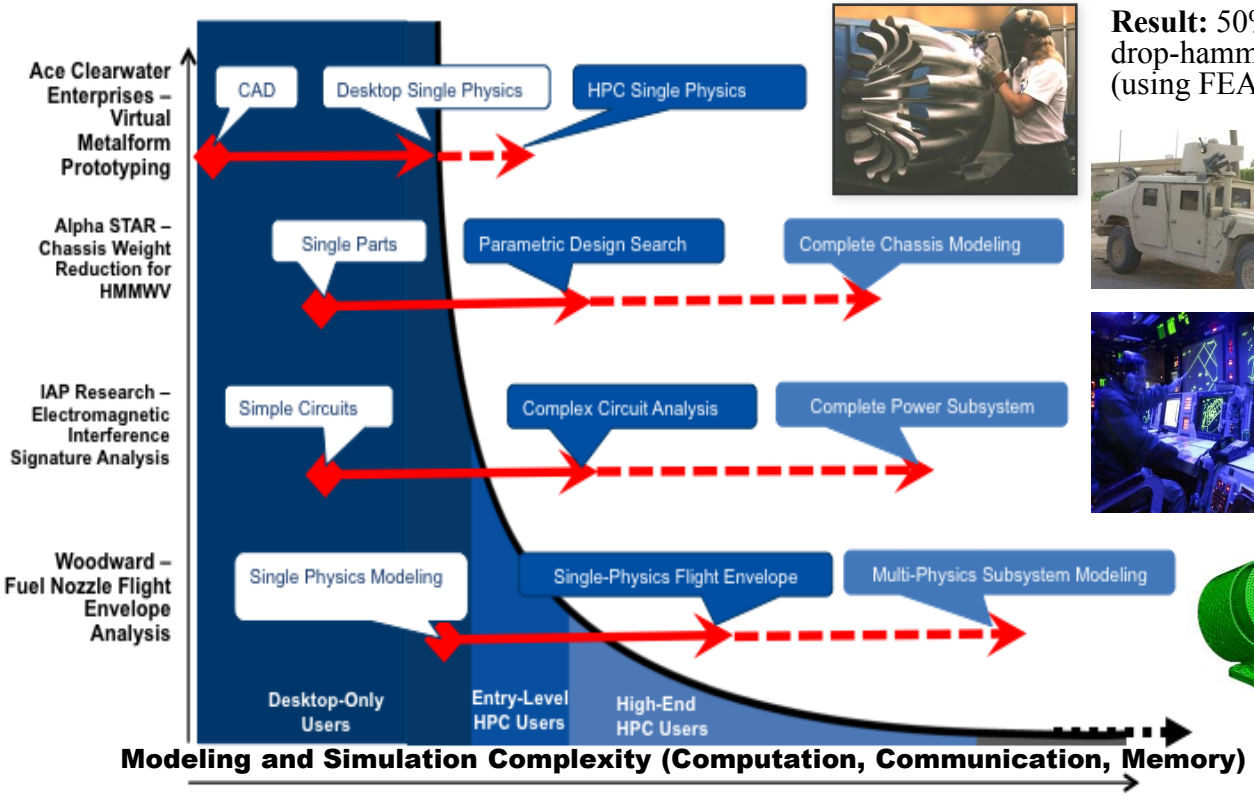


First-Ever Studies of Desktop Technical Computing Users:

- *HPC is often perceived as an ultra high-end technology appropriate only for government or academia;* ***limits supply-chain adoption of virtual prototyping****.*
- *There is a lack of understanding of the business value (**ROI**) of simulation and analysis with HPC;* ***few public successes among small/medium suppliers.***
- *Access to talent, lack of software, and capital costs are all barriers;* ***suggests market for on-demand HPC and software for entry-level & periodic users.***

DoD Supply Chain Pilots

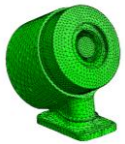
PROJECT GOALS



Result: 50% reduction in development time for drop-hammer and hydro forming tooling (using FEA virtual prototyping).

Result: HPC parametric search found 70% weight reduction with 230% increase in load for hybrid composite control arm design.

Result: HPC analysis with Xyce ~30X reduction in probability of defect at qualification, with direct cost savings estimate $490K and ~12 weeks design time per PNCC power subsystem.



Result: Value stream mapping of design cycle show savings of 43% per design iteration and 76% across all iterations. The 120X increase in processing on HPC (4MDOF vs. 480MDOF) provided up to a 5:1 reduction in design failure escapes.

Each of the pilots had a significant ROI impact unto themselves

But what about scaling to O(100,000) SMMs

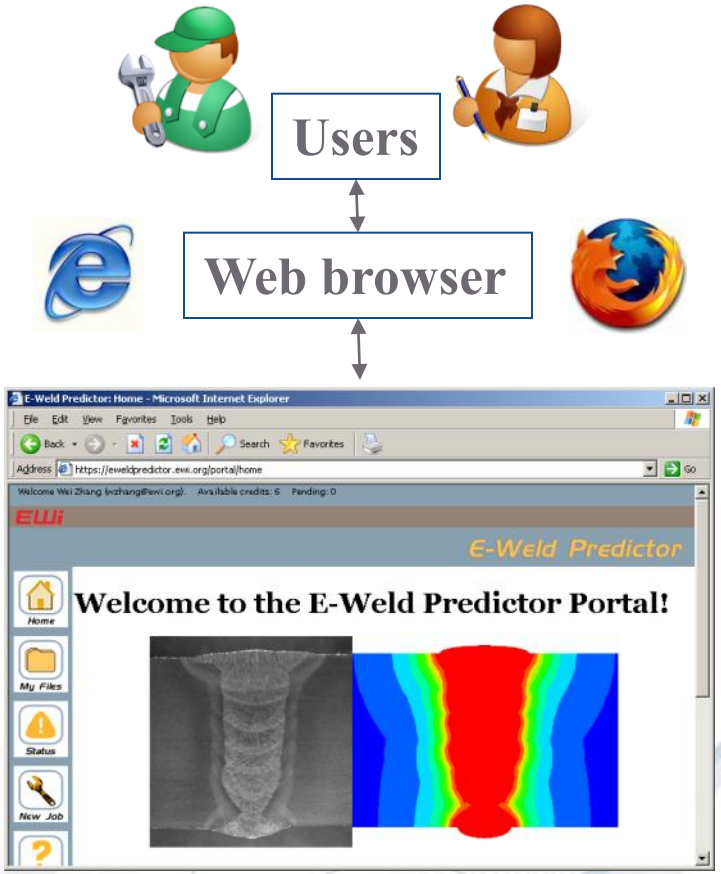
Blue Collar Computing Clients

Two classes of industrial clients:

- Experienced HPC users who need access to larger systems for specific tasks ("peaking" facility)
  - E.g., Goodyear, P&G, Ohio auto maker
- Novice - *and some experienced* – HPC users where we develop industry-specific portals in collaboration with industry-focused organizations
  - EWI, PolymerOhio

Partnership with Edison Welding Institute
EWI-OSC WeldPredictor

- Secure website
- Easy access to advanced weld modeling tools
- Arc welding procedures
- Single and multi-pass welding simulation
- Output
  - Temperature
  - Hardness
  - Residual stress
  - Distortion



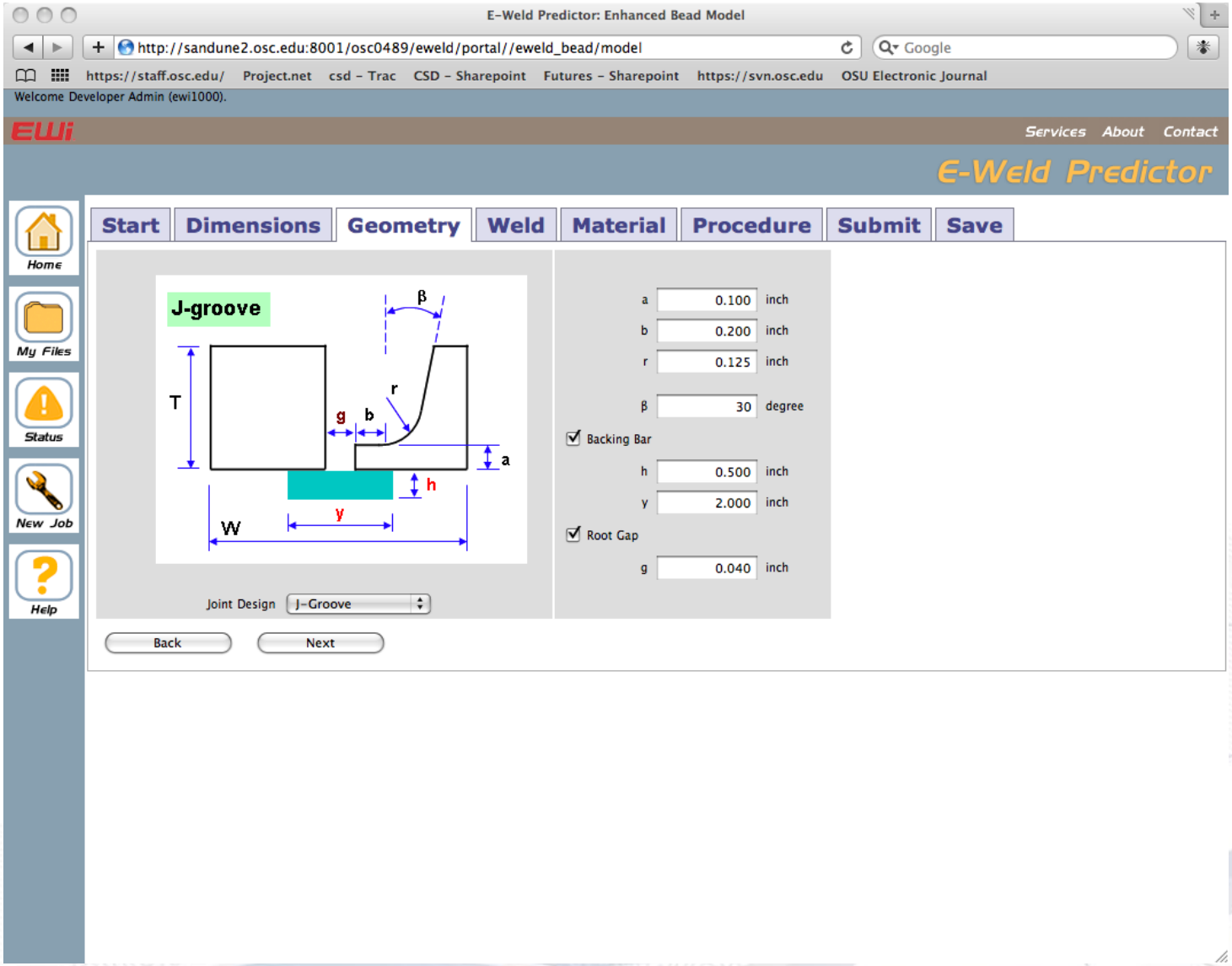
https://eweldpredictor.ewi.org/

WeldPredictor Portal Impact

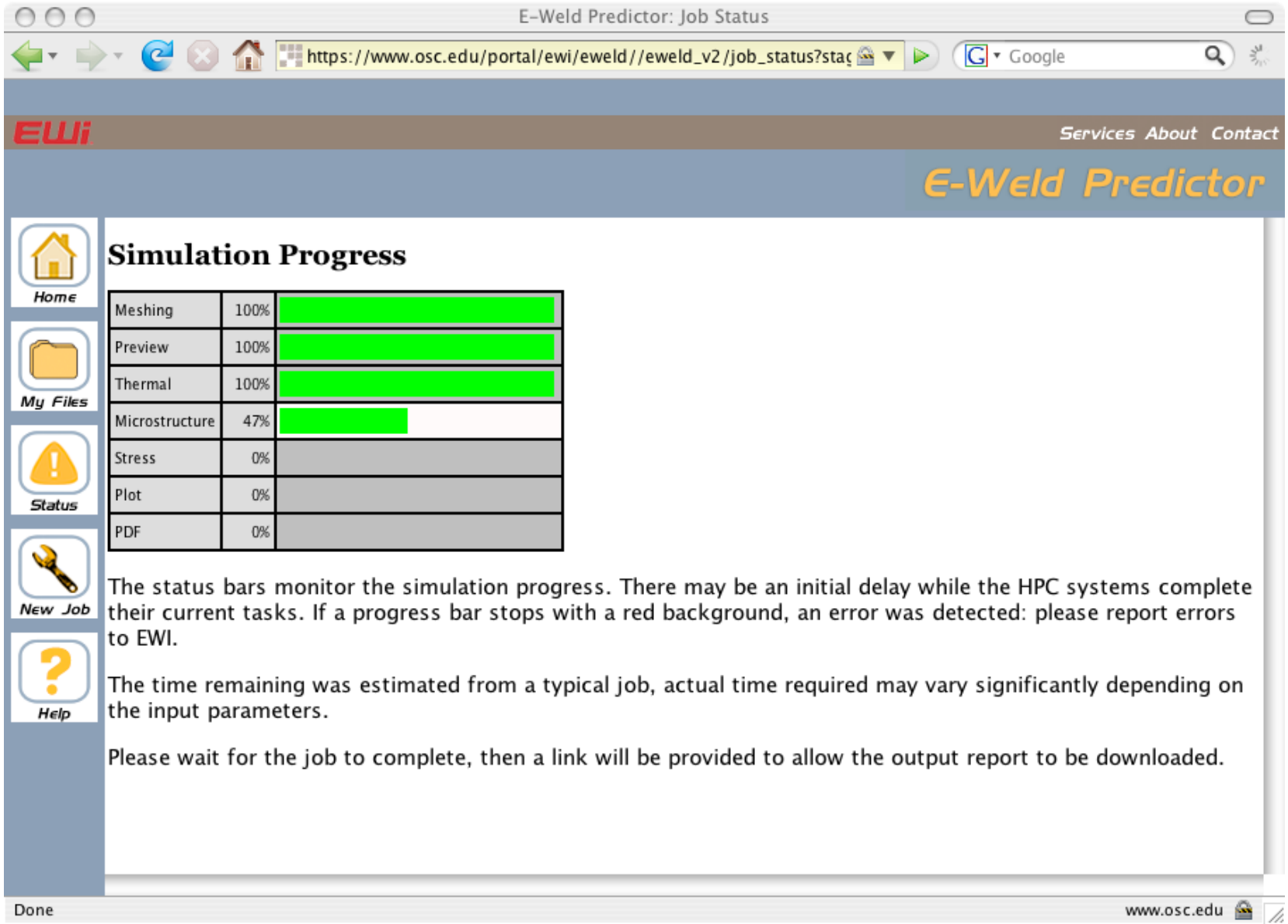
- WeldPredictor allows industrial companies to access ***advanced weld modeling technology in the cloud***.
- WeldPredictor is free to EWI members
- WeldPredictor changes industrial engineers' thinking from physical prototypes to virtual prototypes and to apply modeling in problem solving.
- About 550 engineers worldwide have used EWI WeldPredictor

EWI WeldPredictor Portal Impact		
	Previously	**WeldPredictor**
Expertise Needed	Ph.D.	**B.S.**
Analysis Setup	12 hours	**1 hour**
Project duration	6 months	**1 month**

Weld Geometry Selection

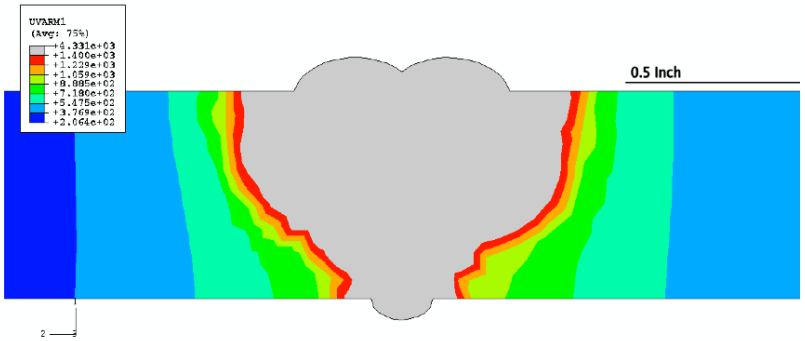


Status Page


E-Weld Predictor: Job Status
https://www.osc.edu/portal/ewi/eweld//eweld_v2/job_status?stat
Google
EWI
Services About Contact
E-Weld Predictor
Home
My Files
Status
New Job
Help
Simulation Progress
Meshing 100%
Preview 100%
Thermal 100%
Microstructure 47%
Stress 0%
Plot 0%
PDF 0%
The status bars monitor the simulation progress. There may be an initial delay while the HPC systems complete their current tasks. If a progress bar stops with a red background, an error was detected: please report errors to EWI.
The time remaining was estimated from a typical job, actual time required may vary significantly depending on the input parameters.
Please wait for the job to complete, then a link will be provided to allow the output report to be downloaded.
Done
www.osc.edu

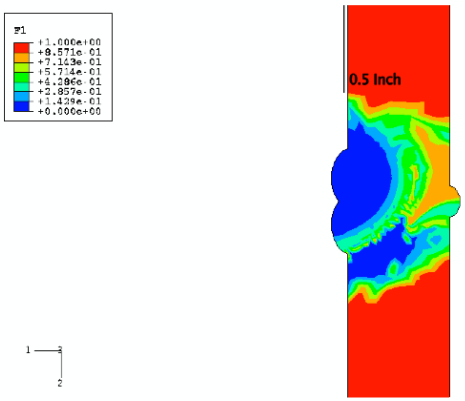
E-Weld Predictor Example Output

Distribution of peak temperatures (*C)

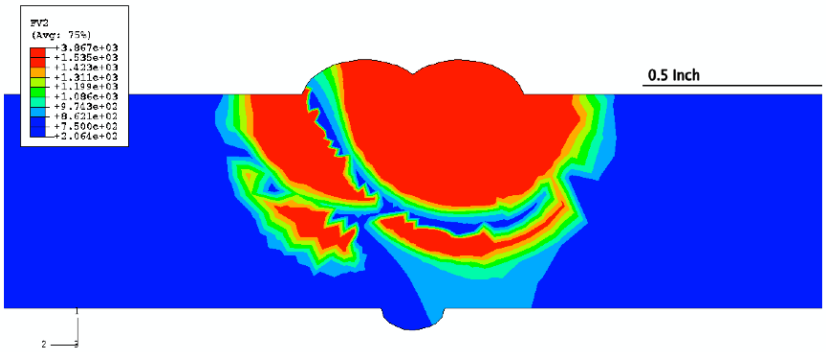


Section 4 - Microstructure Analysis

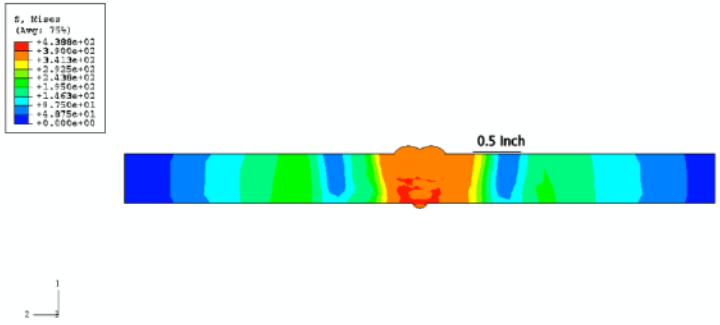
Distribution of ferrite



Distribution of reheating temperatures (*C)



Distribution of von mises stresses (MPa).



Partership with PolymerOhio
PolymerOhio-OSC PolymerPortal

- Polymer Portal being developed in collaboration with PolymerOhio
- The Polymer Portal will offer:
  - Computational resources and software for modeling/simulation
  - Expertise in polymer science and engineering
  - Training
  - Databases with relevant material properties
  - Advanced instrumentation
  - Business intelligence and strategy
- Offering Moldex3D and Ximex for industry and education training

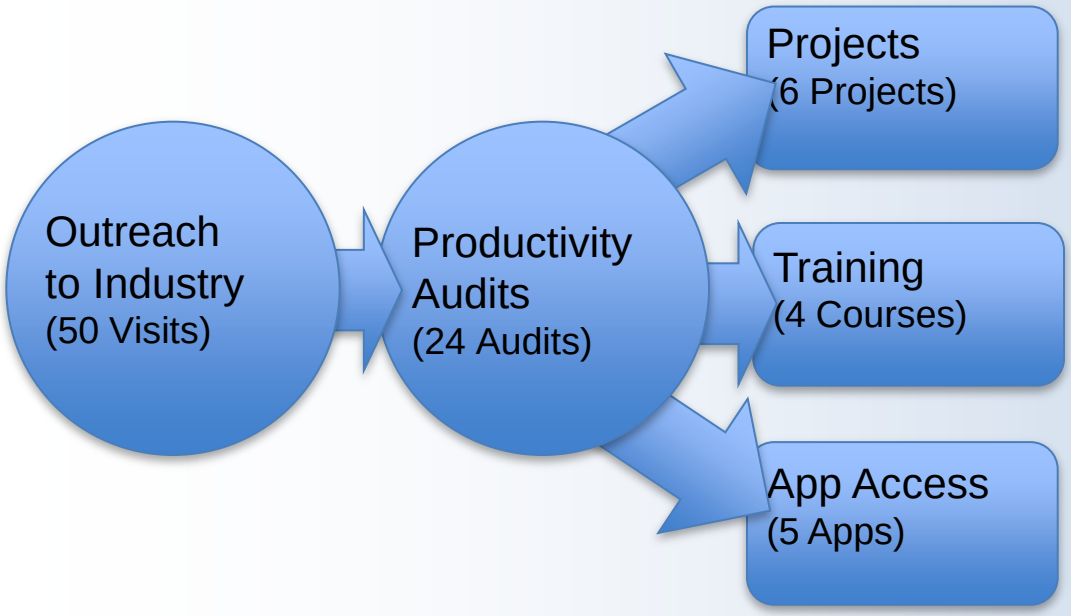
Web front end

- –Pylons
- –JSON
- –Tomcat
- –mySQL
- –JUnit
- –Apache
- –Ant
- –Python and Java

Software components supporting the OSC Portals

MEP Advanced Modeling and Simulation

- Funded by NIST MEP for PolymerOhio and OSC
- Goals:
  - Raise awareness of MS&A in Polymer industry and MEP system
  - Make cost-effective computational methods available to SMEs
- ~$700K for 1st year



Case studies provide MEP model to:

- Illustrate MS&A value to production and profitability
- Assist companies in application selection
- Develop training for high value-added MS&A apps
- Engage companies in employee training for MS&A
- Provide broad access to low-cost, productivity-enhancing apps

OH!Polymer PolymerOhio, Inc.

Empower. Partner. Lead

Ohio Supercomputer Center

How do Companies Move Beyond the Discovery Phase?

Academic HPC Centers

Commercial On-demand ISV Licenses

Commercial Discovery Licenses Limited # Jobs Unlimited Nodes

Academic ISV Licenses

Commercial On-demand ISV Licenses

Commercial Discovery Licenses Limited # Jobs Unlimited Nodes

Academic ISV Licenses

OEM & Tier 1 Compute Resources

Tier 2-4 Supplier Low Cost M&S Desktop Resource

Private Cloud Suppliers

Commercial On-demand Licenses

Commercial Traditional ISV Licenses

Flexible On-Demand Resources Are Required

From: Bob Graybill

Current Events

- America COMPETES Renewal Act of 2011
  - IAWG to pursue solutions space for the MM, led be DOC
- PCAST released recommendation report summary last week (WO May 16, 2011) to create an *Advanced Manufacturing Initiative*
  - http://www.whitehouse.gov/sites/default/files/microsites/ostp/Advanced-manu.pdf
  - Noted among other things:
    - "A strong advanced manufacturing sector is essential to national security."
  - Proposed a budget of $500M spread across DOC, DOE, and DoD, growing to $1B in four years.

Summing up the US MFG MM

- Nearly 280K SMMs in the US
  - NAM
- Nearly half would use MS&A, if they could
  - IDC REVEAL
- Represents nearly the equivalence of the WW HPC Market Segment as we now know it

Definition of Success:

When the "middle" isn't "missing"

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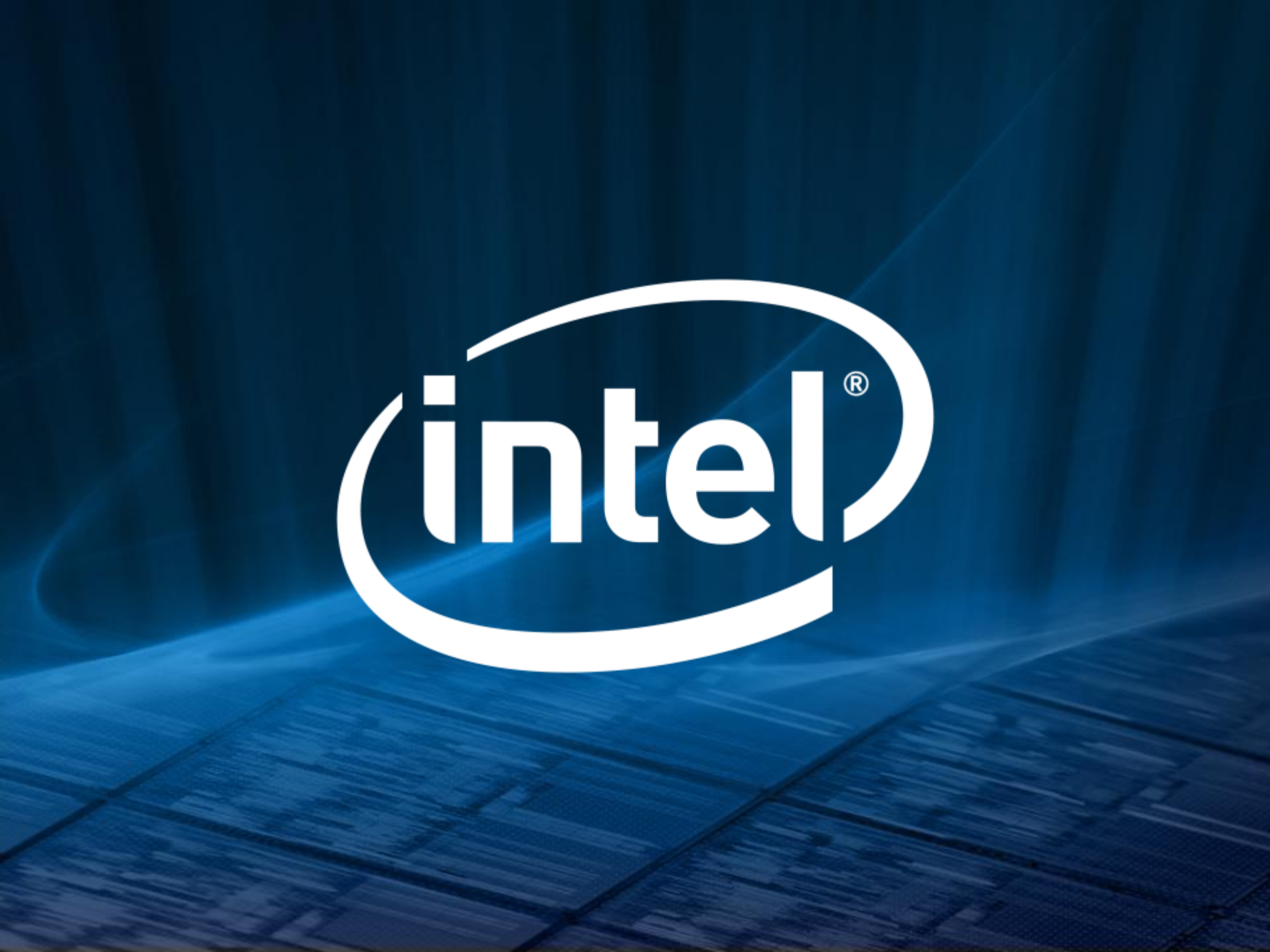
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AHPDM Focus Areas

- Industry analytics: Nature of the MM and the key barriers
- Public Policy: Setting the national agenda for Transforming American Manufacturing
- Communications: Engaging with and about the MM
  - www.digitalmanufacturing.org
  - Major industry and government engagement: monthly cadence
- Solutions: How to resolve the "missing" element
  - Digital Supply Chain
  - PICs