

# Delivering Competitiveness with High Performance Computing

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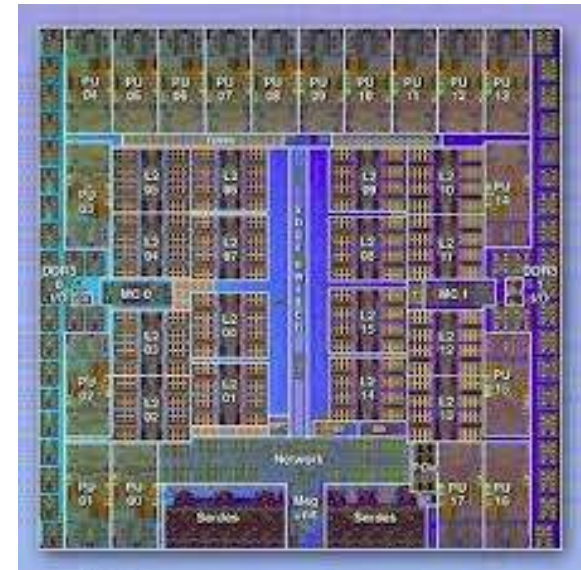
**A partnership formed in 2007 between Rensselaer Polytechnic Institute, IBM, and New York State supporting computationally intensive research and development by the Center's academic, industry, and government partners.**

**#7 in the fall 2007  
Top500 list**

**Over  
1,000,000,000  
CPU hours  
provided**

## September 2007

- Heterogeneous computing environment – 16 racks of Blue Gene/L (89 teraflops) and clusters (12 teraflops)

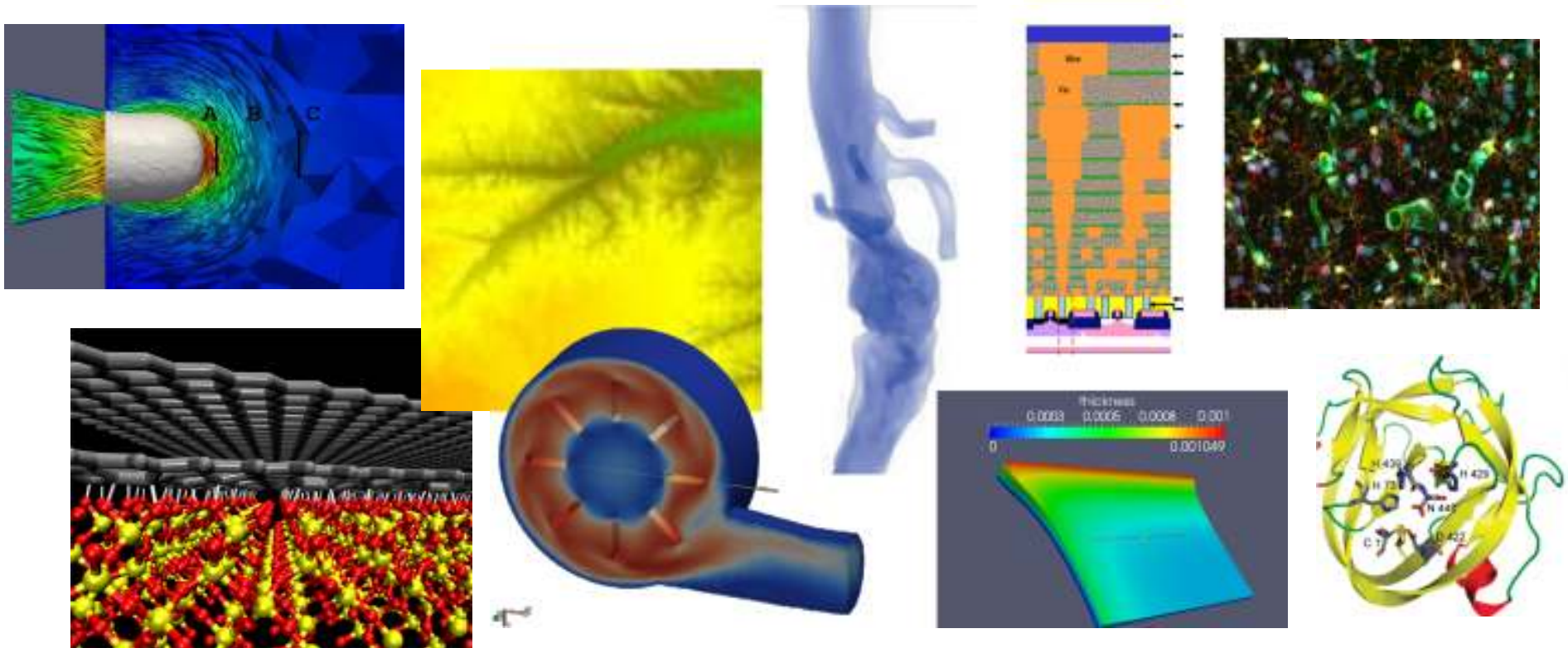


## ~September 2012

- Heterogeneous “balanced” computing environment Blue Gene/Q (208 TF peak), cluster/GPUs (~28 teraflops), updated storage and network, visualization capabilities

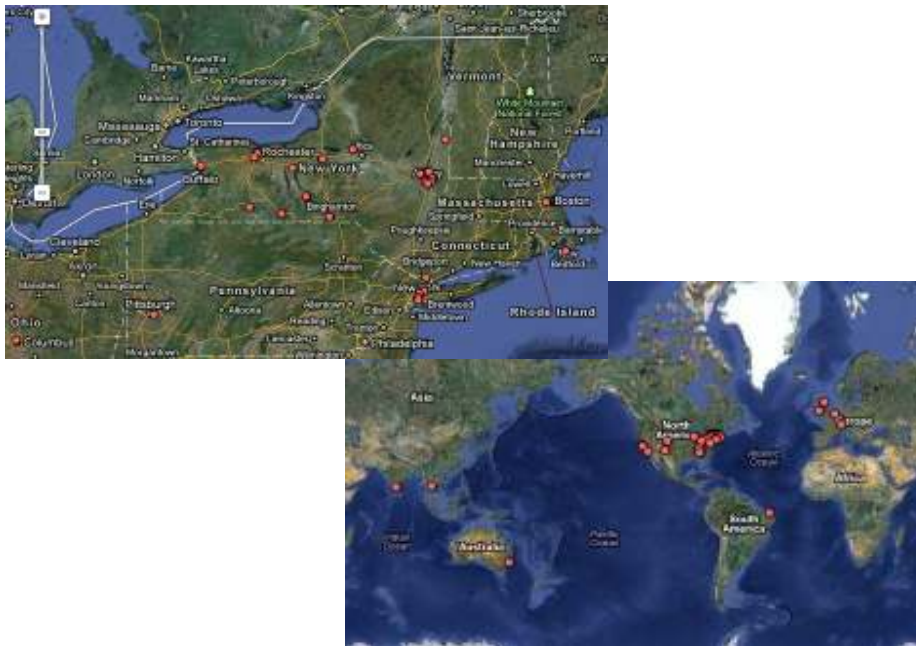
CCNI – Projects across many disciplines

**Over 180 projects and 830 users**  
**Academic, Government, and Industry**

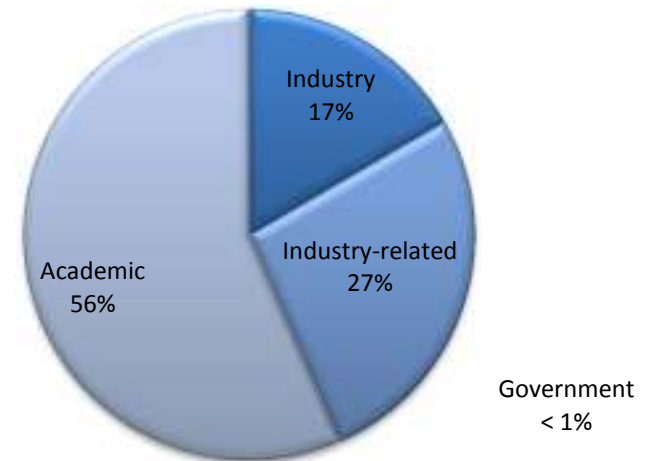


# CCNI Usage Statistics

<b>Projects</b>	<b>183</b>	<b>User Accounts</b>	<b>838</b>
IBM	14	Academic	717
NYS	60	Industry	90
RPI	109	Government	31



**CCNI Usage as of 5/17/2012**  
(cpu-hours)





**Industry/Stakeholder Assessment**

**Competitive Awards (e.g. SBIR, GOALI)**

**Memberships**

**Membership Renewals**

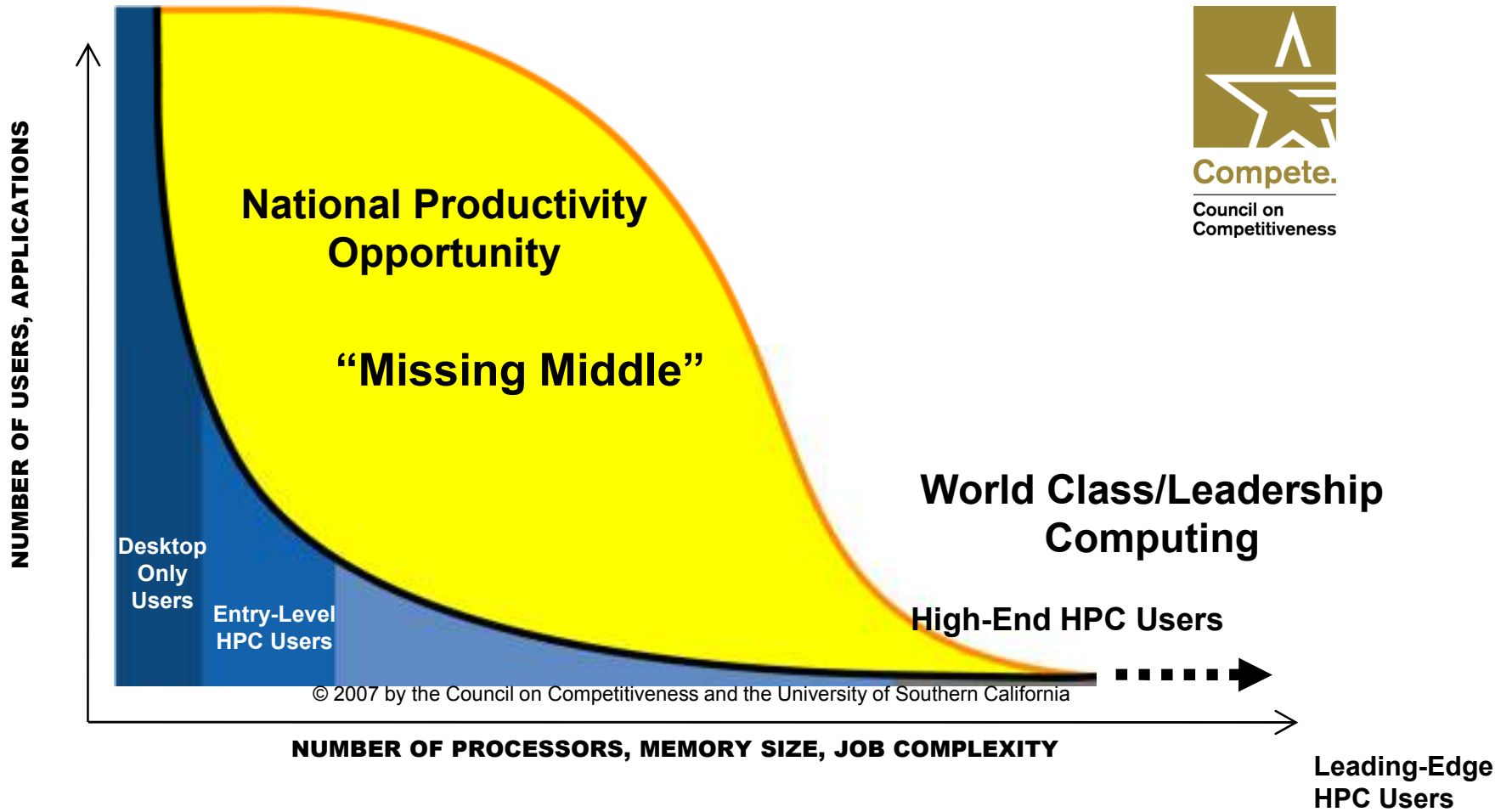
**Jobs, Economic Impact**

**→ CCNI/RPI/HPC<sup>2</sup> are an asset for NY companies and academic institutions and a good investment for their partners**

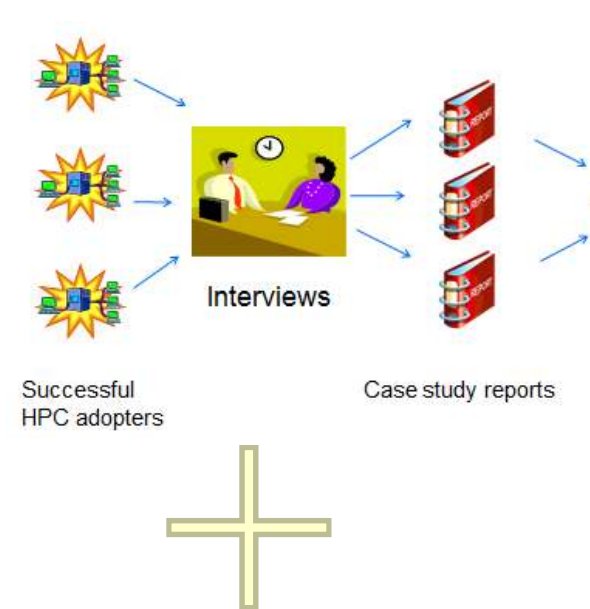
**What are we doing right today?**

**How do we help scale DEM to regional  
and national competitive advantage?**

# The Challenge of Access



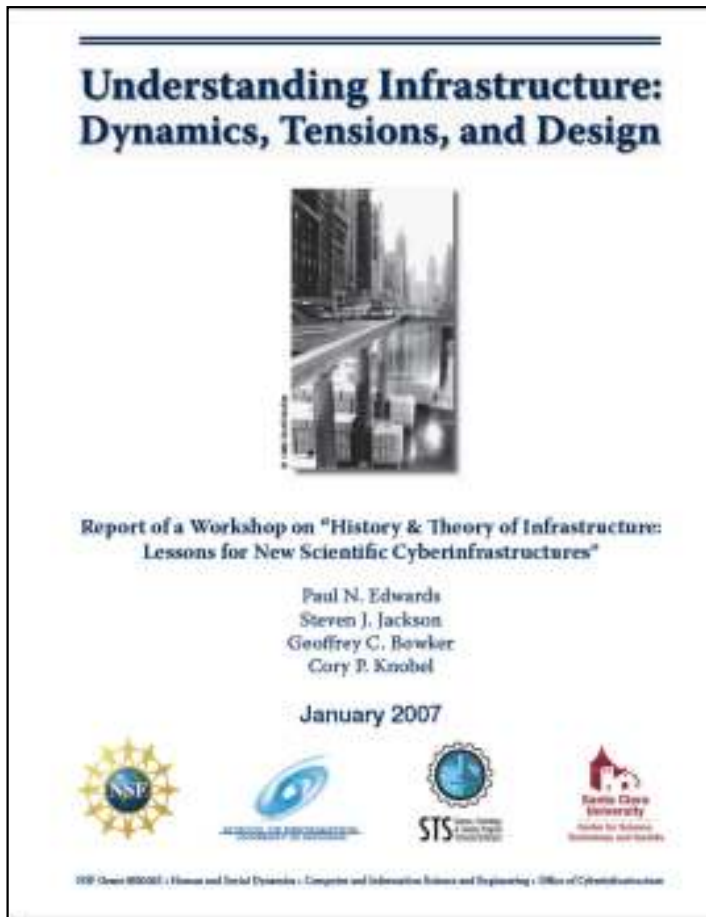
# The Competitiveness Sound-bite: HPC Access!



“Business just needs to change its culture and embrace HPC...”



# Building and using advanced HPC/Cyberinfrastructure:



## Infrastructure is socio-technical

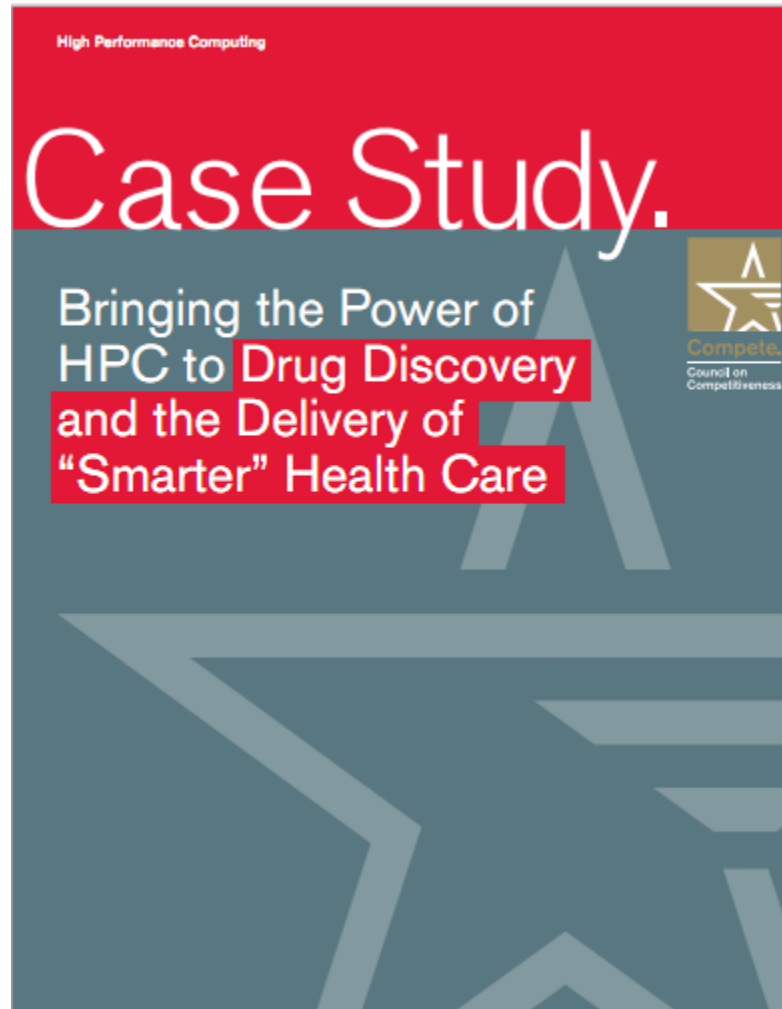
- Technology changes practices
- Practices affect technical choices

## It is not research or service (Stewardship) Infrastructure creation/adoption is a team sport

- Project leads have to care deeply about the result and be credible,
- everyone who's needed has to gain from participating
- The one problem that no one owns is *the* problem, and

## While infrastructure has organic, non-linear effects (benefits and path dependencies), adoption is driven by immediate direct value

## The Latest Case Study: GNS



using large-scale resources including CCNI's Blue Gene L...

**CCNI was founded with industrial engagement as a key component of its mission:**



**are all active stakeholders...**

## High Performance Computing Consortium (HPC<sup>2</sup>) :

- Rensselaer Polytechnic Institute,
- University at Buffalo,
- U. Stony Brook/Brookhaven Nat'l Lab,
- NYSERNET

## Resources, Software, Consulting, Portal



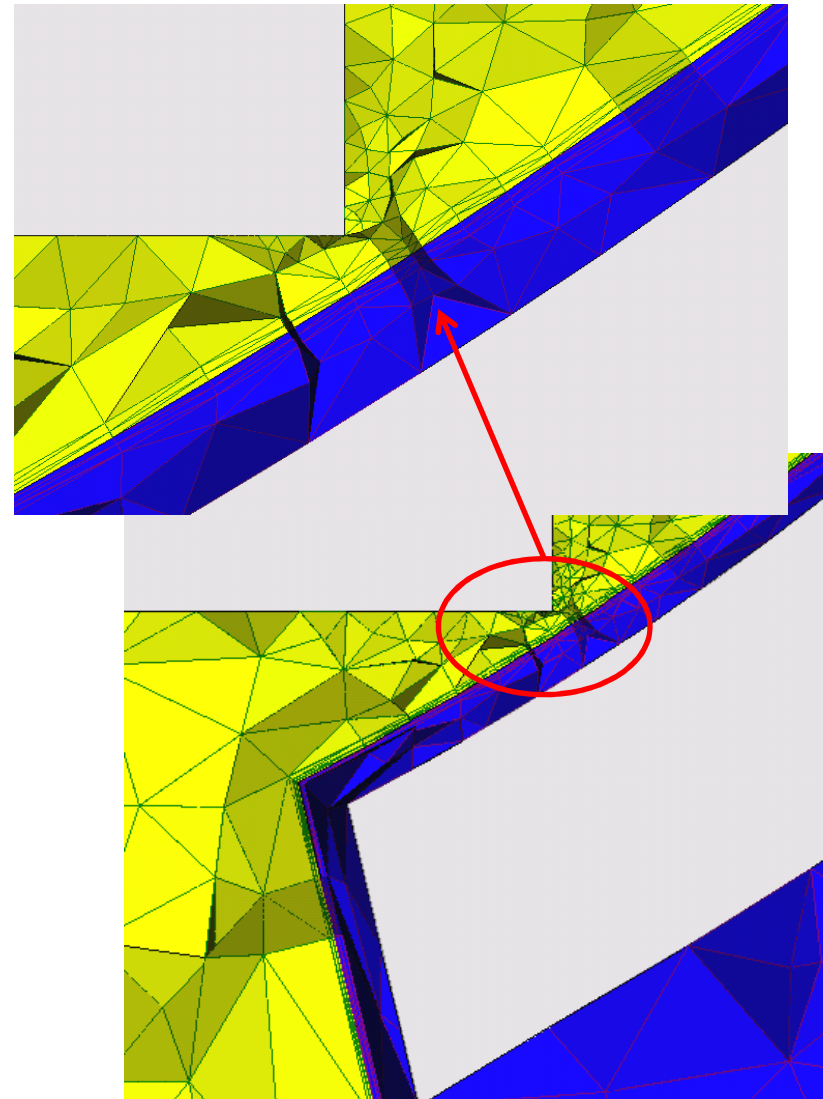
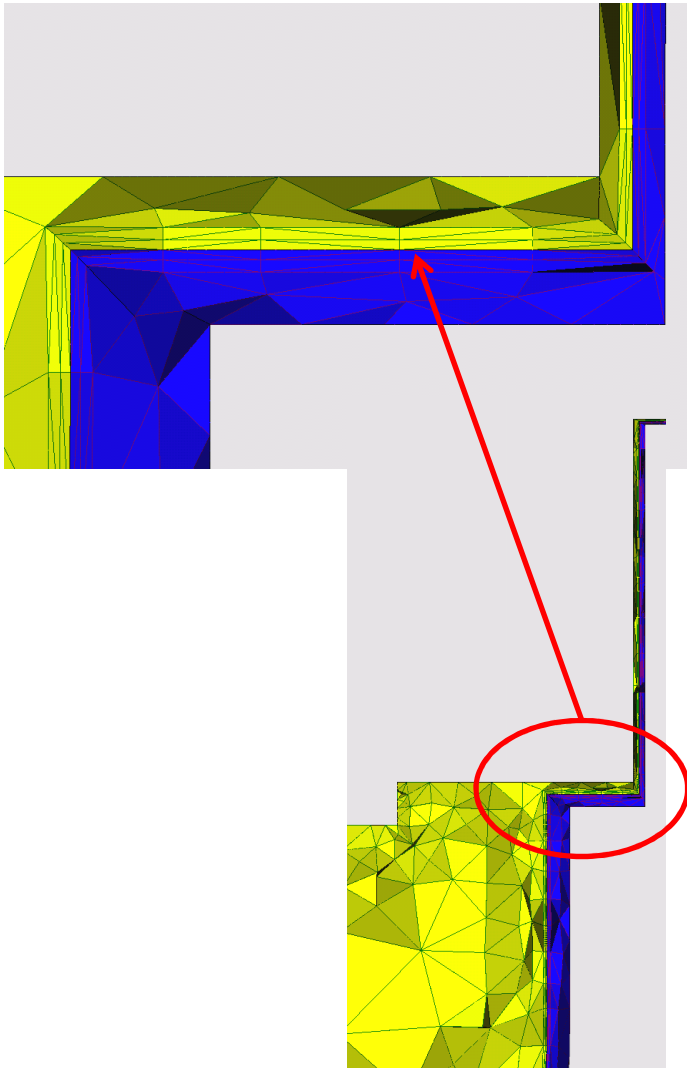
Rensselaer Polytechnic Institute • Stony Brook University • University at Buffalo • Brookhaven National Laboratory • NYSERNet

- **Scientific Computational Research Center**
- **Center for Automation Systems and Technologies**
- **National Labs and Software Vendors**
- ...

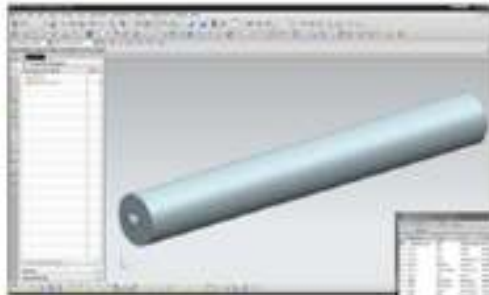
## From concept to impact:

- Introduction of new techniques
- Scaling
- Adaptation
- Multi-component modeling
- Workflow
- Flexible Memberships
  - “master agreement” model
  - “Try before you buy”
  - Cycles, Consulting, Research

# From proof-of-concept to realistic geometries



# Embed models in environments...



**NX**



Geometric  
Modeling



Mesh  
Generation  
and  
Problem  
Definition



Flow solver  
and Mesh  
Adaptation

**PHASTA** (Open Source CFD)



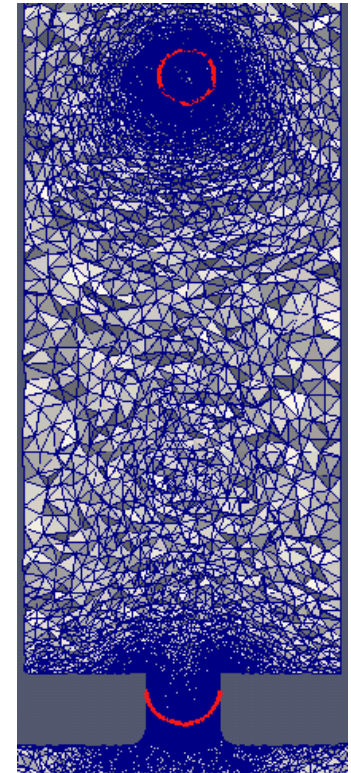
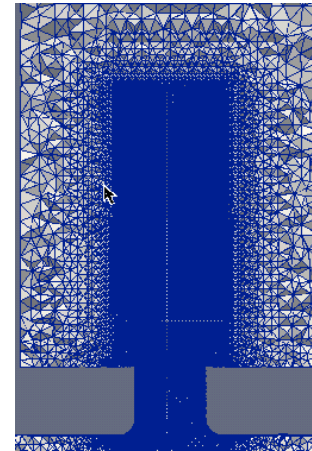
Post-Processing



Go beyond solving the research problem....

## Fixed mesh

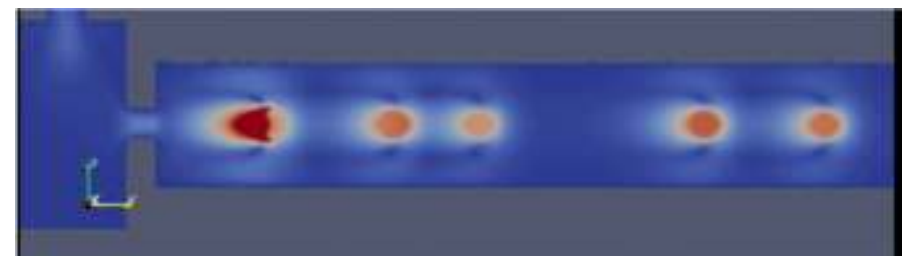
- Max size: ~20.0M elements
- Simulation runs until the fluid-air interface reaches the coarse mesh region



Axial 2D slice of two-phase PHASTA CFD simulation. The red line depicts the fluid-air interface.

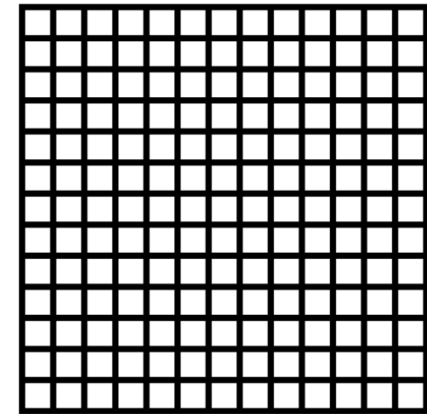
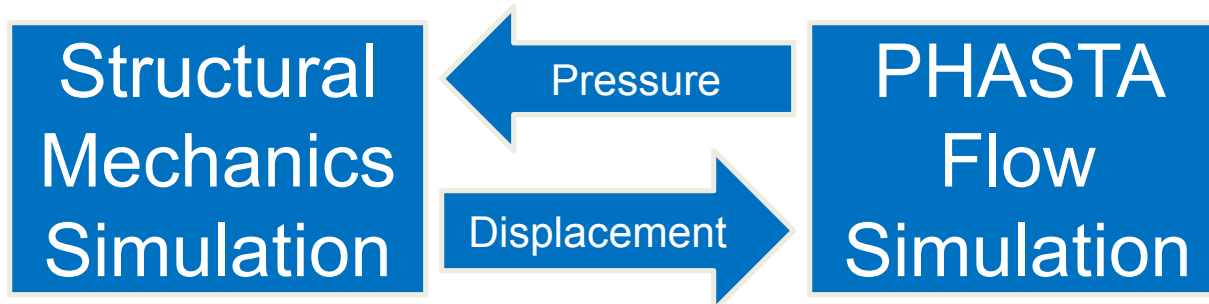
## Adaptive mesh

- Max size: 0.98M elements
- Anisotropy factor of 4.0 in the nozzle and around the 0-levelset
- Simulation runs until the detached fluid exits the computational domain

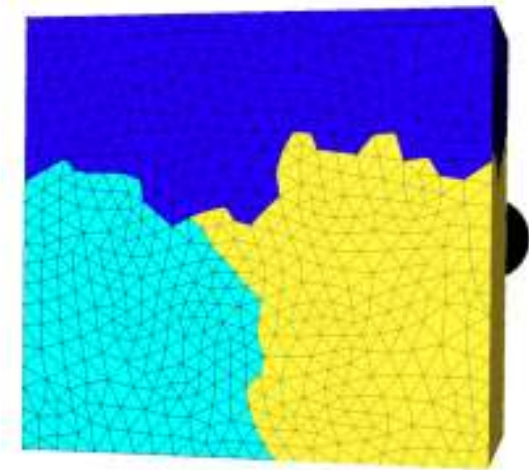


To solve the business problem...

- Implemented functionality in PHASTA to couple with structural mechanics analysis software for input boundary condition.
- Spatial (temporal) interpolation supports different discretizations in structural mechanics and PHASTA simulations.
- Structural mechanics simulation runs in serial. PHASTA simulation runs in parallel.



Mesh of Input Face



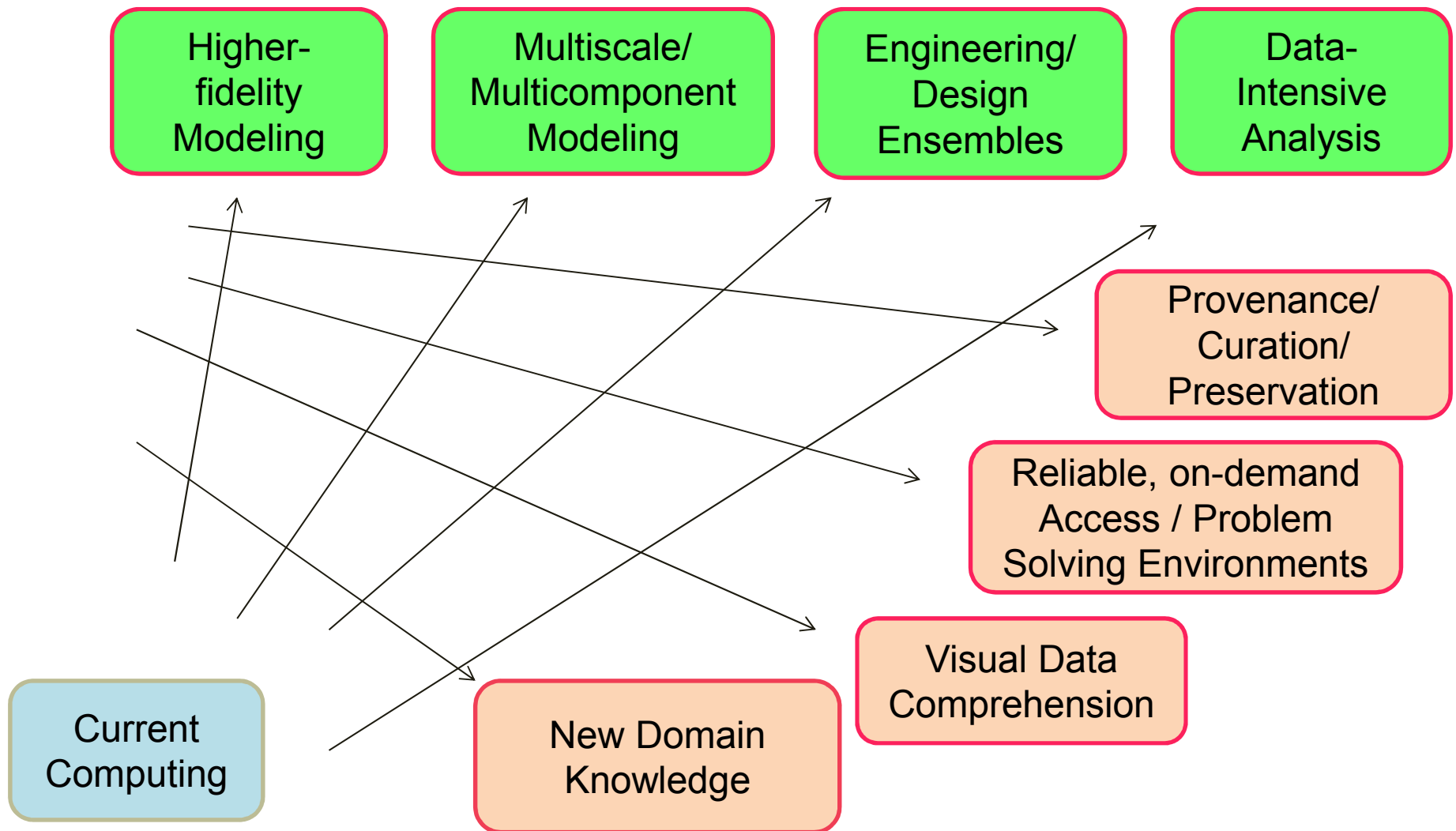
PHASTA Partitioned Mesh of Input Face

**Highly scalable codes open the door for new products and processes in the future, but ...**

**making overnight or weekend runs something that become multiple runs per day can increase revenue/lower risk today**

... hosting ISV codes (and solving the contractual issues there) can do this and start a virtuous cycle...

The problem is not getting easier...



### In New York:

- HPC<sup>2</sup>
- Centers for Advanced Technology
- Regional technology Transfer Centers
- NIST MEP-funded Centers
- Centers of Excellence
- Software Vendors
- Engineering Firms

→ Train the experts in HPC, encourage inter-center partnership, employ portals to encourage state-wide collaboration, ...

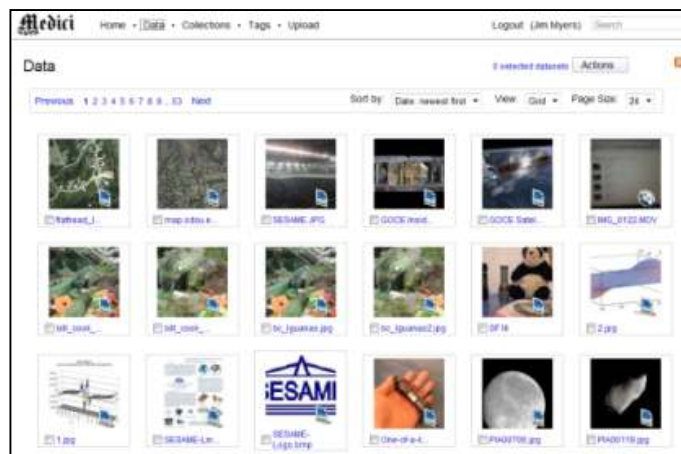
- **Include HPC in Venture/Incubator programs, Technology Park offerings**
- **Engage business schools for analysis of HPC in manufacturing and company-specific ROI analyses**

# Broaden access by broadening services ...

## Apps: HPC2 Hub (e.g. LAMPSS)



## Data: SEAD DataNet portal



## New Partners for:

Training

Software Development

Project Development

Consulting  
/Engineering

SaaS

Software

HW Resources

Collectively, we need to

## **Provide Access to**

- Peta- and Exascale
- Multiscale
- Ensemble
- Large Data

## **as Part of Domain Solutions**

The 'missing middle'  
has been missing for  
good reasons...

**Cost effectively, with available expertise, and at a  
scale of 100000+ partnerships instead of 10's**

The path forward...

**Working to understand the business need and being willing to change to accomplish business goals delivers competitiveness and starts virtuous cycles...**

**This is what partnership for competitiveness is about... and how we need to make sure HPC Access is defined.**

# Thank You!

**CCNI, SCOREC, HPC<sup>2</sup>: staff and partners**  
**CoC HPC Advisory Board**



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