



RICE

Unconventional Wisdom



Preparing Students for HPC Careers in the Energy Sector

Jan E. Odegard

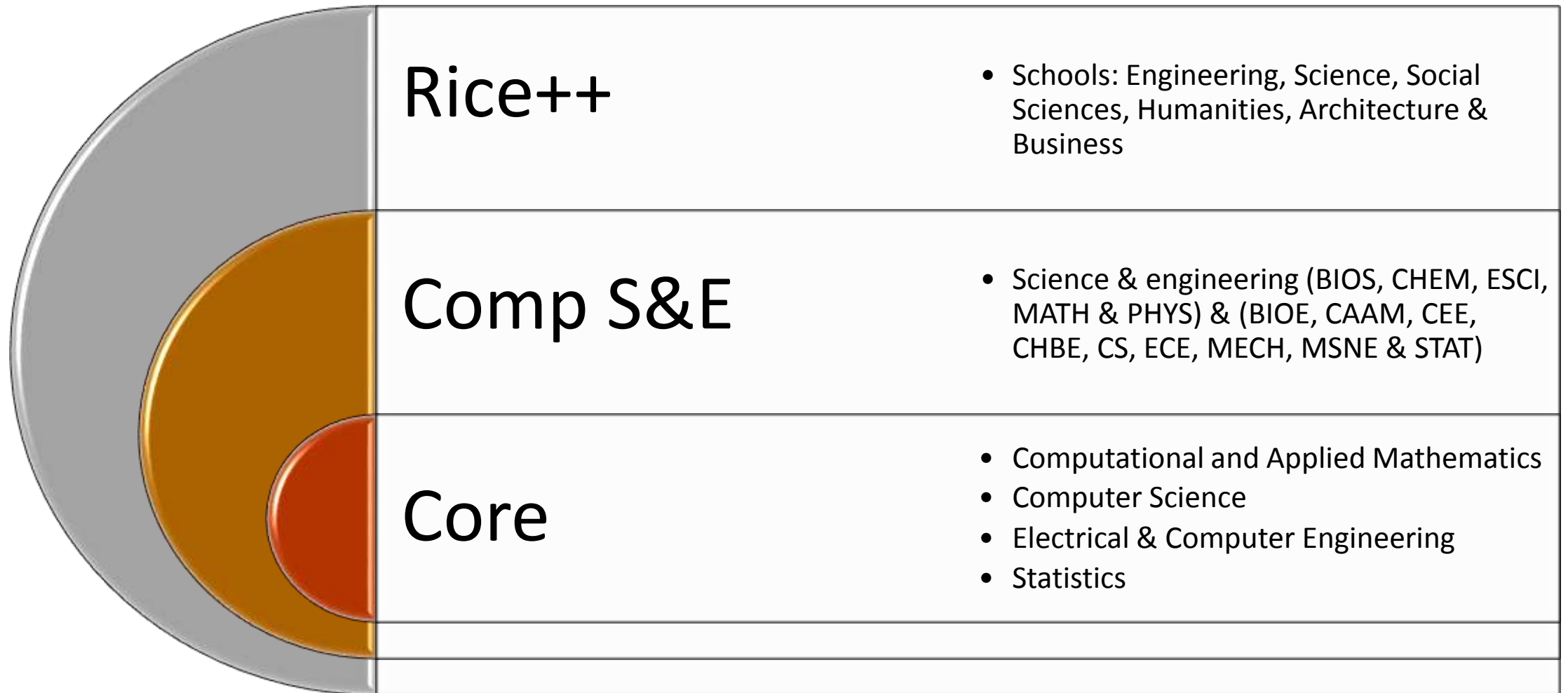
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Ken Kennedy Institute Community

IT research & education enabler



Rice: Computing as a Universal Enabler

Data analytics, data mining, and machine learning ...

Numerical methods, solvers, modeling, and simulation ...

Programming models, languages, compilers, and tool

Tool makers

Fundamental R&D in: computer science, electrical & computer engineering, applied mathematics, statistics, signal processing, imaging, modeling, machine learning, data-science, cyber-security, energy, materials, biomedicine, ...

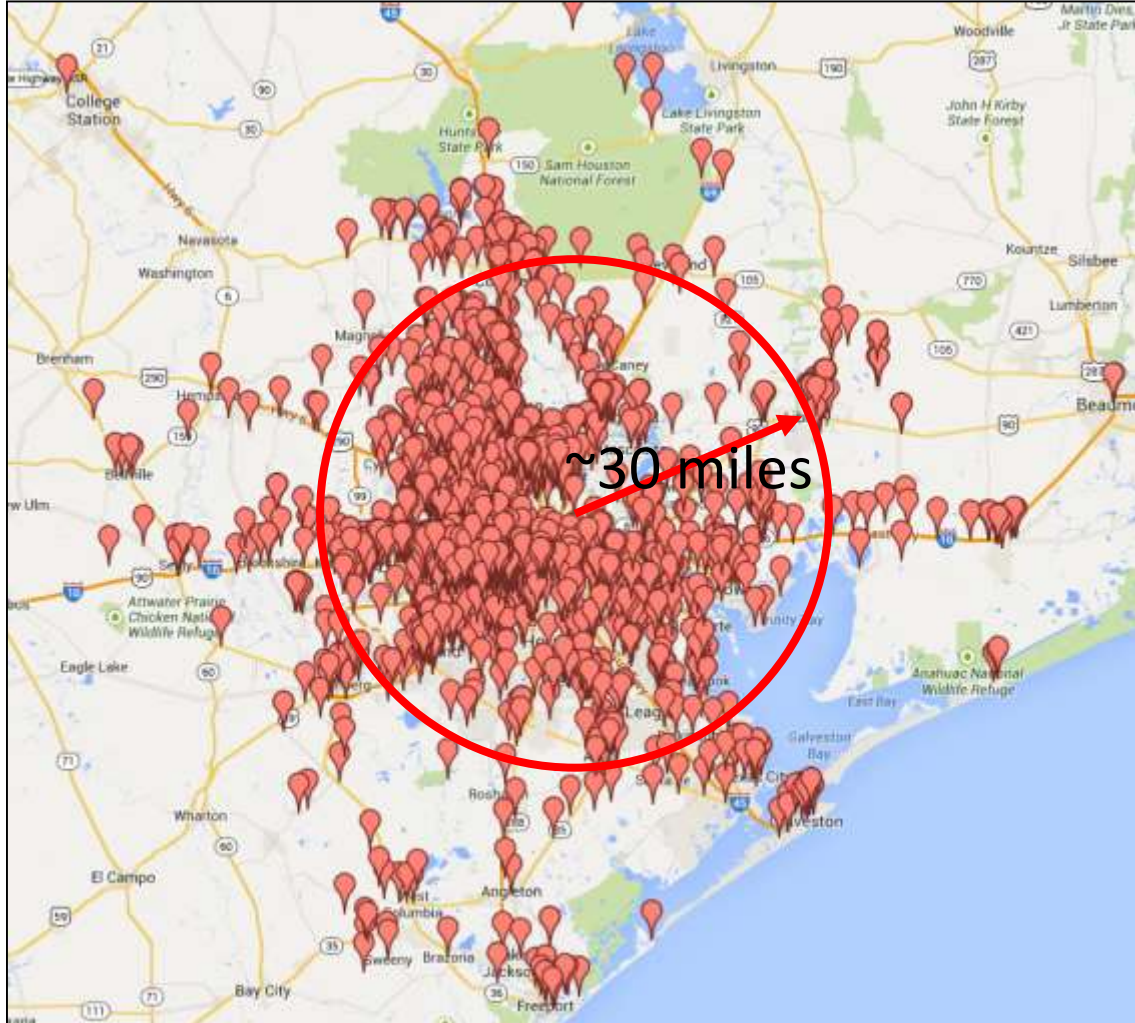
Cyber-Infrastructure to enable and accelerate research

Research Computing: Rice's profile in HPC

“The [global] computational science community views Rice [University] as a tier-1 HPC site”

2014 IDC Study: Best Practices in Securing Funding for University-based HPC Centers

Energy Capital of the World (data from 2014)



Houston

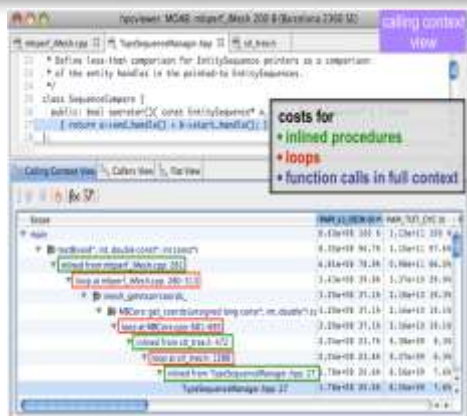
- 3,600+ oil & gas companies around Houston
- 50% of Houston's employment in energy sector
 - 10% in oil & gas
- 1 in 5 jobs created since 2010 in oil & gas
- 29% of total U.S. oil & gas employment

Texas

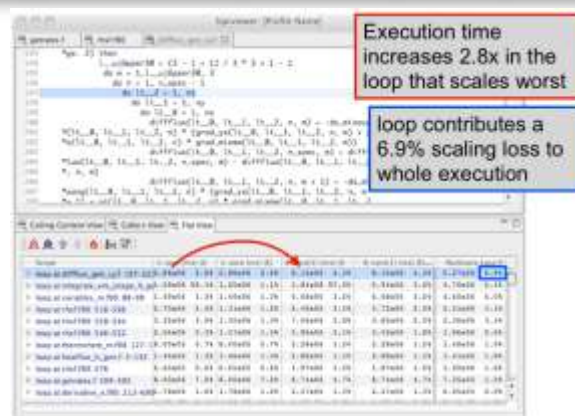
- 36% of the oil produced in U.S. comes from Texas
- 23% of crude oil produced in the U.S. comes from GOM offshore production
- 389,000 Texans are directly employed by oil & gas
- 1.8 million additional jobs are supported by economic gains from oil & gas industry spending
- **Economic Impact on Texas: \$308B**

Performance Tools: HPCToolkit

John Mellor-Crummey, CS



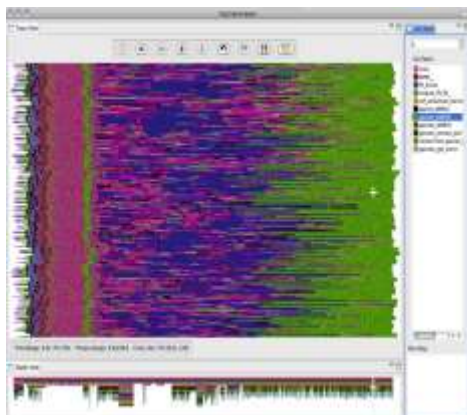
Attribute Costs to Code



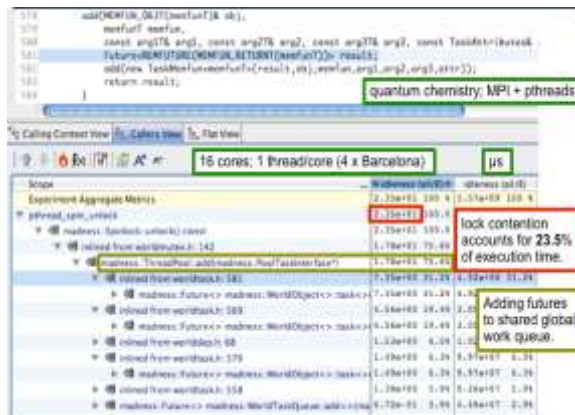
Pinpoint & Quantify Scaling Bottlenecks



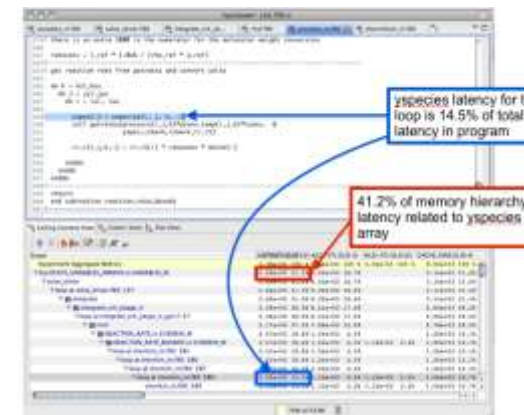
Assess Imbalance and Variability



Analyze Behavior over Time



Shift Blame from Symptoms to Causes



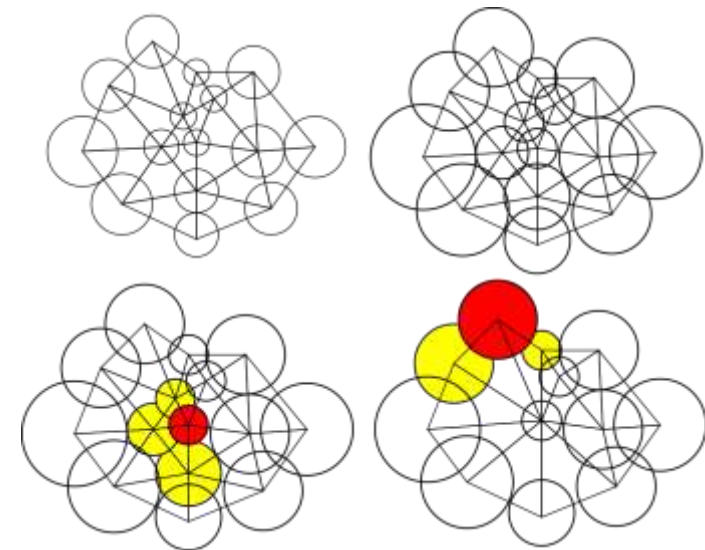
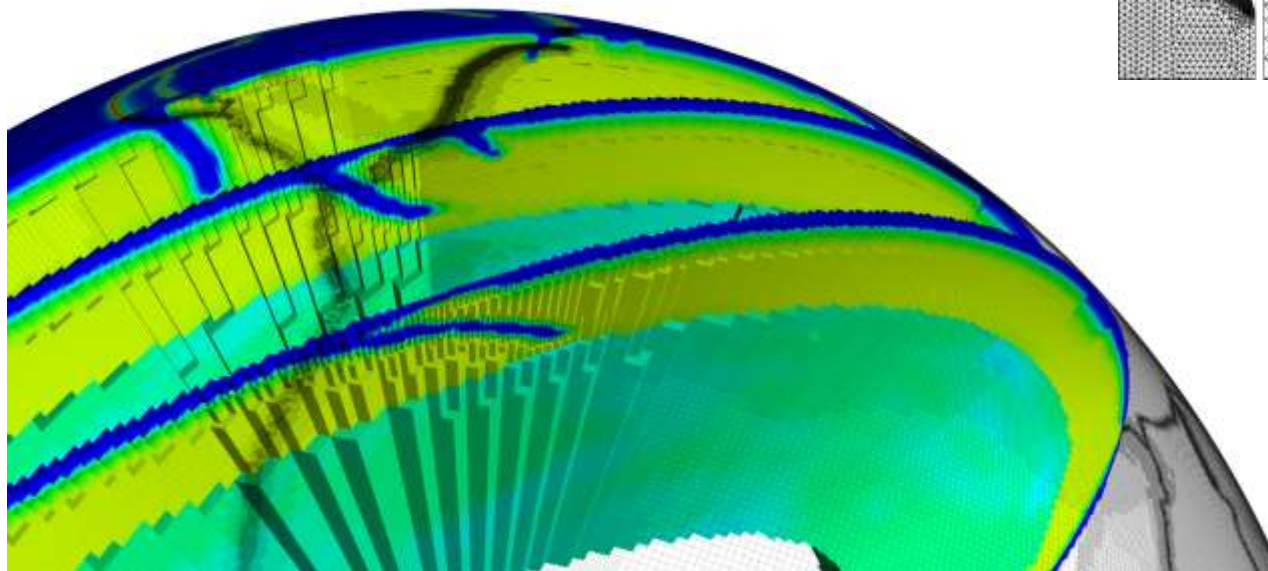
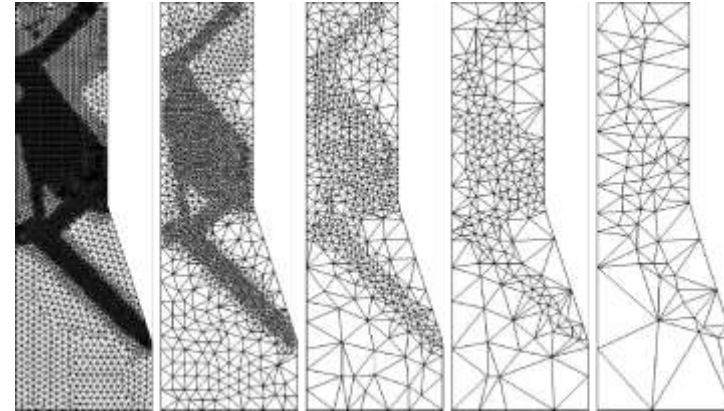
Associate Costs with Data

Performance tools can play an important role in guiding development to maximally leverage infrastructure

Scalable Solvers & Numerical Libraries

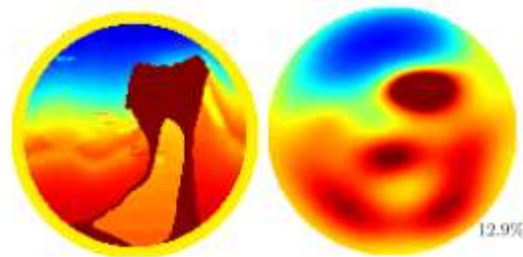
Matthew Knepley, CAAM

- Unstructured grids
- Node-aware optimization
- Intel Parallel Computing Center
 - ✓ Accelerating and expanding PETSc

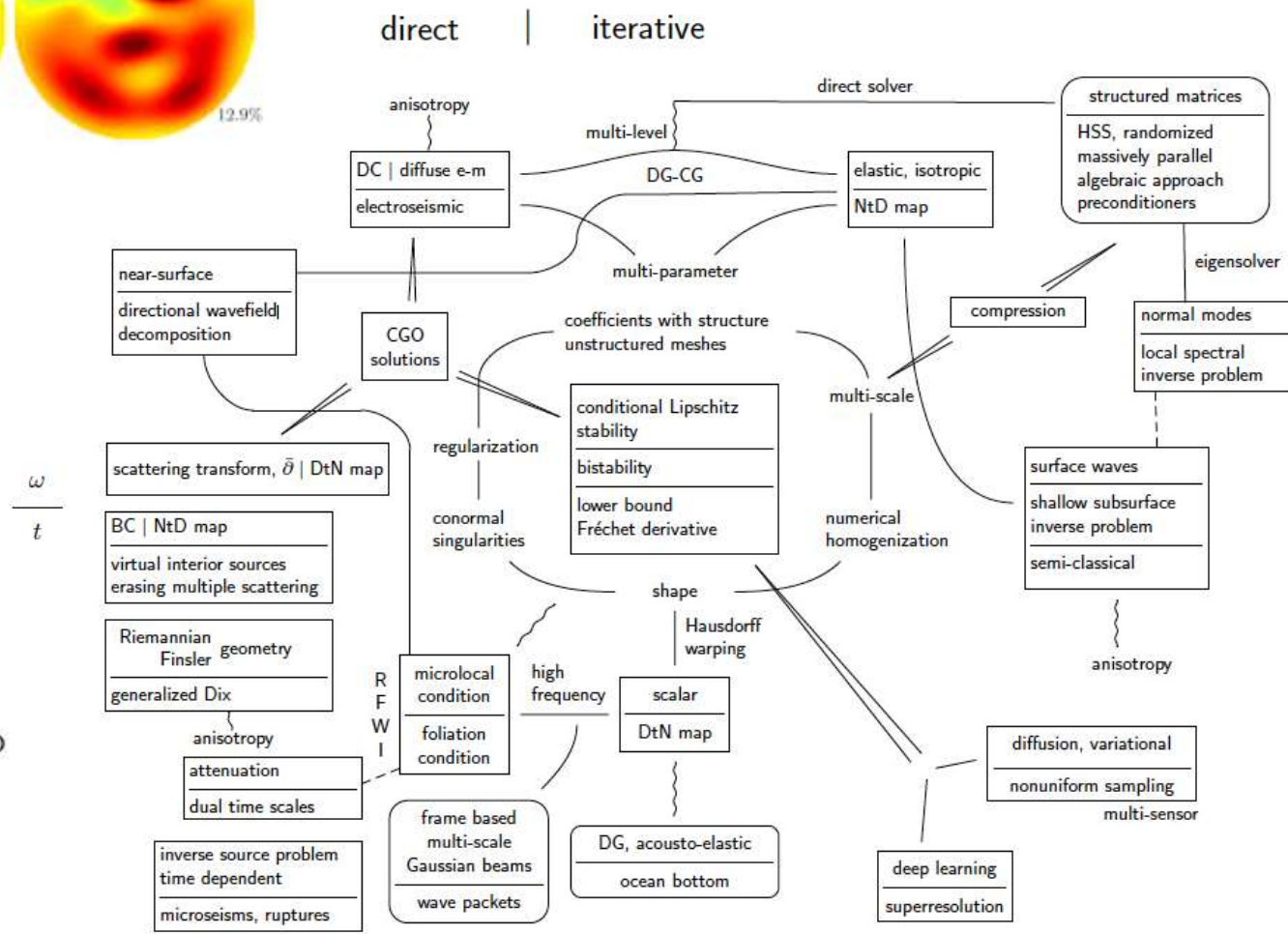
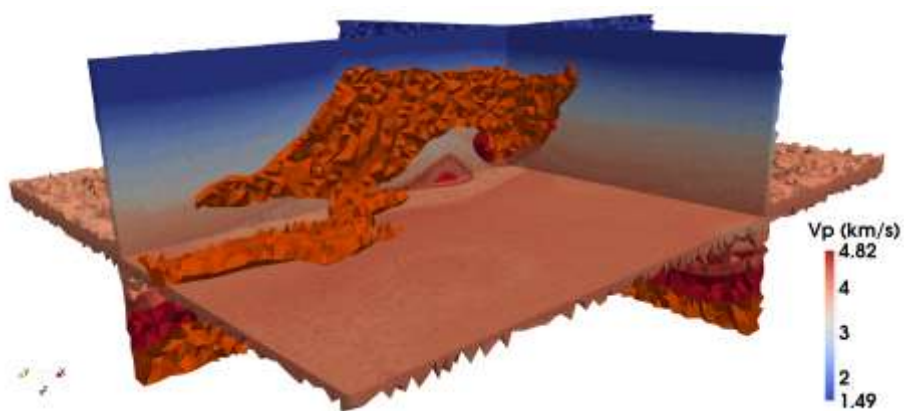


Geo-Mathematical Imaging

- Direct nonlinear methods
- Iterative methods (FWI)
- Attenuation
- Spectral methods
- Micro-seismicity
- Deep learning



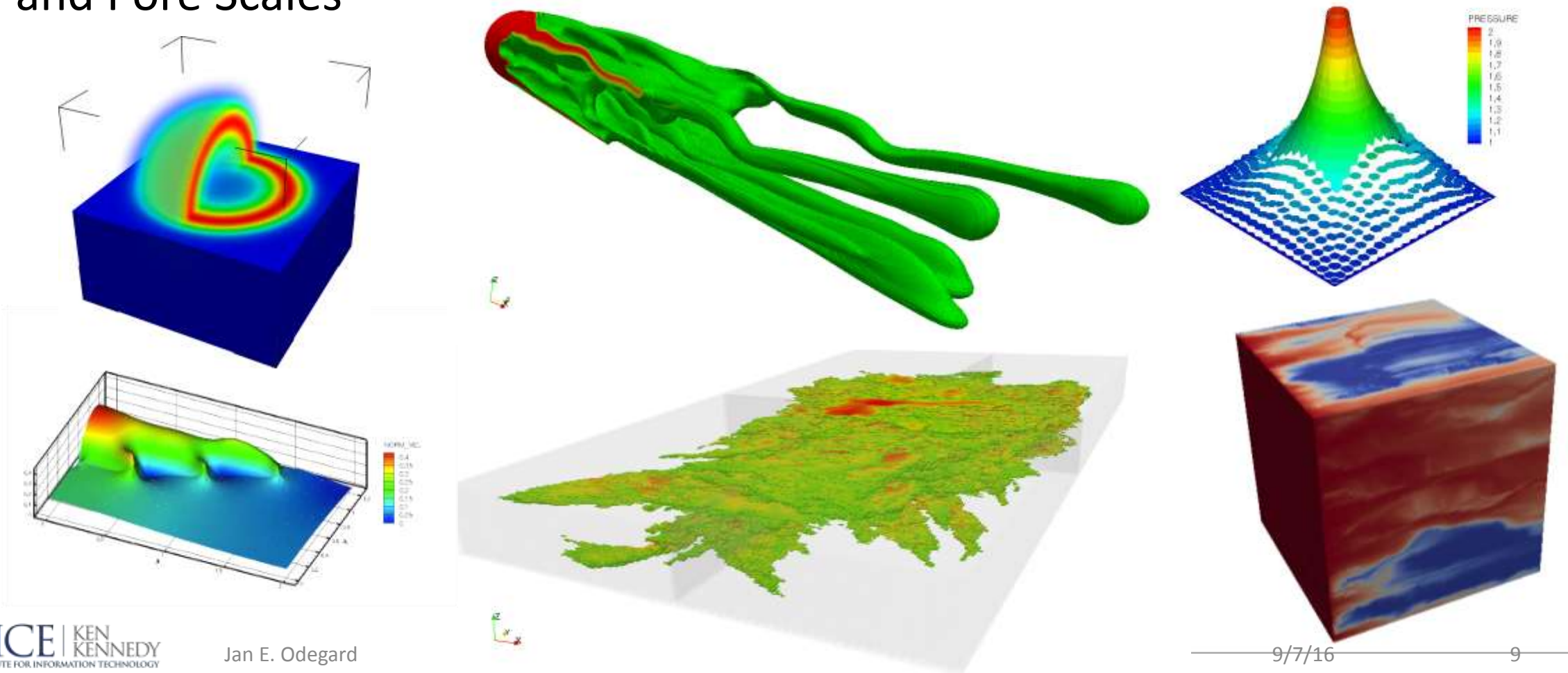
Maarten de Hoop, CAAM



Coupled Flow & Reservoir Simulation

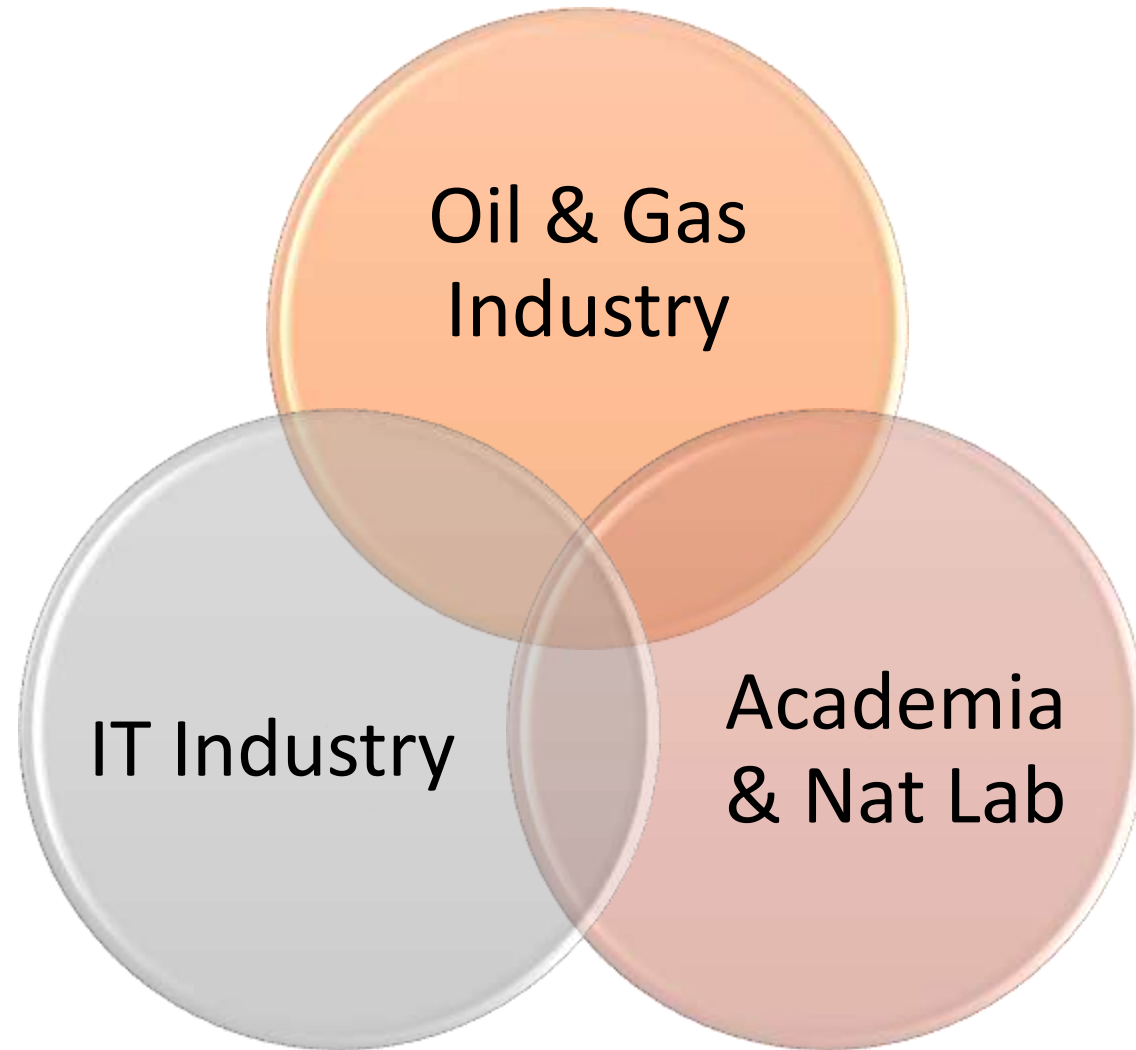
Beatrice Riviere, CAAM

Modeling and Simulation of Processes in Porous Media at Field, Darcy and Pore Scales

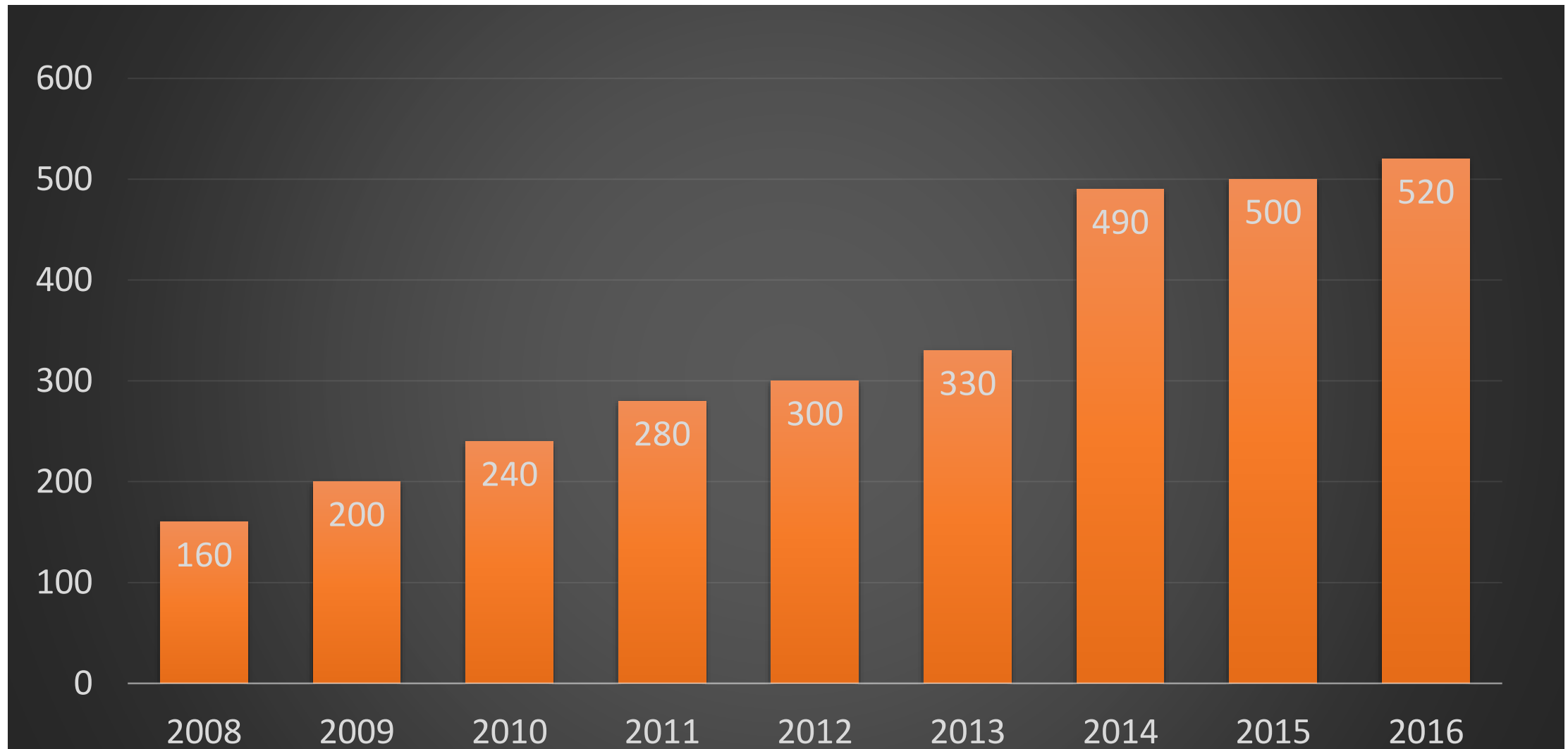


Private-Public Partnership

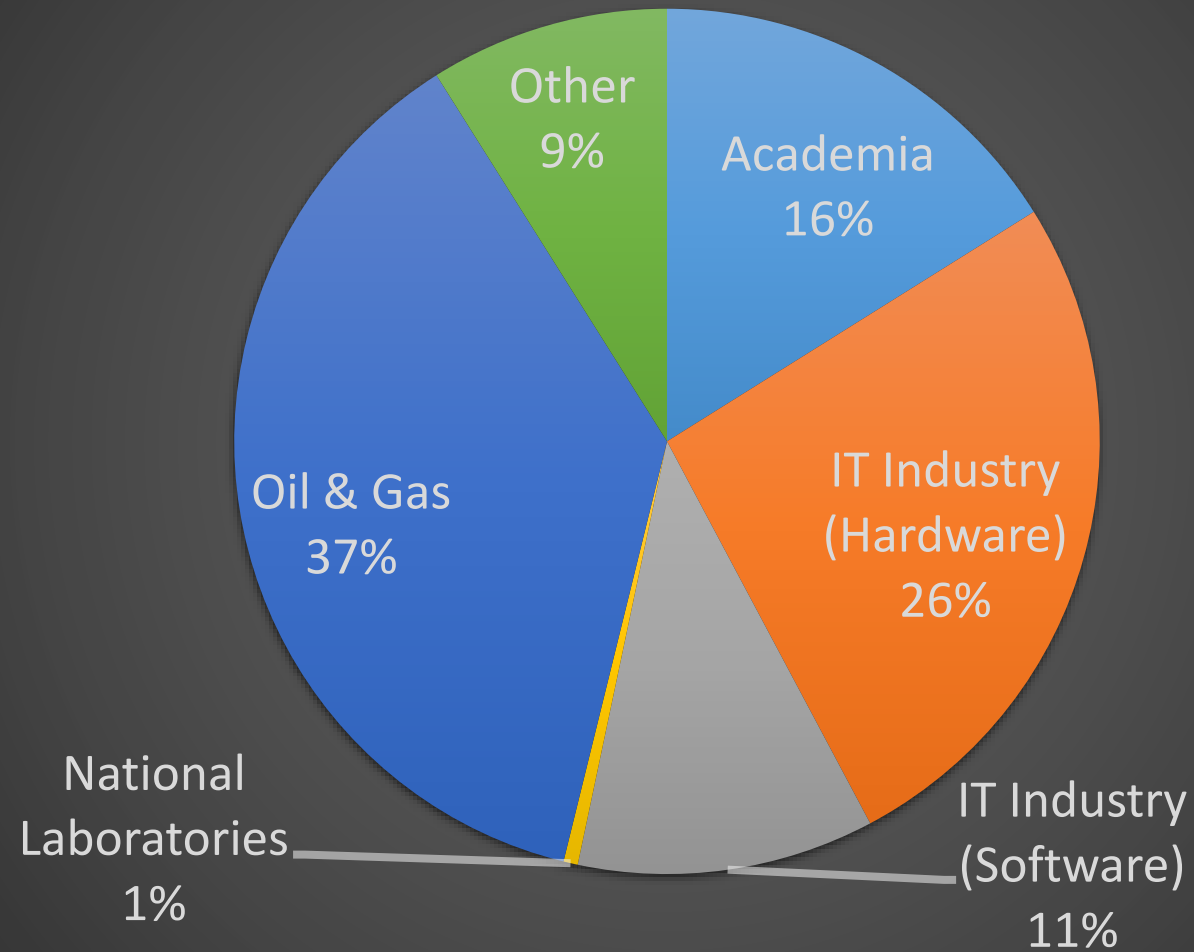
A private-public partnership to support cyberinfrastructure operation and development challenges, develop a sustainable and diverse high performance computing, computational science & engineering, and data-science workforce directed at industry needs



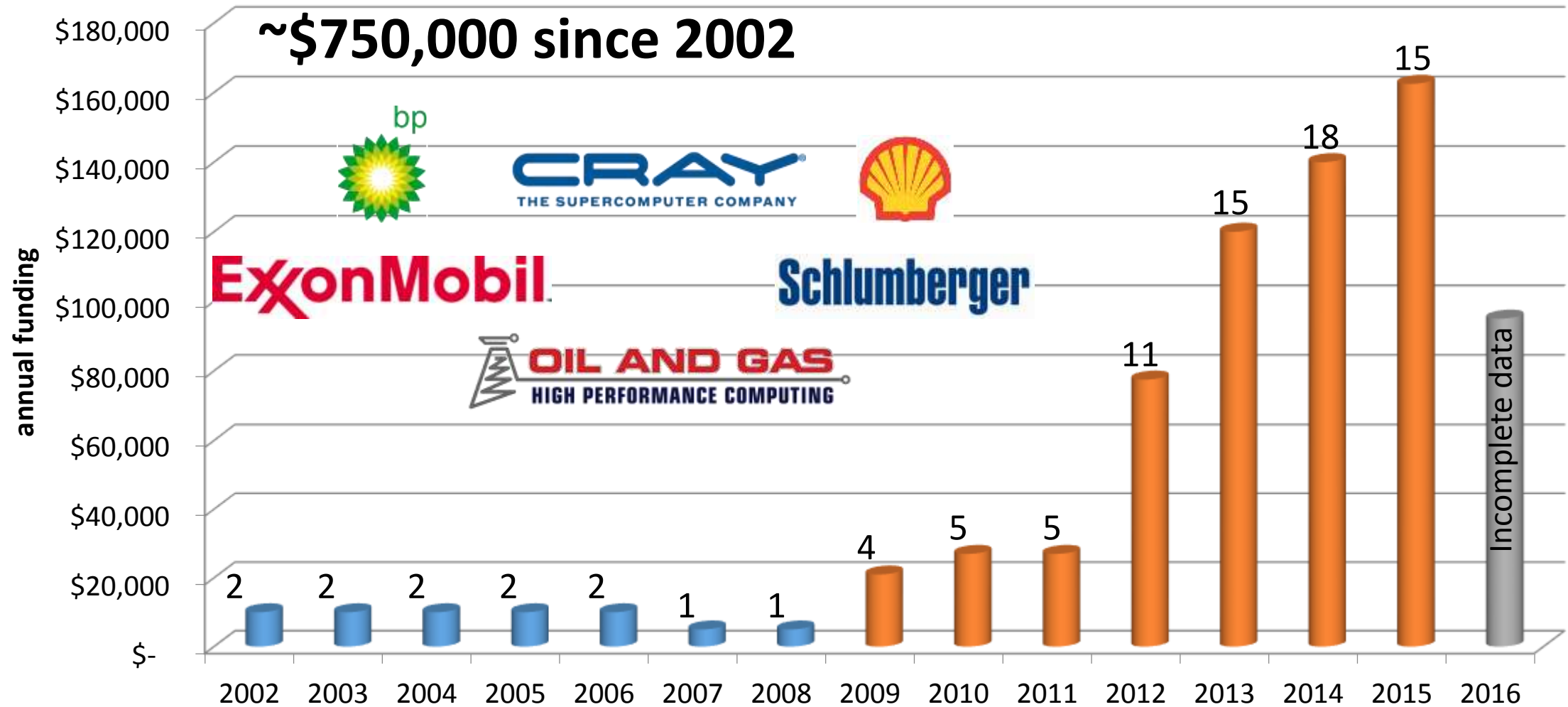
Conference Attendee History



Attendance by Industry Segment



Graduate Student Support to Create Awareness



Where/how are fellowships allocated?

- In computational departments
 - Computational and Applied Mathematics
 - Computer Science
 - Earth Science
 - Electrical and Computer Engineering
 - Statistics
 - Applied Physics
- Used to support students already in these programs at Rice
- Used to recruit students to computational programs at Rice
 - Support MSc & PhD students
- Industry partnership also led to the development of the professional masters degree in Computational Science and Engineering
 - 30 credit hours of course work, can be part time

Boot Camps: Industry Summer Training

High-Performance Computing

Data-Science

Boot camps offered by Ken Kennedy Institute at Rice with leading faculty and researchers as instructors.

Intensive lecture/lab training to quickly acquire basic skills for beginners or intermediate users (**can be mid career boost vehicle**).

- Intro to thread-based parallelism
- Intro to MPI
- Performance analysis tools
- GPU Accelerated computing
- Intro to parallel I/O
- Intro to R & Python
- Intro to AWS, Hadoop and Spark
- Intro Unsupervised Learning
- Intro Supervised Learning



SAVE THE DATE:

March 15-16, 2017

10th Anniversary

2017 Rice Oil & Gas HPC Conference

<http://rice2017.og-hpc.org>

Abstracts due by November 23, 2016.

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