

NSF, CyberInfrastructure, & You: The Vision of a New Revolution in Research & Education

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*U.S. – South America Workshop: Mechanics & Advanced
Materials – Research & Education*

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National Science Foundation (**NSF**)

*(On Detail to the Directorate for Computer & Information Sciences &
Engineering (**CISE**), Division of Shared CyberInfrastructure (**SCI**))*





Outline

- **NSF**
 - Overview of agency mission, structure, & leadership
 - CISE reorganization: drivers and goals
 - New Division of Shared CyberInfrastructure (**SCI**)
- **CyberInfrastructure (CI)**
 - Definition & Overview
 - A Vision for Revolutionizing Science & Engineering
 - NSF Activities & Plans
- **CyberInfrastructure & You**
 - The Realities of Research & Education
 - Your Input
- **Summary, and...**



Outline – **Post Script**

- ***Office of International Science & Engineering***
(OISE)
 - ***June 2004: Two New Funding Opportunities***
(Strategic changes in funding mechanisms)
 - ***July 23, 2004: Vision of New Leadership***
***Article “Kerri-Ann Jones: Forging International
Cooperation to Enhance Scientific Advancement”***
(<http://www.ostina.org/html/bridges/article.htm?article=1102>)



Summary – Let's start here

- The Revolution of CyberInfrastructure
 - “Emerging CI = Invention of the Printing Press”
 - “Emerging CI = The new petroleum”
- What are **your** ideas & needs for Cyberinfrastructure ?



NSF – The Mission

Enabling the Nation's future through discovery, learning, and innovation...

Strategic Goals

People: Diverse, internationally competitive, and globally engaged Science & Engineering (S&E) workforce

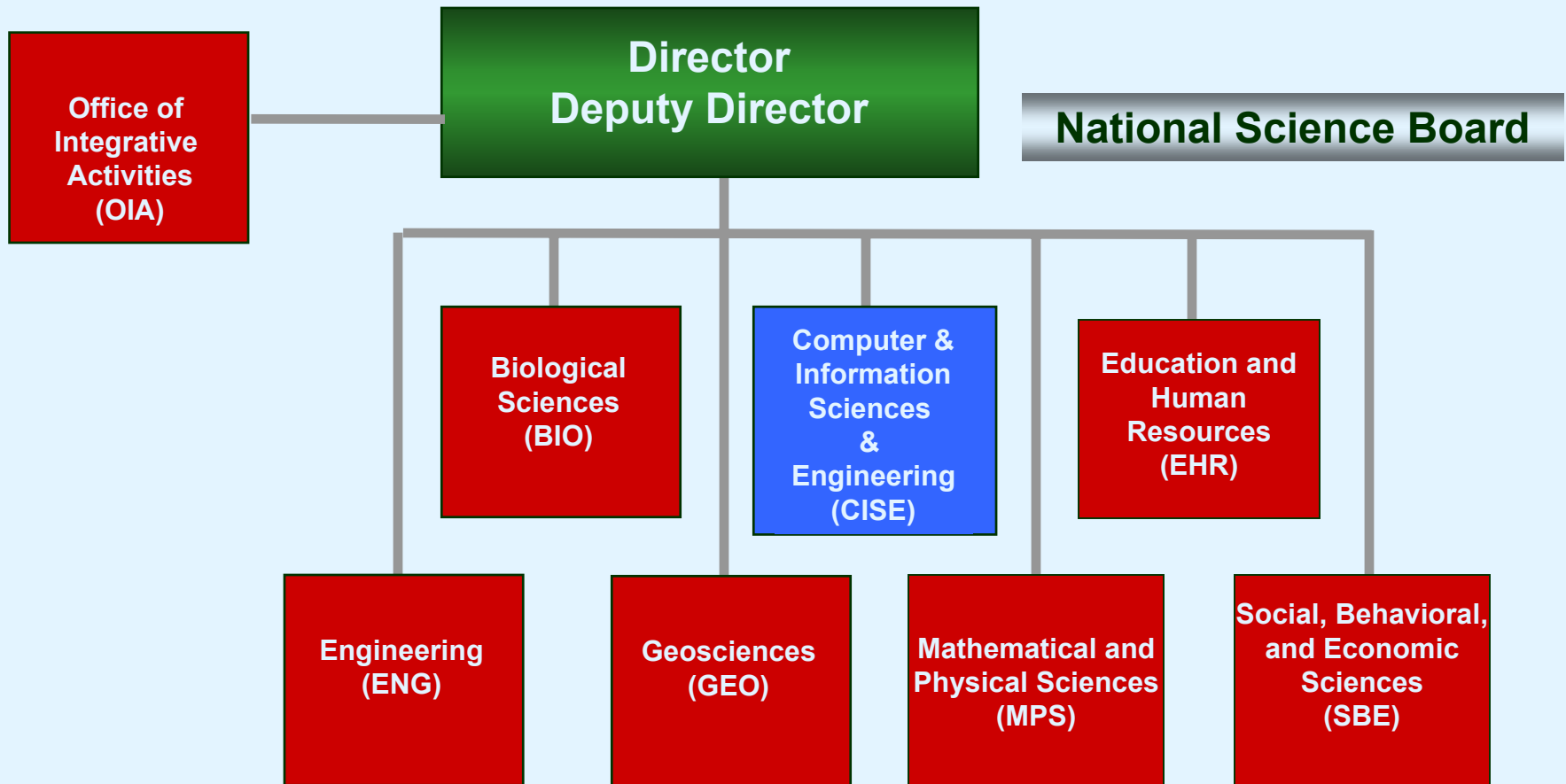
Ideas: Discovery across the frontiers of S&E, connected to learning, innovation and service to society

Tools: Accessible, state-of-the-art, and shared research and education tools

Organizational Excellence: An agile, innovative organization that fulfills its mission through leadership in state-of-the-art business practices.



NSF - Structure & Leadership





CISE Reorganization: Drivers

- Scientific: changes to the field (computer science)
CISE had essentially the same organization from 1985 to 2003
- Administrative: proposal pressure
Up 125% from 1997 to 2003 (vs. 16% for NSF);
up even more in FY 2004
- Financial: end of **ITR** “Priority Area”
(**I**nformation **T**echnology **R**esearch “Priority Area”)



Information Technology Research Priority Area (Dollars in Millions)

	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004
	Actual	Actual	Actual	Actual	Estimate
Biological Sciences		5.19	6.08	6.80	7.50
Computer and Information Science and Engineering	90.00	155.48	173.51	215.17	218.11
Engineering		8.17	10.23	11.17	11.17
Geosciences		10.90	12.16	13.21	14.56
Mathematical and Physical Sciences		29.62	32.66	35.52	35.52
Social, Behavioral and Economic Sciences		3.82	4.36	4.60	5.15
Office of Polar Programs		1.09	1.22	1.33	1.55
Subtotal, Research and Related Activities	90.00	214.27	240.22	287.80	293.56
Education and Human Resources		2.00	2.00	2.48	9.53
Major Research Equipment and Facilities Construction	36.00	44.90	35.00	44.83	9.94
Total, Information Technology Research	\$126.00	\$261.17	\$277.22	\$335.11	\$313.03

Totals may not add due to rounding.

Key Point: Cross-Directorate, Interdisciplinary



CISE Strategic Objectives

- Enhance research portfolio
 - Strengthen the core
 - Cyberinfrastructure
 - Cybersecurity
- **Broaden participation**
- Improve organizational effectiveness



Broadening Participation

- NSF Review Criteria
 - Merit = Intellectual Merit + **Broader Impact**
- Broaden participation
 - EPSCoR States (Experimental Program to Stimulate Competitive Research - 21 states + U.S. Territories)
 - Access by the wider public (e.g. amateur astronomy)
 - Empowering more people & more disciplines
 - (e.g. going beyond challenges in human physical capabilities, location, & history)
- Taxpayer \$\$, Democracy, Accountability, National Health/Economic Growth

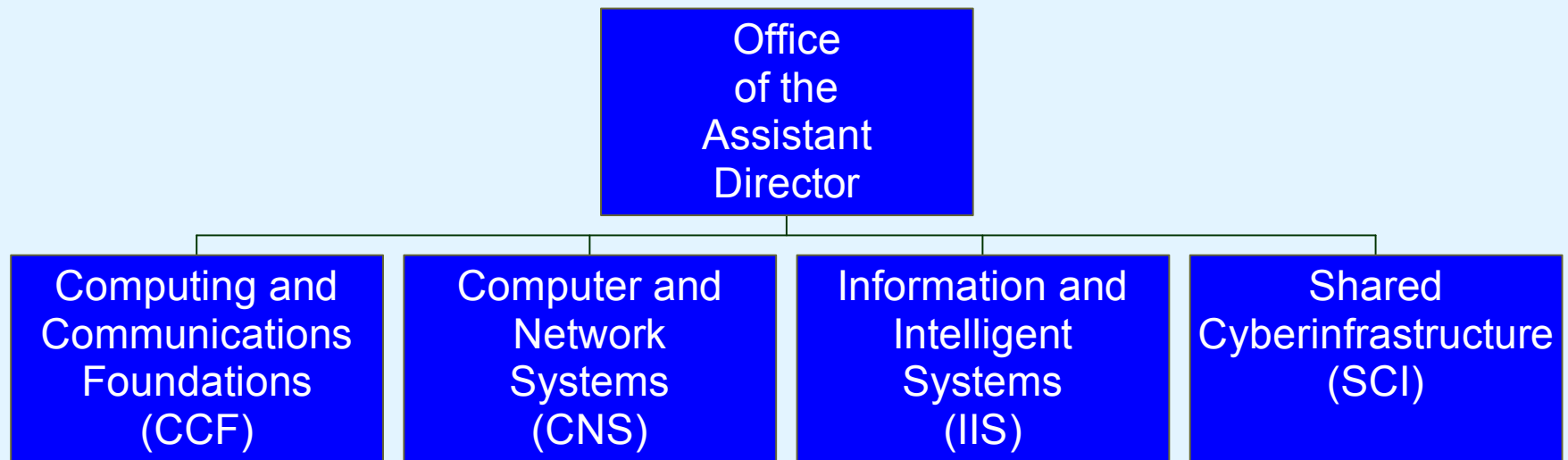


CISE Reorganization: Goals

- Align divisions to reflect the field
- Group similar programs into *clusters*
 - Sharpen focus
 - Increase flexibility
 - Eventually increase grant size & duration
- Develop cross-cutting *emphasis areas*
- Integrate education and research
- Build on success of ITR “Priority Area”



New CISE Organization – Overview of Divisions



*Key Point: Consider your research topic areas & interests
("Some good places to start exploring")*



Computing and Communication Foundations (CCF)

- **Formal and Mathematical Foundations**
 - Computer science theory; numerical computing; computational algebra and geometry; signal processing and communication
- **Foundations of Computing Processes and Artifacts**
 - Software engineering; software tools for HPC; programming languages; compilers; computer architecture; graphics and visualization
- **Emerging Models for Technology and Computation**
 - Computational biology; quantum computing; nano-scale computing; biologically-inspired computing



Computer and Network Systems (CNS)

- **Computer Systems**
 - Distributed systems; embedded and hybrid systems; next-generation software; parallel systems
- **Network Systems**
 - Networking research broadly defined plus focus areas in programmable wireless networks and networks of sensor systems
- **Computing Research Infrastructure**
 - Research infrastructure; minority institutional infrastructure; research resources
- **Education and Workforce**
 - Curriculum development/educational innovation; IT workforce; special projects; cross-directorate activities (e.g., REU sites)



Information and Intelligent Systems (IIS)

- **Systems in Context**
 - Human computer interaction; educational technology; robotics; computer-supported cooperative work; digital government
- **Understanding, Inference, and Data**
 - Databases; artificial intelligence; text, image, speech, and video analysis; information retrieval; knowledge systems
- **Science & Engineering Informatics/Information Integration**
 - Bioinformatics; geoinformatics; cognitive neuroscience; ...



Shared Cyberinfrastructure (SCI)

Dr. Sangtae Kim, Division Director

- **High-Performance Computational Infrastructure**
 - supercomputers, high-capacity mass storage systems, system software suites & programming environments, productivity software libraries & tools, large-scale data repositories, experts & staff to maintain facilities...
- **Advanced Networking Technologies and Infrastructure**
 - end-to-end networking protocols, performance monitoring tools & measurement infrastructure, wireless networks, strategic international collaborations, testbeds to support trial deployment...
- **Advanced Services and Cybertools**
 - information management systems & data services, scalable interactive visualization tools, middleware service building blocks for high-end computational resources & networked instrumentation & sensors...



Shared Cyberinfrastructure (SCI)

Dr. Sangtae Kim, Division Director

- *Collaborating closely across NSF Directorates & Offices to ensure the advancement of CyberInfrastructure will meet the demands of tomorrow's science & engineering communities*

- *“Guiding Principles” for Education, Outreach, & Training Efforts*
 - *Ubiquitous nature of CI – the community is from “large” to “everybody”*
 - *Balancing the needs of extant & emerging CI communities*
 - *Build CI communities*



Shared Cyberinfrastructure (SCI) *(Dollars in Millions)*

	FY 2003	FY 2004	FY 2005	Change over	
				FY 2004	
				Actual	Estimate
Shared Cyberinfrastructure	95.07	112.63	123.60	\$10.97	9.7%
Total, SCI	\$95.07	\$112.63	\$123.60	\$10.97	9.7%



SCI Activities

- FY 2005
 - Continuing support for centers (PACI, ETF)
 - Cyberinfrastructure Training, Education, Advancement, and Mentoring (CI-TEAM) Concept
 - NSF Middleware Initiative (NMI): spring 2005
 - Collaboration with other agencies/directorates/working groups (e.g. Interagency Modeling & Analysis Group - IMAG)
 - Leveraging and coordinating shared and domain-specific cyberinfrastructure: **contact a program director if you have ideas for leveraging CISE research**

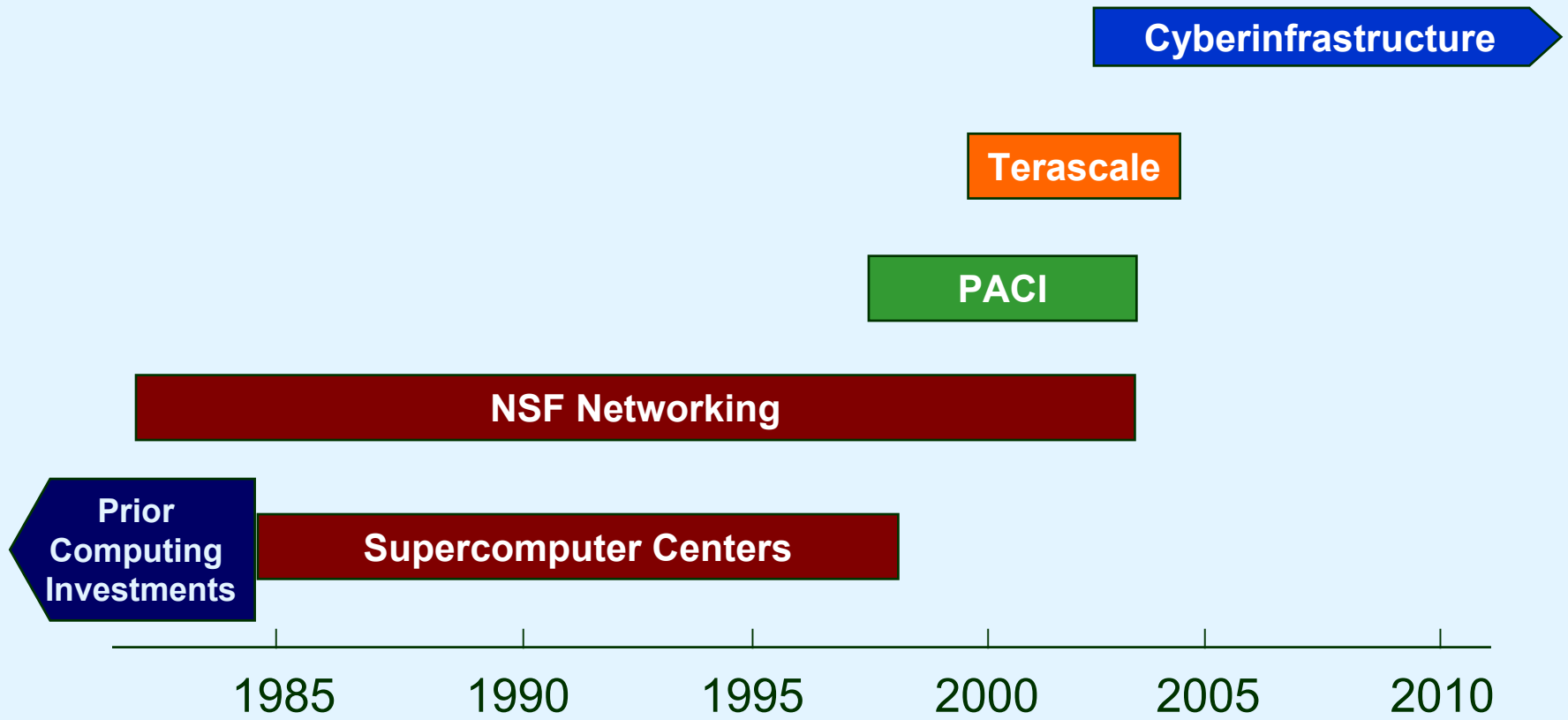


What is Cyberinfrastructure?

Think "Infrastructure" + "Resources"



Evolution of NSF Support for Computational Infrastructure



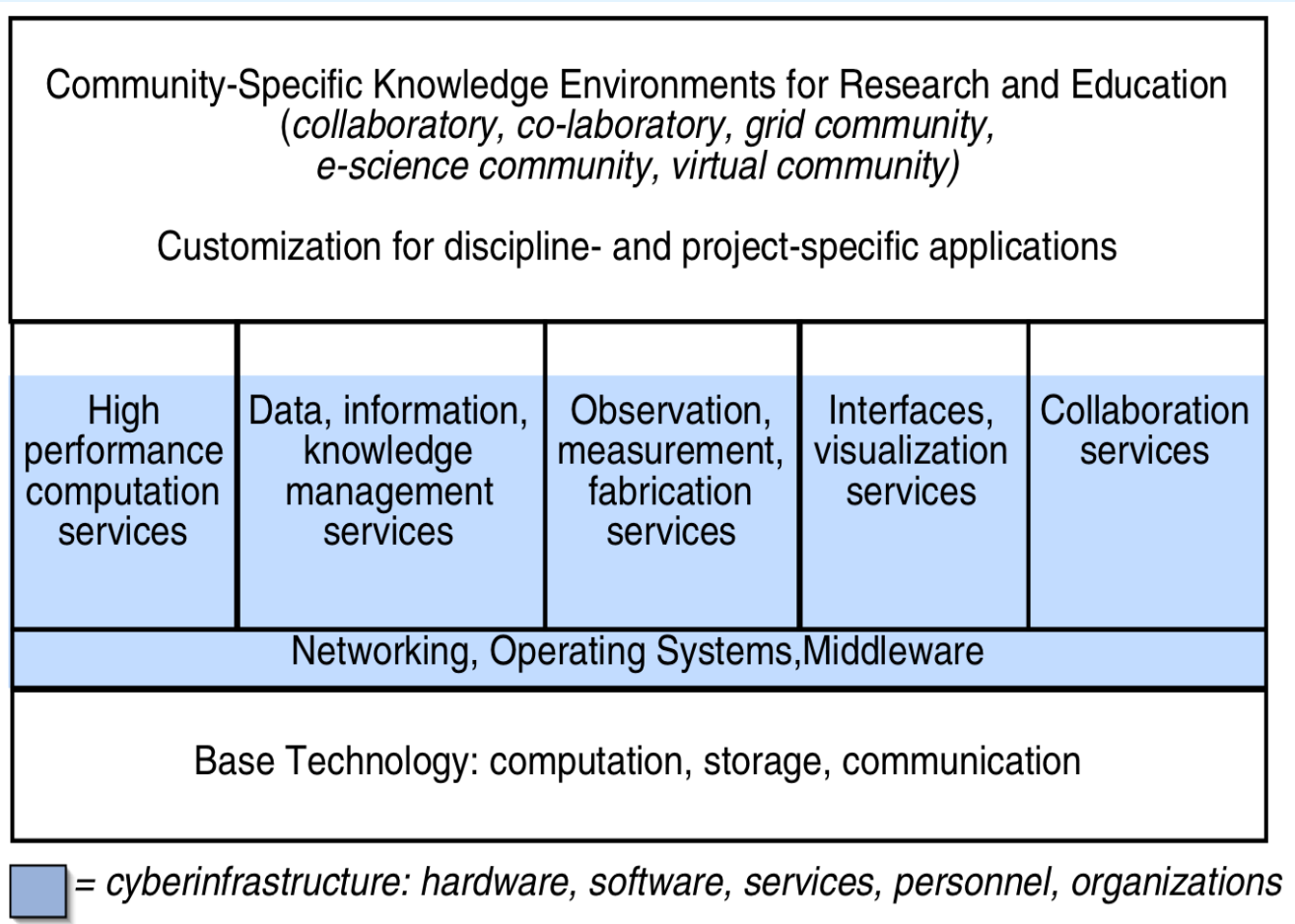


What is Cyberinfrastructure?

- A New Vision:
 - ...“more **ubiquitous, comprehensive digital environments** that become interactive & functionally complete for research communities in terms of people, data, information, tools, & instruments that operate at **unprecedented levels of computational, storage, and data-transfer capacity**”.

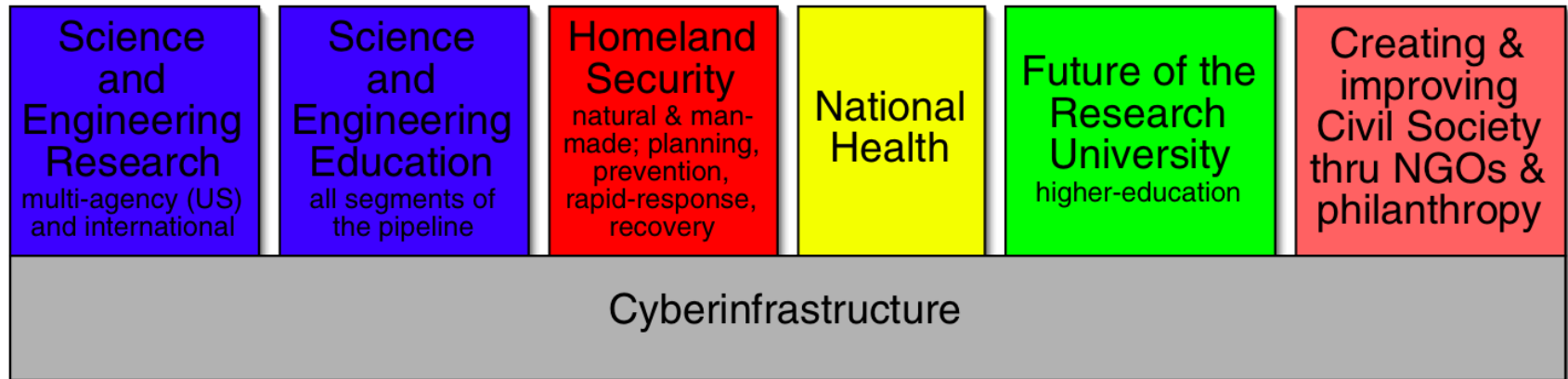


Cyberinfrastructure (CI)





Pervasiveness of CI



- Opportunities and challenges for multi-use
- Opportunities for leverage and "coalition building" for doing things "at the frontier"



CyberInfrastructure

It is much more than its component parts...

<i>CyberInfrastructure isn't just...</i>	<i>Unless it also involves...</i>
Individual infrastructure components (e.g., devices that collect data, data mining as a science, big computing resources...)	Playing an integrative role in a larger system
Sharing distributed data across research groups or disciplines	Transforming data into meaningful information
Data and resources that are collected, processed, and used by a community	Distributing collection, storage and access across multiple locations and communities



Example of CyberInfrastructure - George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES)

- Extends national capacity for earthquake engineering through unique, shared infrastructure
- *What makes NEES CyberInfrastructure?*
 - Real-time video & data enable participation from remote sites
 - Real-time communications allow experiments to span facilities, link physical experiments with numerical simulation
 - 15 experimental facilities linked by common network, data repository, tools, metadata





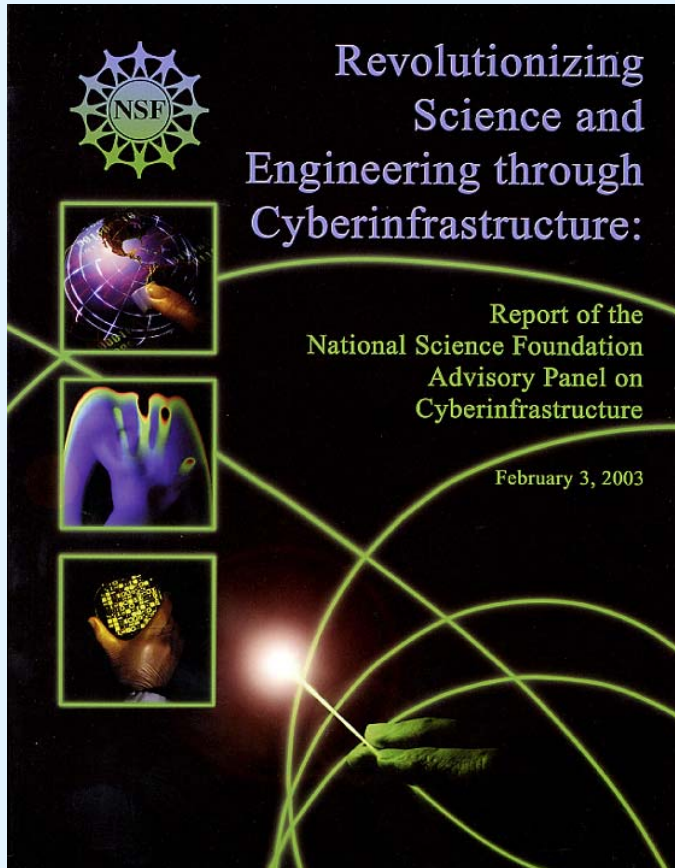
NEES as CyberInfrastructure – Enabling New Types of Discovery

- ✓ Ability to access and reuse others' experiment design, numerical components, and results
 - Improves research productivity
- ✓ Ability for simulations to “steer” physical experiments
 - Reduces need for experiments and increases their relevance
- ✓ Ability to link facilities to study cross-domain problems
 - Enables new areas of research (like soil-structure interactions)
- ✓ Ability to design & conduct experiments remotely
 - Opens access to researchers from all institutions





The Demand for “CyberInfrastructure”



- “The Atkins Report” – Advice to CISE
Daniel E. Atkins, (Chair), U. Michigan
Kelvin K. Droege-meier, U. Oklahoma
Stuart I. Feldman, IBM
Hector Garcia-Molina, Stanford U.
Michael L. Klein, U. Pennsylvania
David G. Messerschmitt, U. California Berkeley
Paul Messina, California Institute of Technology
Jeremiah P. Ostriker, Princeton U.
Margaret H. Wright, New York U.
- Call for a national-level, integrated system of hardware, software, & data resources and services
- The Revolution = new infrastructure to open the door to new types of scientific/engineering research and education



Cyberinfrastructure – Some NSF Activities & Plans

- Support for 3 of top 15 supercomputers on the “Top 500” List (<http://www.Top500.org>)
- \$60 million investment in supercomputer operations in 2005
- 25 teraflops added to San Diego Supercomputer Center (SDSC) and National Center for Supercomputing Applications (NCSA) in 2004
- Up to 50 teraflops upgrade at Pittsburgh Supercomputer Center in 2005-2006
- Leadership in cyberinfrastructure research investments
- Develop domain-specific and generic computational science
- Workshops on computational science, cyberinfrastructure, and education
- Cooperation with other agencies and international counterparts

(Ref: June 17, 2004 Presentation by Dr. Arden Bement, Acting Director, NSF
http://www.itrd.gov/pitac/meetings/2004/20040617/20040617_bement.pdf)



Cyberinfrastructure – Some NSF Activities & Plans

Key Point:

Frontier research in cutting-edge systems

&

Comprehensive, Integrated Cyberinfrastructure



Cyberinfrastructure – Challenges, Costs, & Risks

- Absent **coordination**, will researchers in different fields & at different sites adopt different formats & representations of key information, making it forever difficult or impossible to combine or reconcile data ?
- Effective use of CI can break down artificial disciplinary boundaries, while **incompatible tools and structures** can isolate scientific communities for years
- Dramatic changes are coming in computing application architectures; **lack of consideration of work in other sciences and in the commercial world** could render projects obsolete before they deliver.
- Much of the effort underway to use CI for collaborative research lacks adequate attention to **sociological and cultural barriers** to technology adoption that may cause failure, even after large investments.



CyberInfrastructure & You

The Realities of Research & Education Efforts

- **Geographically dispersed resources, data, and collaborations are the new foundations of science & engineering research...**



- **“U.S. Agencies Look to Interdisciplinary Science”, The Chronicle of Higher Education, June 14, 2002**



CyberInfrastructure & You

or...

“We Need Your Input (!)”

- You = Your “Research Community”
- How could your community benefit from CyberInfrastructure ?
 - “If we had XXX, we could do YYY”
 - “My *specific* CyberInfrastructure “wish list” is...”
- Examples of nascent CyberInfrastructure ?
 - Community efforts where CyberInfrastructure-like components are already being developed ?
 - How can applications from your community be generalized to apply to other communities?
- Examples of emerging standards that could be leveraged ?
(Standards are a community-based process)



Summary

- The Revolution of CyberInfrastructure
 - “Emerging CI = Invention of the Printing Press”
 - “Emerging CI = The new petroleum”
- What are **your** ideas & needs for Cyberinfrastructure ?



Postscript: Office of International Science & Engineering
(**OISE**)

(<http://www.nsf.gov/sbe/int/start.htm>)

June 2004: New Funding Opportunities

(Ref: <http://www.nsf.gov/pubsys/ods/getpub.cfm?nsf04034>)

- (1) **Planning Visits and Workshops:** A new solicitation, *International Research and Education: Planning Visits and Workshops (NSF 04-035)*, invites proposals for workshops and planning visits that are catalytic and may lead to innovative international partnerships, training activities or collaborative research that could be funded by OISE and/or by NSF research directorates.

- (2) **Global Scientists & Engineers:** Support for U.S. students & early-career scientists & engineers (e.g. Research Experience for Undergraduates, Pan-America Advanced Studies Institute, International Research Postdoctoral Fellowships)

- (3) **Partnerships for International Research and Education:** This new program, planned to begin in FY2005 and subject to availability of funds, will invite proposals in which long-term international research and educational activities build on institutional strengths to provide an international collaborative experience that can involve U.S. researchers at all levels.



**Postscript: Office of International Science & Engineering
(OISE)**

(<http://www.nsf.gov/sbe/int/start.htm>)

July 23, 2004: Article “*Vision of New Leadership*”

- *Dr. Kerri-Ann Jones, Office Director, OISE*
- *“Dr. Jones hopes to develop new models for international collaboration between the American research community and its international partners. “I am especially committed to providing enriching international research and education experiences for U.S. students and early career scientists and engineers,” she says. “*

(<http://www.ostina.org/html/bridges/article.htm?article=1102>)



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And in conclusion -

For research at the frontier...

PENSE

Pense enquanto não existir solução

Thank You !