NSF EPSCoR and the Role of Cyberinfrastructure

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National Science Foundation

EPSCoR Office

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Outline

- CyberInfrastructure for 21st Century Vision
- CyberInfrastructure within EPSCoR
  - Networking
  - Data Sharing
  - Collaboration

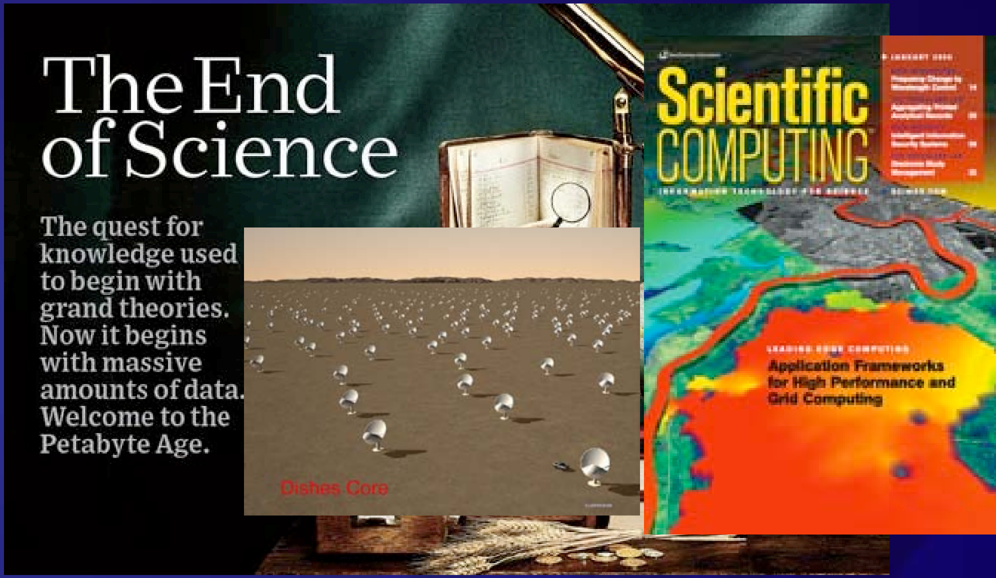
Research Is Changing

- Geographically distributed user communities
  - Numerous labs, universities, industry
- Integration with other national resources
  - Inevitably multi-agency, multi-disciplinary
- Extremely large quantities of data
  - Petabyte data sets, with complex access patterns
  - Also thousands of SMALL data sets
  - None of it tagged as you need it, or in the right format

Framing the Question

Science has been Revolutionized by CI

- Modern science
  - Data- and compute-intensive
  - Integrative
- Multiscale Collabs
  - Add’l complexity
  - Individuals, groups, teams, communities
- Must Transition NSF CI approach to address these issues



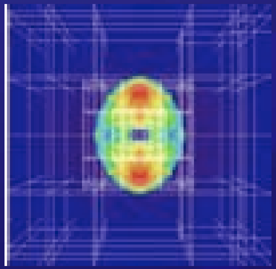
The End of Science

The quest for knowledge used to begin with grand theories. Now it begins with massive amounts of data. Welcome to the Petabyte Age.

Scientific COMPUTING

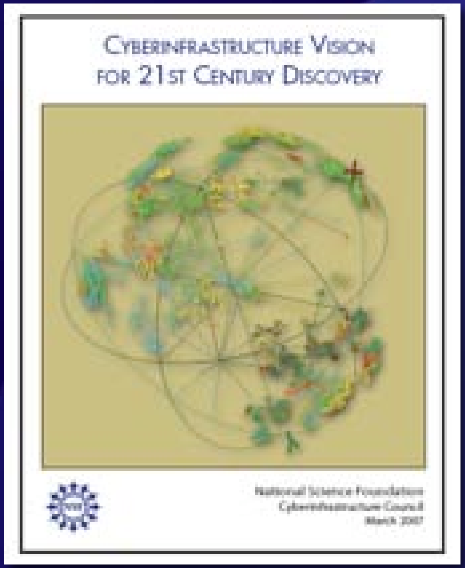
LEADING EDGE COMPUTING

Application Frameworks for High Performance and Grid Computing



What is Needed?

An ecosystem, not components…



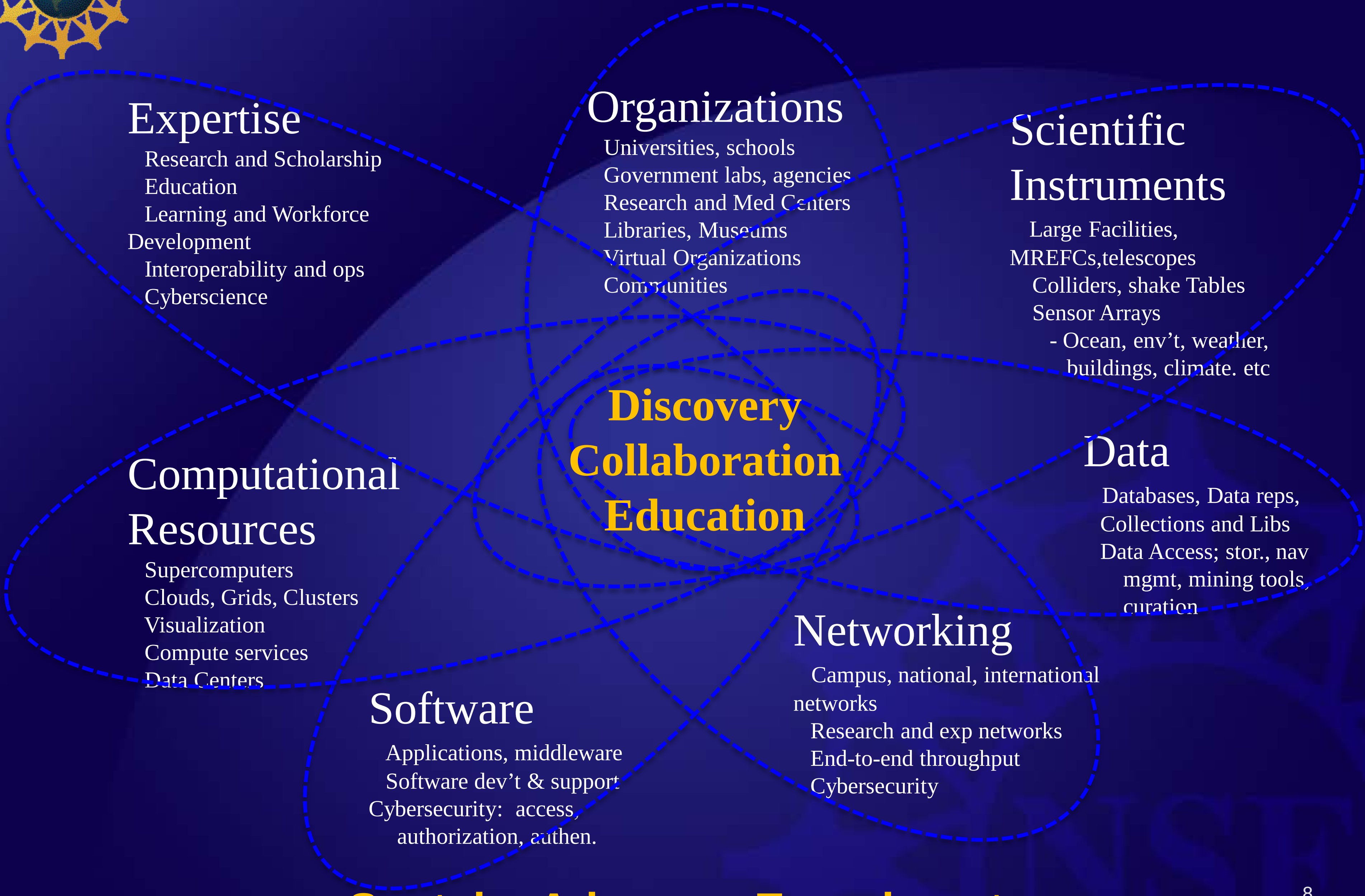
Cyberinfrastructure Vision for 21st Century Discovery

National Science Foundation
Cyberinfrastructure Council
March 2007

NSF-wide CI *Framework* for 21st Century Science & Engineering

People, Sustainability, Innovation, Integration

CyberInfrastructure Ecosystem



Expertise

Research and Scholarship
Education
Learning and Workforce Development
Interoperability and ops
Cyberscience

Organizations

Universities, schools
Government labs, agencies
Research and Med Centers
Libraries, Museums
Virtual Organizations
Communities

Scientific Instruments

Large Facilities, MREFCs,telescopes
Colliders, shake Tables
Sensor Arrays
- Ocean, env’t, weather, buildings, climate. etc

Discovery
Collaboration
Education

Computational Resources

Supercomputers
Clouds, Grids, Clusters
Visualization
Compute services
Data Centers

Data

Databases, Data reps,
Collections and Libs
Data Access; stor., nav mgmt, mining tools, curation

Networking

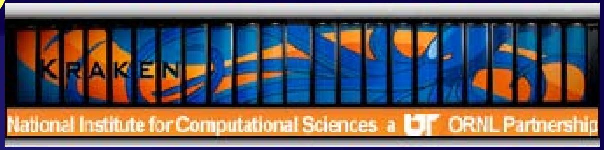
Campus, national, international networks
Research and exp networks
End-to-end throughput
Cybersecurity

Software

Applications, middleware
Software dev’t & support
Cybersecurity: access, authorization, authen.

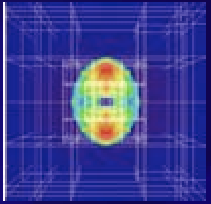
Sustain, Advance, Experiment

Cyberinfrastructure Framework for the 21st century (CF21)


KRAKEN
National Institute for Computational Sciences a UT ORNL Partnership

- High-end computation, data, visualization for transformative science
  - Facilities/centers as *hubs of innovation*

- MREFCs and collaborations including large-scale NSF collaborative facilities, international partners



- Software, tools, science applications, and VOs critical to science, integrally connected to instruments

- Campuses fundamentally linked end-to-end; grids, clouds, loosely coupled campus services, policy to support

- People Comprehensive approach workforce development for 21st century science and engineering

ACCI
Task Forces

Campus Bridging

Craig Stewart

Data (Viz)

Dan Atkins
Tony Hey

- Timelines: 12-18 months
- Advising NSF
- Workshop(s)
- Recommendations
- Input to NSF informs
  - CF21 programs
  - 2011-2 CI Vision Plan

Software

David Keyes
Valerie Taylor

Computing (Clouds Grids)

Thomas Zacharia

Education Workforce

Alex Ramerez

GC & VOs

Tinsley Oden

Preliminary Task Force (TF) Results

- Computing TF Workshop Interim Report
  - Rec: Address sustainability, people, innovation
- Software TF Interim Report
  - Rec: Address sustainability, create long term, multi-directorate, multi-level software program
- GCC/VO TF Interim Report
  - Rec: Address sustainability, OCI to nurture computational science across NSF units
- Software Sustainability WS (Campus Bridging)
  - Rec: Open source, use sw eng practices, reproducibility

CF21 Strategy

- Driven by science and engineering
- Intense coupling of data, sensors, satellites, computing, visualization, grids, software, VOs; entire CI ecosystem
- Better campus integration
- Major Facilities CI planning
- Task Forces and research community provides guidance and input
- All NSF Directorates involved

- Sustain, Advance, Experiment

EPSCoR and CI

EPSCoR Origins

- NSF's 1979 statutory authority "authorizes the Director to operate an Experimental Program to Stimulate Competitive Research (EPSCoR) to assist less competitive states" that:
  - Have historically received little federal R&D funding; and
  - Have demonstrated a commitment to develop their research bases and improve science and engineering research and education programs at their universities and colleges.

EPSCoR

- Purpose/Objectives:
  - Build research capacity and competitiveness
  - Broaden individual and institutional participation in STEM
  - Promote development of a technically engaged workforce
  - Foster collaborative partnerships
- Support state-wide programs

NSF EPSCoR Jurisdictions

1980

Arkansas
Maine
Montana
South Carolina
West Virginia

1985

Alabama
Kentucky
Nevada
North Dakota
Oklahoma
Puerto Rico
Vermont
Wyoming

1987

Idaho
Louisiana
Mississippi
South Dakota

1992

Kansas
Nebraska

2000

Alaska

2001

Hawaii
New Mexico

2002

U.S. Virgin Islands

2003

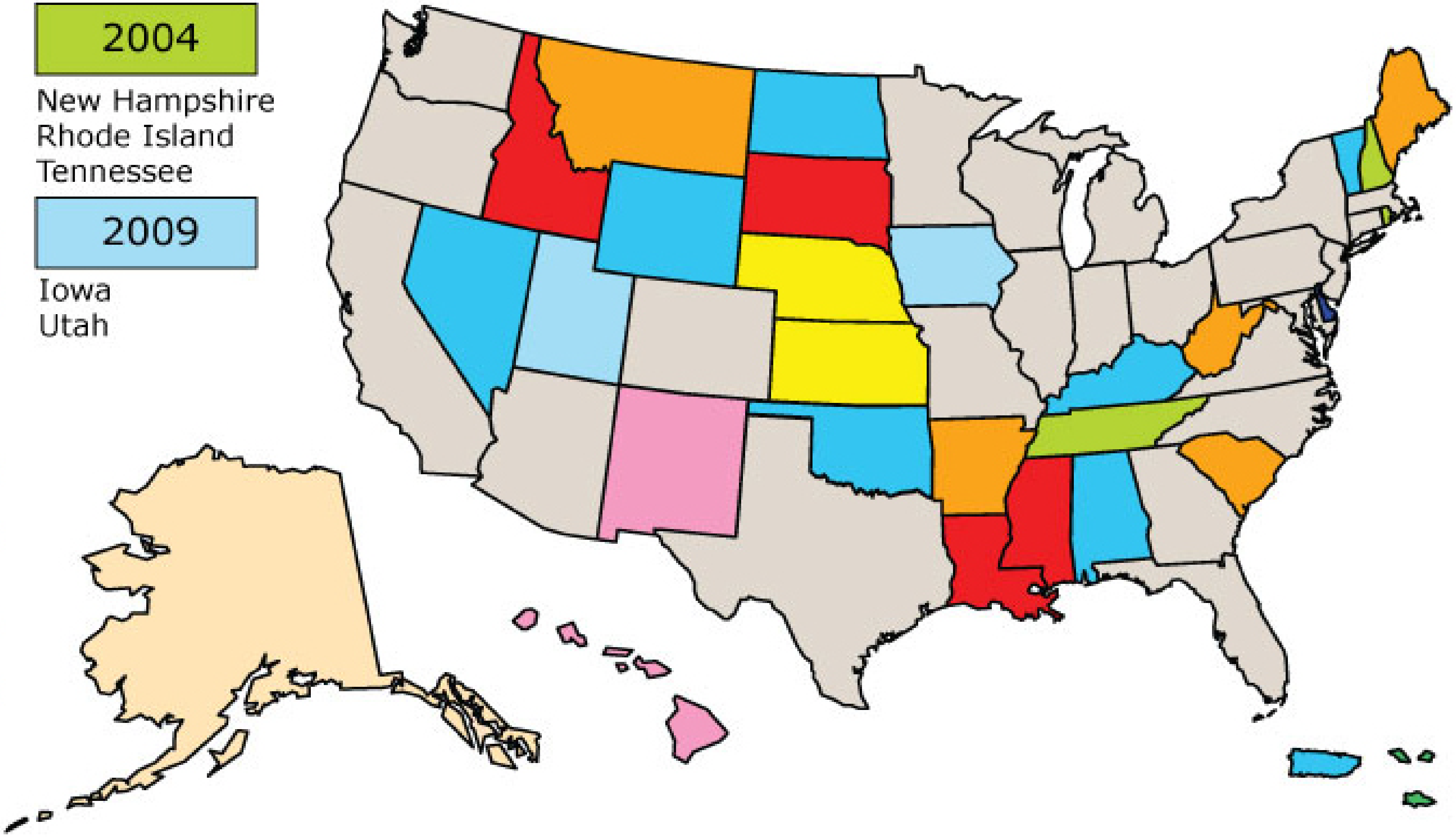
Delaware

2004

New Hampshire
Rhode Island
Tennessee

2009

Iowa
Utah



Stats: In the 29 Jurisdictions...

- 21% of the nation’s total population
- 24% of the research institutions
- 16% of the employed scientists and engineers

- Receive about 12% of all NSF research funding.

EPSCoR 2020

- In 2006 workshop and follow-on report made a number of recommendations
  - Refocusing for EPSCoR
  - Vision for moving forward in the context of collaborative science
- 6 Recommendations

http://www.nsf.gov/od/oia/programs/epscor/docs/EPSCoR_2020_Workshop_Report.pdf

Recc 1: More Flexible Research Infrastructure and Improvement Awards

- 2008- Raised duration to 5 years
- 2009 – Raised funding to $4M per year
- Additional programs were offered

Sub-Recommendation

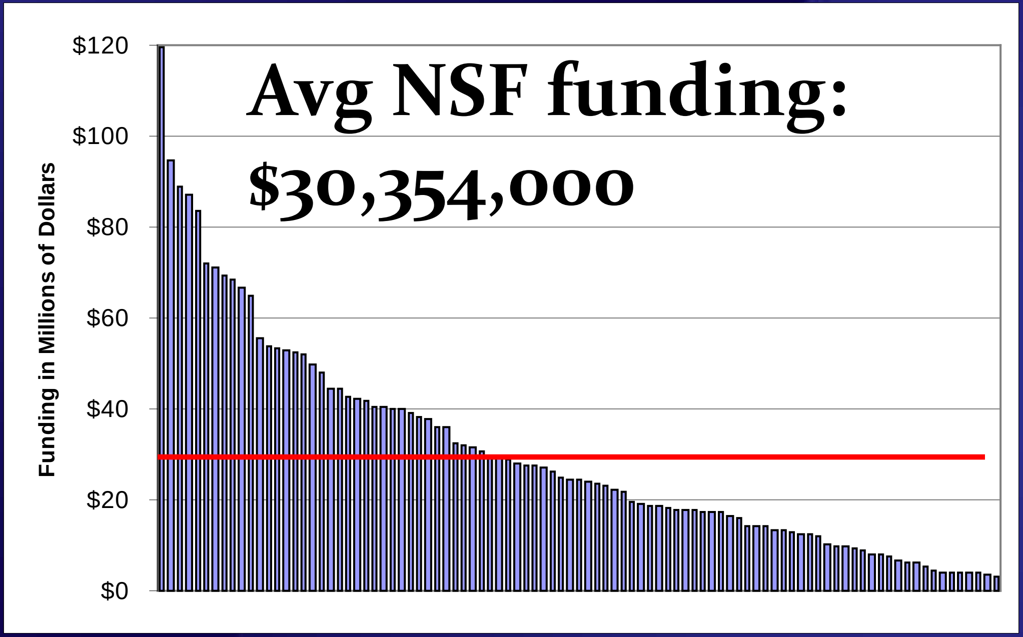
- Ensure that all EPSCoR jurisdictions have the CI necessary to attract and execute advance research
  - Specifically to attract (and train) the next generation workforce

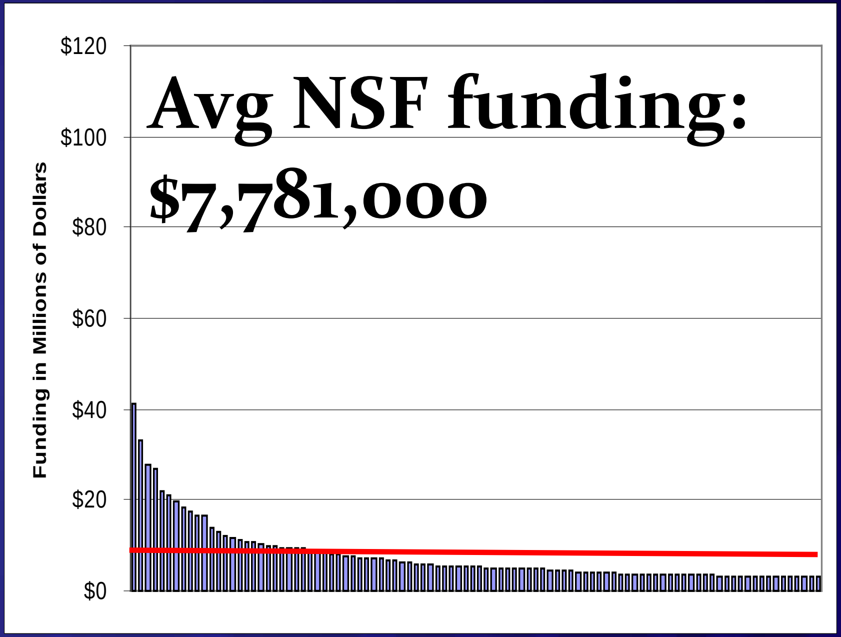
A Related Study:

- Amy Apon, U. Arkansas
  - “Demonstrating the Impact of High Performance Computing to Academic Competiveness”
- Investigating correlation between
  - University investment in CI
    - In this case, was there a machine in the “Top 500”
  - Research productivity measures
    - NSF Funding, federal funding, publications, etc

With HPC Investment

Without HPC Investment





FY06: 95 of Top NSF-funded Universities with HPC

98 of Top NSF-funded Universities without HPC

Amy Apon, aapon@uark.edu

Caveats

- Correlation not causation
- Open question if these are the right things to measure
- Dr. Apon herself says this is very preliminary
  - But follow on work is fascinating
- Another open question – how do we measure return on investment?

CI in EPSCoR

- Networking
- Data Sharing
- Collaboration

Research Infrastructure Improvement Awards (RII) Cyber Connectivity (C2)

- Up to 2 years and $1M
- Support inter-campus and intra-campus cyber connectivity and broadband
- Across a EPSCoR jurisdiction
- In FY10: 23 Props Rec'd; 17 Funded (ARRA)
- In FY 11: 12 eligible jurisdictions

Networking can...

- Support applications accessing remote data sources
- Support educational opportunities
- Support collaborations

- SUPPORT SCIENCE!

Data Sharing

- To support collaborations, cross- disciplinary, transformational research, curation of data is the keystone

Digital resources that are not properly curated do not remain accessible for long

Study	Resource Type	Resource Half-life
Koehler (1999 and 2002)	Random Web pages	2.0 years
Nelson and Allen (2002)	Digital Library Object	24.5 years
Harter and Kim (1996)	Scholarly Article Citations	1.5 years
Rumsey (2002)	Legal Citations	1.4 years
Markwell and Brooks (2002)	Biological Science Education Resources	4.6 years
Spinellis (2003)	Computer Science Citations	4.0 years

Source: Koehler W. (2004) Information Research, 9 (2), 174

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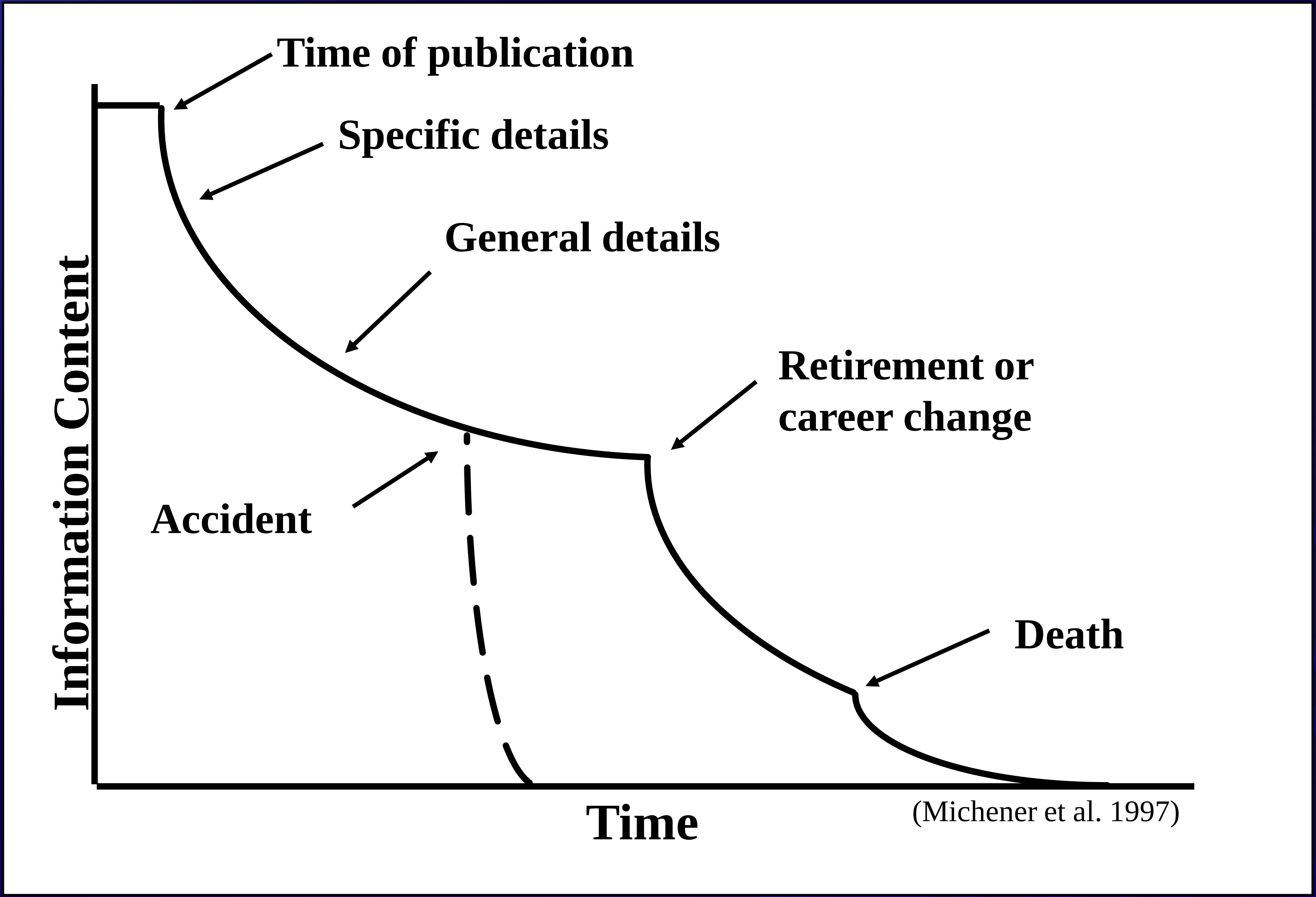
Poor Data Practices



(Michener et al. 1997)

The Shift Towards Data *Implications*

- All science is becoming data-dominated
  - Experiment, computation, theory
- Totally new methodologies
  - Algorithms, mathematics
  - All disciplines from science and engineering to arts and humanities
- End-to-end networking becomes critical part of CI ecosystem
  - Campuses, please note!
- How do we train “data-intensive” scientists?
- Data policy becomes critical!

Long Standing NSF Data Policy

“Investigators are expected to share with other researchers, at no more than incremental cost and within a reasonable time, the primary data, samples, physical collections and other supporting materials created or gathered in the course of work under NSF grants. Grantees are expected to encourage and facilitate such sharing.”

Has not been widely enforced, with a few exceptions like OCE

NSF Proposal and Award Policy and Procedure Guide, Award and Administration Guideline PDF page 61

http://www.nsf.gov/pubs/policydocs/pappguide/nsf10_1/aagprint.pdf

Changing Data Management Policy IMPLEMENTATION

- Planning underway for 2+ years within NSF
- May 5, 2010 National Science Board meeting
  - Change in the implementation of the existing policy on sharing research data discussed
- Oct 1, 2010
  - Change in the NSF GPG released

http://www.nsf.gov/news/news_summ.jsp?cntn_id=116928&WT.mc_id=USNSF_51

http://news.sciencemag.org/scienceinsider/2010/05/nsf-to-ask-every-grant-applicant.html

As of January 2011:

- All proposals must include a data management plan
- Two-page supplementary document
- Can request budget to cover costs
- Echos the actions of other funding agencies
  - NIH, NASA, NOAA, EU Commission

http://www.nsf.gov/pubs/policydocs/pappguide/nsf11001/gpg_index.jsp

Guidelines will be Community Driven

- Avoid a one-size-fits-all approach
  - Different disciplines encourage the approaches to data-sharing as acceptable within those discipline cultures
- Data management plans will be subject to peer review, community standards
  - Flexibility at the directorate and division levels
  - Tailor implementation as appropriate
- Request additional funding to implement their data management plan

DMP cont.

- DMP may include only the statement that no detailed plan is needed
    - Statement must be accompanied by a clear justification
- DMP will be reviewed as an integral part of the proposal, coming under Intellectual Merit or Broader Impacts or both, as appropriate for the scientific community of relevance

Directorate, Office, Program Specific Requirements

http://www.nsf.gov/bfa/dias/policy/dmp.jsp

- If guidance specific to the program is not available, then the requirements in GPG apply
- Individual solicitations may have additional requirements as well

One More Thing to Keep In Mind

- This policy mandates that you have to make your data accessible
  - Archive, open access, metadata tagged
- This is actually the easy step

- Getting the data out again, using other people’s data – a MUCH harder problem
  - But not part of this work

Collaborations

Research Infrastructure Improvement Awards (RII) Track 1

- Up to 5 years and $20M
- Improve physical and human infrastructure critical to R&D competitiveness
- Priority research aligned with jurisdiction S&T plan

- In FY 2009: 9 Proposals Received; 6 Funded
- In FY 2010: 14 Proposals Rcv'd; 7 Funded
- In FY 2011: 7 eligible jurisdictions

Research Infrastructure Improvement Awards (RII) Track 2

- Up to 3 years and $6M
- Consortia of jurisdictions
- Support innovation-enabling cyberinfrastructure
- Regional, thematic, or technological importance to suite of jurisdictions

- In FY 09: 9 Props Rec’d; 7 Funded (5 ARRA)
- In FY10: 9 Props Rec’d; 5 Funded
- In FY11: 6 eligible jurisdictions

Collaborations

- Support the jurisdiction S&T plans
  - Includes industry involvement
- Support the jurisdiction CI plan
- Support research and education across the jurisdiction
  - Including community colleges, tribal colleges, PUI's, and others
- Support workforce development, external outreach

Research Is Changing

- Geographically distributed user communities
  - Numerous labs, universities, industry
- Integration with other national resources
  - Inevitably multi-agency, multi-disciplinary
- Extremely large quantities of data
  - Petabyte data sets, with complex access patterns
  - Also thousands of SMALL data sets
  - None of it tagged as you need it, or in the right format
- EPSCoR and NSF are growing and changing to support new science

More Information

- Jennifer M. Schopf
  - jschopf@nsf.gov
  - jms@nsf.gov

- Dear Colleague letter for CF21

http://www.nsf.gov/pubs/2010/nsf10015/nsf10015.jsp