# Cyberinfrastructure for Research: New Trends and Tools (Part 1 of 2)

Craig Stewart
ORCID ID 0000-0003-2423-9019
Jetstream Principal Investigator
Executive Director, Indiana University Pervasive Technology Institute
September 30 2015
Presented at University of Vermont, Burlington VT

Supplemental line if need be (example: Supported by the National Science Foundation) Delete if not needed.





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### Introduction and outline

- What is cyberinfrastructure, anyway?
  - First used in security briefing by Richard Clark in 1998.
  - Cyberinfrastructure consists of systems, advanced instruments and data repositories, visualization environments, and people, all linked together by software and high-performance networks to improve research productivity and enable breakthroughs not otherwise possible.

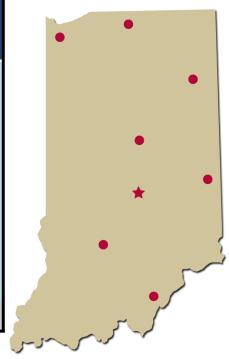
### Outline

- A bit of IU history
- Some thoughts about the current technology environment
- Nationally accessible resources (effort, but no \$\$ needed)
- Cyberinfrastructure as an ecosystem problem
- Note: slides will be posted online within a day or two





		Nonacademic		Grad. & Prof.
Campus	appointees	Staff	Students	Students
IUB	2,942	5,379	32,371	9,762
IUPUI	3,895	4,449	22,271	8,180
<b>IU Northwest</b>	425	243	5,636	548
<b>IU South Bend</b>	542	305	7,860	630
IU East	267	159	4,052	134
<b>IP Fort Wayne</b>	N/A	N/A	N/A	N/A
IU Kokomo	191	138	3,581	138
<b>IU Southeast</b>	498	243	6,203	701
Totals	8,760	10,916	81,974	20,093



### 1,200 degree programs

IU community: 121,743 people total

1.2 million credit hours per semester

Two core research/education campuses, six regional campuses

Tuition and mandatory fees per year: \$12,000 per year for Indiana Residents





# Key IU metrics – IU's scale helps, but CI strategy scales down pretty well



IU Budget Category	2012/2013 Budget
Unrestricted	\$2,155,174,476
Restricted	\$640,532,854
Auxiliary	\$403,026,761
Total	\$3,198,734,091



- -No agricultural research
- -No veterinary school

IU Health Patient Metrics – 2012/2013				
Admissions	143,219			
<b>Outpatient visits</b>	2,244,320			
Staffed beds	3,326			





## Strategy Matters

- "If you don't know where you are going, any road will get you there."
   Lewis Carroll
- If you want to go somewhere, set a strategy and pursue it with diligence.
- IU Goals
  - To be a leader, "in absolute terms for uses and applications of IT."
     (1996, Myles Brand, 16th President of IU)
  - To be one of the great public universities of the 21st Century.
     (2008, Michael A. McRobbie, 18th President of IU)
- Culture may eat strategy for breakfast, but only if you are not careful about tactics. With the right tactics and enough time strategy can change culture.







# 1998 – Indiana University Information Technology Strategic Plan: Architecture for the 21st Century

- A University IT strategic plan not a strategic plan for the university IT organization
- 10 Recommendations, 68 Actions
- Theme: Get the technology stacks right (We did not have them right in 1997)



Financing
Network access "In the language of today's technology, "No busy signals!"
Incentivize use of IT
Teaching and learning IT
Research

Student systems
Telecomm convergence
Learning IT
Digital libraries
Policies





# A bit about organizational structure

- CIO
  - Learning Technologies
  - Client Services and Support
  - Enterprise Software
  - Networks
  - GlobalNOC
  - Research Technologies
  - Pervasive Technology Institute
  - University Security & Policy Offices
- Other important roles at IU: President, VPR, Associate Vice Provost for Research, IU School of Medicine Executive Associate Dean



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### How far have we come?

- 1996: You could take everyone who knows how to use a supercomputer and fit them into a small conference room.
- 1997: Why does IU have a display at the Supercomputing Conference? Don't you understand what this conference is about?
- 1998: Start involvement in grid activities that would lead to IU managing Open Science Grid operations
- 2001: Wins largest MRI grant award given by NSF that year.
- 2003: Part of TeraGrid
- 2005: Data Capacitor (MRI)
- 2008: FutureGrid
- 2014: Jetstream



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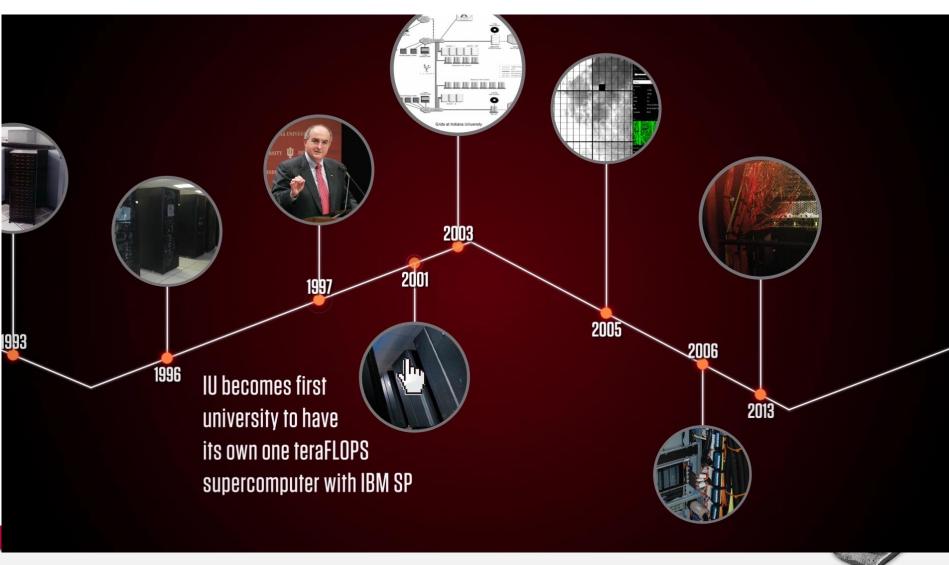




From Research and Academic Computing retreat in 1997 – in midst of UITS formation

Goals (Draft)

- 1. Enhance quality and quantity of research done at IU by providing an excellent research computing environment which both responds to needs and creates new possibilities for IU's researchers. [Partnering making new types of research possible]
- 2. Achieve national prominence in research computing, enabling this to be an area of competitive advantage for IU?
- 3. Provide leadership in deployment and use of new computing technologies





RESEARCH TECHNOLOGIES



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# 2008: 2<sup>nd</sup> IU IT Strategic Plan, Empowering People

- The hard part: role-centric view: 15 Recommendations, 72 Actions.
- http://ep.iu.edu

IT Foundations

- 1. Infrastructure
- 2. Networks
- 4. Financials
- 5. Security
- 6. Environment
- 7. IT Staff

Human-centric IT

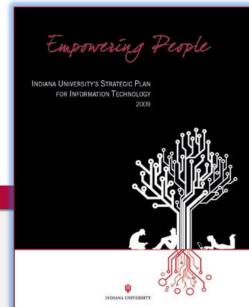
- 8. IT Development
- 9. Institutional Data
- 3. Collaboration 10. Student Success
  - 11. Engagement Beyond

**Grand Challenges** 

- 12. Scholarly Record
- 13. Health Care
- 14. Teaching & Learning
- 15. Research & Scholarship







### RT Goals for 2020 (apply to all staff)

### IU researchers, scholars, students, and artists will

- Use information technology within a policy and security framework that serves as a model for academia and the US in general.
- Be able to pursue their academic and creative activities with no limitations created by access to data, and few limitations caused by access to computational power.
- Be able to examine and present research results or artistic creations in ways that are intuitive and enhance effectiveness through:
  - 2- and 3-D display and interface resources generally available in offices, labs and meeting rooms.
  - State-of-the-art. large-scale facilities located conveniently throughout IU.
- Have access to resources that:
  - Grow in capability and capacity predictably, steadily, and in ways that keep IU
    researchers at the leading edge of discovery.
  - Are available resiliently by design (24 x 365 at never less than 75% aggregate capacity).
  - Are available immediately when immediacy is essential.
  - Are accessible through interfaces that are intuitively usable by the large majority of IU researchers.





## RT Goals for 2020 (2) (apply to all staff)

### Indiana residents will

- Benefit from new, high-quality jobs created by IU's advanced IT environment (at rates exceeding the present job-creation rate and contributing to the Indiana economy). Such jobs will be created in three ways:
  - Bring federal money into the state to create new jobs.
  - Attract existing companies to locate major business operations in Indiana.
  - Create new companies through commercialization of IU innovations.
  - We will measure accomplishment by job creation (direct and indirect), and by IU rankings in major economic assessments – rising at least five places in one of the major rankings from 2008 to 2020
- Have access to education and training so anyone growing up in Indiana can strive for and obtain
  one of these high-quality jobs. The School of Informatics and Computing and other IU schools
  produce well-educated graduates, many of whom stay in Indiana.
- Have an improved quality of life stemming from these achievements:
  - We will help IU biomedical research and health services communities improve state rankings in such major health indicators as obesity and tobacco use.
  - US and world residents will benefit through access to information technology services and ITrelated information made available by IU and benefit from IT-related outcomes of IU discoveries and innovations.







# We've supported some REALLY cool research and creative activity along the way.

- Higgs boson
- One-Degree Imager
- Operation Ice Bridge
- Just doin' the neutron dance
- Daphnia genome
- Fetal alcohol spectrum disorder
- Indiana CTSI
- Cell-surface function
- History of philosophy and science
- Variations
- Ethnography
- Music composition
- Fine arts
- Performing arts







### Fine Arts



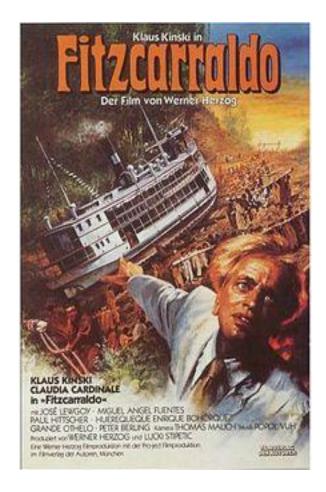
Photo: Ed Dambik; used with permission; may not be reused without permission.



Light Totem by Rob Shakespeare; Photo: Chris Eller; cc by 3.0 license.







## Performing Arts



**IUPUI Percussionist / Composer Scott Deal** 

IU Cinema – e.g., DCP for Herzog films

Image: http://en.wikipedia.org/wiki/File:Fitzcarraldo.jpg







# Humanities - http://webapp1.dlib.indiana.edu/newton/



I saac Newton, like Albert Einstein, is a quintessential symbol of the human intellect and its ability to decode the secrets of nature. Newton's fundamental contributions to science include the quantification of gravitational attraction, the discovery that white light is actually a mixture of immutable spectral colors, and the formulation of the calculus. Yet there is another, more mysterious side to Newton that is imperfectly known, a realm of activity that spanned some thirty years of his life, although he kept it largely hidden from his contemporaries and colleagues. We refer to Newton's involvement in the discipline of alchemy, or as it was often called in seventeenth-century England, "chymistry." Newton wrote and transcribed about a million words on the subject of alchemy. Newton's alchemical manuscripts include a rich and diverse set of document types, including laboratory notebooks, indices of alchemical substances, and Newton's transcriptions from other sources.

#### Newton & Alchemy

It is important to see how chemical technology and medicine were connected to Newton's involvement to the "Great Work," just as it is important to see how his chymistry was related to his other intellectual and technical pursuits. Newton & Alchemy

#### Latent Semantic Analysis

Computational tools to aid analysis of the language and projects encompassed in Newton's alchemical manuscripts. Latent Semantic Analysis

#### **Featured Presentation**

William R. Newman presented a lecture titled Why did Isaac Newton Believe in Alchemy? at the The Perimeter Institute on October 2, 2010. Project Presentations





# Aiding global environment and Indiana economy



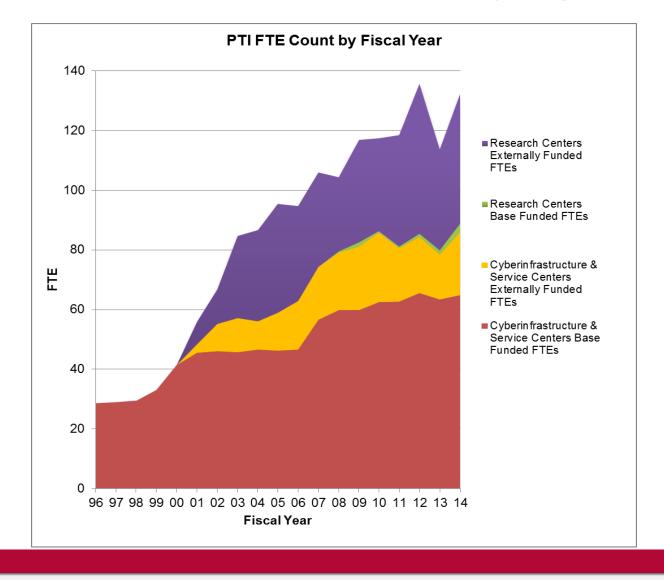
- Working with Cummins to explore combustion of new biofuels
- How are soot particles created during and after combustion?
- Collaborating with Convergent Sciences, maker of the popular Converge CFD application, and Lawrence Livermore National Lab







# Promises, promises: Continued job growth...







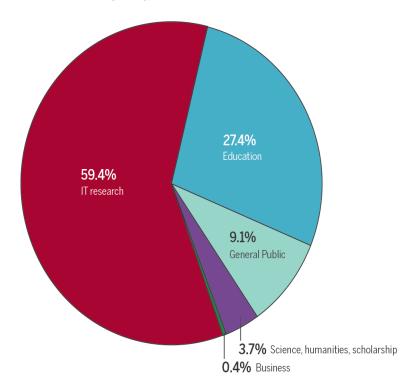


### How the US sees us: Education and Outreach



### **PTI EOT Events by Attendance Numbers**

Overall audience reached during reporting period: 7706



Graphic by Ryan Cobine and Beth Plale







# Nationally we are at a point of particularly rapid change

- Opportunities
  - Vast majority of data created today are born digital
- Diversity of analysis frameworks
  - Traditional MPI & OpenMP parallel programming
  - MapReduce
  - Cloud computing in general
  - New interfaces such as gateways
- Diversity of processors
  - Stability of AMD Intel Nvidia détente is gone
  - Will new Intel processors work?
  - What about ARM?







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- Stewart, C.A. 2015. Cyberinfrastructure for Research: New Trends and Tools (Part 1 of 2). Presentation. University of Vermont, Burlington, VT. 30 September 2015. http://hdl.handle.net/2022/20414
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