The Ultimate Intelligent Platform:

The American Research University

The Age of Knowledge

Educated people and ideas →

Prosperity

Security

Social well-being

Educated people are the most valuable resource for 21st societies and their institutions!!!

Forces of Change

A Changing World

The Knowledge Explosion

Globalization

High Performance Workplace

Diversity

Technological Change

Knowledge Transfer

→

Forces on the University

Economics

Societal Needs

Technology

Markets

→

Evolution?

Revolution?

Extinction?

The Future of the University?

“Thirty years from now the big university campuses will be relics. Universities won’t survive. It is as large a change as when we first got the printed book.”

– *Peter Drucker*

“If you believe that an institution that has survived for a millennium cannot disappear in just a few decades, just ask yourself what has happened to the family farm.”

– *William Wulf*

“I wonder at times if we are not like the dinosaurs, looking up at the sky at the approaching comet and wondering whether it has an implication for our future.”

– *Frank Rhodes*

Outline

- The American Research University, Inc.
- A Restructured Knowledge and Learning Industry
- Possible Strategies
- “Knowledge Management” in the Research University
- The Future of the University

The American Research University

Traditional Roles of the University: The Core

Educating the Young

Seeking Truth
and Creating
New Knowledge

Sustaining and
Propagating
Culture and Values

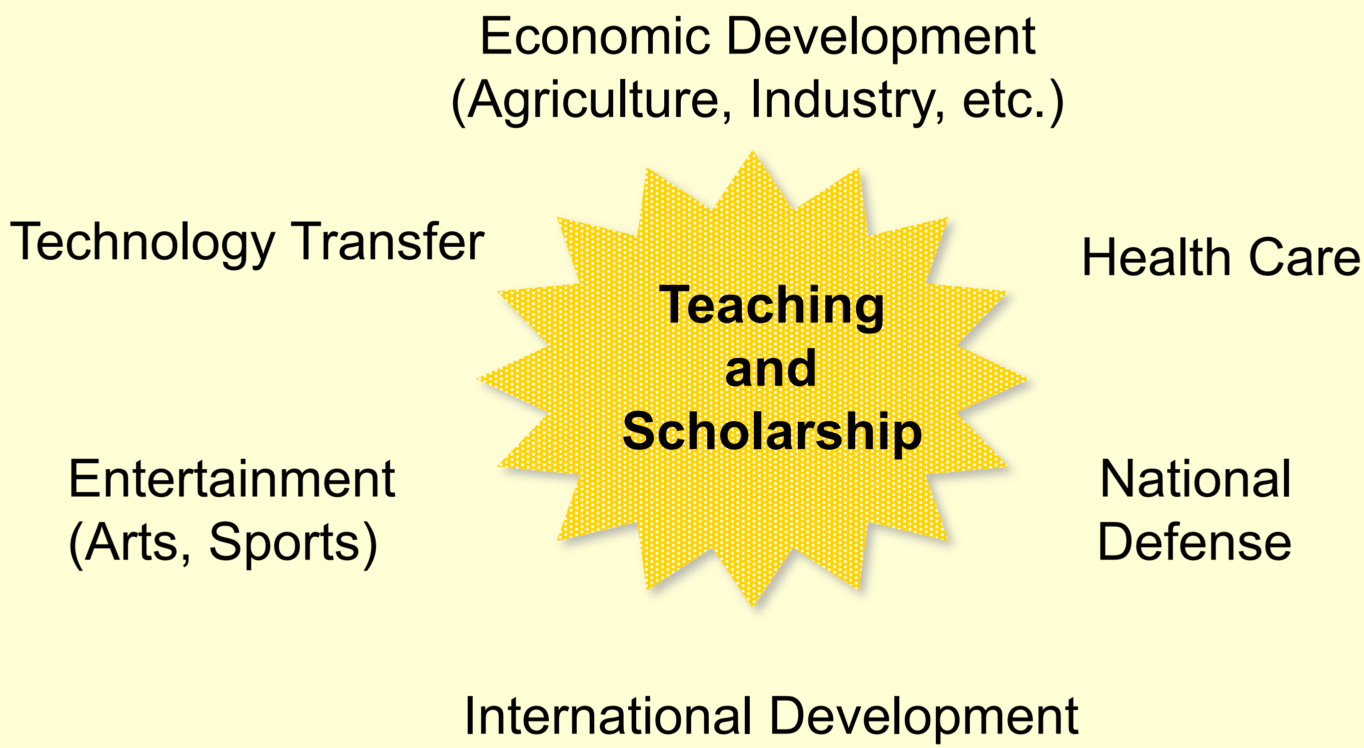
**Teaching
and
Scholarship**

Sustaining
Academic Disciplines
and Professions

Serving as a
Social Critic

Critical Thinking
Analysis and Problem Solving
Moral Reasoning and Judgment

The Traditional Roles of the University: The Periphery



Case Study 1

Higher Education in the United States

The Evolution of U.S. Higher Education

1700s…Frontier America	→	Colonial Colleges
1800s…Industrial Society	→	Land-Grant Universities
1900s…Rise of Professions	→	Technical Colleges
1940s…WWII, the Cold War	→	Research Universities
1950s…Mass Education	→	University Systems
1990s…Market Forces	→	Cyber-U, Global U, For-profit U

The United States Higher Education “System”

AAU-Class Research Universities (60)

Research Universities (115)

Doctoral Universities (111)

Comprehensive Universities (529)

Baccalaureate Colleges (637)

Two-Year Colleges (1,471)

Total U.S. Colleges and Universities: 3,595

The Evolving U.S. Education System

For profit U
(650)

Open U

Corporate U
(1,600)

AAU Res U
Res U I, II
Doc U I, II
Comp U I, II
Lib Arts Colleges
Community Colleges
K-12

Cyber U
(1,000)

Niche U

New learning
lifeforms

Knowledge Infrastructure
(production, distribution, marketing, testing, credentialing)

Some Other Characteristics of the U.S. System of Higher Education

- 65% of high school graduates attend college
  - (although only 50% of these will receive degrees)
- 15 million students enrolled in 3,595 colleges and universities
  - (520,000 international students)
- 80% of students enrolled in “public” universities
- $200 billion/year spent on U.S. higher education
  - $50 billion/y in federal student financial aid
  - $20 billion/y in federal research grants
  - $60 billion/y in state (regional) appropriations
  - $70 billion/y in tuition, gifts, business activities, etc.

The Role of Government in the U.S.

- The Federal Government:
  - No ministry, no national system, no controls…no policy
  - $50 B/y of financial aid for students
  - $15 B/y of research grants to faculty
  - NOTE: The federal government provides funds to people (students, faculty, patients), not universities.

- State Governments:
  - $65 B/y to support operation of public universities
  - Great diversity in state governance, from rigidly controlled systems (New York, Ohio) to strategic master plans (California) to anarchy (Michigan)

Case Study 2

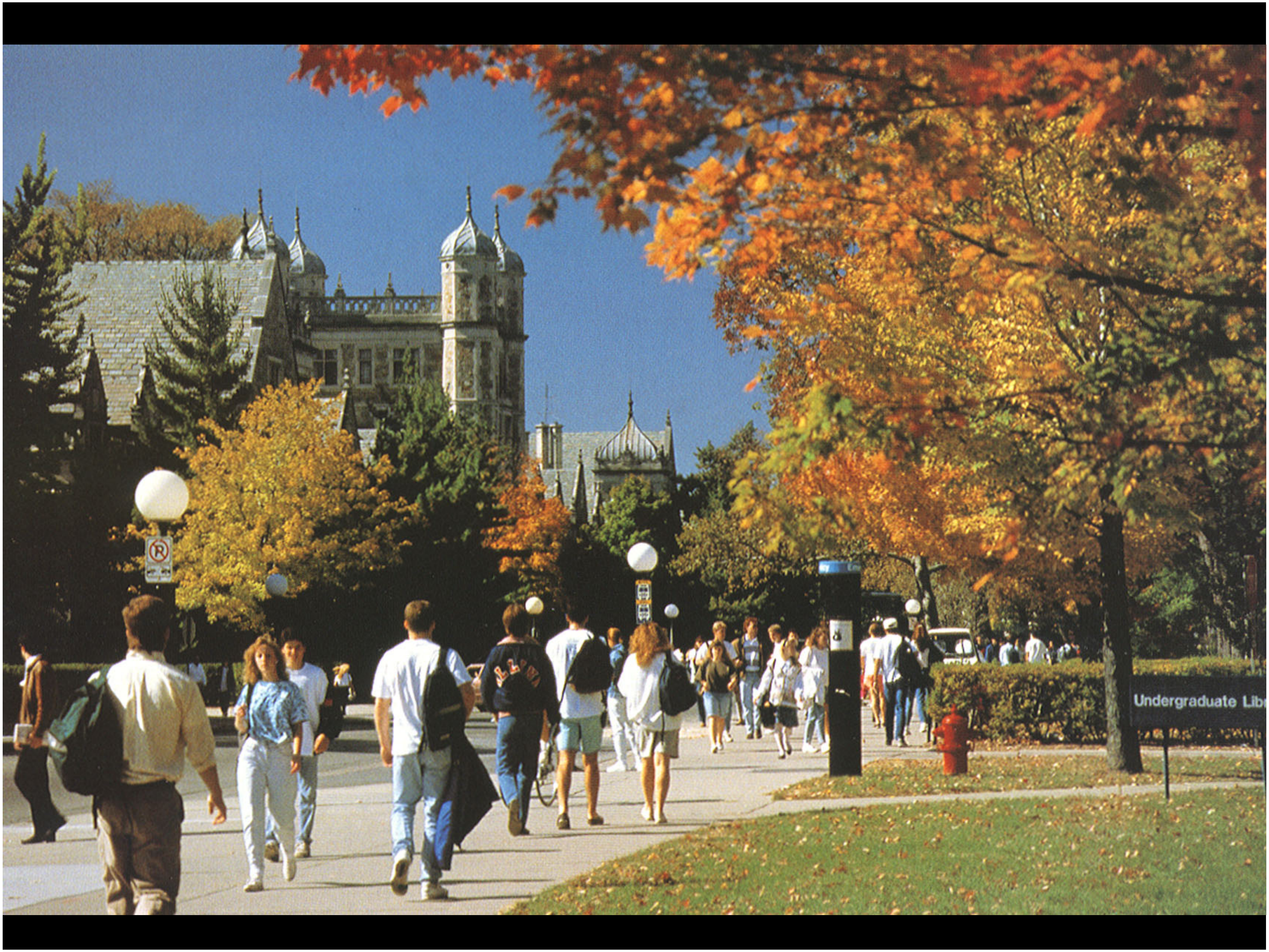
The University of Michigan

University of Michigan

- First truly public university in United States (1817)
- Constitutional autonomy
- One of U.S.'s largest universities
  - People: 50,000 students; 3,500 faculty, 25,000 staff
  - Budget: $3.4 billion/year; ($3.9 billion endowment)
  - Facilities: 3 million m^2 of facilities
  - Campuses in Europe, Hong Kong, Korea, Brazil, cyberspace
- One of U.S.'s leading research universities (> $700 million/year)
- Some other features:
  - First university hospital (1 million patients a year, $1.4 billion/year)
  - Key role in developing and managing the Internet (now Internet2)

UM Schools and Colleges

- Architecture
- Art and Design
- Business Administration
- Dentistry
- Education
- Engineering
- Graduate programs
- Information
- Kinesiology
- Law
- Humanities
- Medicine
- Music
- Natural Resources
- Nursing
- Pharmacy
- Public Health
- Public Policy
- Sciences
- Social Work


Undergraduate Lib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STATES

THIS FLAG CARRIED ABOARD APOLLO 15 DURING THE FIRST EXTENDED SCIENTIFIC EXPLORATION OF THE MOON. JULY 26 — AUGUST 7, 1971


MICHIGAN
MICHIGAN


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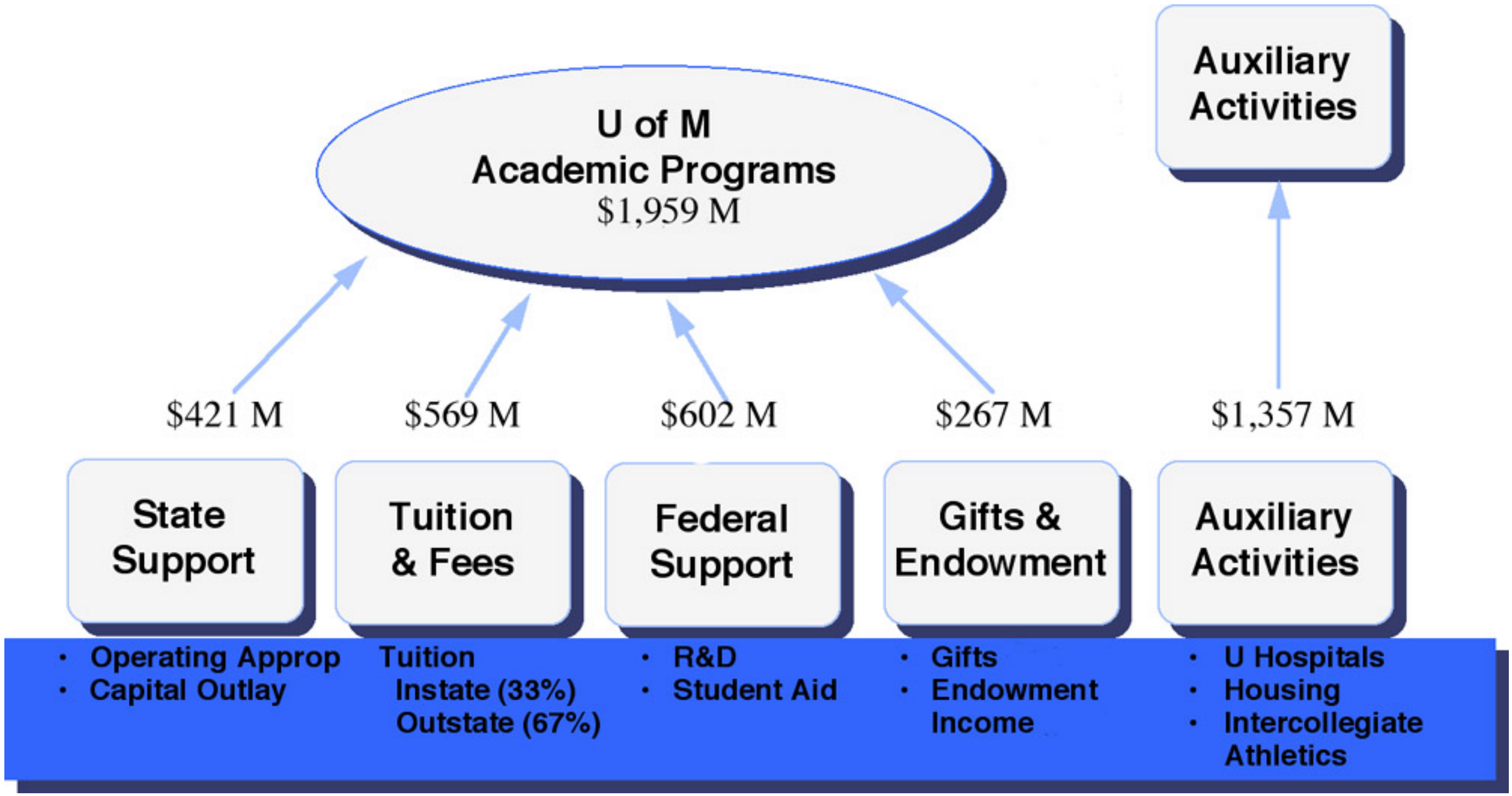
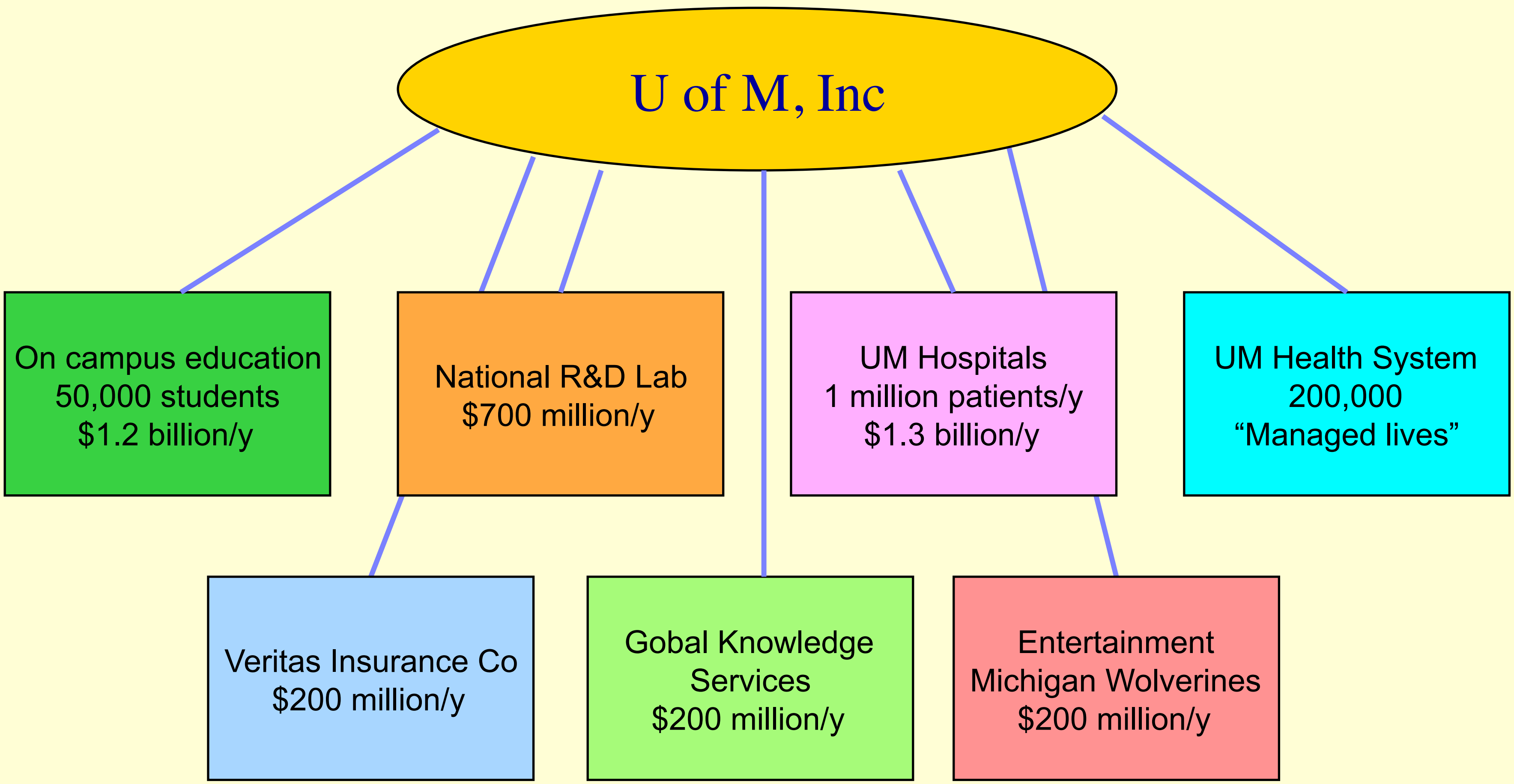
NATIONAL CHAMPIONS
MICHIGAN

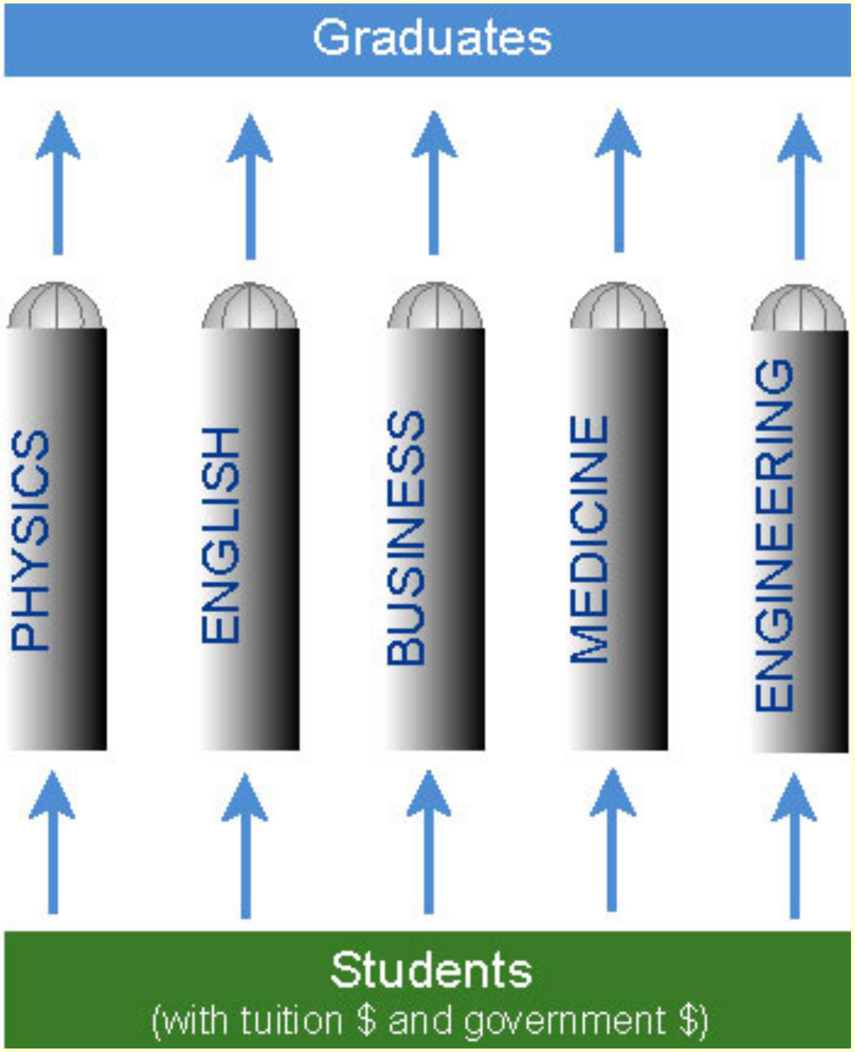
Financing the University



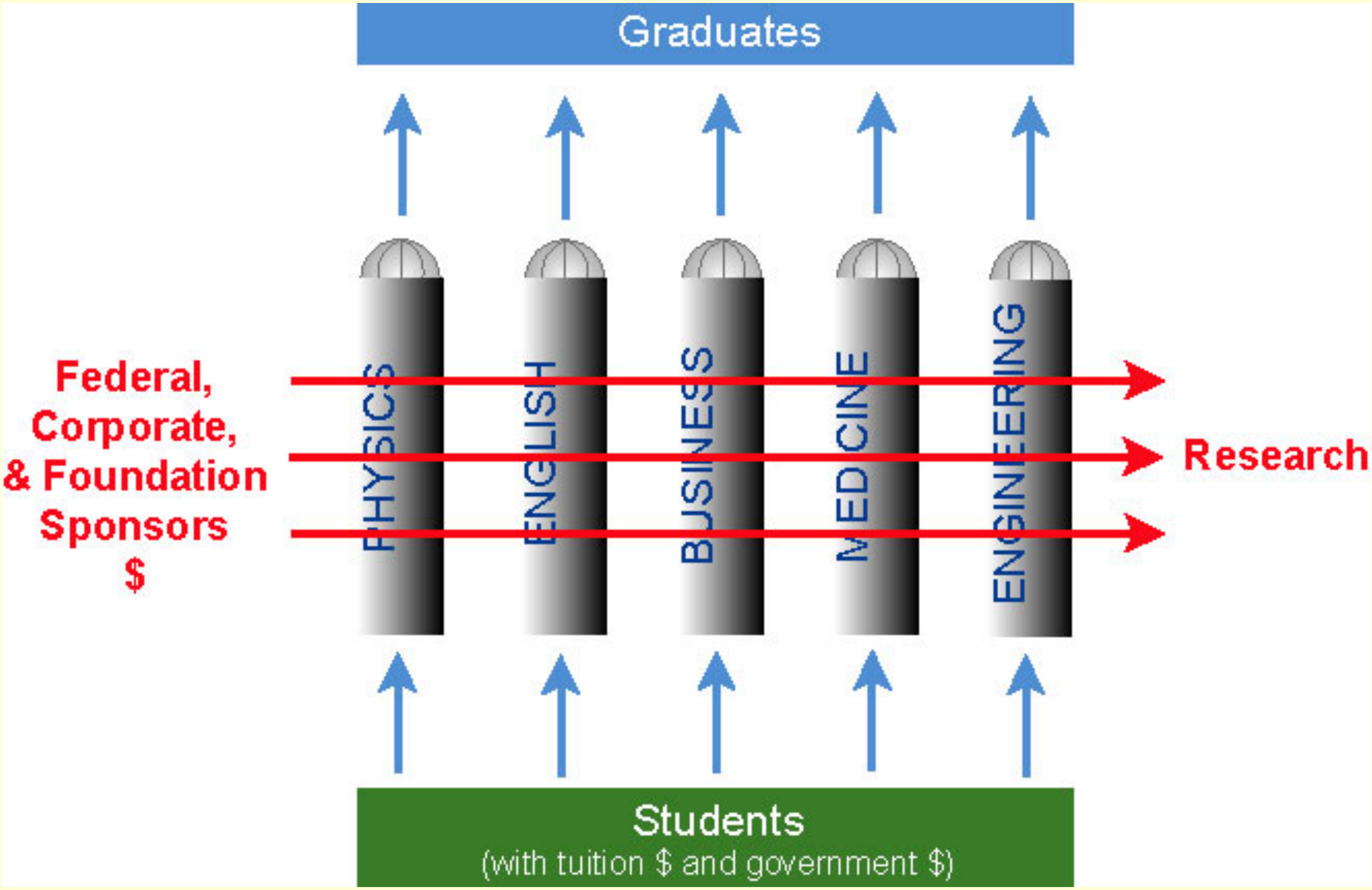
Another way to look at UM



First, a fact of university life: disciplinary silos



But in a research university…



Another way to think of the research university:

- “The contemporary research university is nothing more than a holding company for research entrepreneurs!”

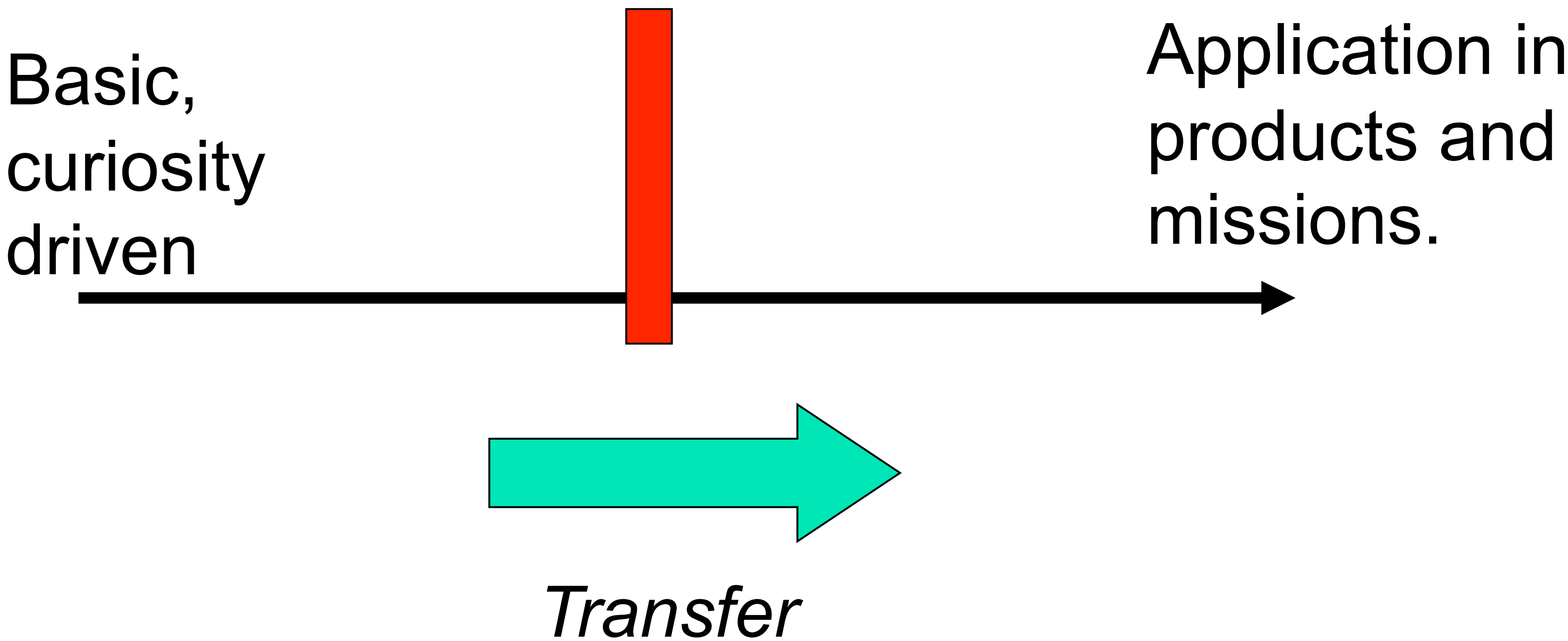
  A frustrated junior faculty member

- “Our faculty members can do anything they want– provided they can raise the funds to support what they do…”

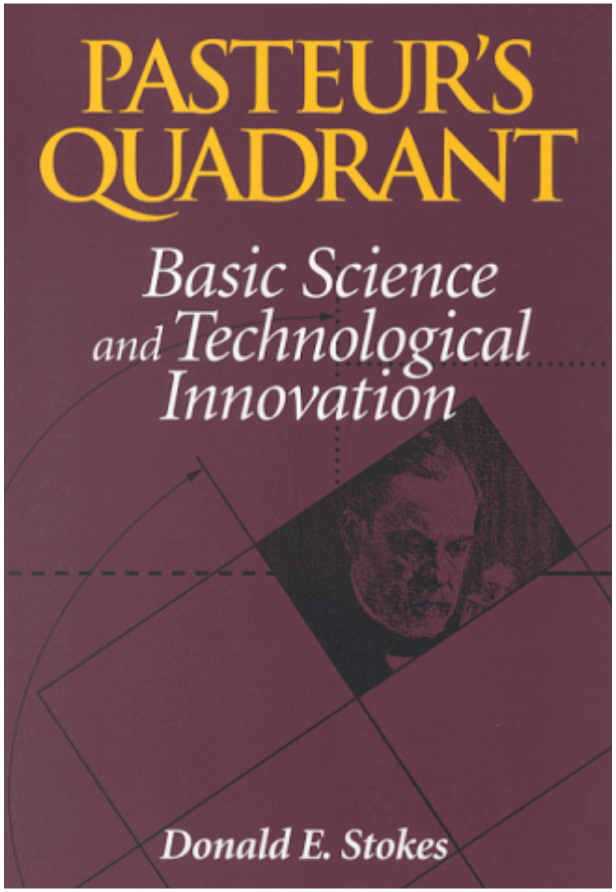
  A former MIT president

Vannevar Bush Linear Model of Research

Science: The Endless Frontier



Pasteur’s Quadrant



Pasteur's Quadrant Research Model (from Donald Stokes)

Extent of Focus on New Knowledge Creation?

Extent of Focus on Application/Product

Pasteur's Quadrant Research Model (from Donald Stokes)

Focus on New Knowledge Creation?		Focus on Application? No	Focus on Application? Yes
	Yes	Bohr	Pasteur
	No		Edison

The Forces of Change

Forces of Change

A Changing World

The Knowledge Explosion

Globalization

High Performance Workplace

Diversity

Technological Change

Knowledge Transfer

→

Forces on the University

Societal Needs

Economics

Technology

Markets

→

Brave New World?

Society of Learning?

Changing Societal Needs

- Increasing population of “traditional” students
- The “plug and play” generation
- Education needs of adults in the high-performance workplace (lifelong learning)
- Passive student to active learner to demanding consumer
- “Just-in-case” to “just-in-time” to “just-for-you” learning
- Diversity (gender, race, nationality, socioeconomic,…)
- Global needs for higher education

Concern: There are many signs that the current paradigms are no longer adequate for meeting growing and changing societal needs.

Global Needs

Half of the world's population is under 20 years old.

Today, there are over 30 million people who are fully qualified to enter a university, but there is no place available. This number will grow to over 100 million during the next decade.

To meet the staggering global demand for advanced education, a major university would need to be created every week.

"In most of the world, higher education is mired in a crisis of access, cost, and flexibility. The dominant forms of higher education in developed nations–campus based, high cost, limited use of technology–seem ill-suited to addressing global education needs of the billions of young people who will require it in the decades ahead."

Sir John Daniels, British Open University

Financial Imperatives

- Increasing societal demand for university services (education, research, service)
- Increasing costs of educational activities
- Declining priority for public support
- Public resistance to increasing prices (tuition, fees)
- Inability to re-engineering cost structures

Concern: The current paradigms for conducting, distributing, and financing higher education may not be able to adapt to the demands and realities of our times

Technology

Since universities are knowledge-driven organizations, it is logical that they would be greatly affected by the rapid advances in information and communications technologies

We have already seen this in administration and research.

But the most profound impact could be on education, as technology removes the constraints of space, time, reality (and perhaps monopoly …)

Concern: The current paradigm of the university may not be capable of responding to the opportunities or the challenges of the digital age.

Market Forces

Changing societal needs, economic realities, and rapidly evolving technology are creating powerful market forces in the higher education enterprise. The traditional monopolies of the university, sustained in the past by geography and certification, are breaking apart.

We may be seeing the early signs of a **restructuring** of the higher education enterprise into a global knowledge and learning industry.

Concern: The current faculty-centered, monopoly-sustained university paradigm is ill suited to the intensely competitive, technology-driven, global marketplace.

The Restructuring of the Higher Education Enterprise into a Global Knowledge and Learning Industry

Market Forces

Changing Social Needs

Financial Imperatives

Evolving Technology

Powerful Market Forces

The Role of Markets

The U.S. higher education enterprise is highly competitive!

- For students (particularly the best)
- For faculty (particularly the best)
- For public funds (research grants, state appropriations)
- For private funds (gifts, commercial)
- For winning athletics programs
- For everything and everybody…

The Role of Markets

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- For everything and everybody…

In a sense, Michigan competes not only with UC-Berkeley, Harvard, and MIT, but also with Oxford and Cambridge, not to mention IBM and Microsoft!

A Restructured Industry?

There are signs that higher education may be in the early stages of a major restructuring like other economic sectors such as energy, banking, and transportation that underwent restructuring following deregulation.

The restructuring of the higher education enterprise is being driven by changing social needs, financial pressures, rapidly evolving technology, and most significantly, emerging market forces. These are also driving a convergence of education with other knowledge-intensive industries such as information technology, telecommunications, information services, and entertainment into what might be regarded as:

A Global Knowledge and Learning Industry

A Quote from a Venture Capital Prospectus

"As a result, we believe education represents the most fertile new market for investors in many years. It has a combination of large size (approximately the same size as health care), disgruntled users, lower utilization of technology, and the highest strategic importance of any activity in which this country engages . . . . Finally, existing managements are sleepy after years of monopoly."

Scenario 1

The Brave, New World

of

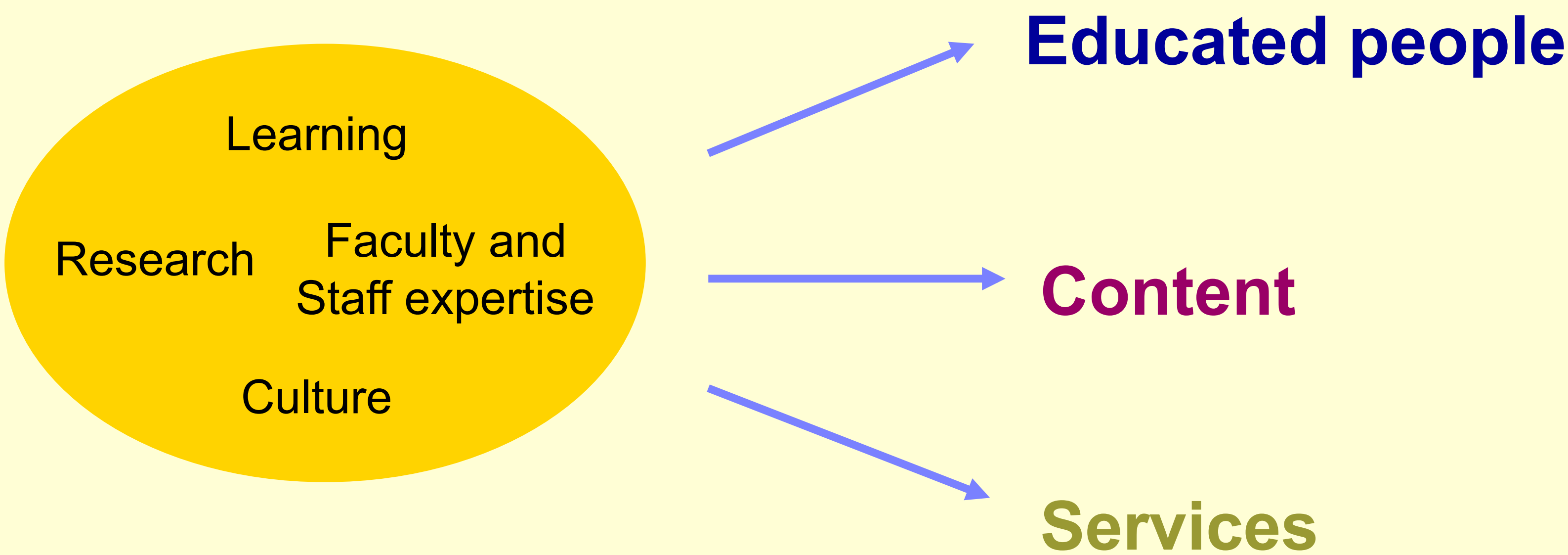
Commercial Higher Education

Contributions of the Research University

The Knowledge Industry

Hardware →	Boxes, PCs, PDAs →	IBM, HP, Sun, Lucent, Nokia, Ericcson
Networks →	Backbones, LANs, Wireless →	AT&T, MCI, Telcoms
Software →	OS, Middleware, Applications →	Microsoft, IBM, Sun
Solutions →	Systems, Integrators →	Accenture, EDS, IBM, Unisys
Content →	Data, Knowledge, Entertainment, Learning? →	Time-Warner, Disney, "dot.coms", **AAU?**

The Core Competencies of the University



A Possible Future for the U.S. Higher Education Enterprise

- $300 billion ($3 trillion globally)
- 30 million students
- 200,000 faculty “facilitators”
- 50,000 faculty “content providers”
- 1,000 faculty “celebrity stars”

Supported by a commercial industry handling the production and packaging of learning ware, the distribution and delivery of educational services to learners, and the assessment and certification of learning outcomes.

(compared to 800,000 current faculty serving a $180 billion enterprise with 15 million students …)

Possibilities

- Unbundling
- A commodity marketplace
- Mergers, acquisitions, hostile takeovers
- New learning lifeforms
- An intellectual wasteland???

Scenario 2

A Society of Learning

A Society of Learning

Since knowledge has become not only the wealth of nations but the key to one's personal prosperity and quality of life, it has become the responsibility of democratic societies to provide their citizens with the education and training they need, throughout their lives, whenever, wherever, and however they desire it, at high quality and at an affordable cost.

Key Characteristics of Education in a Society of Learning

- Learner-centered
- Affordable
- Lifelong learning
- A seamless web
- Interactive and collaborative
- Asynchronous and ubiquitous
- Diverse
- Intelligent and adaptive

A Key Policy Question

How do we balance the roles of market forces and public purpose in determining the future of higher education. Can we control market forces through public policy and public investment so that the most valuable traditions and values of the university are preserved?

Or will the competitive and commercial pressures of the marketplace sweep over our institutions, leaving behind a higher education enterprise characterized by mediocrity?

Which of the two scenarios will be our future?

Strategies

Challenges to Change

- The complexity of the contemporary university
- The unrelenting pace of change
- Resistance to change (from within and without)
- Mission creep
- Antiquated governance of universities

Begin with the basics: mission and values

- What are our most important roles? Educating the young? Preserving and transmitting culture? Basic research and scholarship? Sustaining the academic disciplines and professions? A responsible critic of society?

- What are our most important values? Academic freedom? An openness to new ideas? Rigorous study? Faculty governance? Faculty tenure?

The Importance of Diversity

- Diverse institutions to serve diverse societal need (diversity in every human characteristics…race, gender, nationality, socioeconomic background, …)
- Importance of stratified systems, tiered to both achieve excellence and serve mass education needs (e.g., the California master plan)
- Focus on missions that reflect not only tradition and unique roles but also core competencies where institutions can attempt to be world-class
- Avoid the "Harvardization" syndrome

Achieving balance

- Among missions (teaching, research, service)
- Among disciplines (liberal education, academic disciplines, professions)
- Undergraduate vs. graduate vs. professional education (e.g., education vs. training)
- Sciences vs. humanities
- Life sciences vs. everything else (U.S. dilemma)

Governments and Governance

- Public policy that views the university as
  - A “public good” or an individual benefit?
  - A public investment or an expenditure?
  - A government agency or a social institution?
- Increasing government demands for accountability and performance
- Shared governance (rigor mortis or anarchy?)

Financing the University

- Who pays? Governments? Students? Research sponsors? Private donors? Marketplace?
- Tax policy that stimulates private donations (charitable contributions)
- Ownership of intellectual property (Bayh-Dole Act)
- The entrepreneurial university
- The “privately-supported but publicly-committed” university

Alliances

- As universities become more specialized and differentiated, alliances become more important
- Among different types of institutions (research universities, polytechnics, liberal arts colleges)
- International alliances (e.g., Erasmus-Socrates, Bologna Declaration)
- Symbiotic relationships (industry, government)

Experimentation

- Change is accelerating. The future is becoming less certain.
- One possible approach to uncertainty is explore possible futures through experimentation and discovery.
- To encourage a higher-risk culture in which occasional failure is tolerated
- To encourage grass-root engagement of faculty and students (to ban the word “No” from the vocabulary of administrators and bureaucrats)

An Example: the University of Michigan

During the 1990s we explored an array of new paradigms

- A privately-supported, public university (restructuring financing by increasing tuition, federal R&D support, private gifts, endowments, reserves,and moving to more efficient management styles)
- A diverse university with respect to race, gender, nationality, socioeconomic background, etc.
- A world university with programs in Asia, Europe, Latin America, and Africa
- A cyberspace university, with leadership through the Internet (and now Internet2)

“Knowledge Management” in the Research University

IT and the University

Technologies to operate the university as an enterprise

- Information management and collaboration
- Integration of back end, auditing, etc.
- Governance (board, faculty senate, etc.)
- Employee relations (unions, academic staff, etc.)
- Procurement (products, students, etc.)
- Customer relationship management (counseling, careers, scholarships, alumni)
- Marketing (products, services, students)

The University as a Vendor

- Education-traditional (course materials, lectures, classes, credentials)
- Education-nontraditional (part-time, distant, executive)
- Hotel (room, board, parking, telecom,)
- Student and staff services (counseling, content distribution)
- Products and services (publications, intellectual property, entertainment,)
- Consulting and contract research

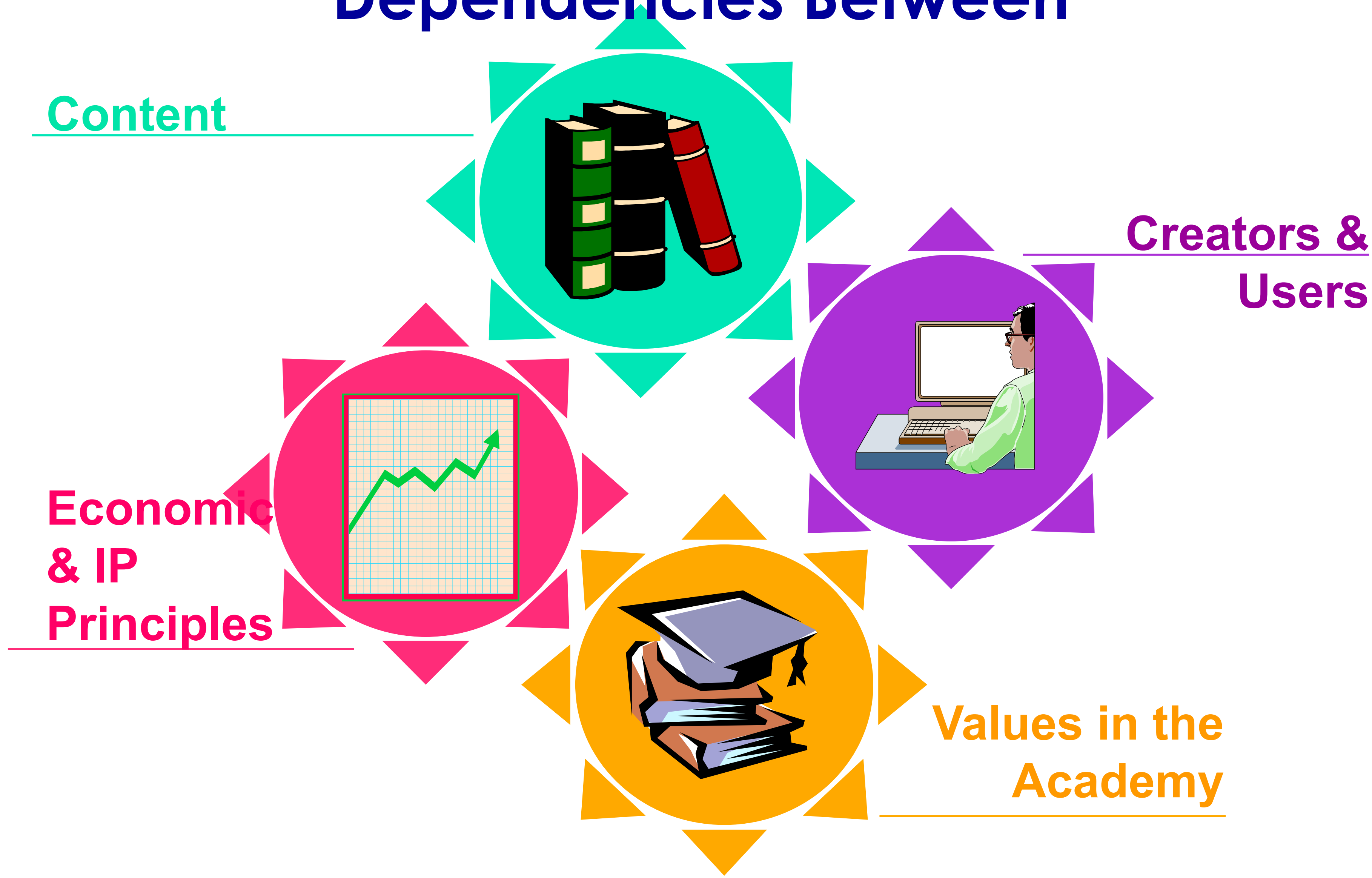
IT and Knowledge Management

- Knowledge creation
  - Traditional models (single investigators)
  - Multidisciplinary, multi-institution
- Knowledge college and integration
  - Libraries
  - New forms, sources, collections
- Knowledge dissemination
  - Students and disciples
  - Publications

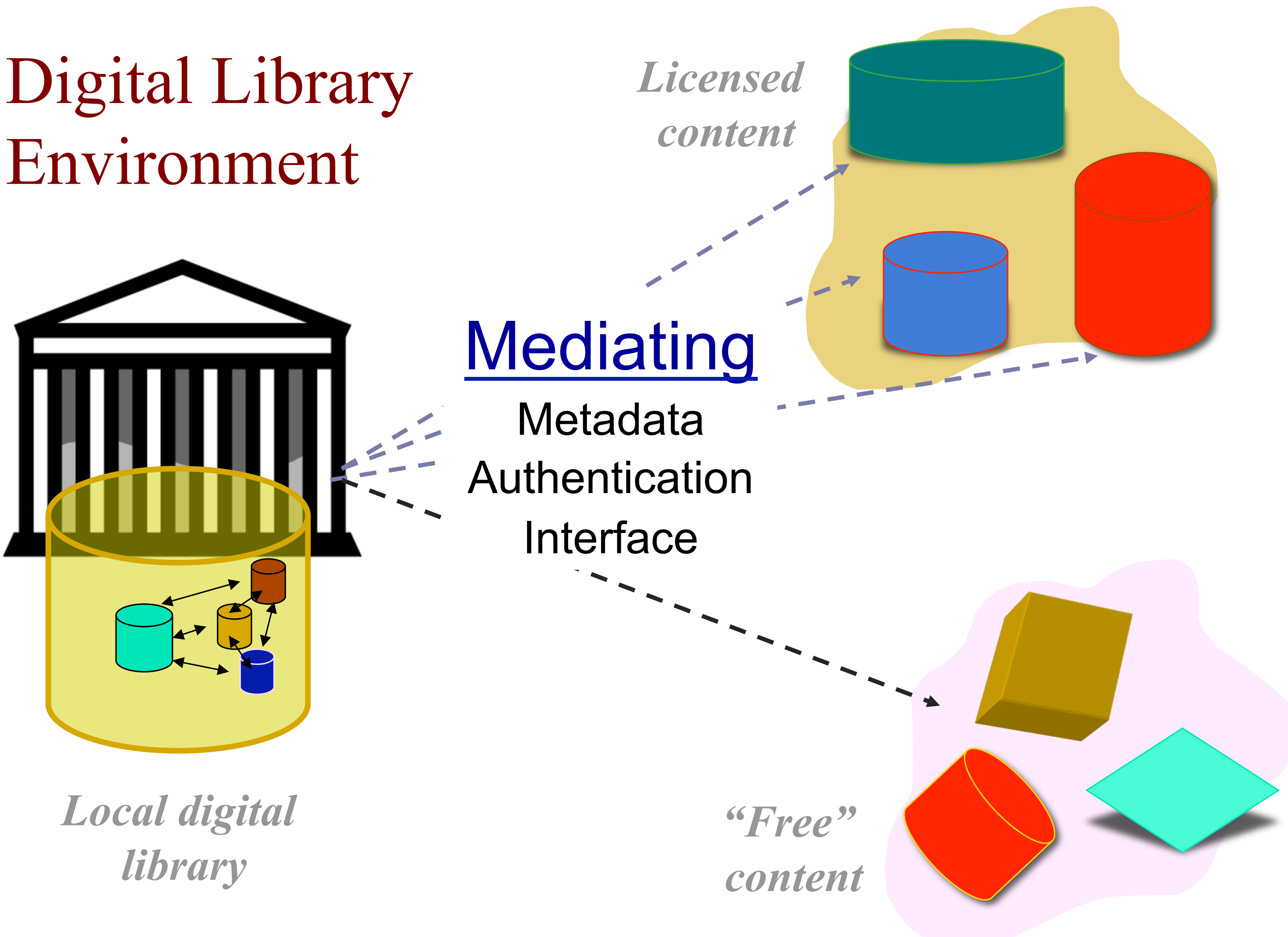
Indicators of Change in Scholarly Publication

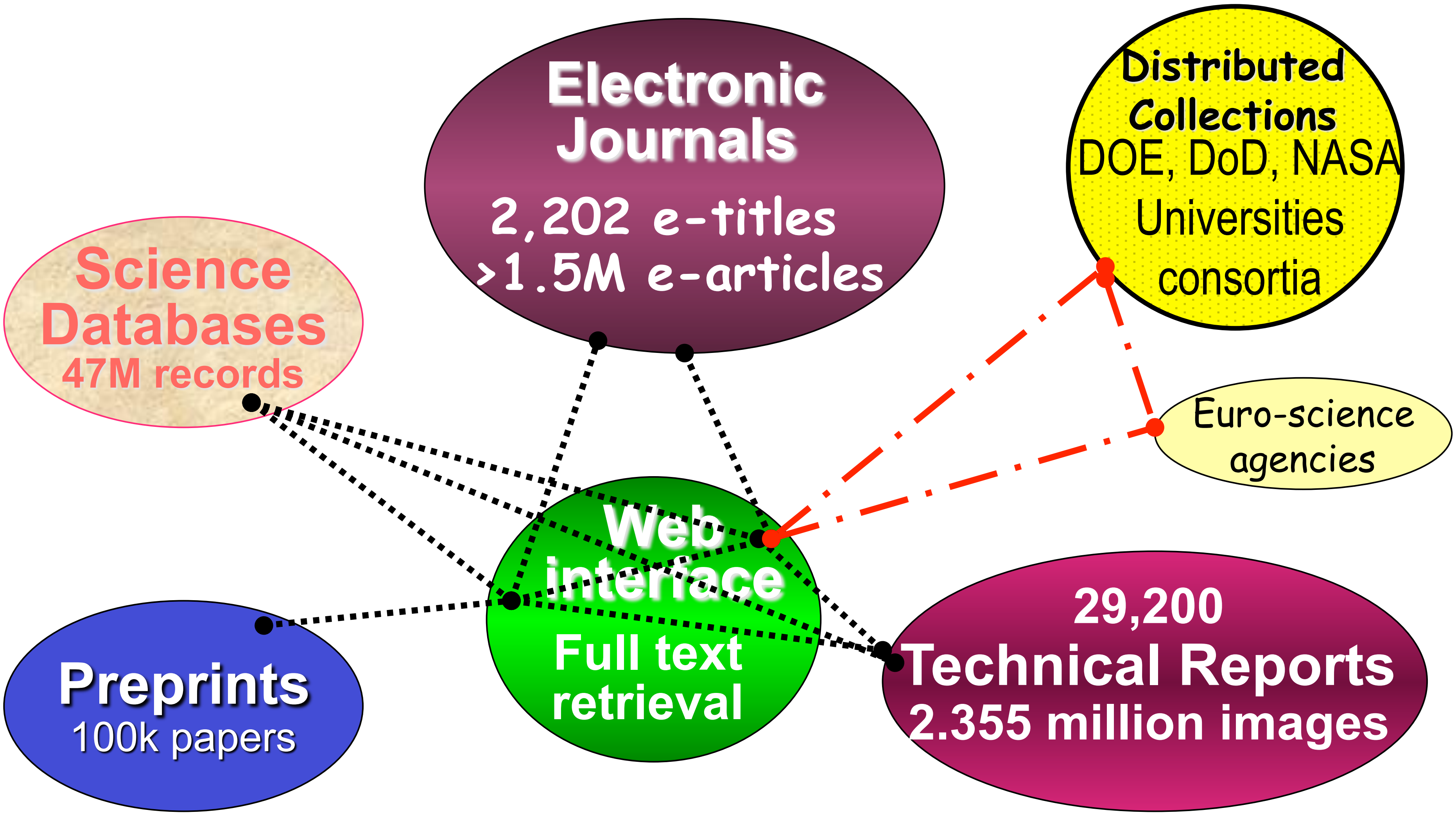
- Public-domain models
- Knowledge conservancies
- Institutional publishing
- Bypass publishing
- For-profit universities
- Open Courseware (MIT)

The "Digital Library" Environments: Dependencies Between



Digital Library Environment

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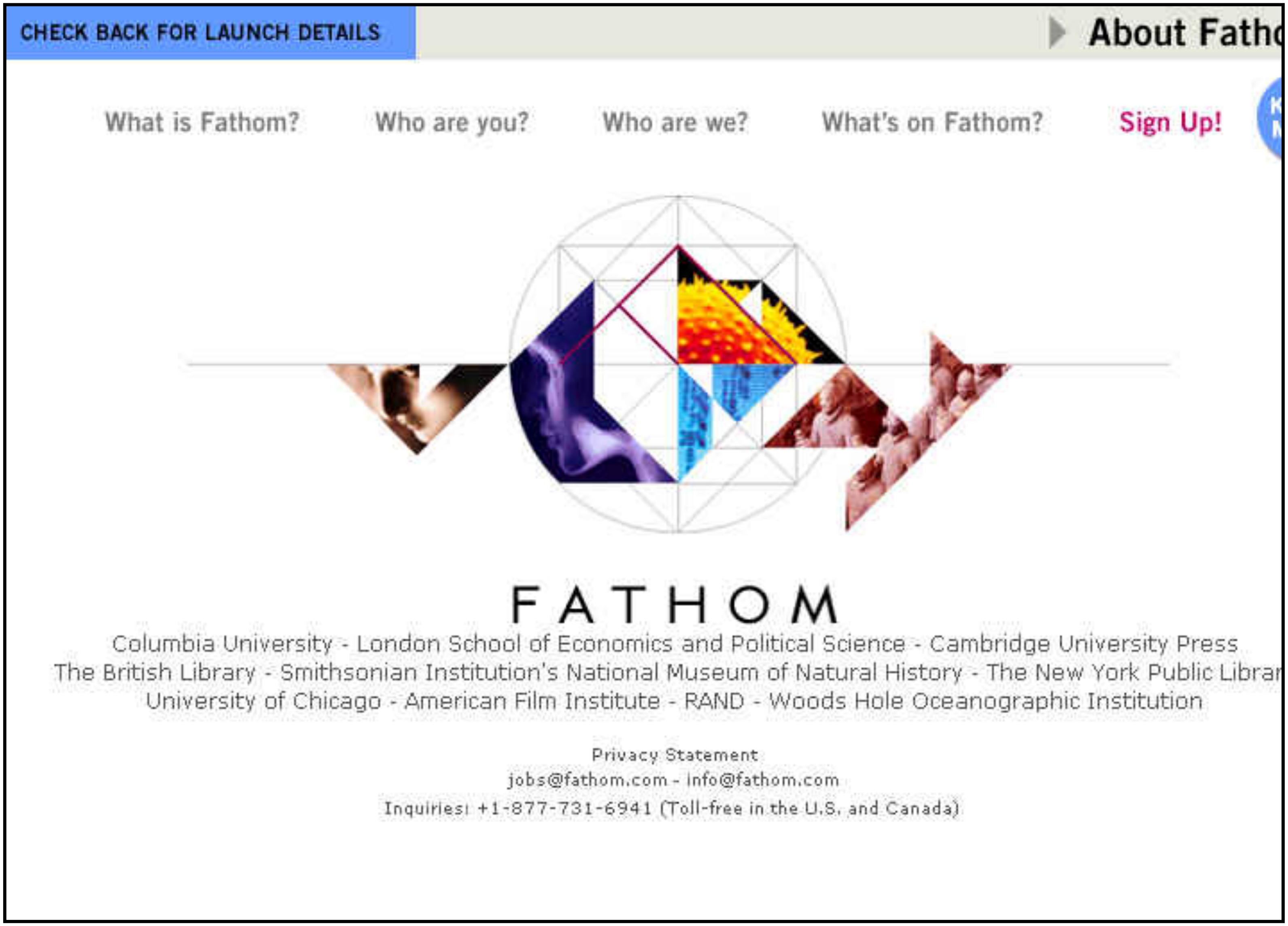
Higher Education Cooperative



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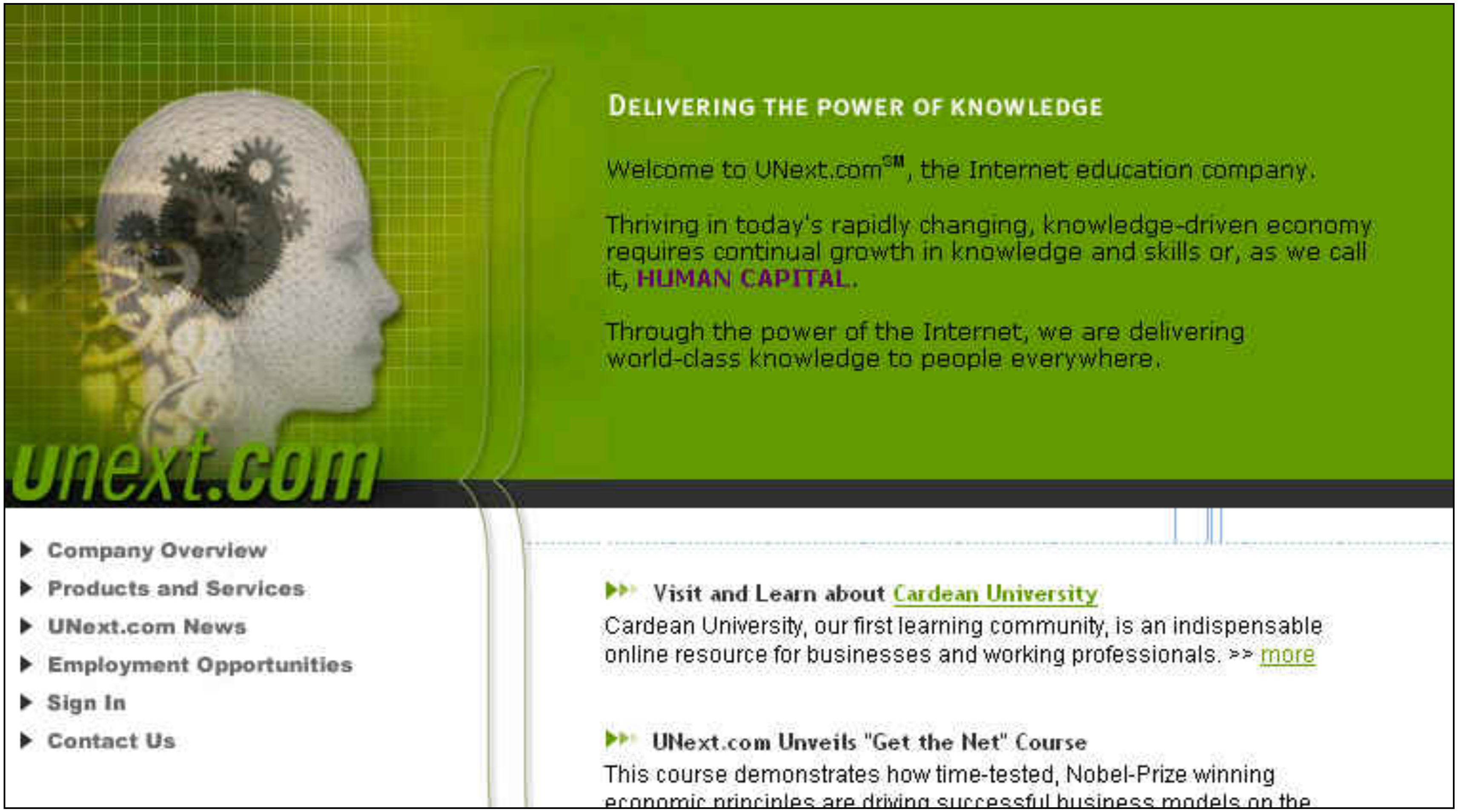


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The “Open Source” University

An Alternative: “The Open Source University”

- Linux software movement
- MIT Open Courseware Project (OCW)
- The Open Knowledge Initiative (OKI)
- Michigan CHEF Project

MITOPENCOURSEWARE
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Welcome to the MIT OpenCourseWare Pilot

MIT and the OpenCourseWare team are excited to share with you a first sampling of course materials from MIT's Faculty. We invite educators around the world to draw upon the materials for their own curricula, and we encourage all learners to use the materials for self-study.

As you explore this pilot version of MIT OCW, we invite you to send us your feedback. Your comments will help to ensure that future editions of MIT OCW will be ever more useful.

A Message from the President

MIT OpenCourseWare reflects the commitment of the MIT faculty to advancing education by increasing access to their academic materials through the Internet and the World Wide Web. We believe that with modern communication technology we can not only transmit information but also stimulate and enhance the deeply human, person-to-person endeavor of education.

We hope the idea of openly sharing course materials will propagate throughout many institutions and create a global web of knowledge that will enhance the quality of learning and, therefore, the quality of life worldwide.

We are opening our pilot to the public for review and feedback. It contains a sample of MIT courses, offering an early look at the content and design of OCW. As we pursue our intensive work to find the most effective way to make OCW a valuable resource for all who use it, we will continue to add courses, until virtually all are available.

We thank our sponsors, the William and Flora Hewlett Foundation and the Andrew W. Mellon Foundation, as well as the faculty who have dedicated so much creative energy and time to this endeavor. We are pleased to have you as a participant in this educational journey.

Chuck Vest

Charles M. Vest, President, MIT

OpenCourseWare Timeline

2002-2003	2003-2005	2005-2007
DISCOVER / BUILD	**PUBLISH / EXPAND**	**ENHANCE**
•Pilot: Representative courses from all five MIT schools •Representative content formats	•Hundreds of courses •Complete curriculum tracks •Metadata-based search •OKI compliance	•Near-full inclusion of ~2,000 MIT courses •Enhanced technology •Dissemination of best practices in publishing Web-based course content •Evaluation of OCW impact
9/02 Pilot open to public	9/03 Launch	9/07 Steady state

Open Knowledge Initiative OKI™

Product Description | Project Information | API Specifications
Internal Documents | Licensing | Press

Monday, November 4, 2002

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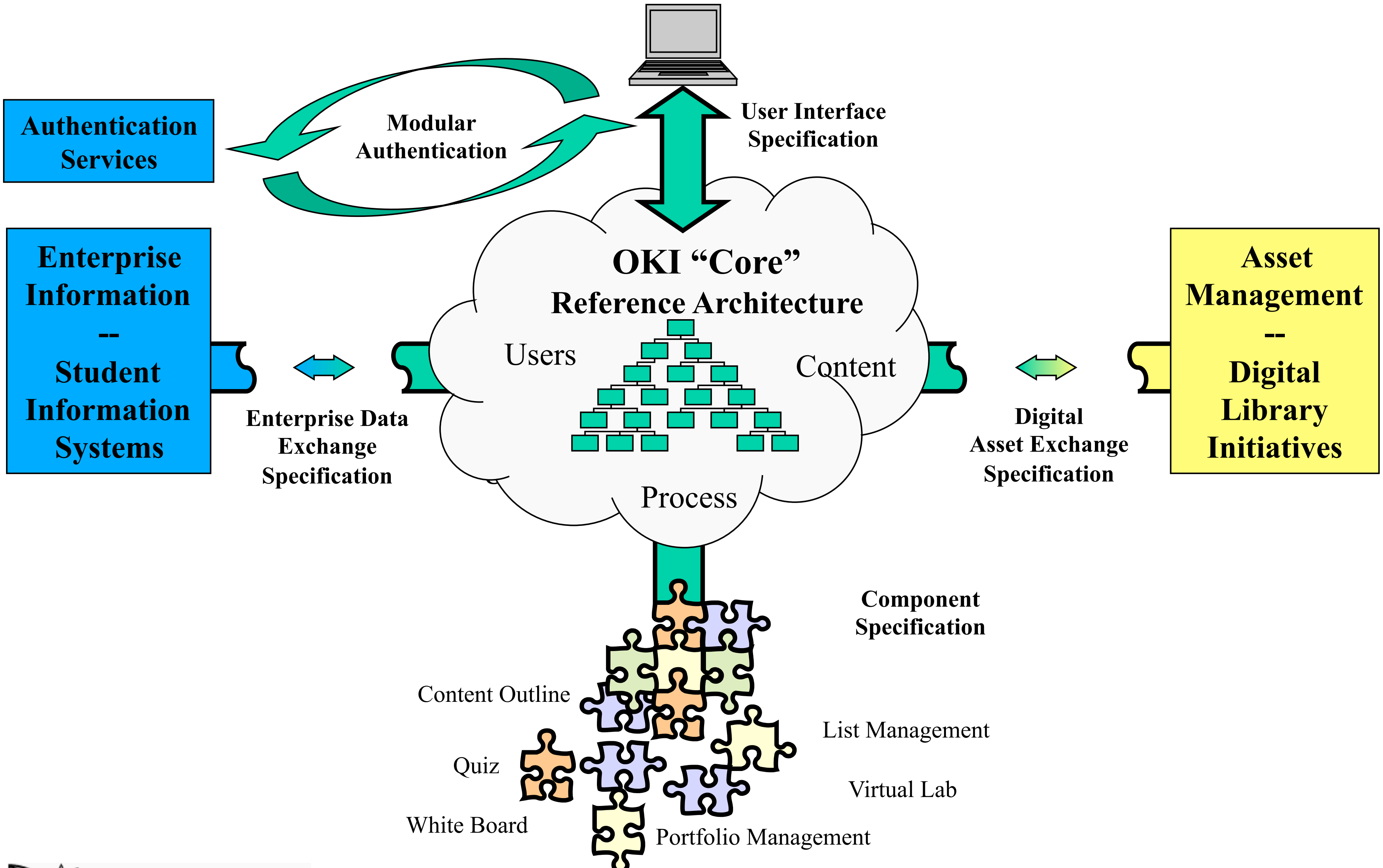
INTERNAL DOCUMENTS

Access the latest internal project information here »

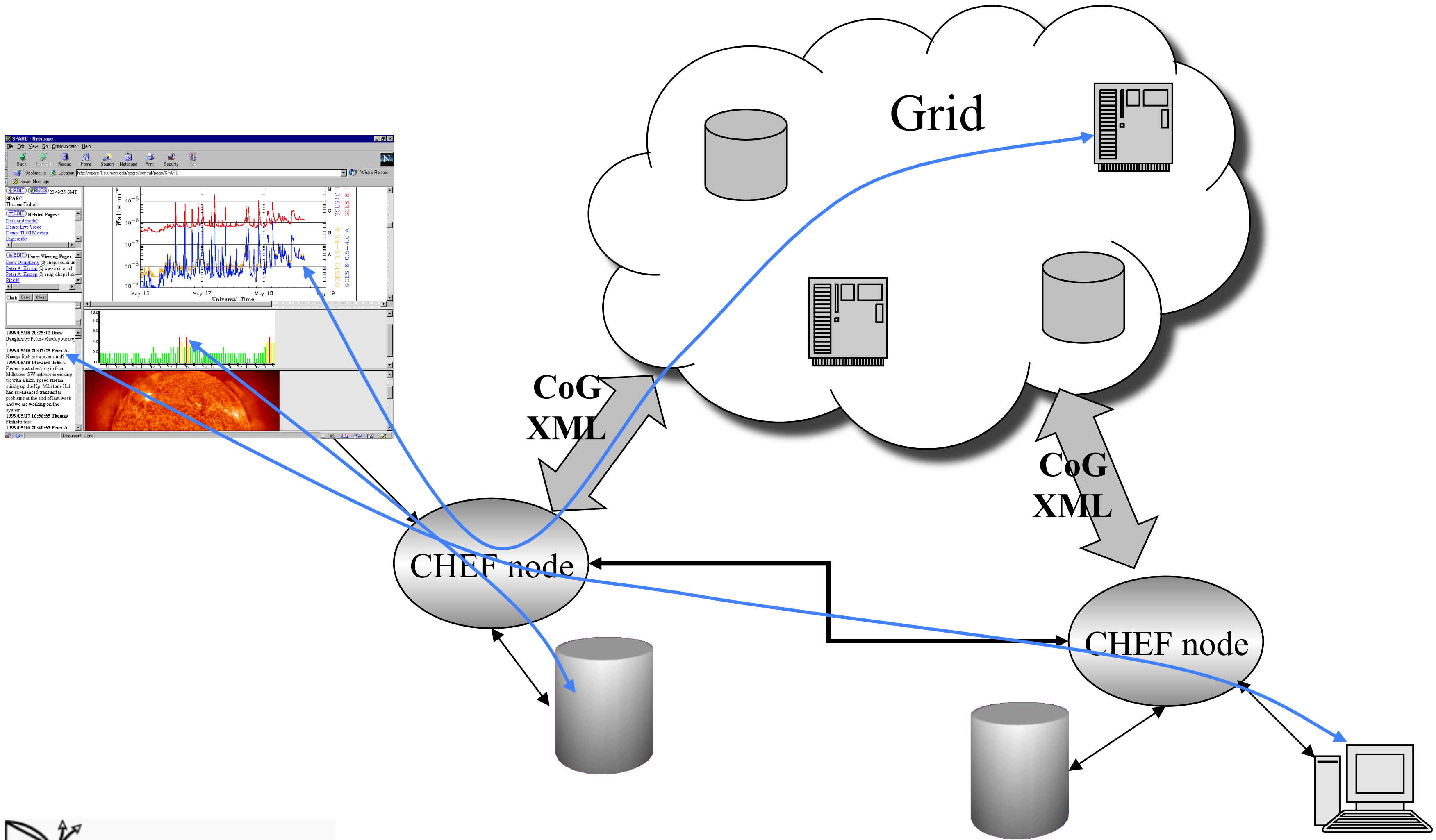
questions & comments to webmaster-oki@mit.edu

OKI – Standards for LMS APIs



Chef
CompreHensive collaborativE Framework

CHEF and the Grid – Access to Nationally Distributed Computing Resources



Chef
CompreHensive collaborativE Framework

DSpace™

Search DSpace at MIT

MITLibraries

Durable Digital Depository

Welcome to DSpace, a newly developed digital repository created to capture, distribute and preserve the intellectual output of MIT.

Many ideas grow better when transplanted into another mind than in the one where they sprang up.

—Oliver Wendell Holmes

As a joint project of MIT Libraries and the Hewlett-Packard Company, DSpace provides stable long-term storage needed to house the digital products of MIT faculty and researchers.

- **For the user:** DSpace enables easy remote access and the ability to read and search DSpace items from one location: the World Wide Web.

- **For the contributor:** DSpace offers the advantages of digital distribution and long-term preservation for a variety of formats including text, audio, video, images, datasets and more. Authors can store their digital works in collections that are maintained by MIT communities.

- **For the institution:** DSpace offers the opportunity to provide access to all the research of the institution through one interface. The repository is organized to accommodate the varying policy and workflow issues inherent in a multi-disciplinary environment. Submission workflow and access policies can be customized to adhere closely to each community's needs.

Definition

DSpace is an open source software platform that enables institutions to:

- capture and describe digital works using a submission workflow module
- distribute an institution's digital works over the web through a search and retrieval system
- preserve digital works over the long term

Our knowledge is the amassed thought and experience of innumerable minds.

- Ralph Waldo Emerson

Mission

To create and establish an electronic system that captures, preserves and communicates the intellectual output of MIT's faculty and researchers.

To support adoption by and federation with other institutions.

Vision

A federation of systems makes available the collective intellectual resources of the world's leading research institutions.

An Alternative: "The Open Source University"

- Linux software movement
- MIT Open Courseware Project (OCW)
- The Open Knowledge Initiative (OKI)
- Michigan CHEF Project

An Alternative: “The Open Source University”

- Linux software movement
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An idea: Suppose a small group of the world’s leading comprehensive universities were to place in the public domain (for all to use) the digital resources supporting their entire curriculum (all academic disciplines and professional programs), along with open-source versions of the software tools and platforms necessary to use these resources…

Cyberinfrastructure

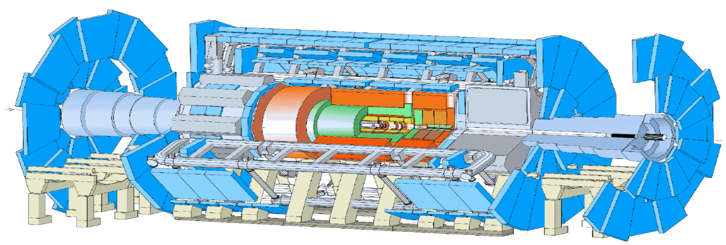
e-Science

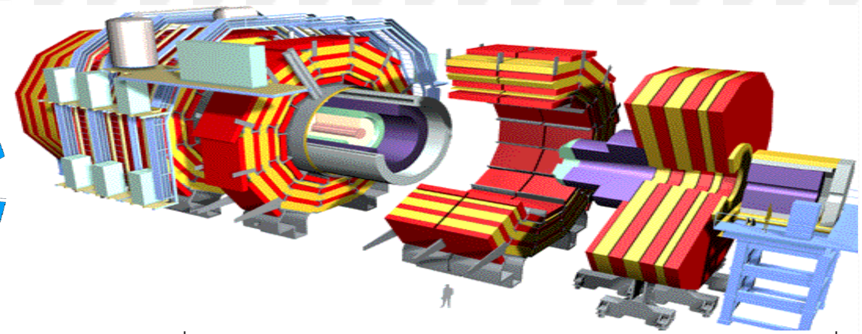
- science increasingly done through ***distributed global collaborations*** between people, enabled by the internet
- using very large data collections, terascale computing resources and high performance visualisation
- derived from instruments and facilities controlled and shared via the infrastructure
- Scaling X1000 in processing power, data, bandwidth

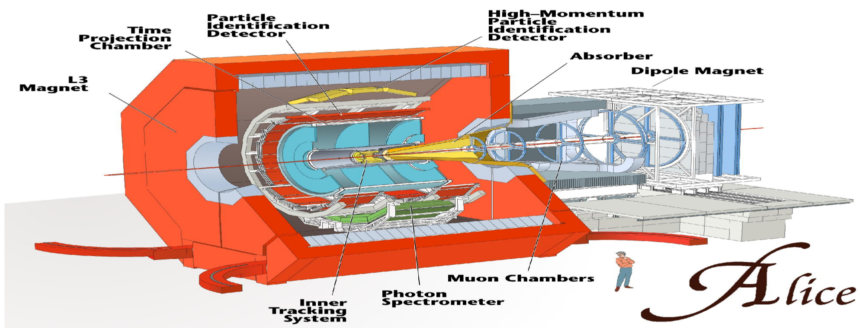
Four LHC Experiments: The Petabyte to Exabyte Challenge

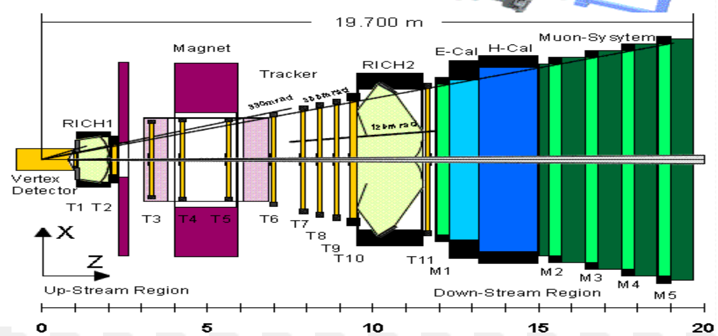
ATLAS, CMS, ALICE, LHCB

Higgs + New particles; Quark-Gluon Plasma; CP Violation







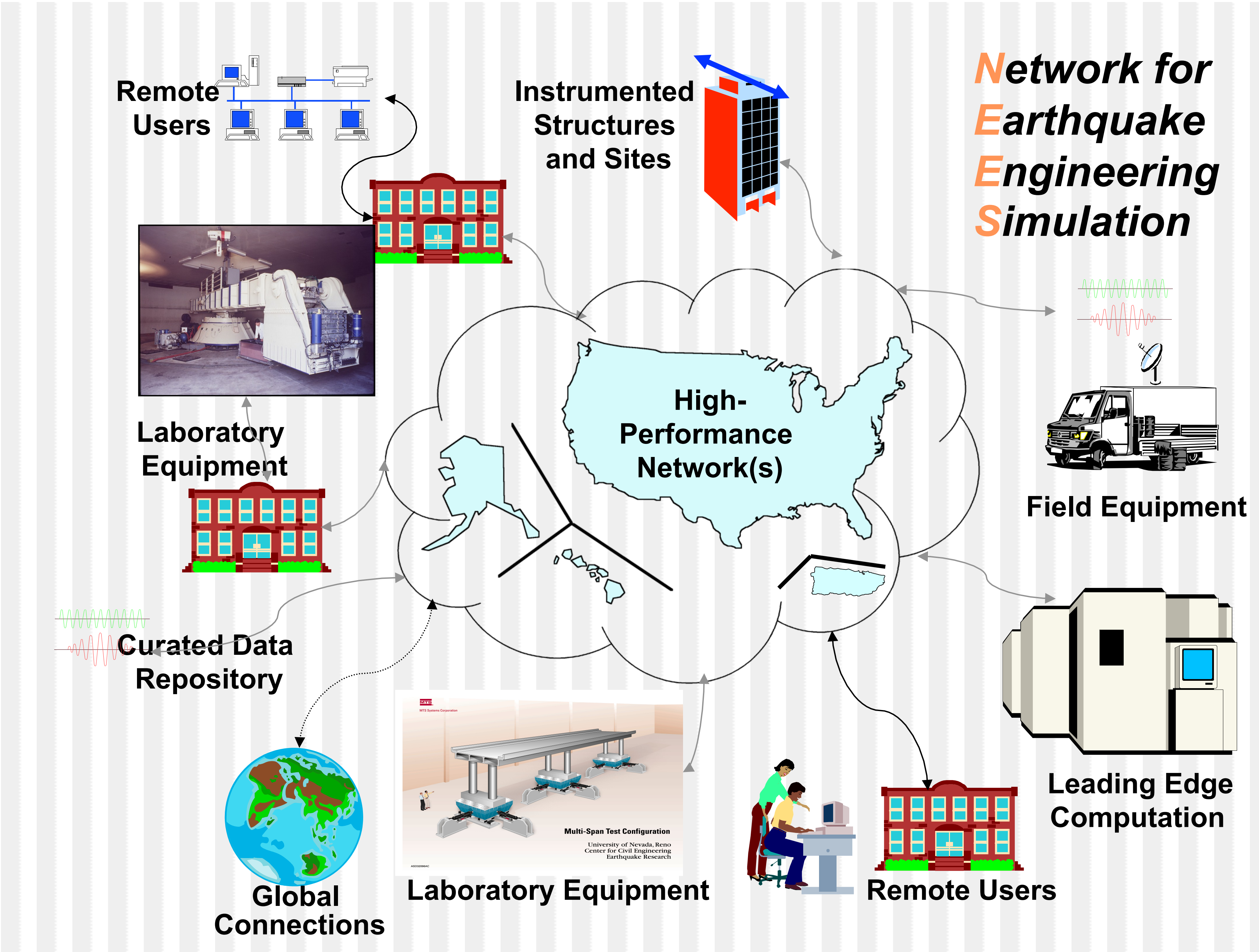


Data stored ~40 Petabytes/Year and UP;

CPU 0.30 Petaflops and UP

0.1 to 1 Exabyte (1 EB = 10^{18} Bytes)

(2007) (~2012 ?) for the LHC Experiments


Network for
Earthquake
Engineering
Simulation
Remote
Users
Instrumented
Structures
and Sites
Laboratory
Equipment
High-
Performance
Network(s)
Field Equipment
Curated Data
Repository
Multi-Span Test Configuration
University of Nevada, Reno
Center for Civil Engineering
Earthquake Research
Leading Edge
Computation
Global
Connections
Laboratory Equipment
Remote Users

TELESCIENCE: REMOTE ACCESS FOR DATA ACQUISITION, GRID - BASED COMPUTING, DISTRIBUTED DATA STORAGE

Project leaders:

Mark Ellisman, UCSD;
Carl Kesselman, USC;
Fran Berman, UCSD;
Rich Wolski, UCSB;

Project Manager:

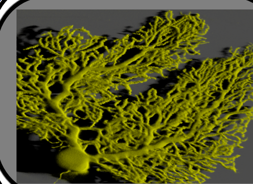
Steve Peltier, UCSD

Senior Participants:

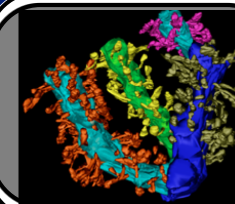
Gwen Jacobs, Montana State U.
Reagan Moore, SDSC/UCSD
Maryann Martone, UCSD/NCMIR
Amarnath Gupta, SDSC/UCSD
Bertram Ludaescher, SDSC/UCSD
Chandrijt Bajaj, U.Texas
Steve Lamont, UCSD
Shinji Shimojo, Osaka Univ.

DATA ACQUISITION

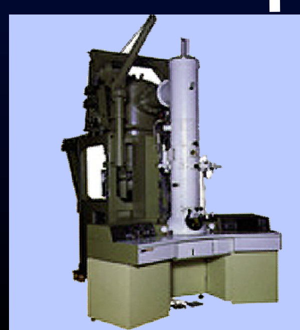
PROCESSING, ANALYSIS



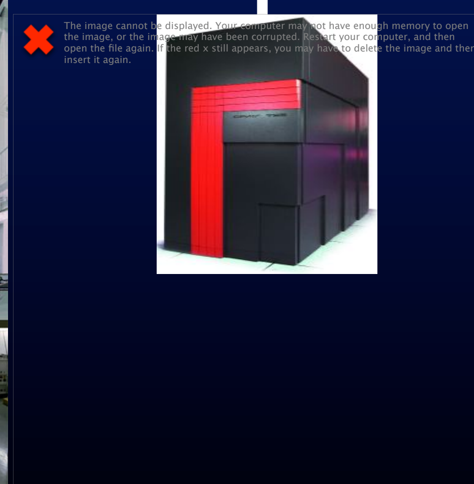
ADVANCED VISUALIZATION



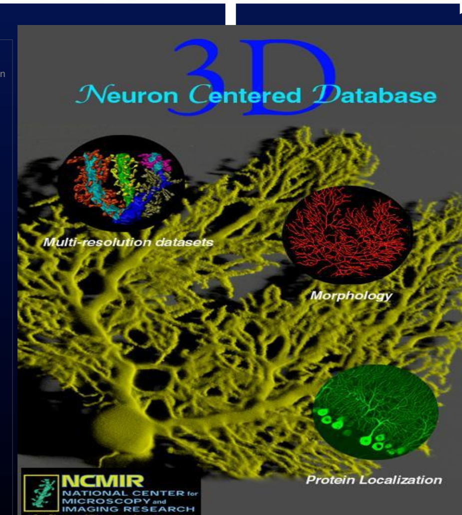
NETWORK



IMAGING INSTRUMENTS



COMPUTATIONAL RESOURCES



LARGE-SCALE DATABASES

(Cyber) infrastructure

- The term *infrastructure* has been used since the 1920's to refer collectively to the roads, bridges, rail lines, and similar public works that are required for an industrial economy to function.
- The recent term *cyberinfrastructure* refers to an infrastructure based upon computer, information and communication technology (increasingly) required for discovery, dissemination, and preservation of knowledge.
- Traditional infrastructure is required for an industrial economy. Cyberinfrastructure is required for an information economy.

Cyberinfrastructure: the Middle Layer

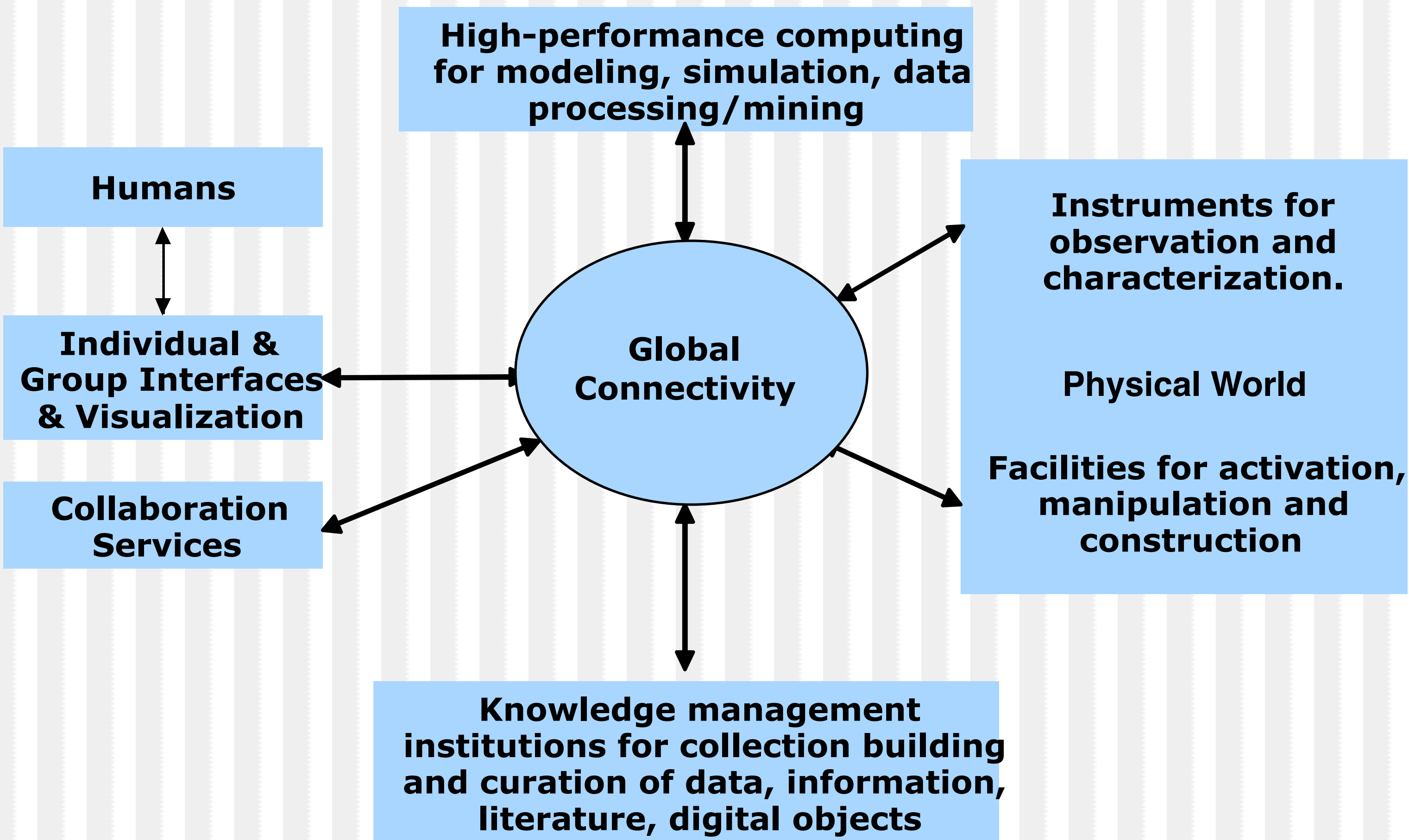
Applications in science and engineering research and education

Cyberinfrastructure: hardware, software, personnel, services, institutions

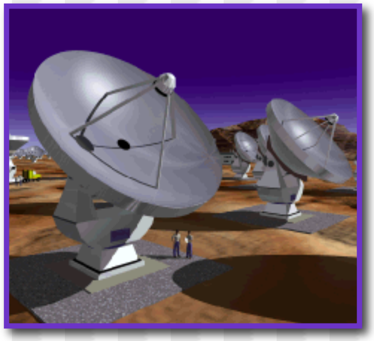
Base-technology: computation, storage, communication

Components of CI-enabled science & engineering

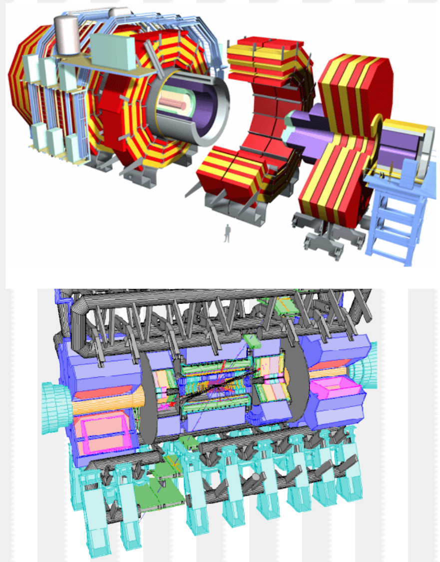
A broad, systemic, strategic conceptualization



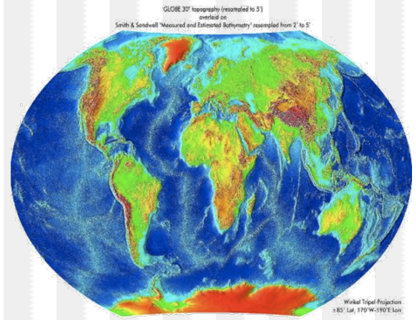
Cyberinfrastructure Enabled Science



NVO and ALMA



ATLAS and CMS



Climate Change

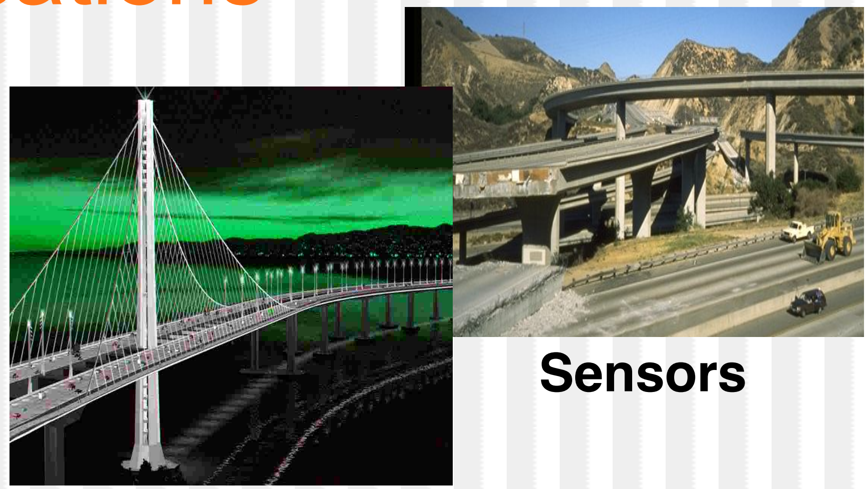
United States virtual observatory

LIGO

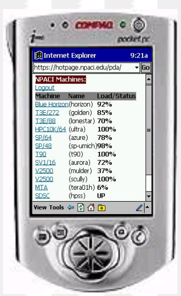
The number of nation-scale projects is growing rapidly!

More Diversity, New Devices, New Applications

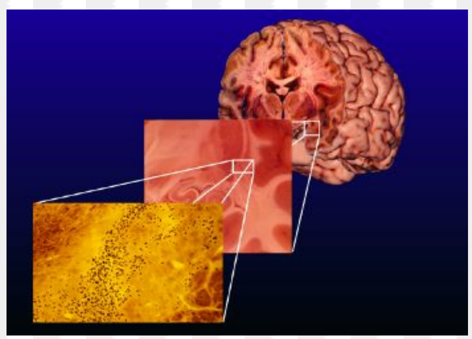
Personalized Medicine



Sensors



Wireless networks

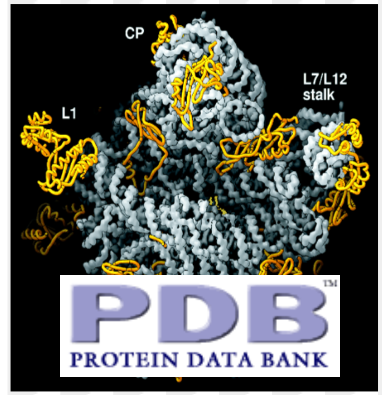


Knowledge from Data

Instruments

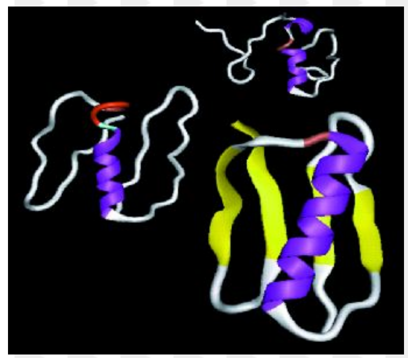
Cyberinfrastructure is a First-Class Tool for Science

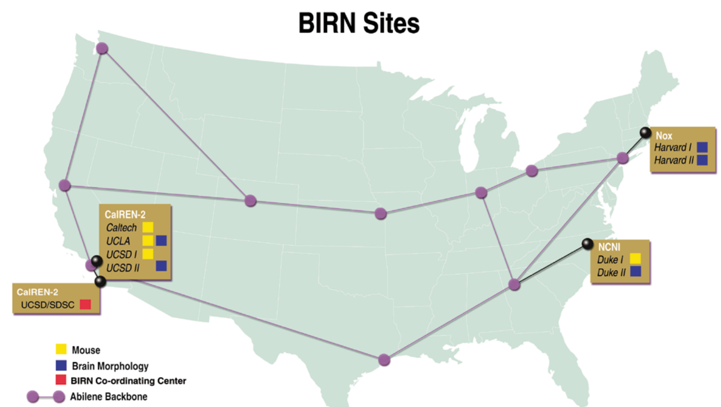
NEESgrid

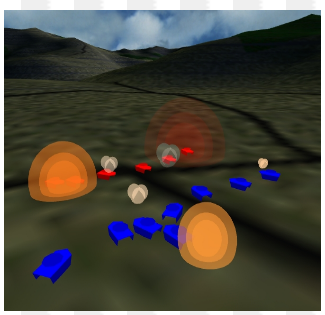


GriPhyN
Data Intensive Science

iVDgL

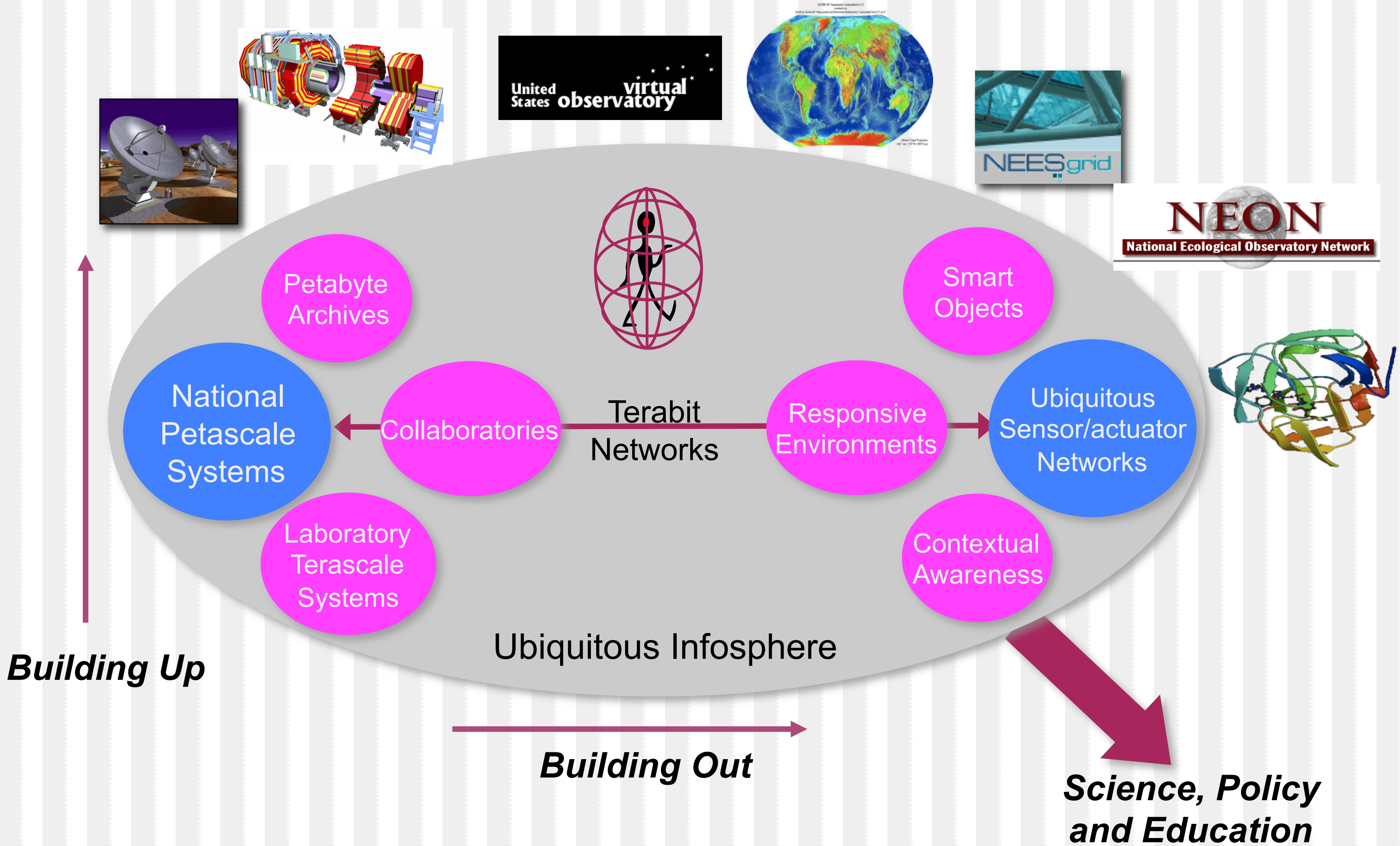






United States virtual observatory

Futures: The Computing Continuum



Two leading U.S. initiatives

- Next Generation Abilene
  - Advanced Internet **backbone**
    - connects entire campus networks of the research universities
  - 10 Gbps nationally
- TeraGrid
  - **Virtual machine room** for distributed computing (Grid)
  - Connecting 4 HPC centers initially
    - Illinois: NCSA, Argonne
    - California: SDSC, Caltech
  - 4x10 Gbps: Chicago ↔ Los Angeles
- Ongoing collaboration between both projects

About Internet2®

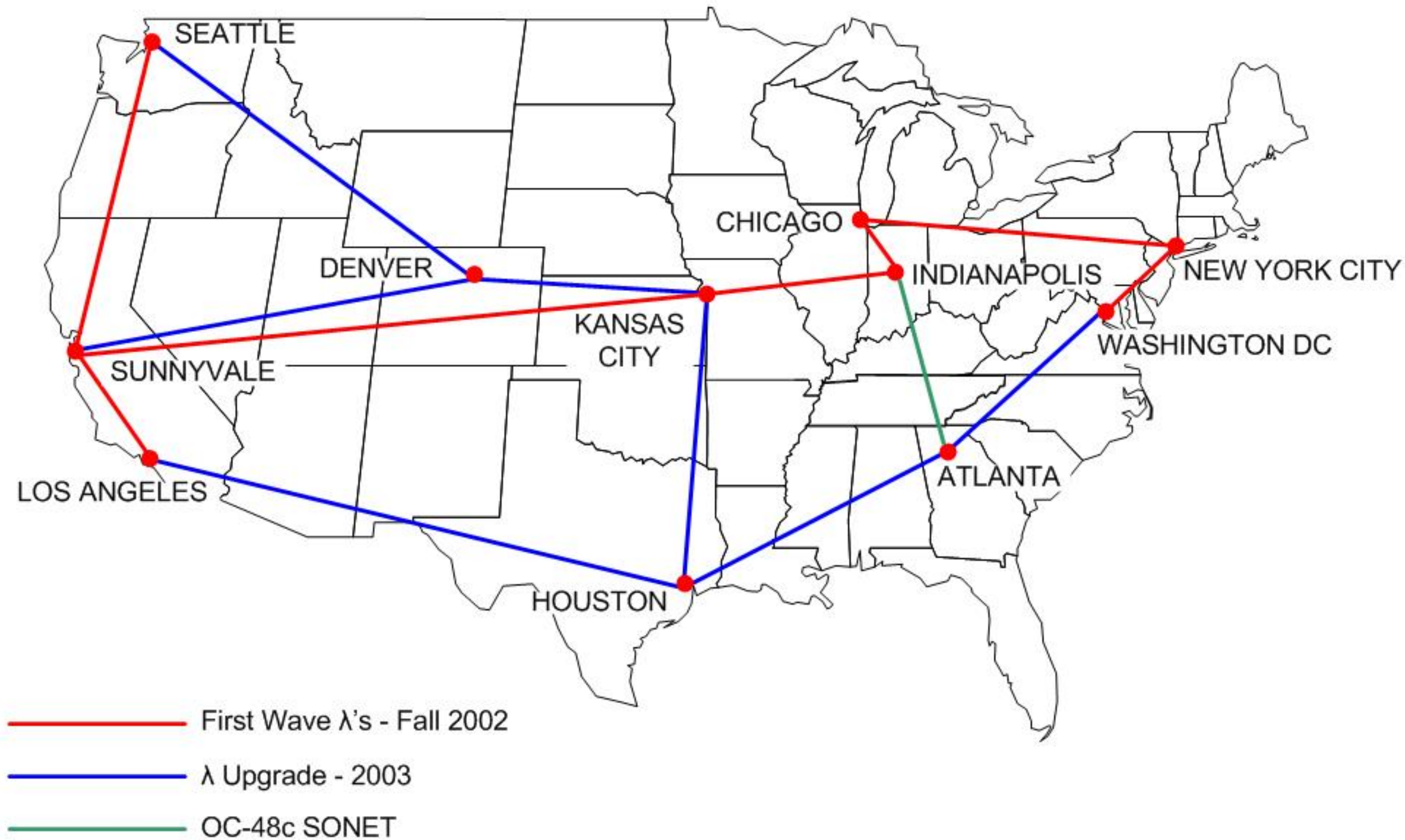
Internet2 is a consortium being led by over 200 universities working in partnership with industry and government to develop and deploy advanced network applications and technologies, accelerating the creation of tomorrow's Internet. Internet2 is recreating the partnership among academia, industry and government that fostered today´s Internet in its infancy. The primary goals of Internet2 are to:

- Create a leading edge network capability for the national research community
- Enable revolutionary Internet applications
- Ensure the rapid transfer of new network services and applications to the broader Internet community.

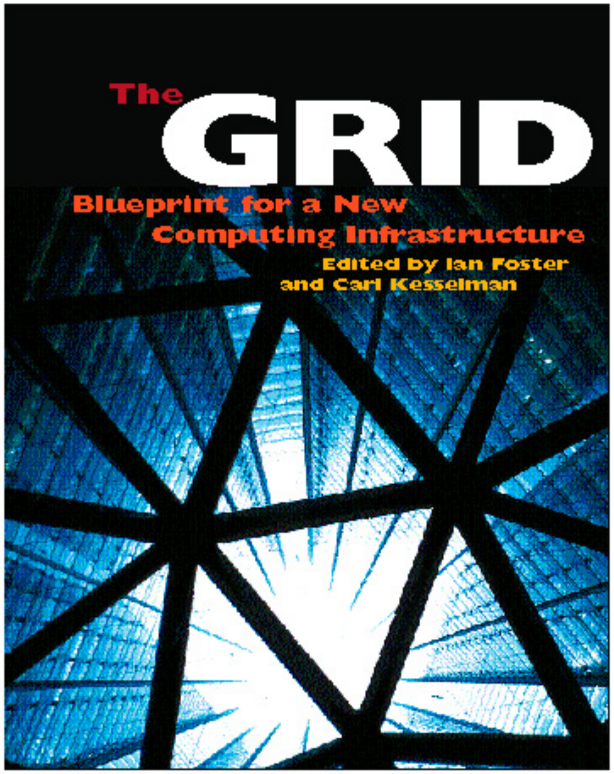
Through Internet2 Working Groups and initiatives, Internet2 members are collaborating on:

- Advanced Applications
- Middleware
- New Networking Capabilities
- Advanced Network Infrastructure
- Partnerships and alliances
- Initiatives

ABILENE NETWORK 10-Gbps OPTICAL UPGRADE - 2002-2003

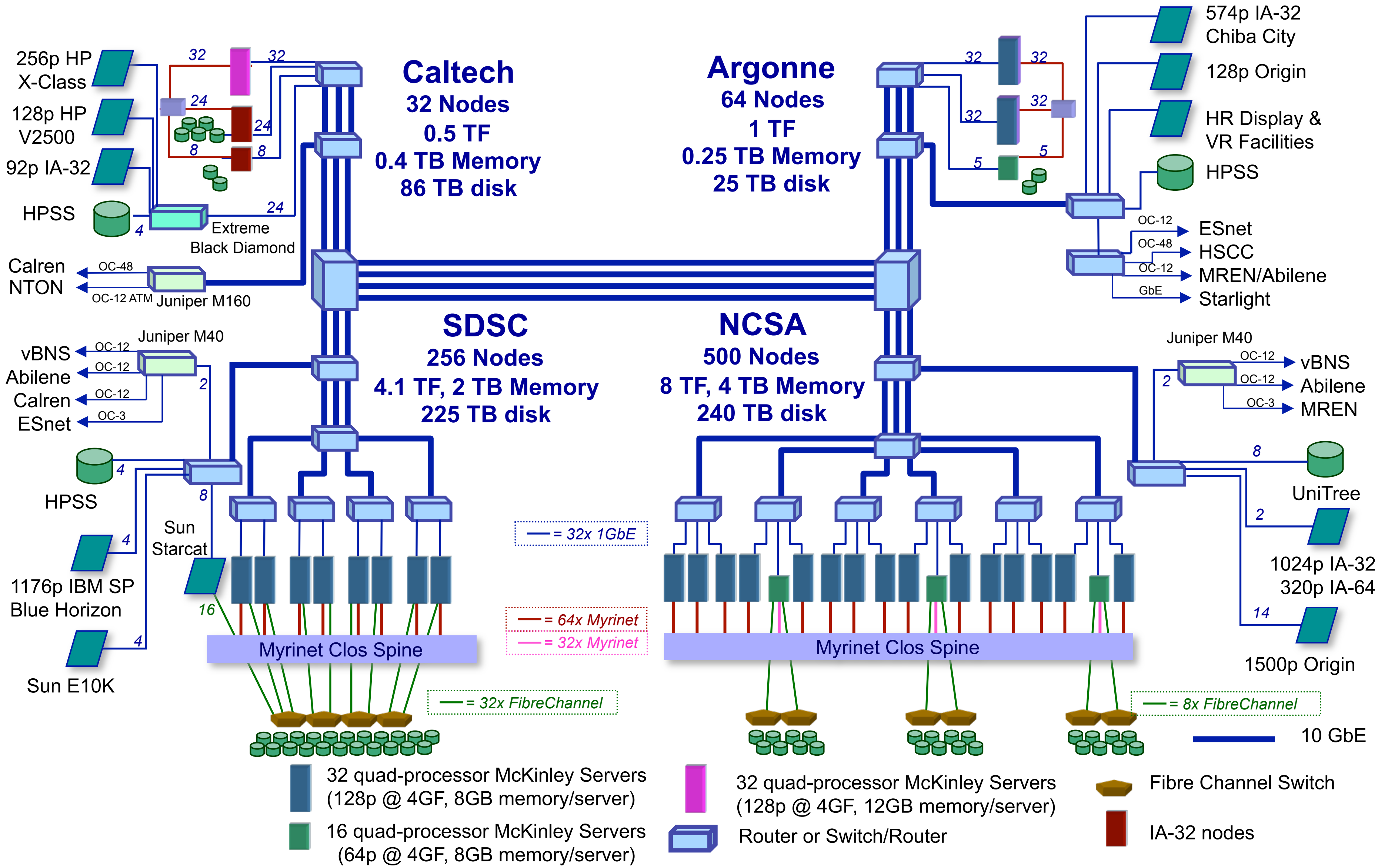


The Grid



Ian Foster and Carl Kesselman, editors, "The Grid: Blueprint for a New Computing Infrastructure," Morgan Kaufmann, 1999, http://www.mkp.com/grids

TeraGrid Architecture – 13.6 TF



WWW and "infocern", the 1st web address ~1990 html (xml) open standards

- •A great achievement and a fantastic idea, at the right time, making the internet available to everybody
- •It proves something about the benefits of assembling together urgent needs, infrastructure and smart people, and letting them interact..
- •And why it is exciting to work at CERN, and in computing
- •And why we should not always listen to wise people who tell us that industry will always do better than we will….

Tim Berners-Lee

To Infinity and Beyond!

"A small group of thoughtful people could change the world. Indeed, it's the only thing that ever has. "

Margaret Mead

Some Remaining Questions

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1. How do we respond to the diverse educational and intellectual needs of knowledge-driven societies? (For example, as human capital becomes more important than physical or financial capital.)

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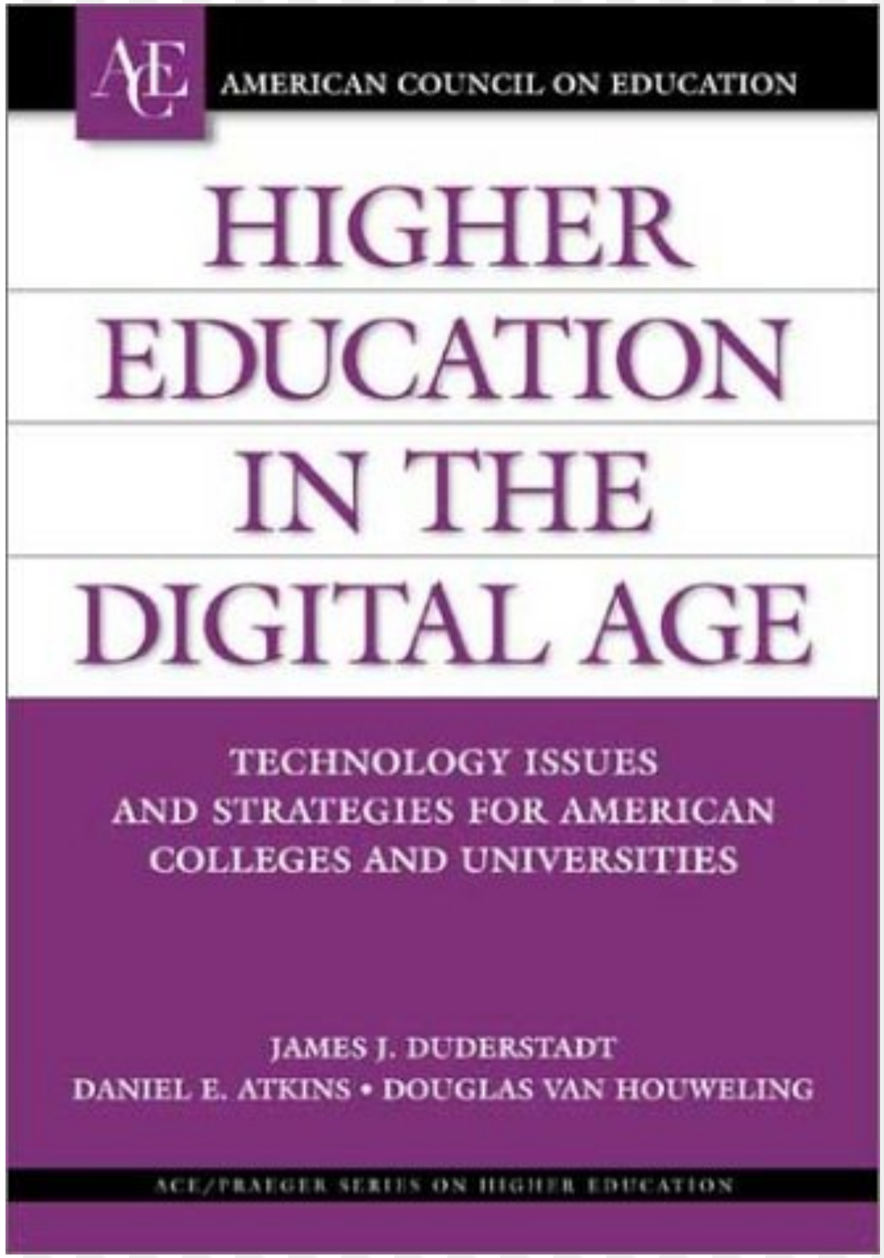
1. How do we respond to the diverse educational and intellectual needs of knowledge-driven societies? (For example, as human capital becomes more important than physical or financial capital.)
2. Is higher education a public or a private good?
3. How do we balance the roles of public purpose versus market forces in determining the future of our universities? (Can public investment counter competitive and commercial market pressures?)
4. What should be the role of the research university within a changing higher education enterprise? Should we lead change? Or should we protect key values and traditions (e.g., academic freedom, social critic)?

And, perhaps the most important question of all…

Are we facing a period of evolution, revolution, or possible extinction of the university as we know it today?


AMERICAN COUNCIL ON EDUCATION
HIGHER EDUCATION IN THE DIGITAL AGE
TECHNOLOGY ISSUES AND STRATEGIES FOR AMERICAN COLLEGES AND UNIVERSITIES
JAMES J. DUDERSTADT
DANIEL E. ATKINS • DOUGLAS VAN HOUWELING
ACE/PRAEGER SERIES ON HIGHER EDUCATION

One of civilization's most enduring institutions

For a thousand years the university has benefited our civilization as a learning community where both the young and experienced could acquire not only knowledge and skills, but as well the values and discipline of the educated mind.

It has defended and propagated our cultural and intellectual heritage, while challenging our norms and beliefs.

It has produced the leaders of our governments, commerce, and professions.

It has both created and applied new knowledge to serve our society.

And it has done so while preserving those values and principles so essential to academic learning: the freedom of inquiry, an openness to new ideas, a commitment to rigorous study, and a love of learning.

The Continuity of Change

Clearly higher education will flourish in the decades ahead. In a knowledge intensive society, the need for advanced education and knowledge will become ever more pressing, both for individuals and societies more broadly.

Yet it is also likely that the university as we know it today–rather the current constellation of diverse institutions comprising the higher education enterprise–will change in profound ways to serve a changing world.

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Yet it is also likely that the university as we know it today–rather the current constellation of diverse institutions comprising the higher education enterprise–will change in profound ways to serve a changing world.

Just as it has done, so many times in the past.