Computer Science: Past, Present, and Future

Ed Lazowska

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University of Washington

Chair, Computing Community Consortium

SIGCSE

March 2008

http://www.cra.org/ccc/

Greatest Engineering Achievements of the 20th Century

Greatest Achievements

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Welcome!

How many of the 20th century's greatest engineering achievements will you use today? A car? Computer? Telephone? Explore our list of the top 20 achievements and learn how engineering shaped a century and changed the world.

1. Electrification
2. Automobile
3. Airplane
4. Water Supply and Distribution
5. Electronics
6. Radio and Television
7. Agricultural Mechanization
8. Computers
9. Telephone
10. Air Conditioning and Refrigeration
11. Highways
12. Spacecraft
13. Internet
14. Imaging
15. Household Appliances
16. Health Technologies
17. Petroleum and Petrochemical Technologies
18. Laser and Fiber Optics
19. Nuclear Technologies
20. High-performance Materials

Greatest Achievements

 Printer-Friendly Version. Text-Only Version. Contact Us.

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Greatest Achievements

10,000,000,000,000,000,000 grains of rice

- Ten quintillion: $10*10^{18}$
  - The number of grains of rice harvested in 2004

10,000,000,000,000,000,000 transistors

- Ten quintillion: $10*10^{18}$
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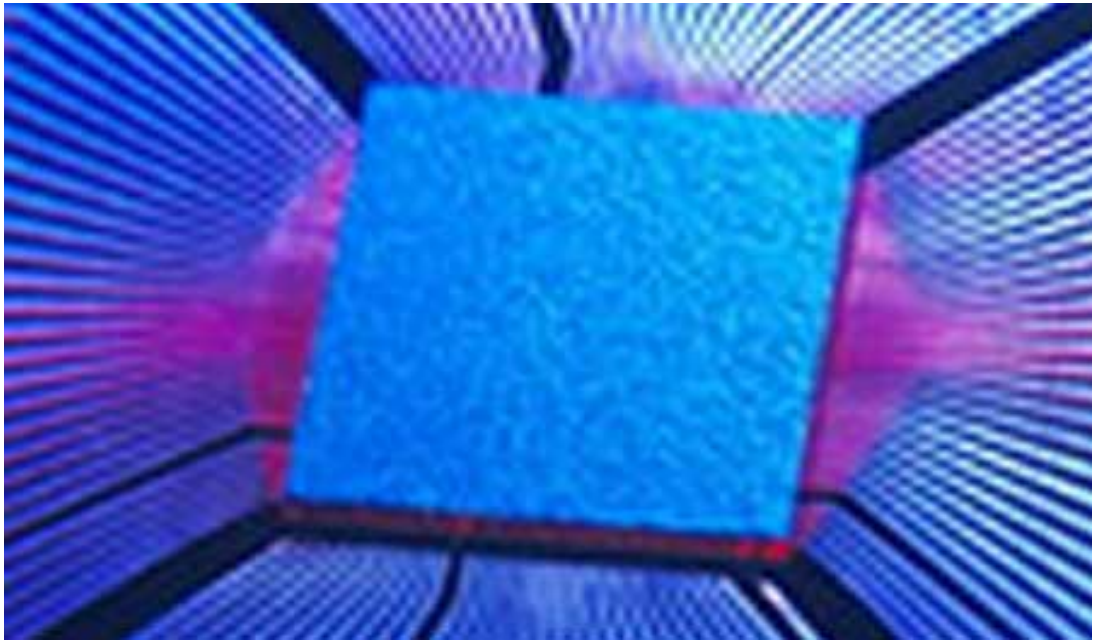
  - The number of transistors fabricated in 2004



The transistor

- William Shockley, Walter Brattain and John Bardeen, Bell Labs, 1947

The integrated circuit

- Jack Kilby, Texas Instruments, and Bob Noyce, Fairchild Semiconductor Corporation, 1958

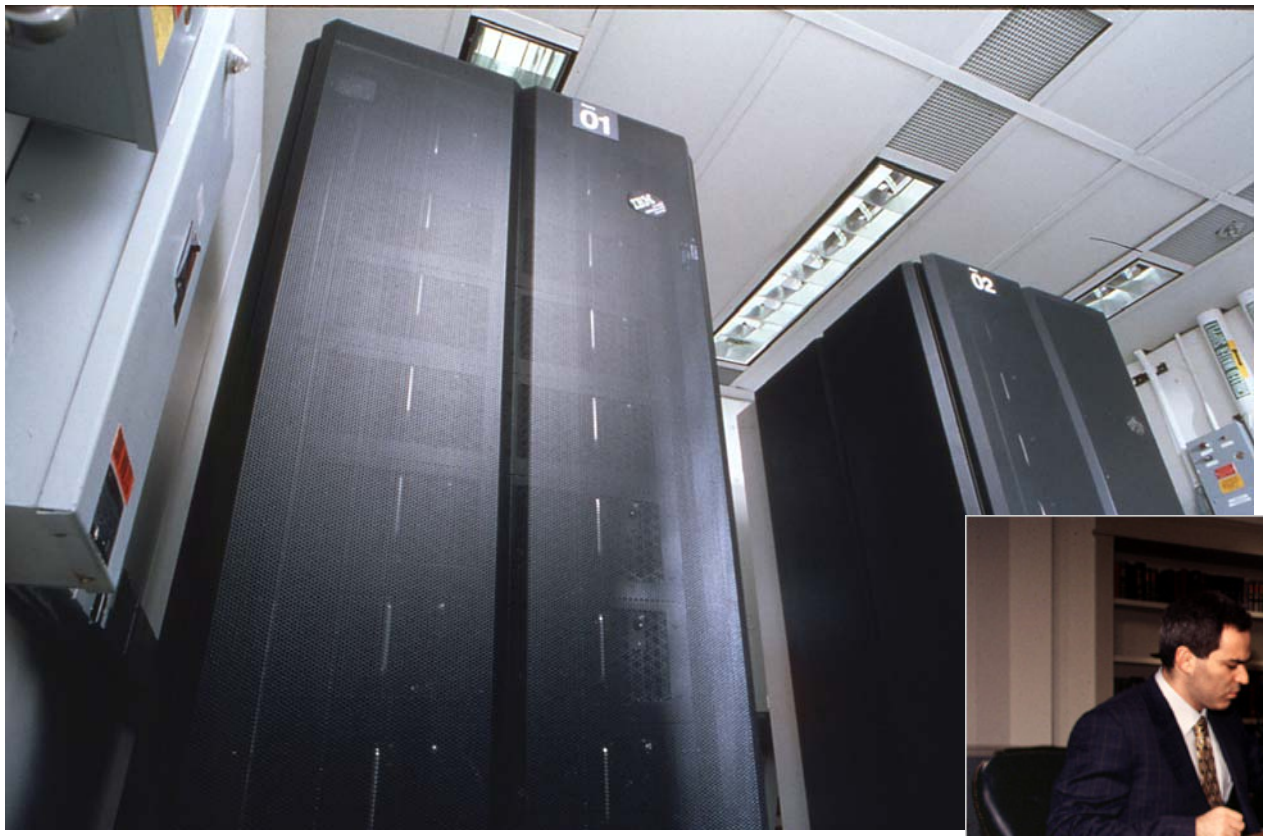
Exponential progress

- Gordon Moore, 1965

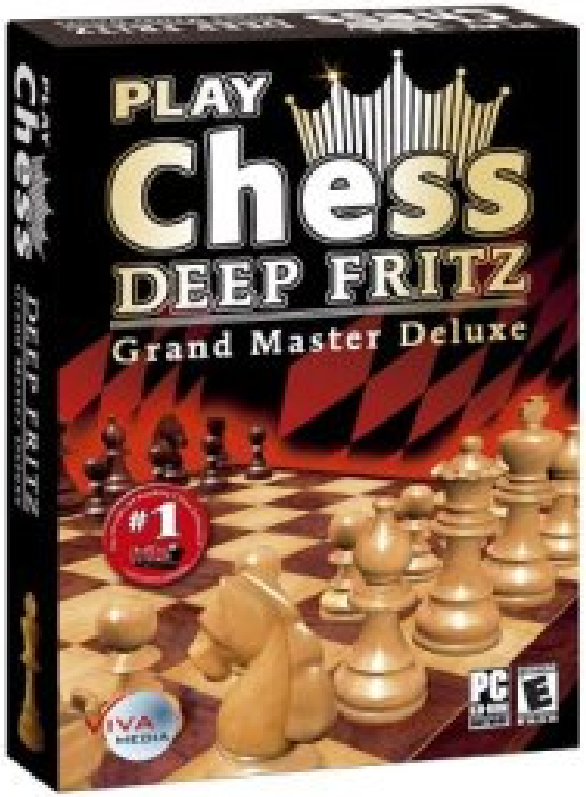

UNIVAC


UNIVAC

Software makes remarkable progress too!



Deep Blue, 1997



Price: $19.99 & eligible for **FREE Super Saver Shipping** on orders over $25.

Deep Fritz, 2002

The New York Times

Chess

February 17, 2008

Deep Blue made history in 1997 by defeating Garry Kasparov in a six-game match. A decade later, no human would dare take on a chess program at even strength. The premier chess engine, Rybka, is estimated at 3100, or 300 points higher than any player.

This sort of progress makes it dicey to predict the future

"I think there is a world market for maybe five computers" – Thomas J. Watson, founder and Chairman of IBM, 1943

"Computers in the future may weigh no more than 1.5 tons" – *Popular Science*, 1949

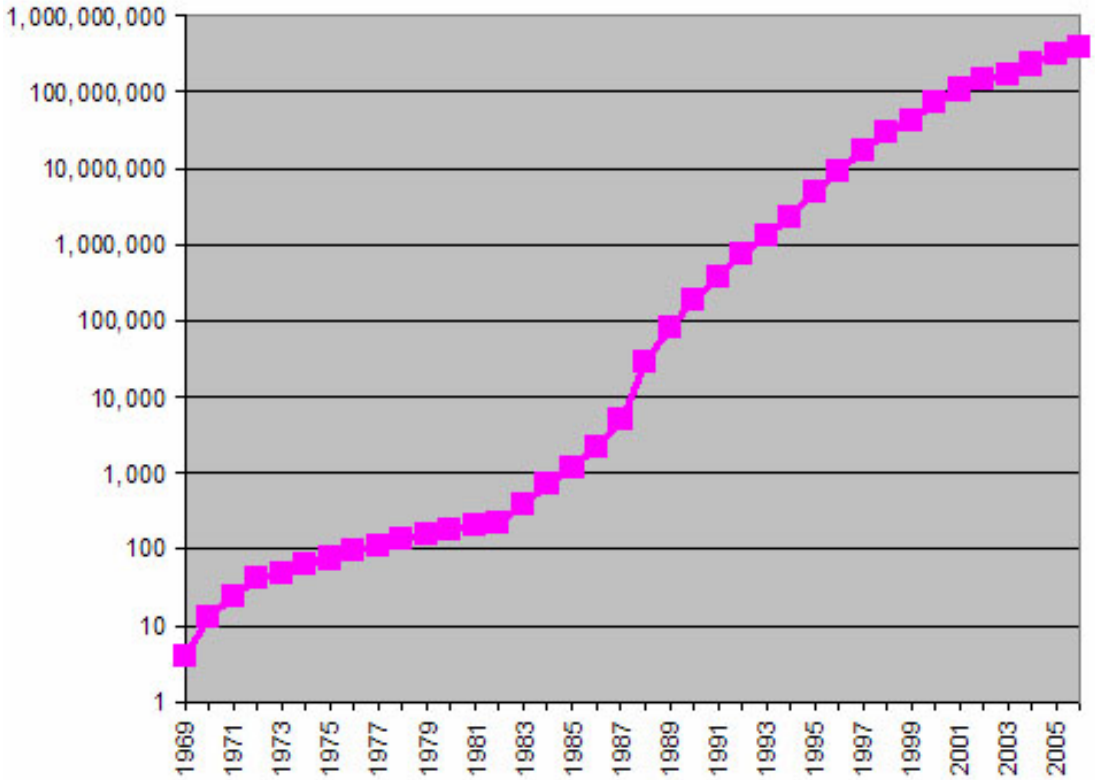
"There is no reason anyone would want a computer in their home" – Ken Olsen, founder and President of Digital Equipment Corporation, 1977

Today: Roughly 1 billion PCs …

Representing less than 2% of all processors!

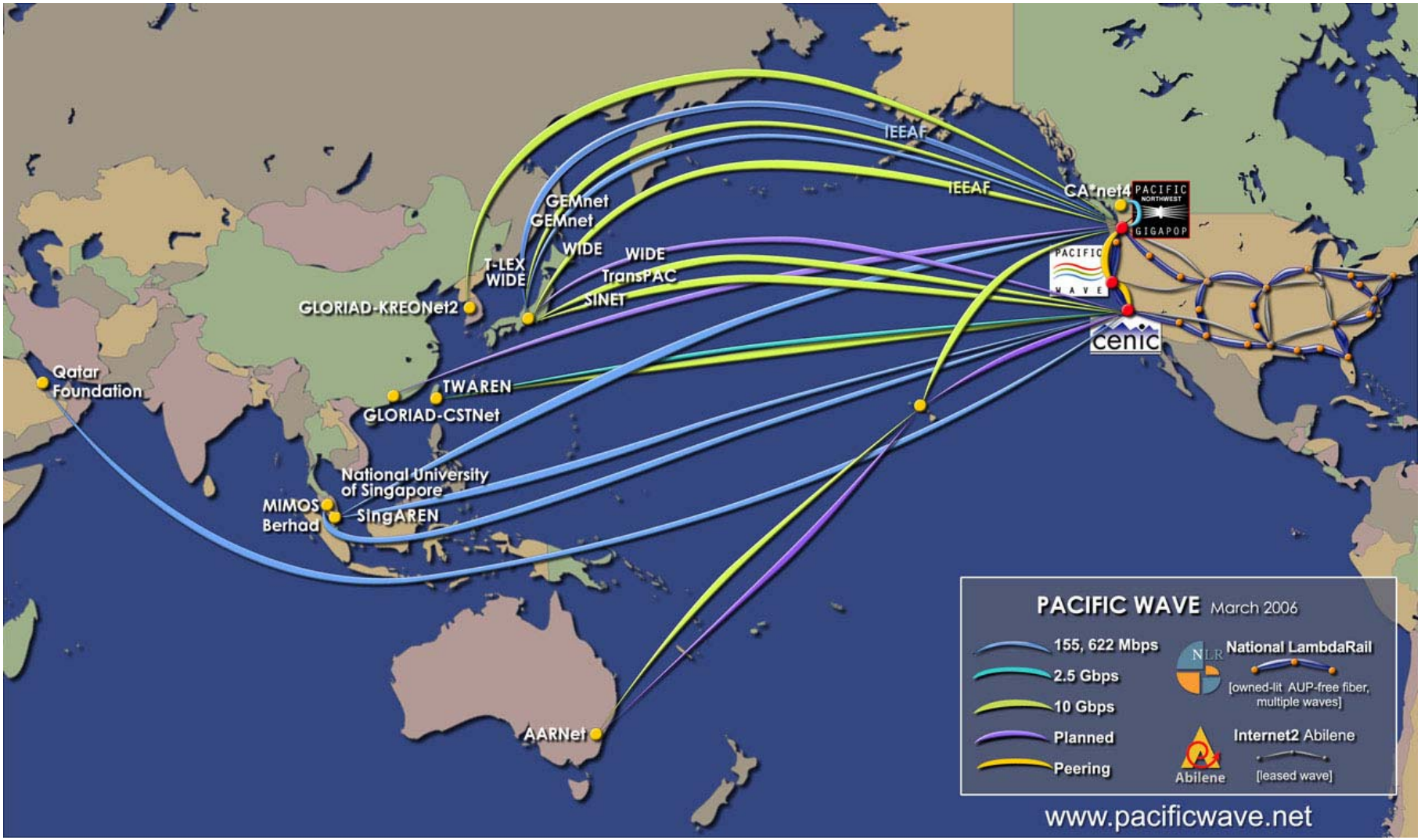
Number of Internet hosts

- 1970: 10
- 1975: 100
- 1980: 200
- 1985: 2,000
- 1990: 350,000
- 1995: 10,000,000
- 2000: 100,000,000
- 2005: 400,000,000

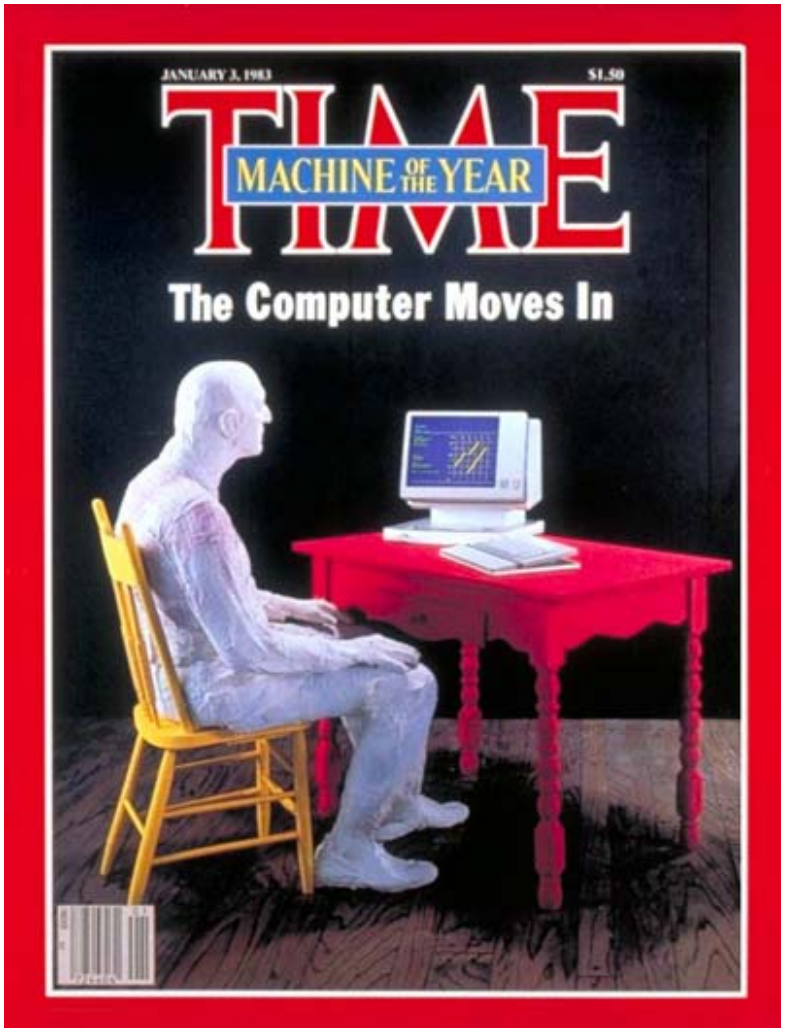


A connected region – then

A connected region – now



The Computer: *Time* Magazine's 1982 "Machine of the Year"



- "In medicine, the computer, which started by keeping records and sending bills, now suggests diagnoses. The process may sound dehumanized, but in one hospital … a survey of patients showed that they found the machine 'more friendly, polite, relaxing and comprehensible' than the average physician.'"

- "When the citizen of tomorrow wants a new suit, one futurist scenario suggests, his personal computer will take his measurements and pass them on to a robot that will cut his choice of cloth with a laser beam and provide him with a perfectly tailored garment."

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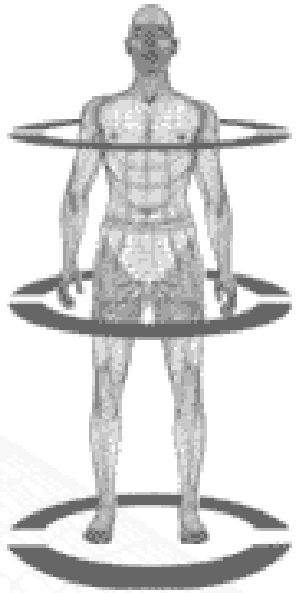

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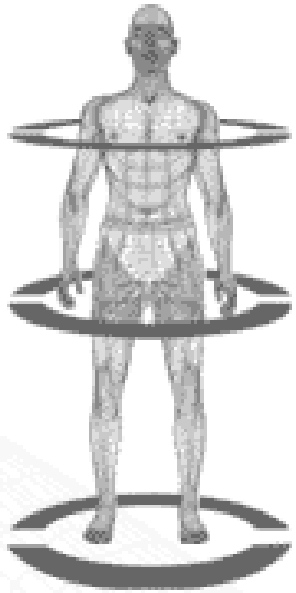

Brooks Brothers

- "In the home, computer enthusiasts delight in imagining machines performing domestic chores."

- "In the home, computer enthusiasts delight in imagining machines performing domestic chores."

vacuum your carpet

iRobot

- "In the home, computer enthusiasts delight in imagining machines performing domestic chores."

wash your floor

iRobot

- "In the home, computer enthusiasts delight in imagining machines performing domestic chores."

scrub your pool

iRobot

- "In the home, computer enthusiasts delight in imagining machines performing domestic chores."

clean your gutters

iRobot

- "In the home, computer enthusiasts delight in imagining machines performing domestic chores."

amuse your pet

iRobot

- "In the home, computer enthusiasts delight in imagining machines performing domestic chores."

detonate your IED's

iRobot

- "Seymour Papert … author of *Mindstorms: Children, Computers and Powerful Ideas* …"

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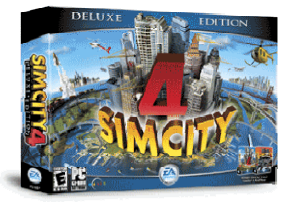
The Computing Community Consortium: Stimulating Bigger Thinking

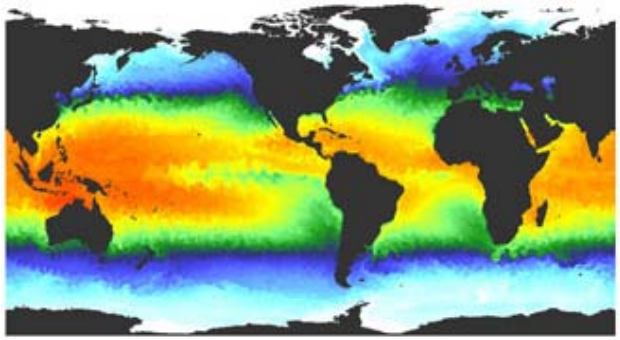
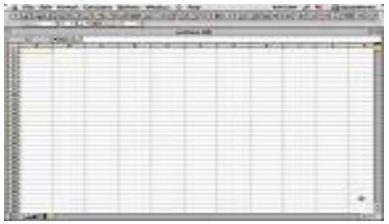
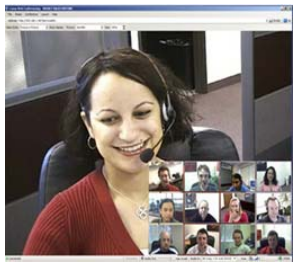
The Computing Community Consortium supports the computing research community in creating compelling research visions and the mechanisms to realize these visions.

Computing has changed the world

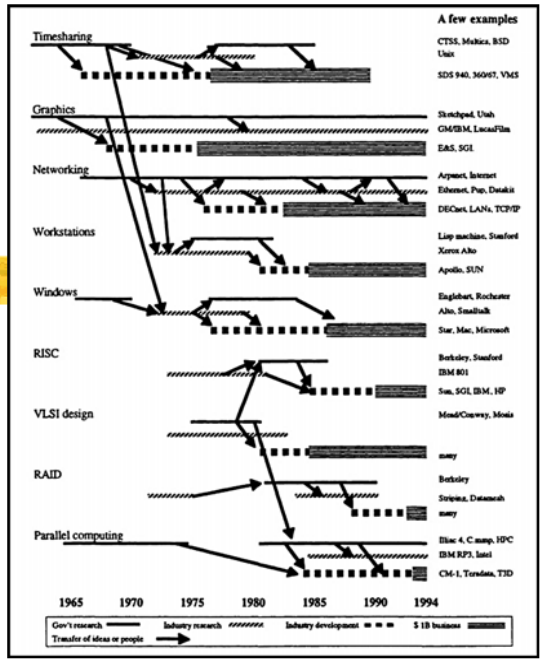
- Advances in computing change the way we live, work, learn, and communicate
- Advances in computing drive advances in nearly all other fields
- Advances in computing power our economy
  - Not just through the growth of the IT industry – through productivity growth across the entire economy



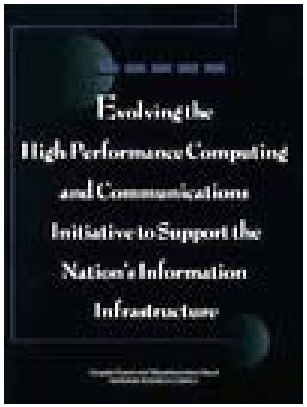


Research has built the foundation

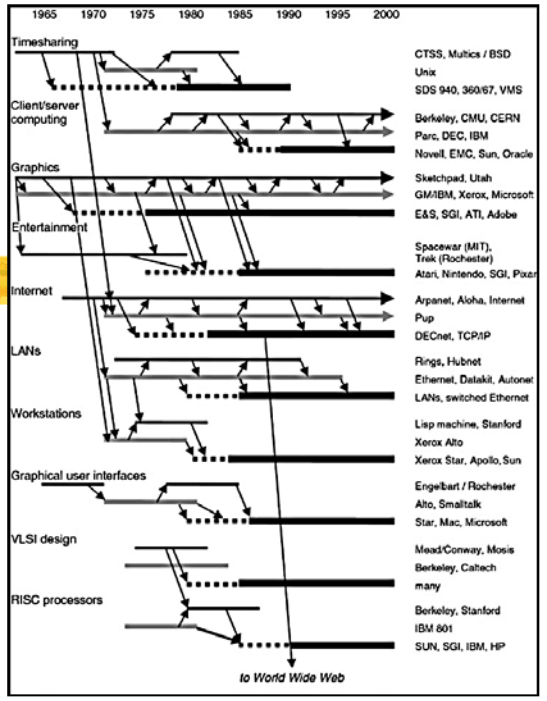


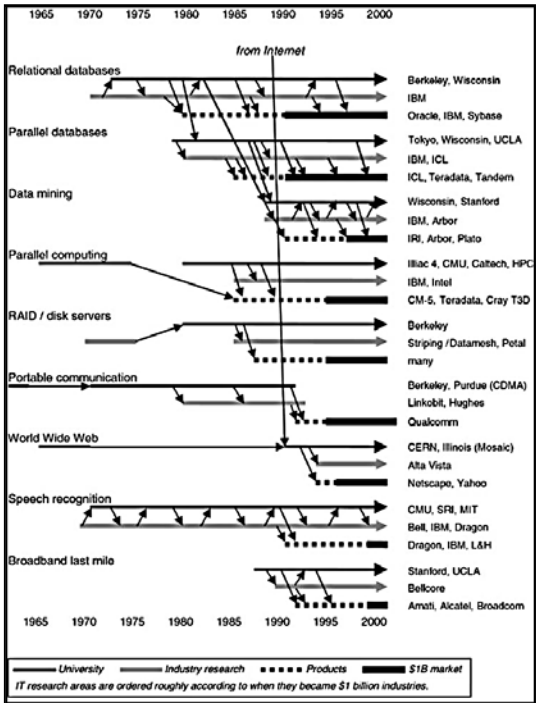
- Timesharing
- Computer graphics
- Networking (LANs and the Internet)
- Personal workstation computing
- Windows and the graphical user interface
- RISC architectures
- Modern integrated circuit design
- RAID storage
- Parallel computing



Much of the impact is recent

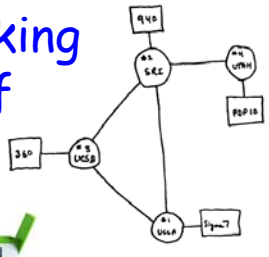
- Entertainment technology
- Data mining
- Portable communication
- The World Wide Web
- Speech recognition
- Broadband last mile

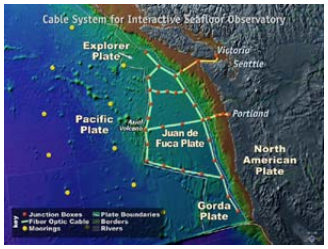


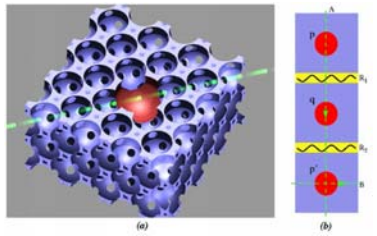


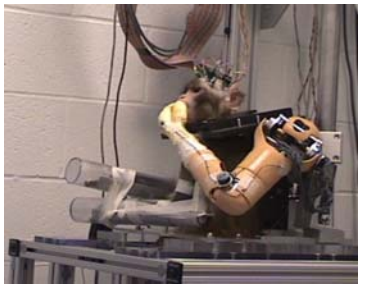
The future is full of opportunity

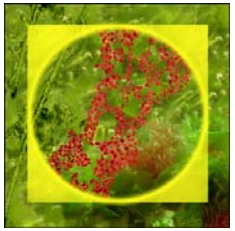
- Creating the future of networking
- Driving advances in all fields of science and engineering
- Wreckless driving
- Personalized education
- Predictive, preventive, personalized medicine
- Quantum computing
- Empowerment for the developing world
- Personalized health monitoring => quality of life
- Harnessing parallelism: many-core and DISC
- Neurobotics
- Synthetic biology
- The algorithmic lens: Cyber-enabled Discovery and Innovation











We must work together to establish, articulate, and pursue visions for the field

- The challenges that will shape the intellectual future of the field
- The challenges that will catalyze research investment and public support
- The challenges that will attract the best and brightest minds of a new generation

To this end, NSF asked CRA to create the Computing Community Consortium

- To catalyze the computing research community to consider such questions
  - To envision long-range, more audacious research challenges
  - To build momentum around such visions
  - To state them in compelling ways
  - To move them towards funded initiatives
  - To ensure "science oversight" of large-scale initiatives
- *A "cooperative agreement" with NSF*
  - Close coordination

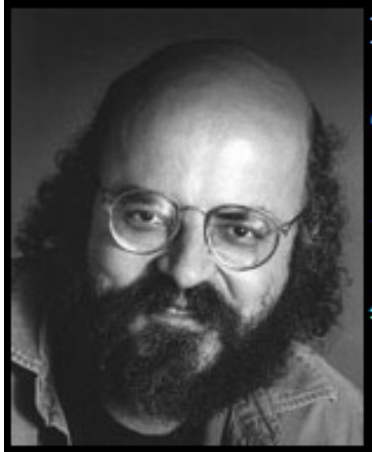
The structure

- CCC is all of us!
  - This process *must* succeed, and it *can't* succeed without broad community engagement
- There is a CCC Council to guide the effort
  - The Council *stimulates* and *facilitates* – it doesn't "own"
  - Inaugural Council appointed through an open process led by Randy Bryant
- The Council is led by a Chair
  - Ed Lazowska, University of Washington
    - Susan Graham, UC Berkeley, serves as Vice Chair
  - 50% effort – not titular
- The CCC is staffed by CRA
  - Andy Bernat serves as Executive Director

- Those involved in shaping CRA's response to NSF's original challenge
  - Andy Bernat
  - Randy Bryant
  - Susan Graham
  - Anita Jones
  - Dick Karp
  - Ken Kennedy
  - Ed Lazowska
  - Peter Lee
  - Dan Reed
  - Wim Sweldens
  - Jeff Vitter
- Inaugural CCC Council
  - Greg Andrews
  - Bill Feiereisen
  - Susan Graham (v ch)
  - Anita Jones
  - David Kaeli
  - Dick Karp
  - John King
  - Ed Lazowska (ch)
  - Peter Lee
  - Andrew McCallum
  - Beth Mynatt
  - Fred Schneider
  - Bob Sproull
  - Karen Sutherland
  - David Tennenhouse
  - Dave Waltz

Activities to date

- Definition and execution of a bootstrapping procedure for the CCC
  - Not straightforward, because community ownership was essential!
- Five plenary talks at the Federated Computing Research Conference (June 2007) to introduce CCC to the computing research community
  - Embracing and amplifying efforts that are already underway



Monday June 11, 6-7 p.m., Grand Exhibit Hall

Christos Papadimitriou, UC Berkeley

The Algorithmic Lens: How the Sciences are Being Transformed by the Computational Perspective

Abstract

Tuesday June 12, 6-7 p.m., Grand Exhibit Hall

Bob Colwell, Independent Consultant

Future of Computer Architecture '07

Abstract

Wednesday June 13, 6-7 p.m., Grand Exhibit Hall

Randal Bryant, Carnegie Mellon University

Data-Intensive Super Computing: Taking Google-Style Computing Beyond Web Search

Abstract

Thursday June 14, 6-7 p.m., Grand Exhibit Hall

Scott Shenker, UC Berkeley

We Dream of GENI: Exploring Radical Network Designs

Abstract

Friday June 15, 11:30 a.m. - 12:30 p.m., Grand Exhibit Hall (FCRC Keynote Talk)

Ed Lazowska, University of Washington and Chair, Computing Community Consortium

Computer Science: Past, Present and Future

Abstract

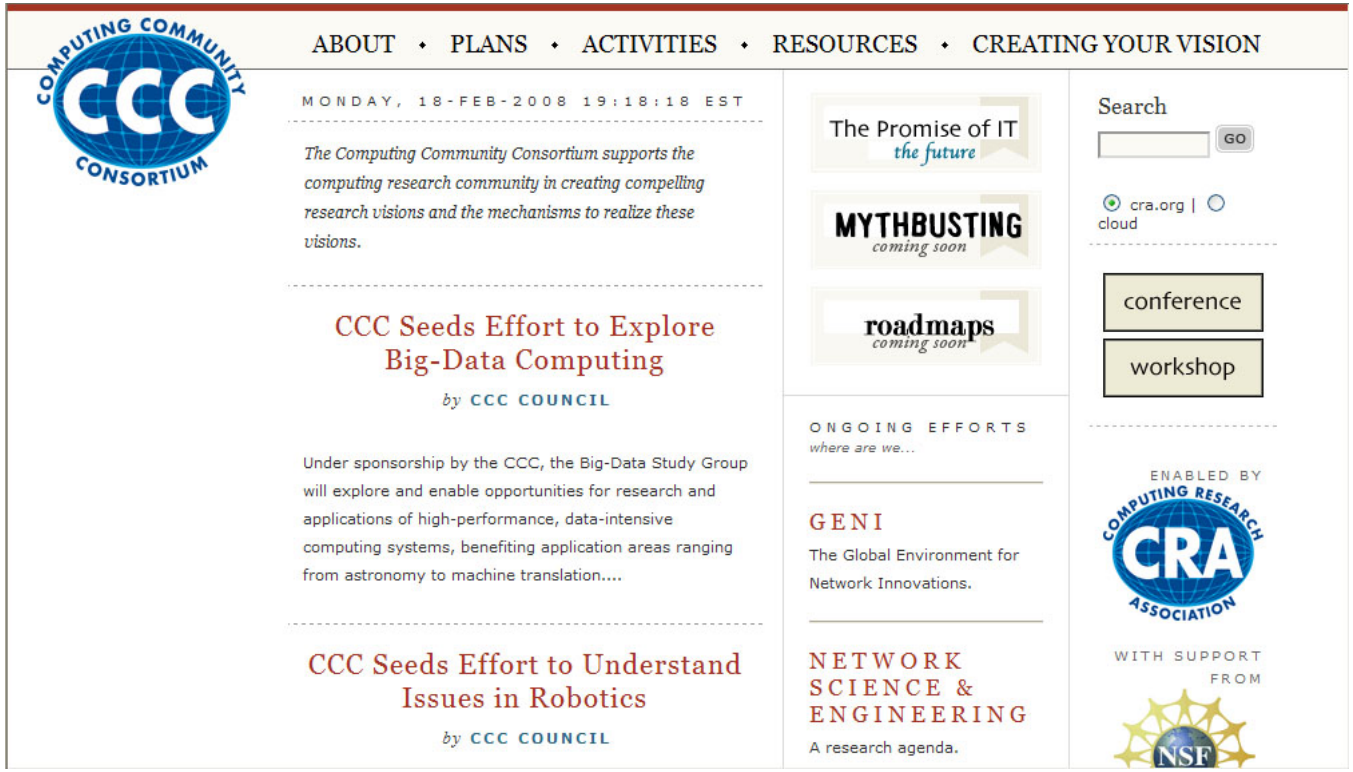
- Definition and execution of an RFP process to support visioning by the computing research community
  - Quarterly deadlines, but a rolling process
  - Three efforts launched thus far:
    - "Big Data Computing Study Group"
    - "Visions for Theoretical Computer Science"
    - "From Internet to Robotics: The Next Transformative Technology"

- *Big Data Computing Study Group*
  - Topic:
    - "The Big Data Computing Study Group will undertake efforts to explore and enable opportunities on the research and application of high-performance computing over very large data sets."
  - Leadership:
    - Randy Bryant, CMU
    - Thomas Kwan, Yahoo! Research
  - Initial activities:
    - Hadoop Summit, March 25, Sunnyvale CA
    - Data-Intensive Scalable Computing Symposium, March 26, Sunnyvale CA

- *Visions for Theoretical Computer Science*
  - Topic:
    - "The purpose of the visioning workshop will be to identify and distill broad research themes within TCS that have potential for major impact in the future … The workshop will aim to produce compelling "nuggets" that can quickly convey the importance of a research direction to a layperson [and] could be used by the CCC or anyone else making the case for a sustained investment in long-term, foundational computing research."
  - Leadership:
    - Richard Ladner, Washington
    - Bernard Chazelle, Anna Karlin, Dick Lipton, Salil Vadhan
  - Initial activities:
    - Workshop prior to STOC, May 17, Seattle WA

- *From Internet to Robotics: The Next Transformative Technology*
  - Topic:
    - "This study will generate a roadmap of applications for robotics across users, producers and researchers. The objective is to provide a comprehensive view of use of robotics, the main obstacles to deployment, and the key competencies required to facilitate the transformation."
  - Leadership:
    - Henrik Christensen, Georgia Tech
    - 10 others (Leslie Kaelbling, Sebastian Thrun, …)
  - Initial activities:
    - Workshop on manufacturing robotics, June 17, Washington DC
    - Workshop on medical/healthcare robotics, June 19-20, Washington DC

- Creation of a website with lots of good intentions for the future …
  - Visioning blog … "Mythbusting" … "The Promise of IT"



- Extensive work with NSF and the computing research community related to GENI (the Global Environment for Network Innovations) and the broader NetSE (Network Science & Engineering) research agenda
  - GENI Community Advisory Board -> GENI Science Council -> NetSE Council
    - 19 members, chaired by Ellen Zegura of Georgia Tech

The desired outcomes

- Broad community engagement in establishing more audacious and inspiring research visions for our field
  - Some may require significant research infrastructure (e.g., NetSE); some will be new programs (e.g., CDI)
- Better public appreciation of the potential of the field
- Attraction of a new generation of students
- Greater impact!

The next ten years …

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Greatest Achievements

NATIONAL ACADEMY OF ENGINEERING
OF THE NATIONAL ACADEMIES

GRAND CHALLENGES FOR ENGINEERING

Make solar energy economical

Provide energy from fusion

Develop carbon sequestration methods

Manage the nitrogen cycle

Provide access to clean water

Restore and improve urban infrastructure

Advance health informatics

Engineer better medicines

Reverse-engineer the brain

Prevent nuclear terror

Secure cyberspace

Enhance virtual reality

Advance personalized learning

Engineer the tools of scientific discovery

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CHALLENGES | IDEAS | NEXT STEPS | COMMITTEE

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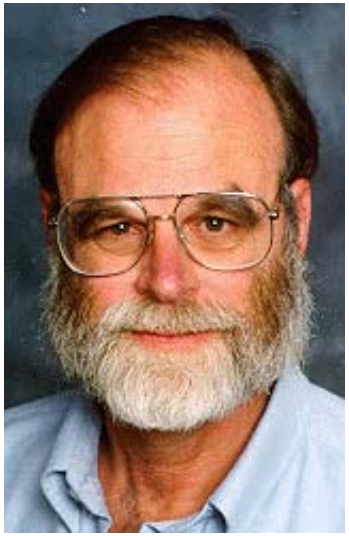
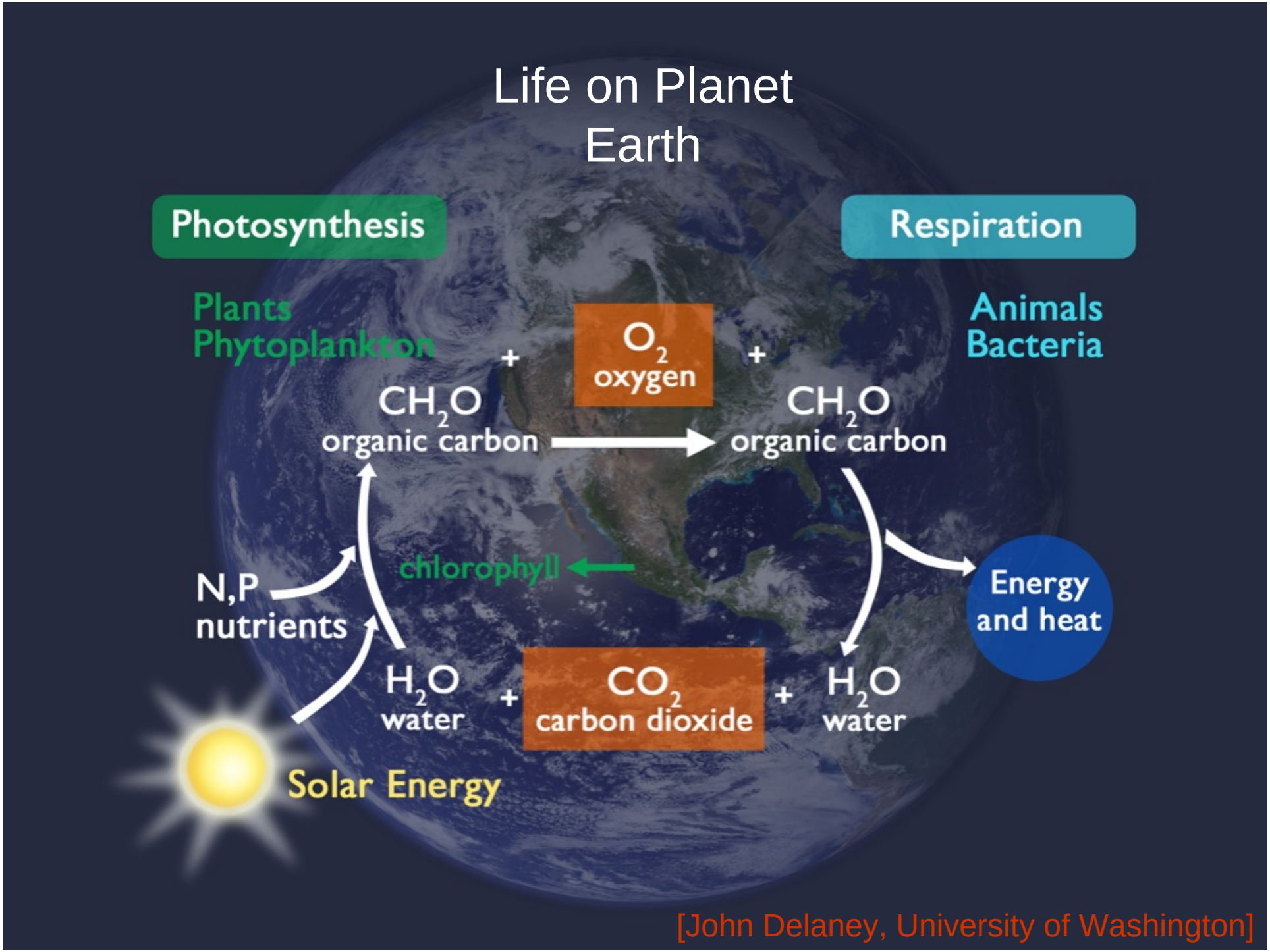
1. eScience: Sensor-driven (data-driven) science and engineering




[John Delaney, University of Washington]

Life on Planet Earth



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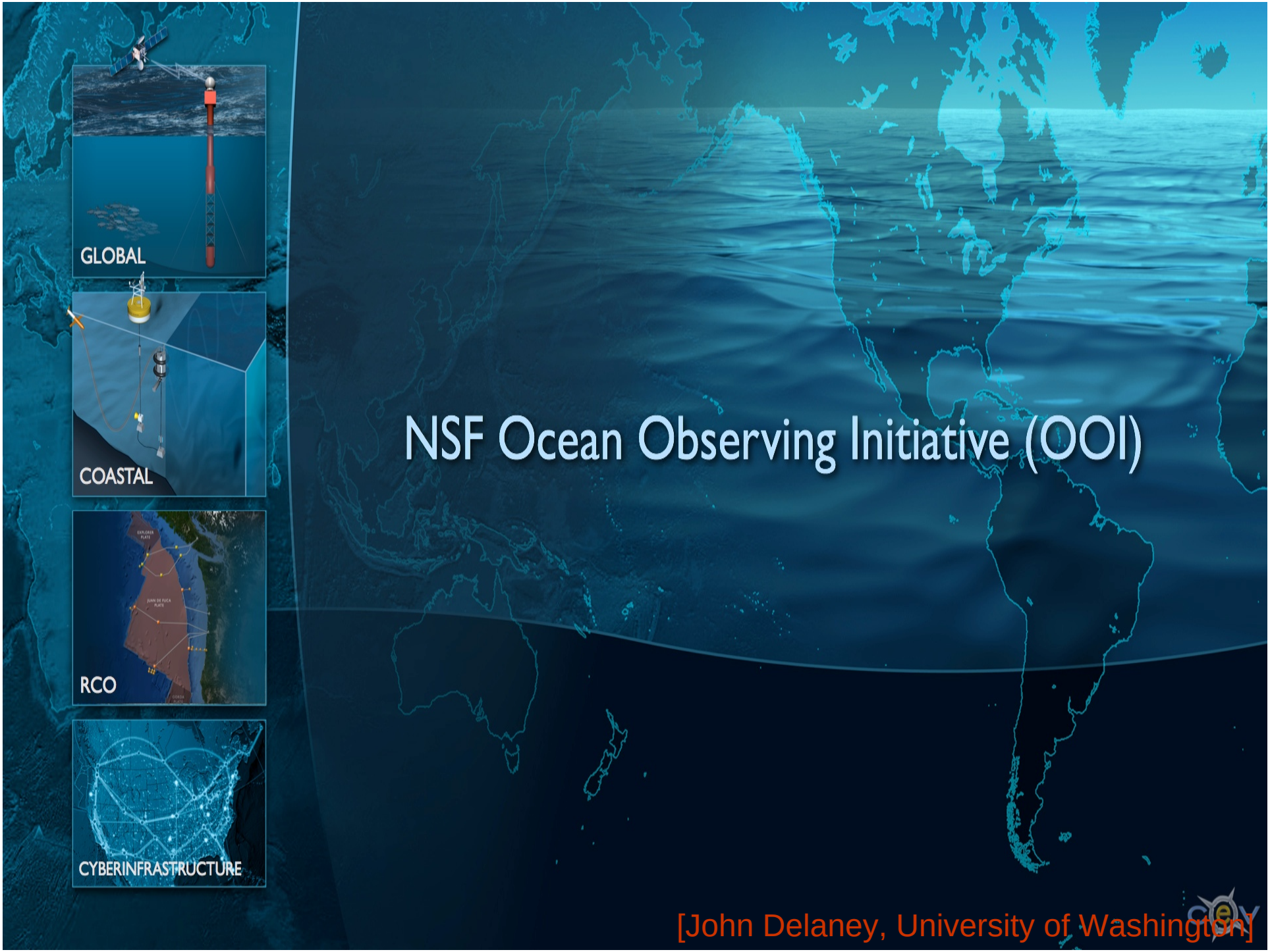
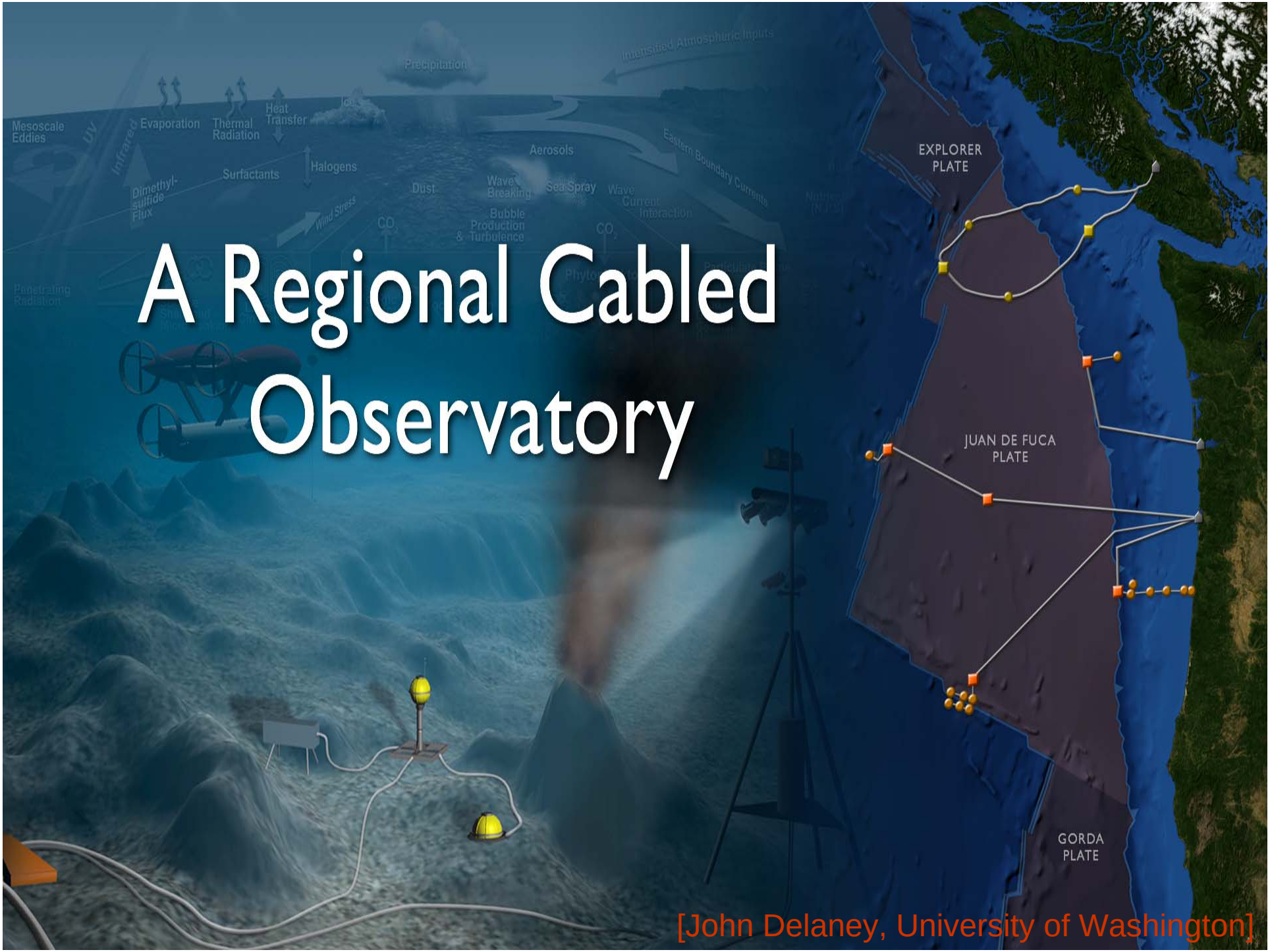

GLOBAL
COASTAL
RCO
CYBERINFRASTRUCTURE
NSF Ocean Observing Initiative (OOI)
[John Delaney, University of Washington]



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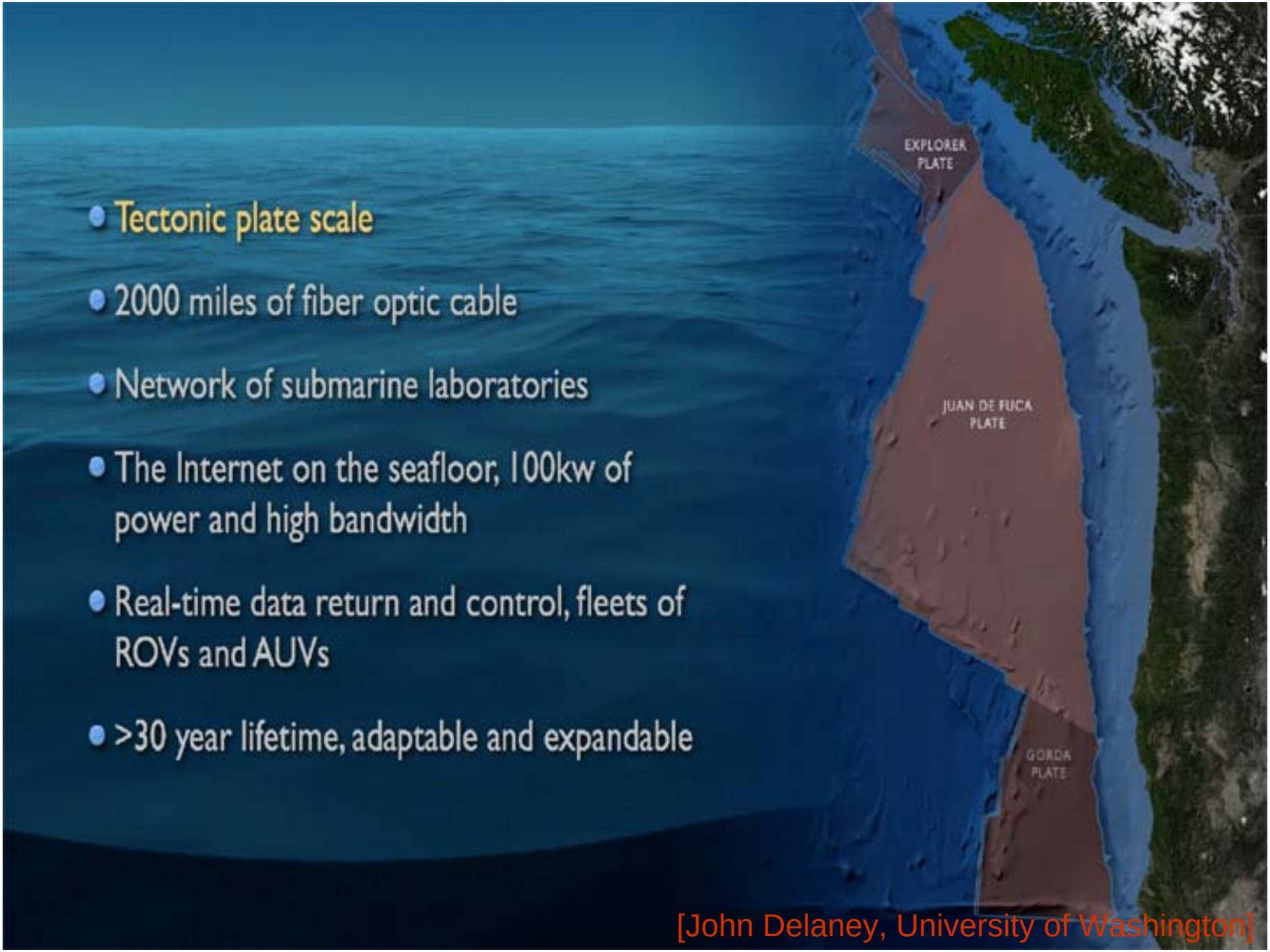
Tectonic plate scale
2000 miles of fiber optic cable
Network of submarine laboratories
The Internet on the seafloor, 100kw of power and high bandwidth
Real-time data return and control, fleets of ROVs and AUVs
>30 year lifetime, adaptable and expandable
EXPLORER PLATE
JUAN DE FUCA PLATE
GORDA PLATE
[John Delaney, University of Washington]

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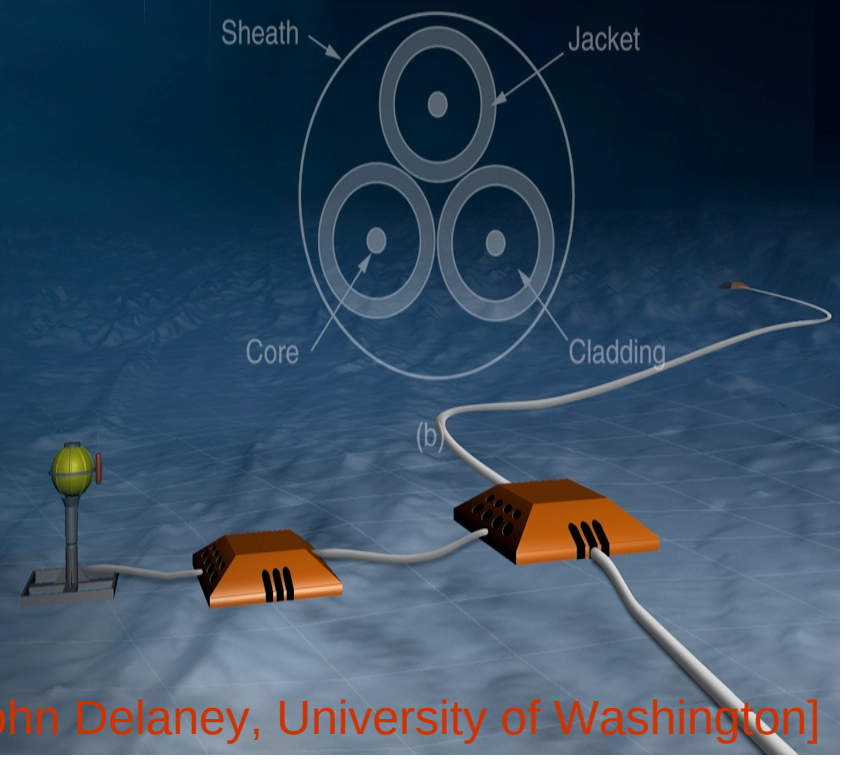
- **The Internet on the seafloor, 100kw of power and high bandwidth**
- Real-time data return and control, fleets of ROVs and AUVs
- >30 year lifetime, adaptable and expandable



[John Delaney, University of Washington]

- Tectonic plate scale
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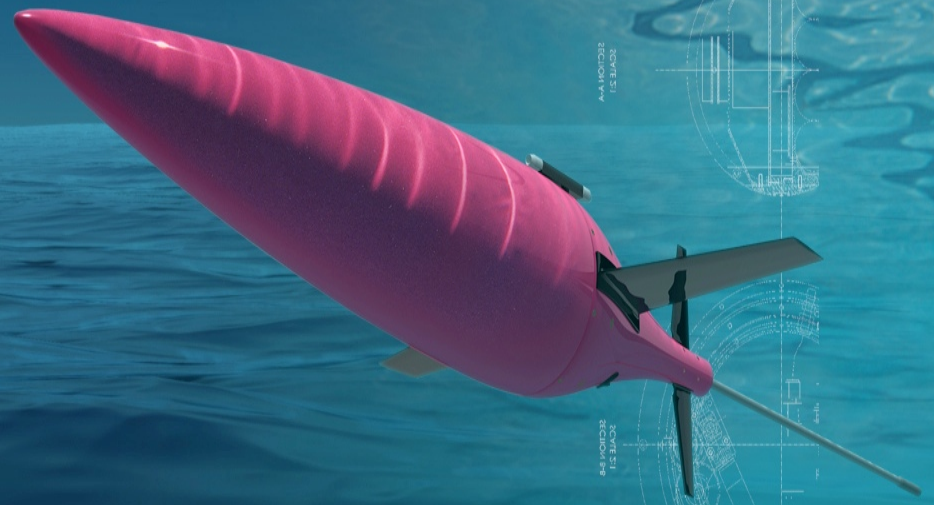
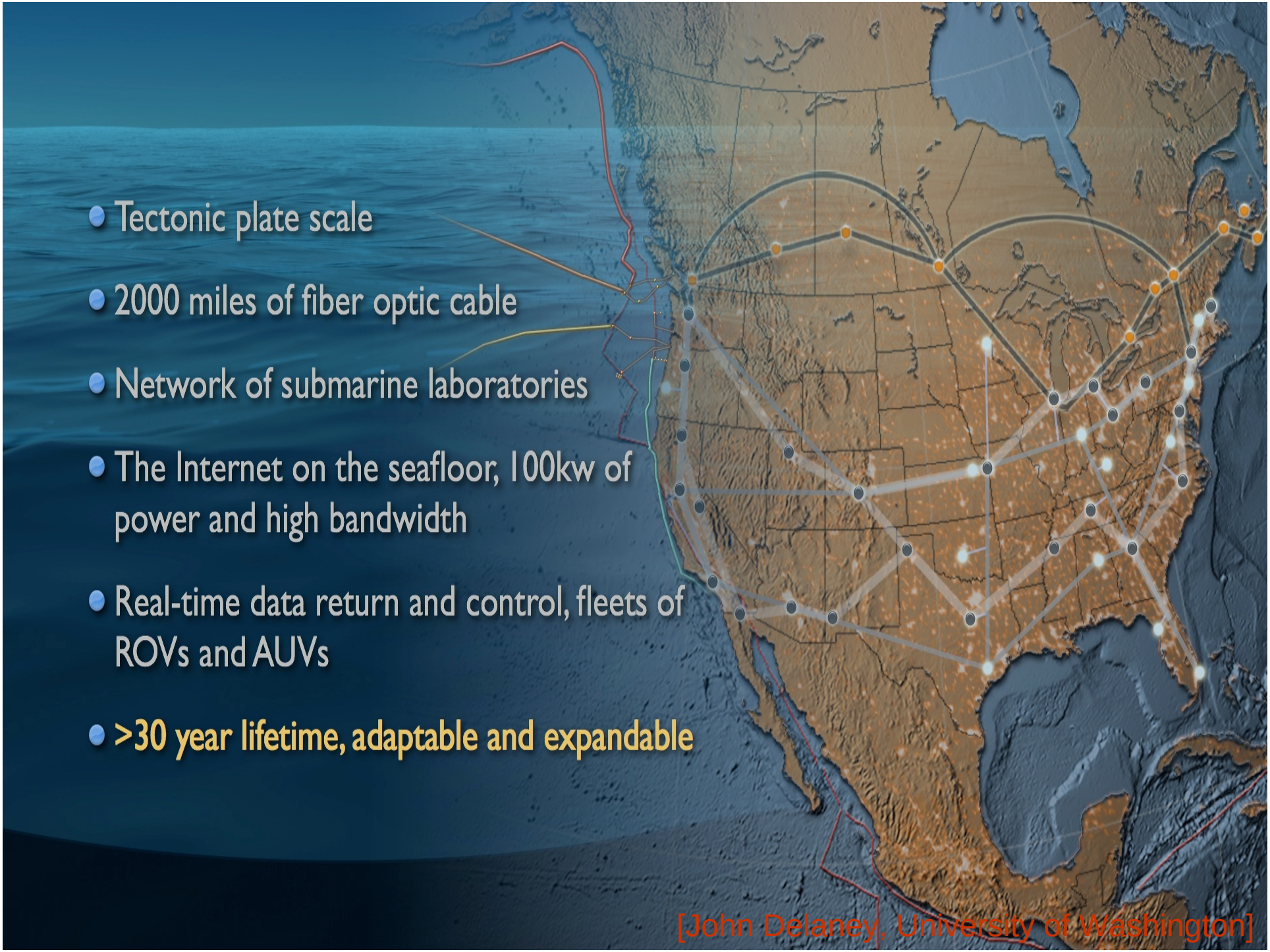


[John Delaney, University of Washington]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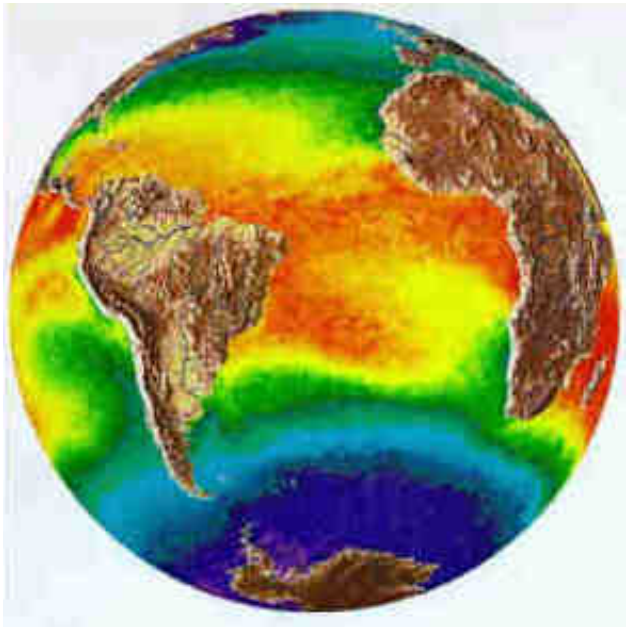
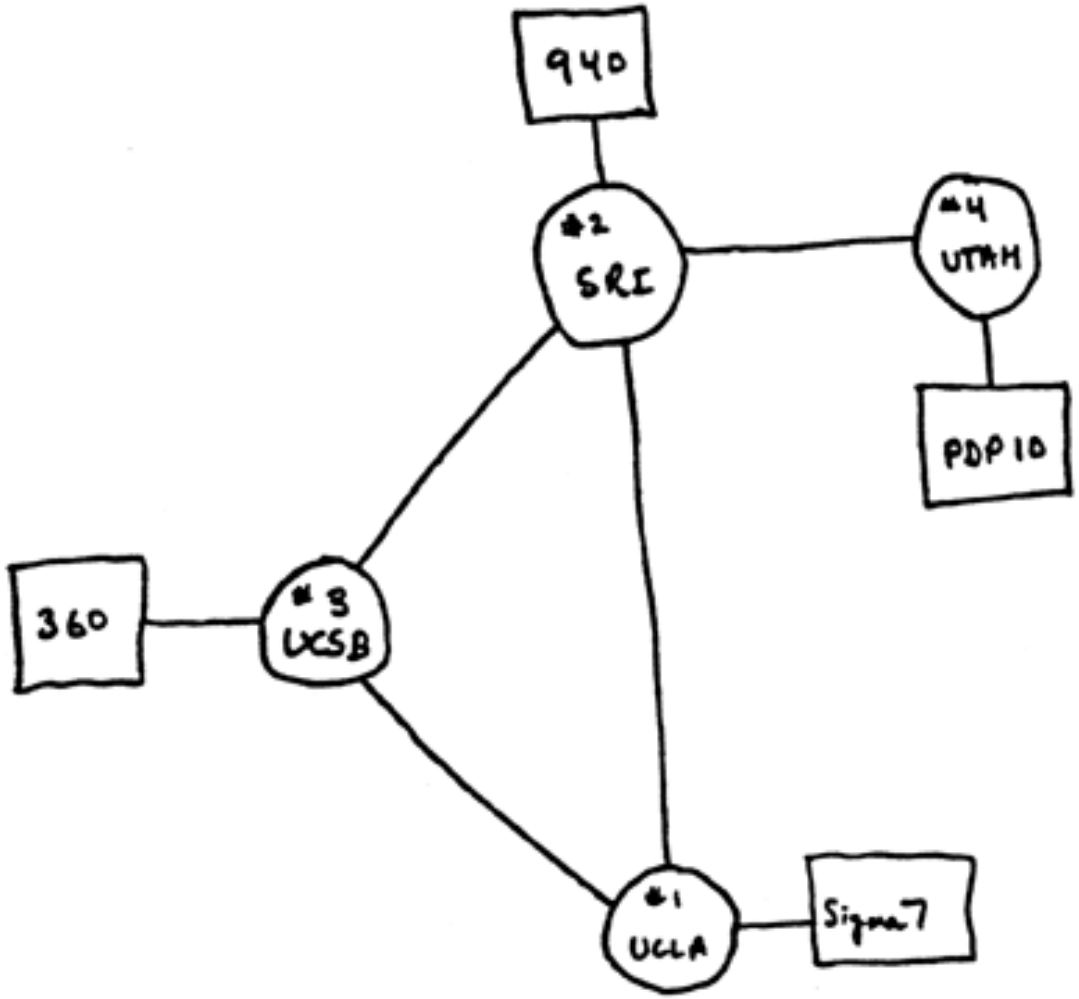
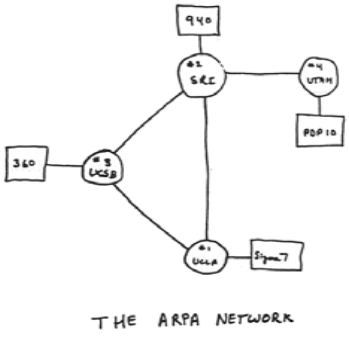


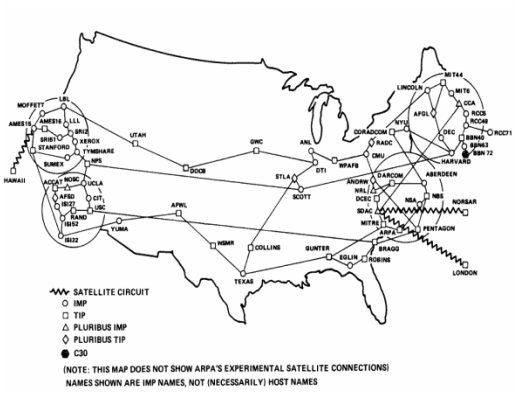
2. NetSE: Creating the future of networking



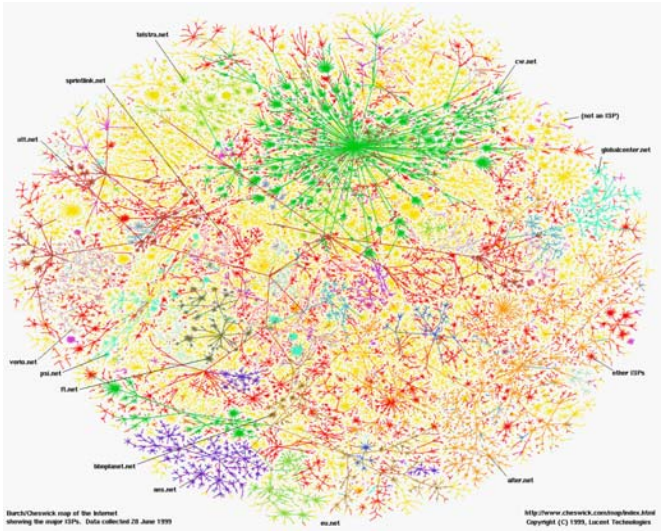
Our Evolving Networks are Complex



1970



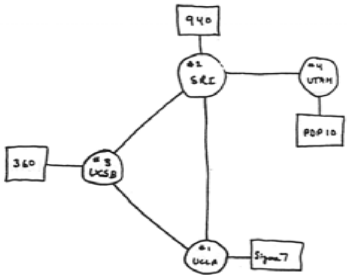
1980



2000

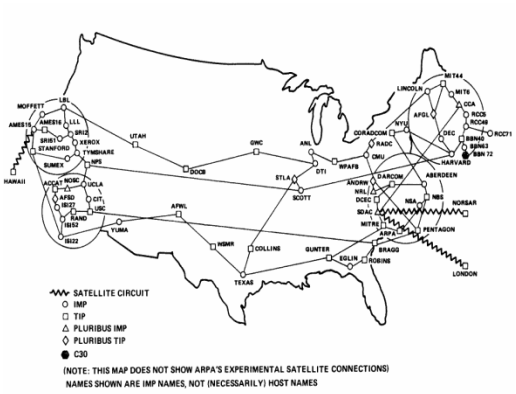
[Jeannette Wing, CMU and NSF]

Our Evolving Networks are Complex



THE ARPA NETWORK

1970



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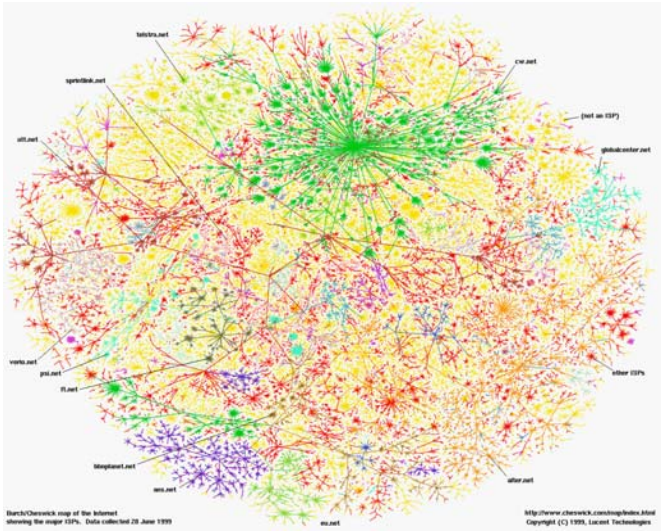

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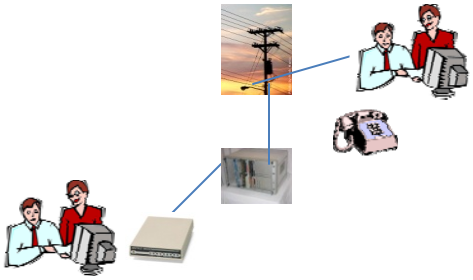
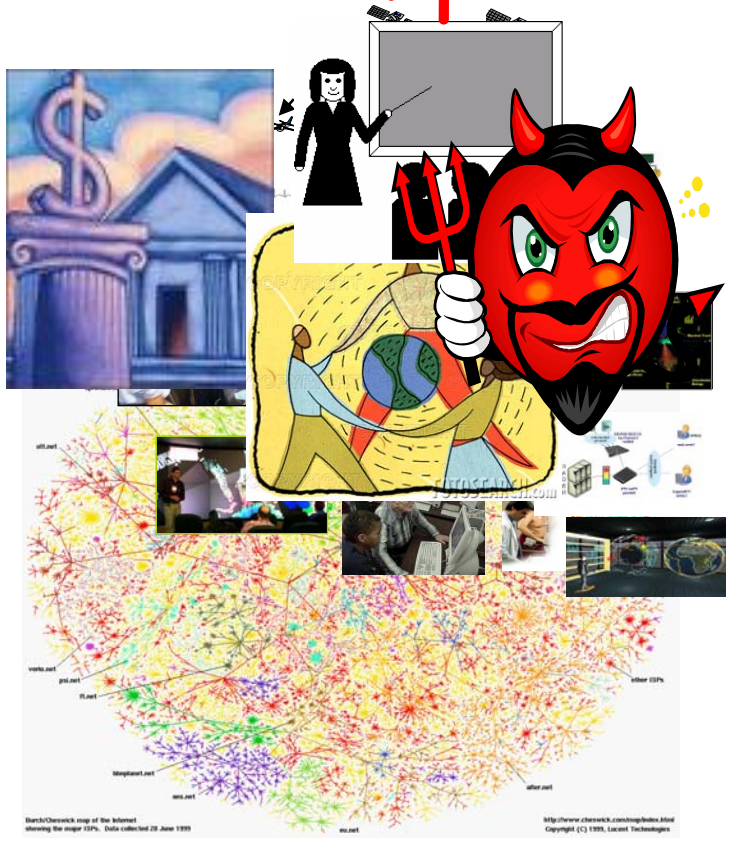
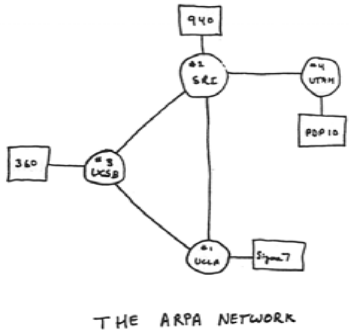
[Jeannette Wing, CMU and NSF]

Our Evolving Networks are Complex







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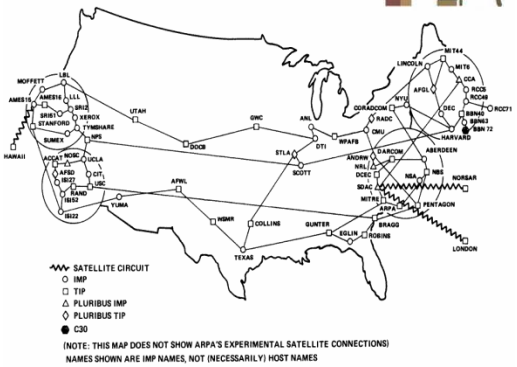


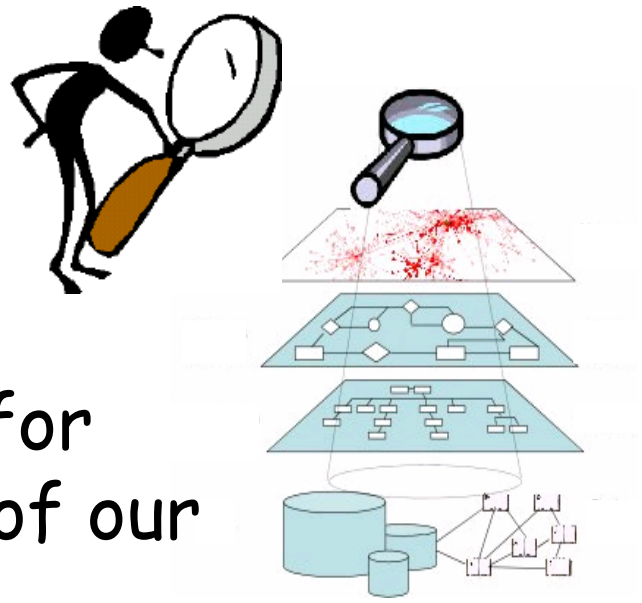
1980

2000

[Jeannette Wing, CMU and NSF]

Challenge to the Community

Fundamental Question: Is there a science for understanding the complexity of our networks such that we can engineer them to have predictable behavior?



Call to Arms: To develop a compelling research agenda for the science and engineering of our evolving, complex networks.

[Jeannette Wing, CMU and NSF]

Network Science and Engineering: Fundamental Challenges

Science → Understand the complexity of large-scale networks → Network science and engineering researchers

- Understand emergent behaviors, local-global interactions, system failures and/or degradations
- Develop models that accurately predict and control network behaviors

Technology → Develop new architectures, exploiting new substrates → Distributed systems and substrate researchers

- Develop architectures for self-evolving, robust, manageable future networks
- Develop design principles for seamless mobility support
- Leverage optical and wireless substrates for reliability and performance
- Understand the fundamental potential and limitations of technology

Society → Enable new applications and new economies, while ensuring security and privacy → Security, privacy, economics, AI, social science researchers

- Design secure, survivable, persistent systems, especially when under attack
- Understand technical, economic and legal design trade-offs, enable privacy protection
- Explore AI-inspired and game-theoretic paradigms for resource and performance optimization

[Jeannette Wing, CMU and NSF]

3. Flattening the world (empowering the developing world)

*3 billion people in the **rural developing world***
need the same information we do

- ✔ Business: new opportunities
- ✔ Finance: capital to invest
- ✔ Government: services & programs
- ✔ Health: informed, consistent care
- ✔ Education: personal advancement




[Tapan Parikh, UW and UCB]

3 billion people in the rural ***developing world***
have different limitations and capabilities

✗ Money: to buy technology

✗ Education: to use technology

✗ Infrastructure: power, connectivity

✔ Time: lots of available labor

✔ Community: lots of relations




[Tapan Parikh, UW and UCB]

CAM: Managing Information from the Grassroots

Information systems are key to scaling microfinance

- *Transaction processing*
- *Monitor members and groups*
- *Analyse performance and impact*
- *Offer more services*
- *Link to formal institutions*

Can we design a UI to document member-level SHG transactions?

- *Accurate and efficient*
- *Accessible to a variety of users*

[Tapan Parikh, UW and UCB]


[Tapan Parikh, UW and UCB]

CAM: Agricultural Monitoring

Working with farmers in Guatemala and India

Extension staff collect geocoded video, images and data

Experts provide feedback and advice via parcel-wise blog

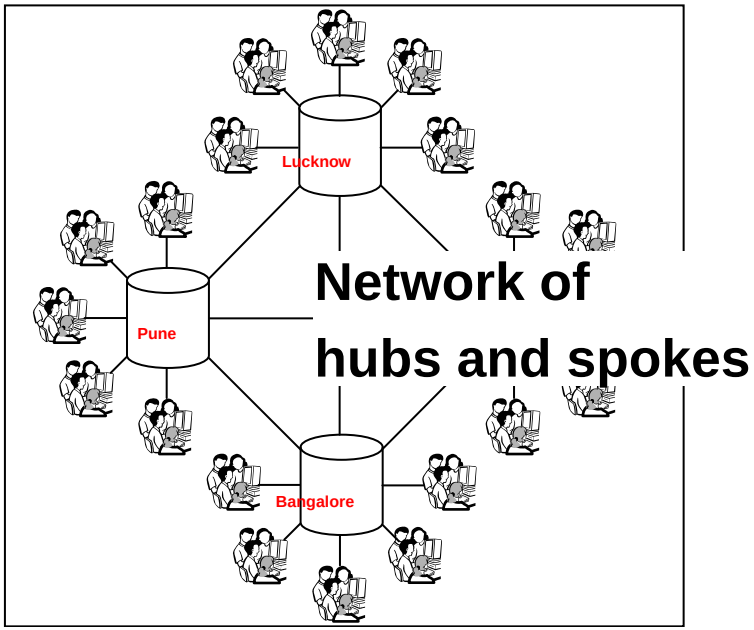
Enable remote certification – organic, bird-friendly, etc.

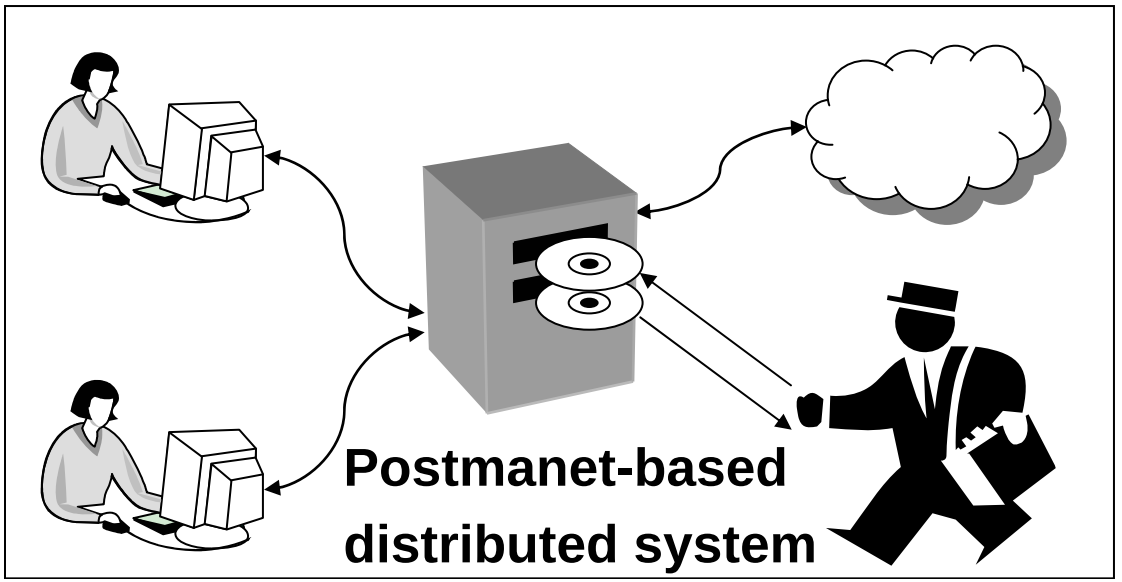
- Traceability
- Product Differentiation
- Land Use

[Tapan Parikh, UW and UCB]

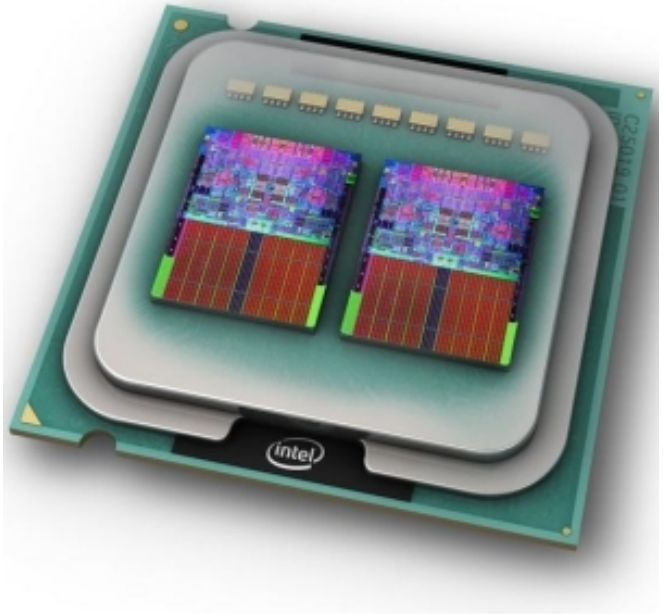
Digital Study Hall

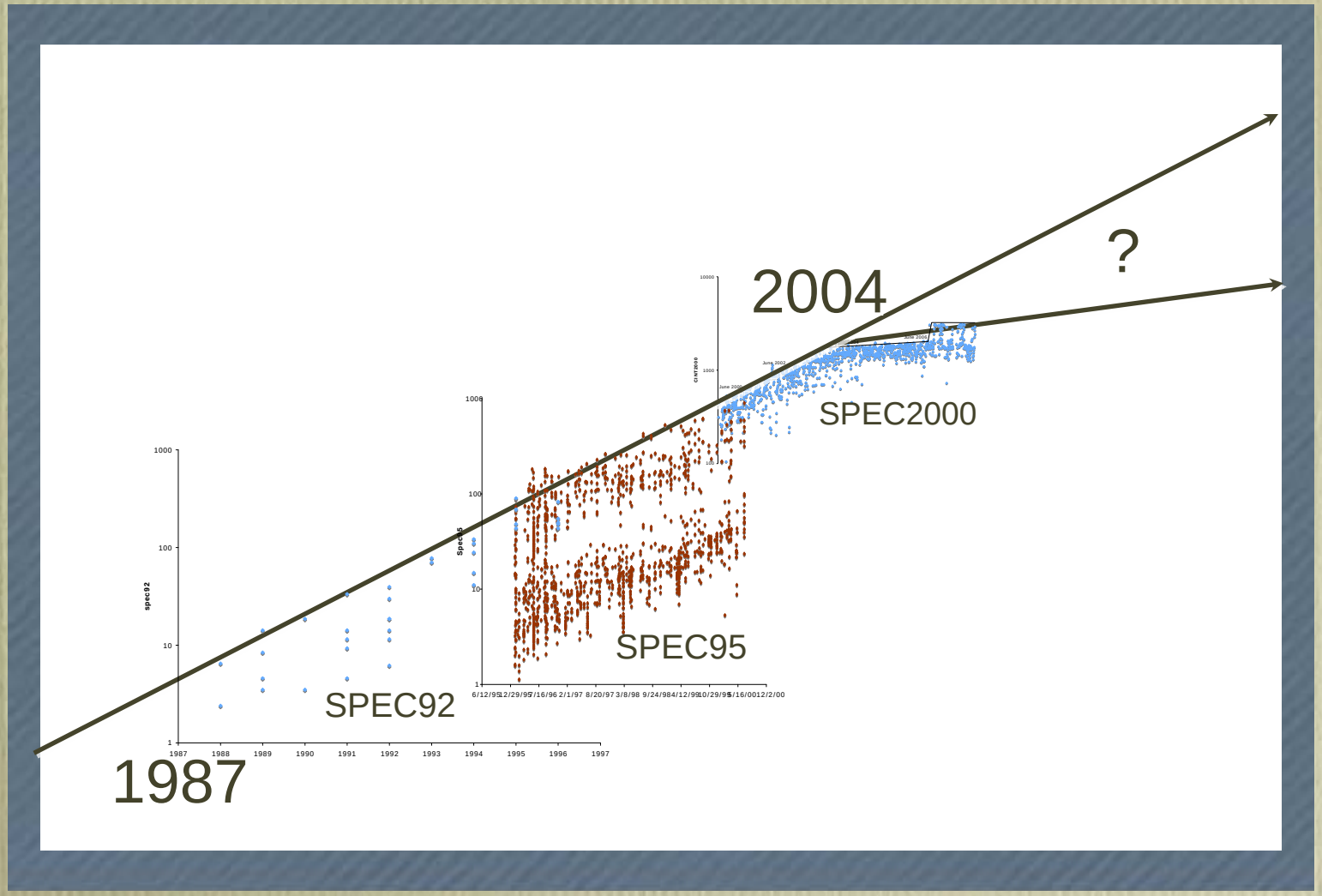
Randy Wang, Tom Anderson, Paul Javid





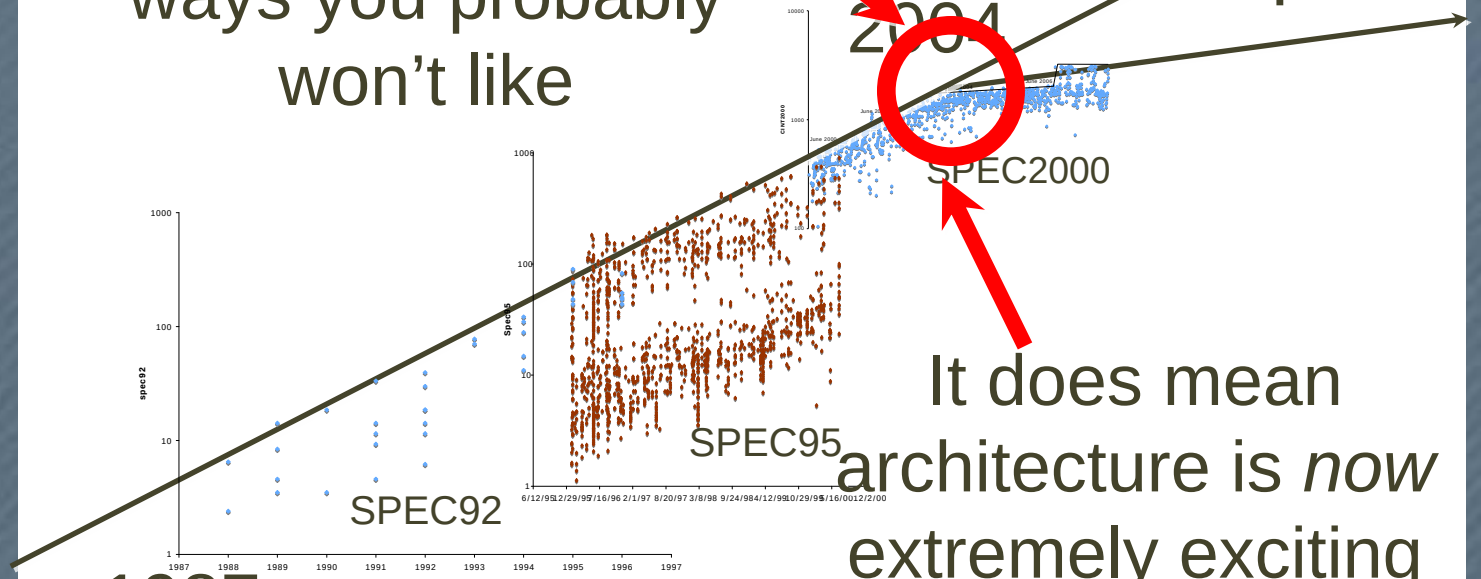
4. Harnessing parallelism





[Mark Oskin, University of Washington]

This is going to change *your* life in ways you probably won't like



It does mean architecture is *now* extremely exciting

[Mark Oskin, University of Washington]

A Parallel Revolution, Ready or Not

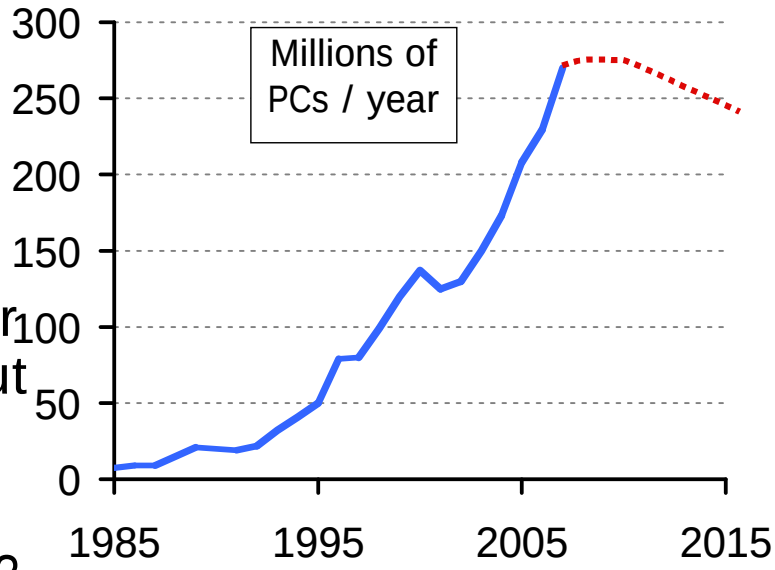
- PC, Server: Power Wall + Memory Wall = Brick Wall
  - ⇒ End of the way we built microprocessors for last 40 years
- ⇒ New Moore's Law is 2X processors ("cores") per chip every technology generation, but same clock rate
  - "This shift toward increasing parallelism is not a triumphant stride forward based on breakthroughs ...; instead, this ... **is actually a retreat from even greater challenges that thwart efficient silicon implementation of traditional solutions**."

    The Parallel Computing Landscape: A Berkeley View, Dec 2006
- Sea change for HW & SW industries since changing the model of programming and debugging
  - New "Moore's Law" is 2X processors per chip every 2 years
  - Duo core, Quad core, ...
- Goal: Productive, Efficient, Correct Programming of 100+ cores & scale as double cores every 2 years (!)

[Dave Patterson, UC Berkeley]

Suppose software stops getting faster

- What if IT goes from a *growth* industry to a *replacement* industry?
  - If SW can't effectively use 32, 64, ... cores per chip
    ⇒ SW no faster on new computer
    ⇒ Only buy if computer wears out
- Impact on US economy if end of "Moore's Law"?
  - How much productivity tied to IT?
  - How much IT tied to faster computers?
- Opportunity to lose US lead in IT if others solve the problem
  - If someone in China invents a Mandarin-based programming language that solves the parallel computing problem, then I'll need to learn Mandarin



[Dave Patterson, UC Berkeley]

More Work Needed

Research Needed

In order of decreasing urgency

1. CMOS end-game electricals problems
2. Multicore SW
3. Power/thermals management
4. Thread and manycore sync: SW needs help
5. Expand synergies between embedded & GP
6. Design-in-the-Large
7. Grand Challenges
8. New technologies like reconfig fabrics, streaming machines, quantum, bio, nano

The McGraw-Hill Companies

DECEMBER 24, 2007 | BUSINESSWEEK.COM

BusinessWeek

GOOGLE'S NEXT BIG DREAM 048

Imagine what you could do with the world's mightiest computer

BY STEPHEN BAKER

MEXICO: THE UGLY SIDE OF MICRO-LOANS 038

CENTRAL BANKERS TO THE RESCUE 025

Christophe Bisciglia, Google's master of "cloud" computing

$4.99US $6.99CAN

52

0 71435 18248 7

Google's Computing Infrastructure

System

- **~ 3 million processors in clusters of ~2000 processors each**
- **Commodity parts**
  - x86 processors, IDE disks, Ethernet communications
  - Gain reliability through redundancy & software management
- **Partitioned workload**
  - Data: Web pages, indices distributed across processors
  - Function: crawling, index generation, index search, document retrieval, Ad placement

Barroso, Dean, Hölzle, "Web Search for a Planet: The Google Cluster Architecture" IEEE Micro 2003

A Data-Intensive Scalable Computer (DISC)

- **Large-scale computer centered around data**
  - Collecting, maintaining, indexing, computing
- **Similar systems at Microsoft & Yahoo**

[Randal Bryant, CMU]

CS Research Issues

Applications

- Language translation, image processing, …

Application Support

- Machine learning over very large data sets
- Web crawling

Programming

- Abstract programming models to support large-scale computation
- Distributed databases

System Design

- Error detection & recovery mechanisms
- Resource scheduling and load balancing
- Distribution and sharing of data across system

[Randal Bryant, CMU]

5. The algorithmic lens – a computational perspective transforms the sciences

- Envisioned by the theory community
- Brought to life as the NSF Cyber-Enabled Discovery Initiative (CDI): $52M in FY08 => $250M in FY12

6. Wreckless driving

LEXUS

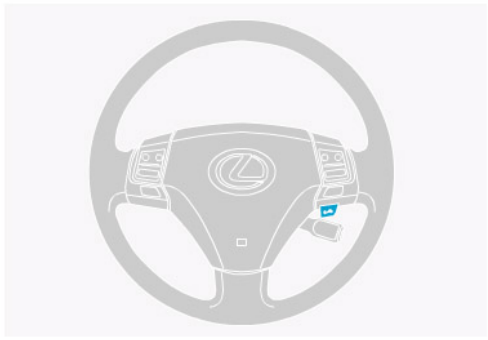
Adaptive Cruise Control (ACC)

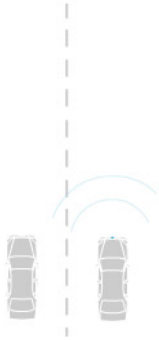
VIEW BY

› ALL FEATURES

› MODEL ...

Acoustic Control Induction System (ACIS)
Active Control Engine Mount
Adaptive Cruise Control (ACC)
Adaptive Variable Suspension (AVS)
Advanced Electronic Climate Control
Aerodynamic Drag Coefficient
AI Shift Artificial Intelligence Shift
Air Suspension
Bluetooth® technology
Brake Assist
Cruise Control
Direct Injection V6
Double Wishbone Suspension
DVD Navigation System
Electro Chromatic Device (ECD)
Electro Chromatic Mirrors
Electro Multi Vision Display (EMV)
Electronic Brakeforce Distribution (EBD)
Electronic Throttle Control System with intelligence (ETCS-i)
Electronically controlled Continuously Variable Transmission (ECVT)
E-shift - Sequential Shift Mode
Flush underbody panels





AVAILABLE IN

IS 250
GS 300 & GS 430
GS 450h
LS 430

If traditional cruise control had a higher IQ, this would be the result. Adaptive Cruise Control (ACC) works just like a more conventional cruise control system - until it detects a car in front of it. Sensors detect that you are approaching a car ahead.
The system then automatically eases off the throttle or even gently applies the brakes to maintain a constant safe distance (which you can adjust) behind that vehicle. As soon as the vehicle pulls into another lane, ACC accelerates, smoothly and progressively, to your original chosen speed.

eGMCarTech
the CarTech Mag

Lexus Prices LS 460's Automated Parking Option Below $1,000

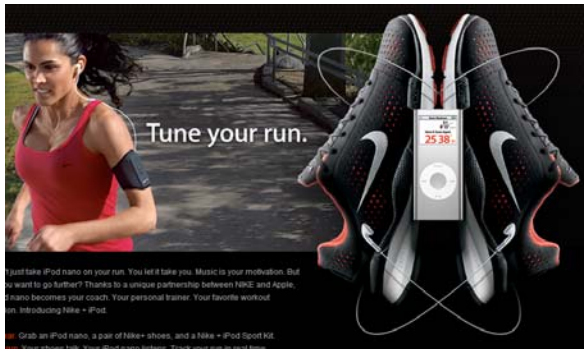
September 22nd, 2006 - Posted under Lexus

While Lexus still hasn't released more images or pricing info on the Lexus LS 460, the company is saying that it will price its Advanced Parking Guidance System below $1,000. The Automated Parking Option in the Lexus LS 460 backs the car into a parking space once the driver has lined up the car properly using rearview camera option on its in-dash screen. The driver will then use the brakes to adjust speed of the vehicle while the car adjusts the steering. Umm, we wouldn't spend even $500 for that options, but we're sure some people will try it off just to say they have it.

- In 2004, in just the United States:
  - 6,181,000 police-reported traffic accidents
    - 42,636 people killed
    - 2,788,000 people injured
    - 4,281,000 had property damage only
  - ~ $500 billion (that's *half a trillion dollars* …) in *annual* economic cost
    - 200 times greater than even an extravagant estimate of the nation's annual investment in computing research

7. Personalized health monitoring => quality of life

Omron pedometer



Nike + iPod

Bodymedia multi-function

Biozoom: body fat, hydration, blood oxygen, etc.

Glucowatch: measuring body chemistry

Quality of Life Technology Engineering Research Center

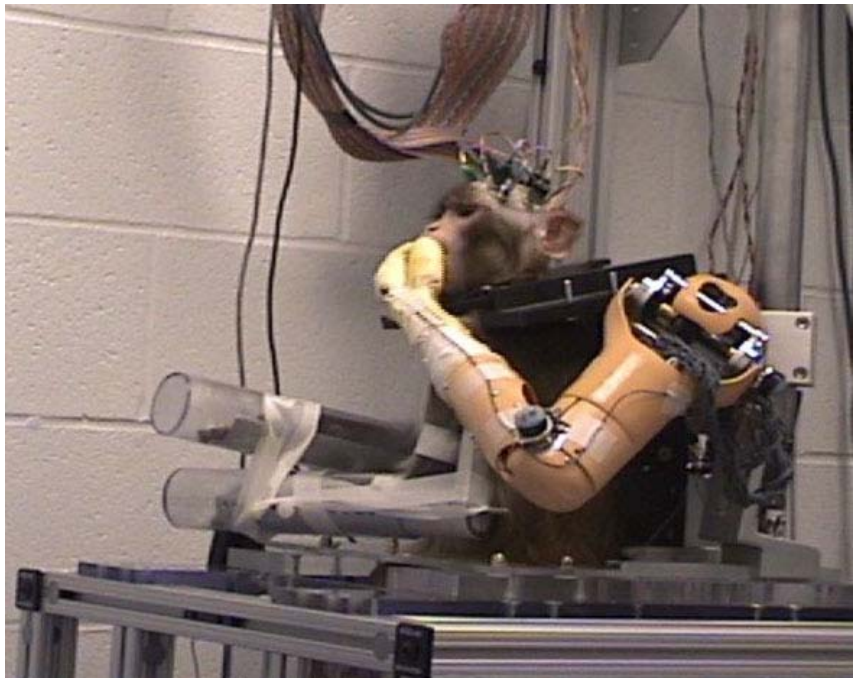
Takeo Kanade
Director
U. A. and Helen Whitaker University Professor
Robotics Institute
Carnegie Mellon University

Rory Cooper
Co-Director
FISA/PVA Chair and Distinguished Professor
Dept of Rehabilitation Science and Technology
University of Pittsburgh

Intelligent systems that augment body and mind

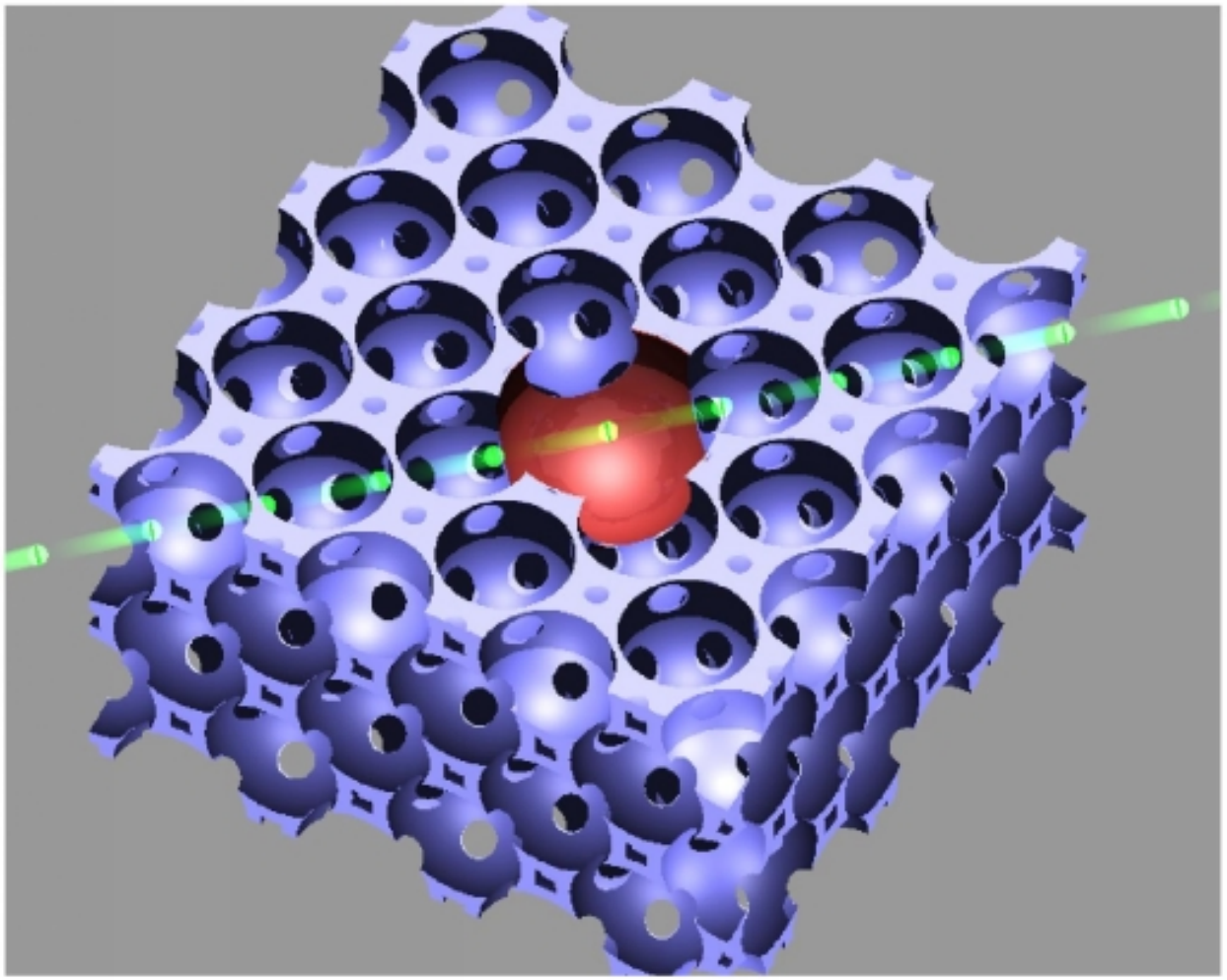
… Technology to Enable Self-determination for Older Adults and People with Disabilities

8. Neurobotics

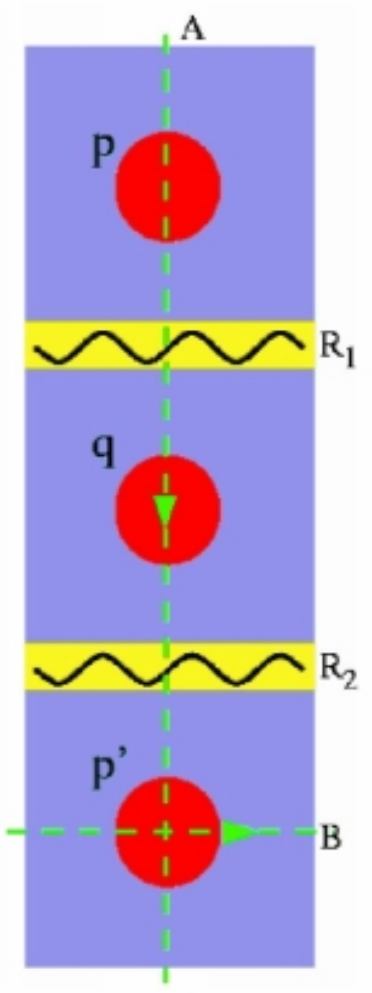


9. Personalized education

10. Quantum computing

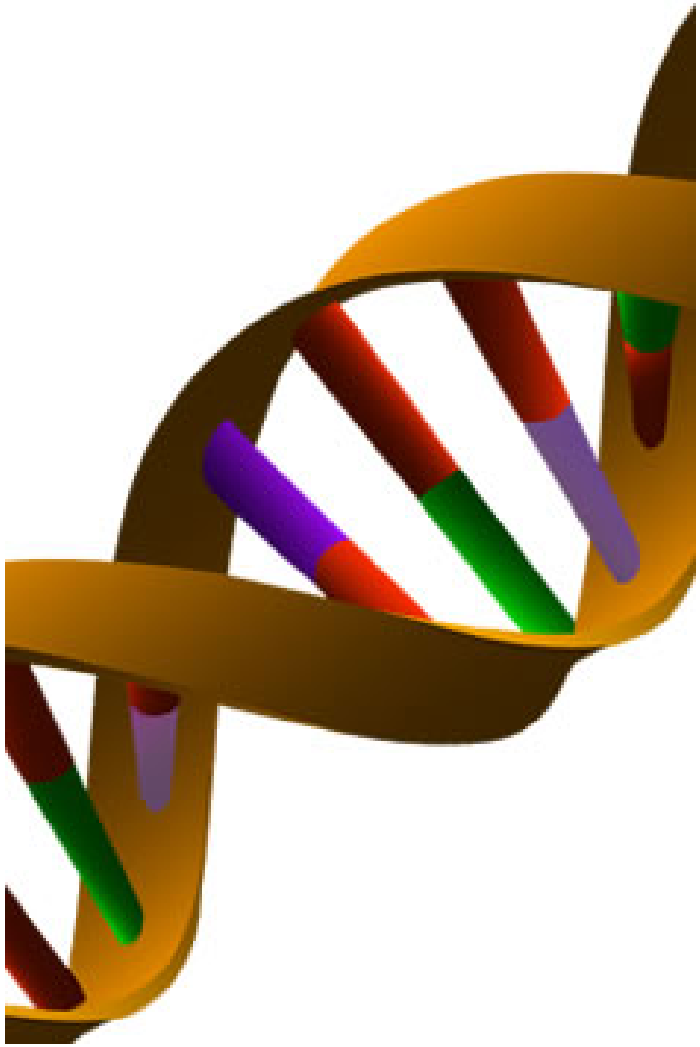


(a)

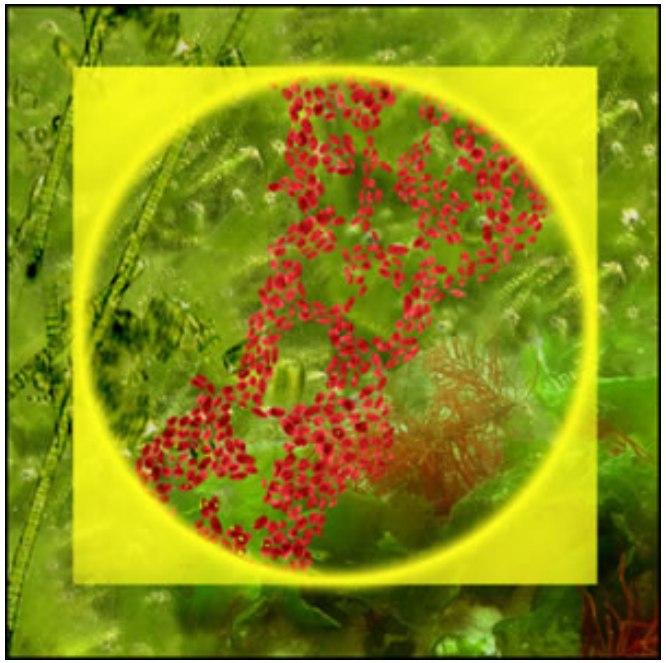


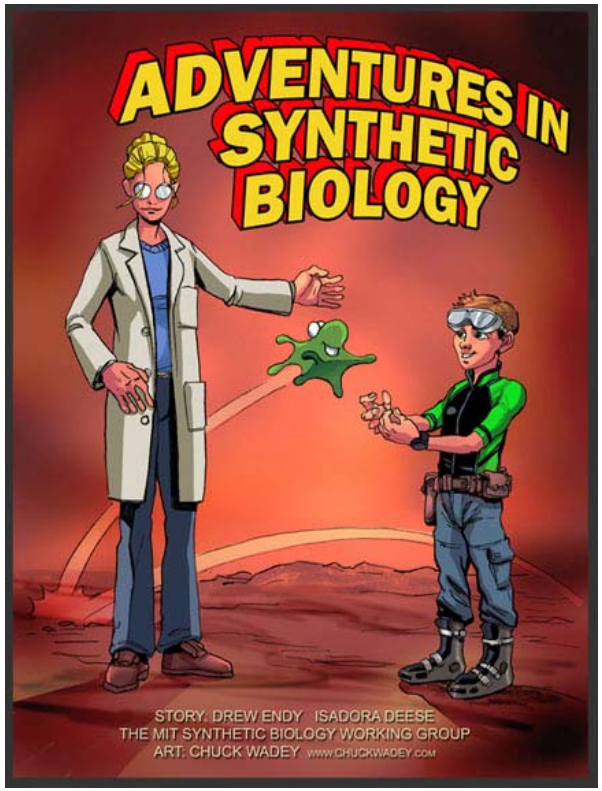
(b)

11. Predictive, preventive, personalized medicine

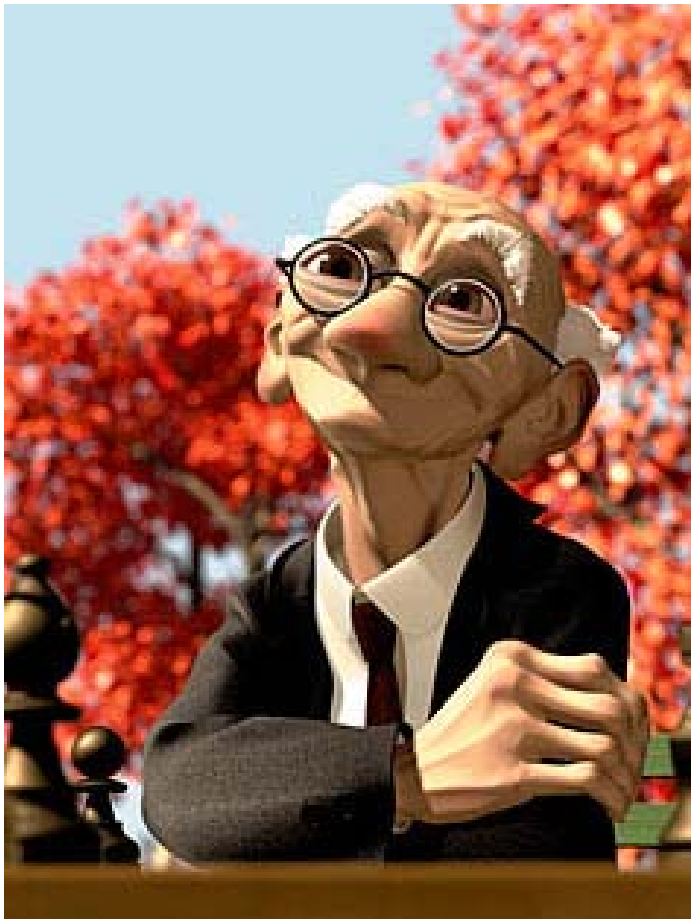


12. Synthetic biology / molecular engineering





13. Entertainment technology; more broadly, content creation tools



14. Learning from data: ubiquitous data mining and machine learning

VIEWER Q&A >>

Get the truth on how the team really feels about the show.

MUSIC MYTHS >>

Can that high note really shatter glass? Bust it now.

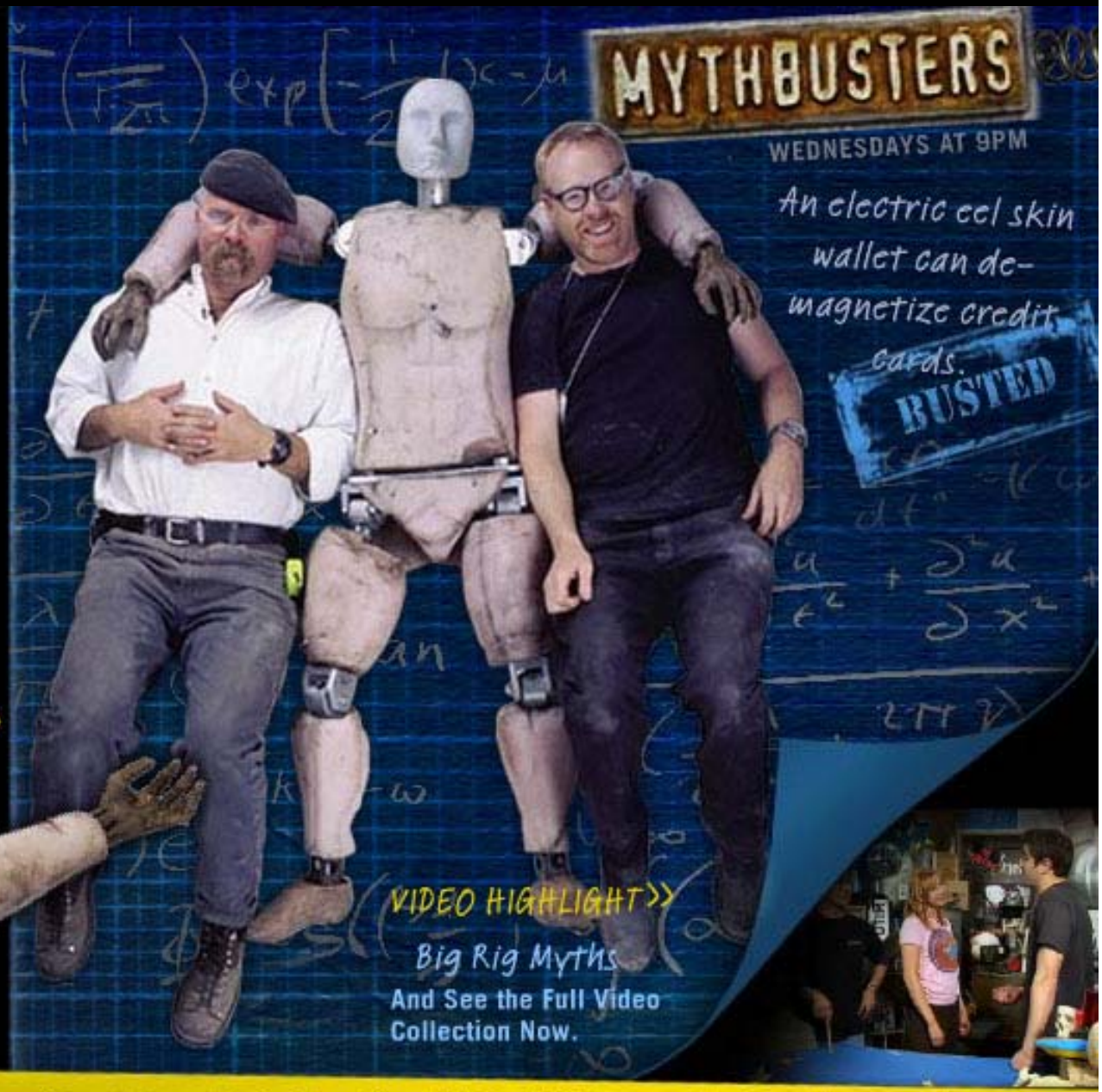
JOIN THE MESSAGE BOARD

"Baby snakes do not have control of how much venom they use and will shoot it all into you while a full grown snake conserves their venom. Is this true?" -- jeredweaver56

SUBMIT A MYTH >>

BE A MYTHBUSTER >>

Debunk a few classic myths. Give this interactive a whirl.



How's Your Brain Function? Watch Video and Take a Memory Exam.

Dispel these myths!

- You need to have programmed in high school to pursue computer science in college
- A computer science degree leads only to a career as a programmer
- Programming is a solitary activity
- Employment continues to be in a trough
- Eventually, all the programming jobs will be overseas
- Student interest in computer science is lower than in most other STEM fields
- Computer science lacks opportunities for making a positive impact on society
- There's nothing intellectually challenging in computer science
- There have been no recent breakthroughs in computer science
- Computer science lacks compelling research visions

[Your part goes here]

- What are *your* compelling visions for the field?
- How can the CCC facilitate your pursuit of them?

http://www.cra.org/ccc/