

Computing the Future: Release 2016



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Presentation Outline

“Where there is no vision, the people perish.”
Proverbs 29:18

- *Imagine the future*
- Technology drivers
- Changes in flight
- Future challenges
- Partnerships
- Innovation



Reality and the Future

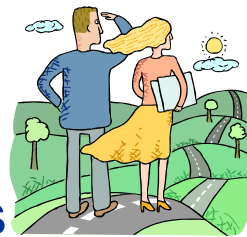
“You take the blue pill and the story ends. You wake in your bed and believe whatever you want to believe. You take the red pill and you stay in *Wonderland*, and I show you how deep the rabbit-hole goes. Remember – all I am offering is the truth, nothing more.”

The Matrix



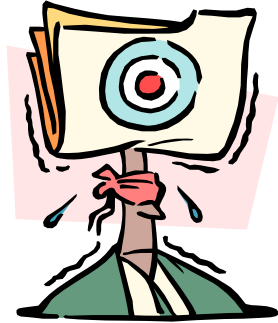
Imagine a Future Where ...

- **Your car finds a parking space for you**
 - ... and also parks the car (already a 2008 Lexus feature)
- **The radio only plays music you love**
 - ... because it knows every song you've ever heard
- **Your phone only rings when you want to answer**
 - ... because it knows your emotional state
- **Your body calls an ambulance when you are ill**
 - ... via implanted, biologically powered diagnostic sensors
- **Your DNA sample determines personalized treatment**
 - ... because genotype-phenotype models are specific
- **Your office adjusts its behavior to your needs**
 - ... because it knows (semantically) what you are doing



Imagine a Future Where ...

- **Your every physical movement is tracked/logged**
 - ... by embedded sensors on all human artifacts
- **Your neighbors know all the books you read**
 - ... because your electronic financial identity was stolen
- **Your every call is monitored for content**
 - ... by deep semantic analysis and logging
- **Your utilities fail due to a virus attack**
 - ... because security was penetrated by a 10 year old
- **Your DNA sample/lifestyle determine health cost**
 - ... because you are targeted as a high risk genotype/lifestyle
- **Cyberwar destroys U.S. financial institutions**
 - ... because U.S. lacks ability to construct IT infrastructure



Ten Years: Past and Future

- **Looking back, in the public mind**

- there were few or no experiences with ...

- web sites, email, spam, phishing, computer viruses
- e-commerce, digital photography or telephony
- digital job offshoring

- cell phones were rare and expensive

- a Sony Walkman was state of the art

- CDs were still pretty cool

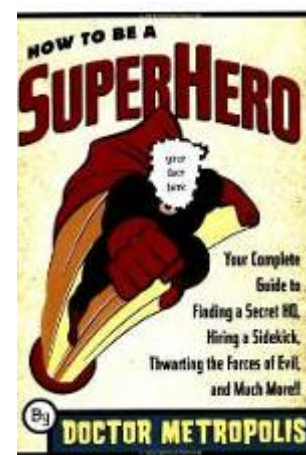
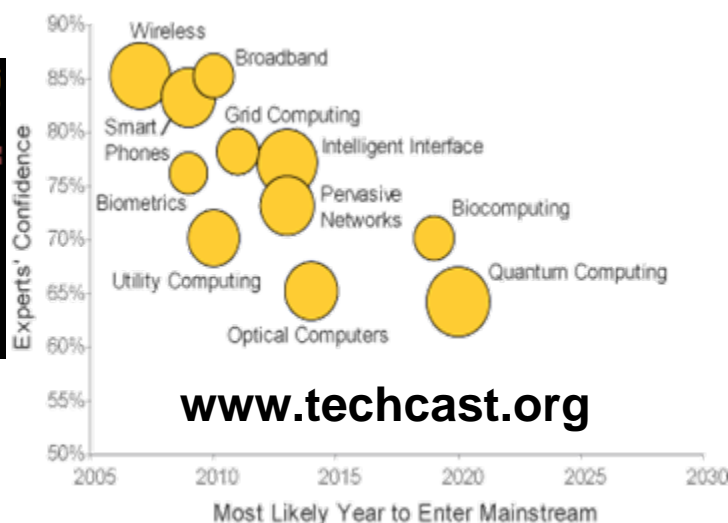
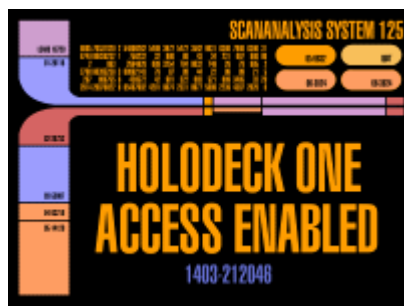
- WiFi was almost unknown



- **What will the future bring?**

Balancing Expectations and Reality

- **Expectations exceed reality**
 - the “CSI effect” – artificially high hopes
 - unknowingly violating physical laws
- **Reality exceeds expectations**
 - underestimating qualitative impacts
 - not recognizing “Metcalf’s Law”
 - network “power” increases as the square of the number of nodes



The Danger of Predictions ...

- **A century ago**
 - average U.S. life expectancy was less than 50 years
 - mean annual income was only a few hundred dollars
 - less than 10 percent of houses had a telephone
 - only a few hundred cars were on the roads
- **We did get**
 - Scotch tape and crossword puzzles
 - canned beer and iced tea
 - self-heating coffee
- **But, we never got**
 - the flying cars
 - the underwater cities
 - those shiny plastimetal clothes
- **Some rules of thumb**
 - in the *near term*, we *overestimate* change
 - in the *long term*, we *underestimate* changes
- **Outside their field of expertise**
 - experts are often better at predictions



Presentation Outline

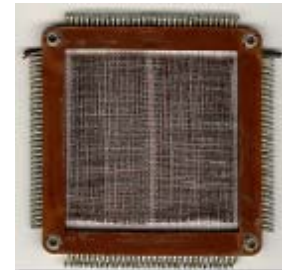
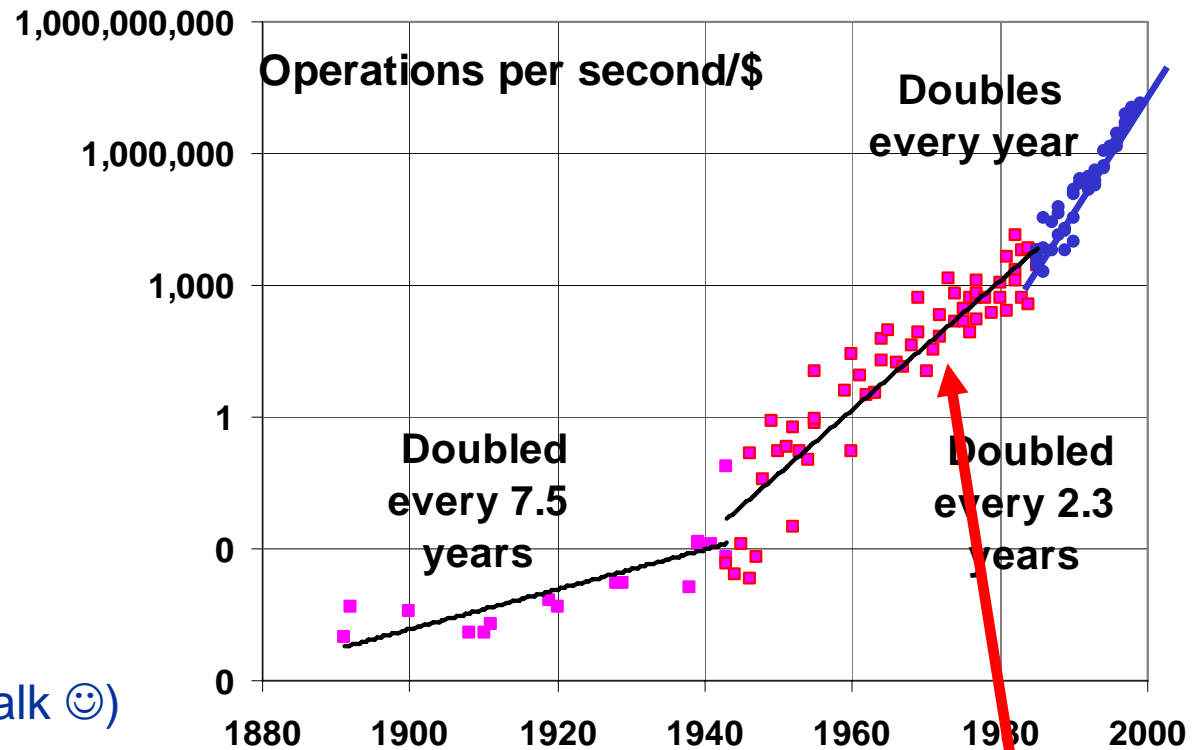
“Where there is no vision, the people perish.”
Proverbs 29:18

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- *Technology drivers*
- Changes in flight
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Computing History and Exponentials

- **1890-1945**
 - mechanical, relay
 - 7 year doubling
- **1945-1985**
 - tube, transistor,..
 - 2.3 year doubling
- **1985-2003**
 - microprocessor
 - 1 year doubling
 - it is slowing (another talk 😊)
- **Exponentials**
 - chip transistor density: 2X in ~18 months
 - graphics: 100X in three years
 - WAN bandwidth: 64X in two years
 - storage: 7X in two years

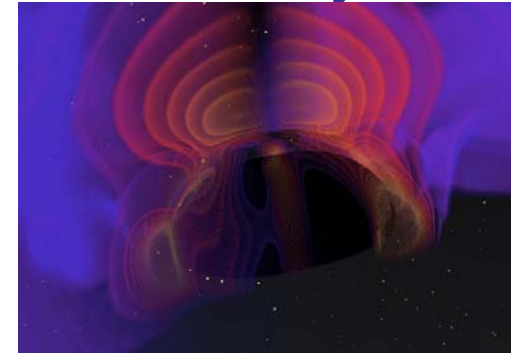
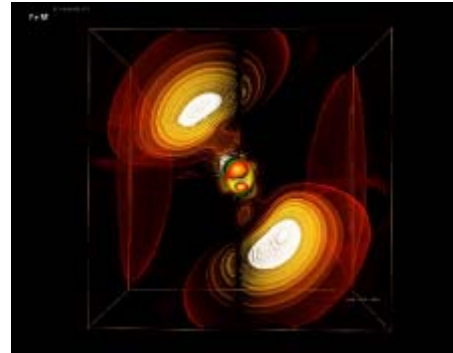
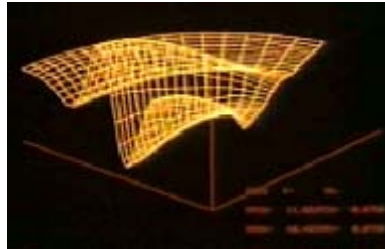
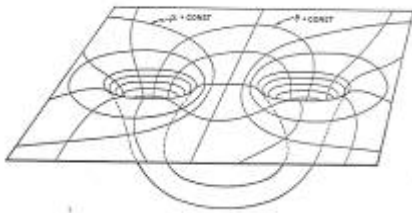


4K bit core plane

Microprocessor Revolution

Computing Exponentials: A Black Hole Example

1,800,000,000X



1963
Hahn and Lindquist
IBM 7090
One Processor
Each 0.2 MF
3 Hours

1977
Eppley and Smarr
CDC 7600
One Processor
Each 35 MF
5 Hours

1999
Seidel and Suen, *et al.*
NCSA SGI Origin
256 Processors
Each 500 MF
40 Hours

2001
Seidel *et al.*
NCSA Pentium III
256 Processors
Each 1 GF
500,000 Hours total
plus 500,000 hours at NERSC

300X

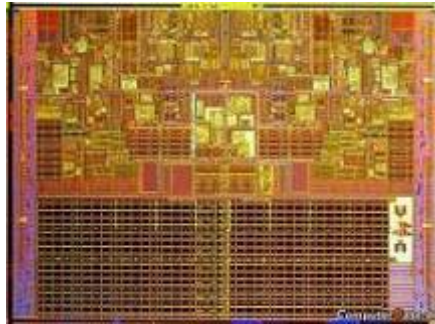
30,000X

~200X

Computing Exponentials



February 1994



- **Flop**
 - one floating point operation/s
 - a fast human with a calculator
- **Megaflops**
 - one million (10^6) operations/s
- **Gigaflops (PC class)**
 - one billion (10^9) operations/s
- **Teraflops (research clusters)**
 - one trillion (10^{12}) operations/s
- **Petaflops (2007-2010)**
 - 10^{15} operations/s
- **Exaflops (being debated)**
 - 10^{18} operations/s

Challenges Ahead

Sequential Terascale Petascale



Storage: The Exponentials



1956



1972



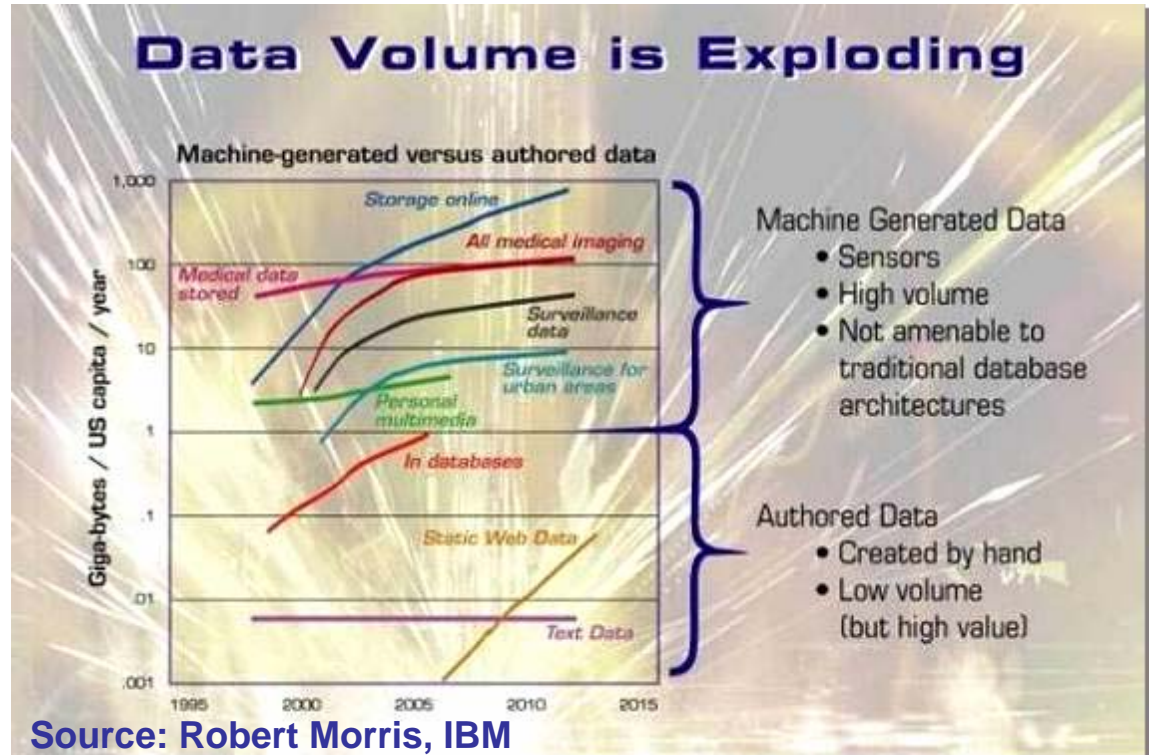
2006

- **Megabyte**
 - a small novel
- **Gigabyte**
 - a pickup truck filled with paper or a DVD
- **Terabyte: one thousand gigabytes** – ~\$1000 today
 - the text in one million books
 - entire U.S. Library of Congress is ~ten terabytes of text
- **Petabyte: one thousand terabytes**
 - 1-2 petabytes equals all academic research library holdings
 - coming soon to a pocket near you!
 - *soon routinely generated annually by many scientific instruments*
- **Exabyte: one thousand petabytes**
 - 5 exabytes of words spoken in the history of humanity

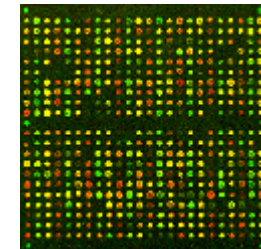


The Data Tsunami

- **Many sources**
 - business
 - agricultural
 - biomedical
 - environmental
 - engineering
 - manufacturing
 - financial
 - social and policy
 - surveillance

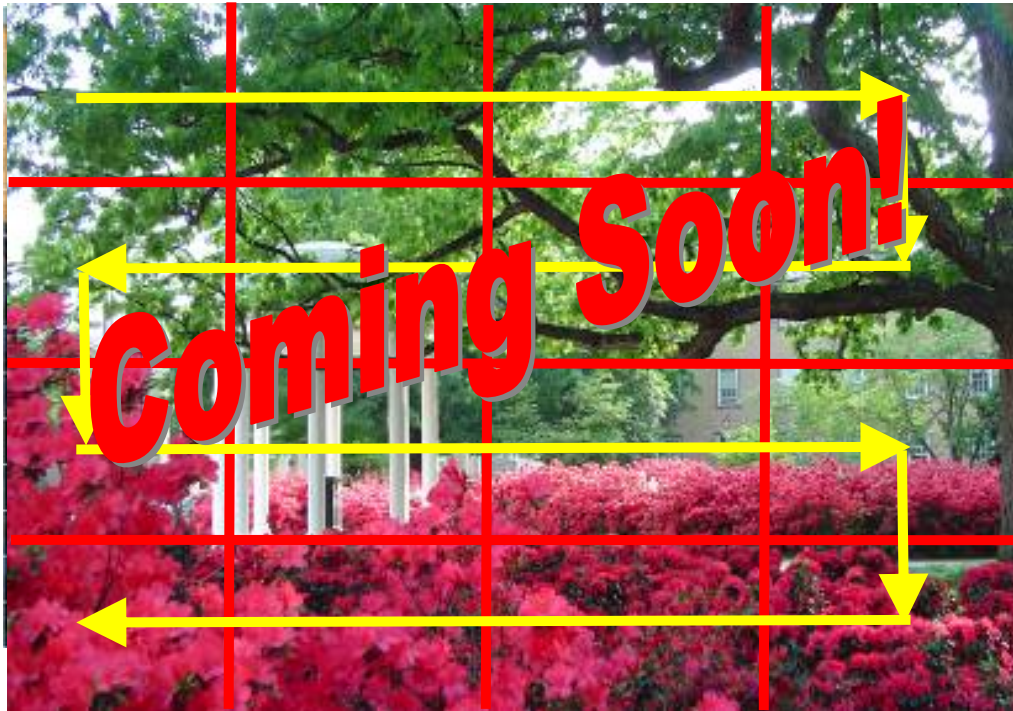


- **Many causes and enablers**
 - increased detector resolution
 - increased storage capability
- **The challenge: *insight!***



AFFYMETRIX GENECHIP®

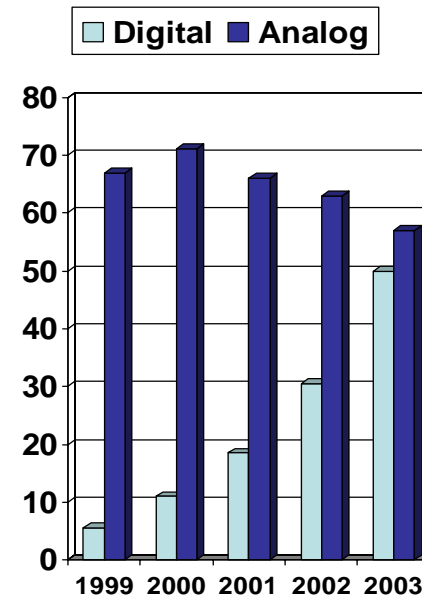
Consumer Imaging Explosion



- 40,784 x 26,800 pixels



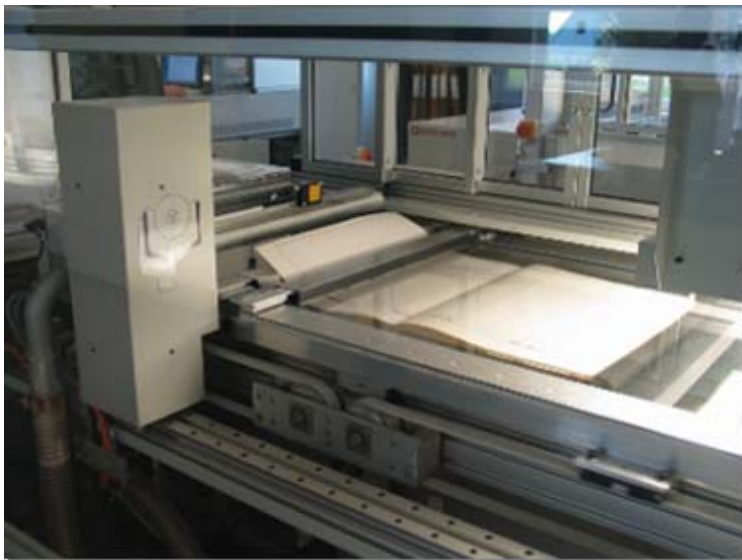
- **Digital camera sales**
 - now exceed analog
 - January 2006
 - Nikon stopped film camera production



Digital Book Scanning

- **Features**

- pneumatic page turning
 - 1500-3000 pages/minute
 - 200-800 dpi
- Google book project



Google Book Search BETA

date:1500-1864 [Advanced Book Search](#)
[Google Book Search Help](#)

Search: All books Full view books

The Speeches of the Duke of Wellington in Parliament
by Arthur Wellesley Wellington, William Hazlitt - [Full Book](#) from the [Google Books Library Project](#)

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184 THE CORN BILL. 1828.

THE DUKE OF WELLINGTON said:

My Lords, it really appears to me that the House should agree to the principle on which the present Bill is founded. I know of no objection to that principle; the only difference is as to the mode of applying it; and I really think that nothing has been proved against the mode proposed. My noble and learned friend (Lord Redesdale) who spoke last talked of the inconvenience of the Warehousing system. I must say, however, that much less inconvenience will be felt in that respect than in the Bill of last year, in consequence of the scale rising every 1s., by which the price of corn in England is brought much nearer to what the corn when released from bond would cost. I beg the House to observe, that under the law of 1815, that of absolute prohibition, whatever quantity of corn there might be warehoused, that corn was, at a certain price, admitted without payment of duty, or, at least, on payment of a very small one, unless under an Act which has since passed. Corn, however, when it now comes out of bond pays a duty; for the price of corn could never rise so high as to allow it to be admitted without a duty. Therefore, as my noble friend wishes, speculation in the Warehouse system would be much less under this Bill, if it should pass, than under the former Acts.

Another point to which I wish to advert is in reply to what a

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books.google.com



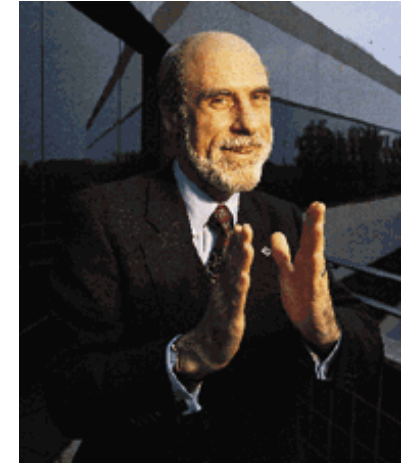
ARPANET



Len Kleinrock



BBN IMP Team



Vint Cerf



Larry Roberts

56 Kb/s Connections!



July 1977



Bob Kahn

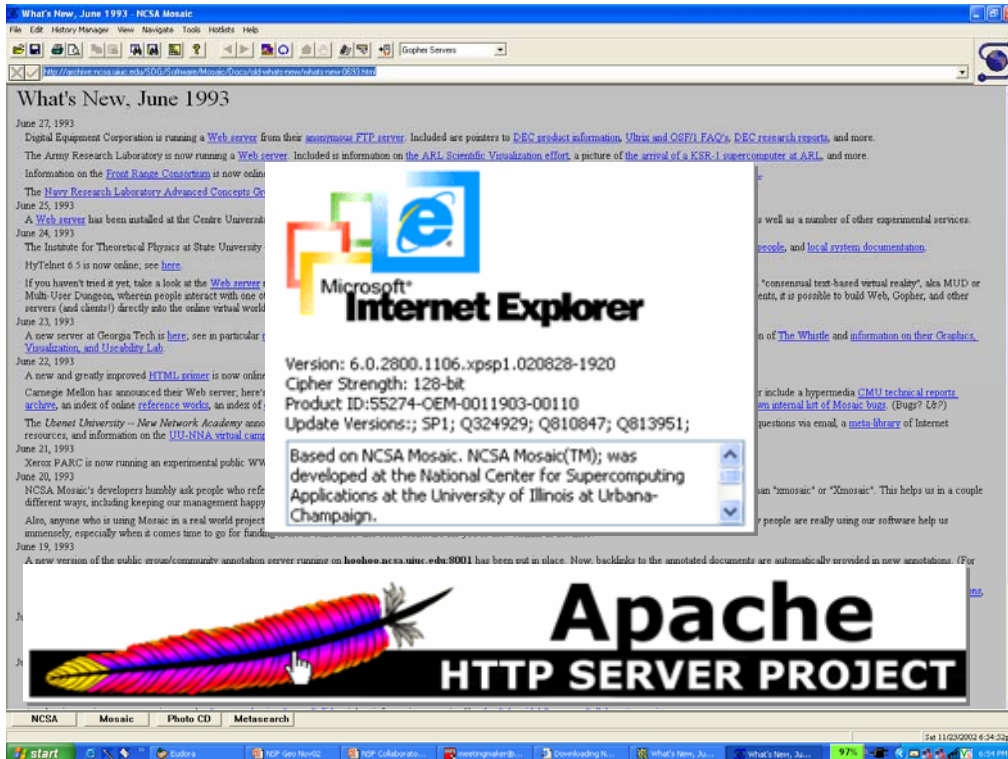
Note the timescale!

Mosaic: A Revolutionary Spark

The New York Times

•December 8, 1993, C Section (Front Page)

–John Markoff, “A Free and Simple Computer Link - NCSA's Mosaic Program”

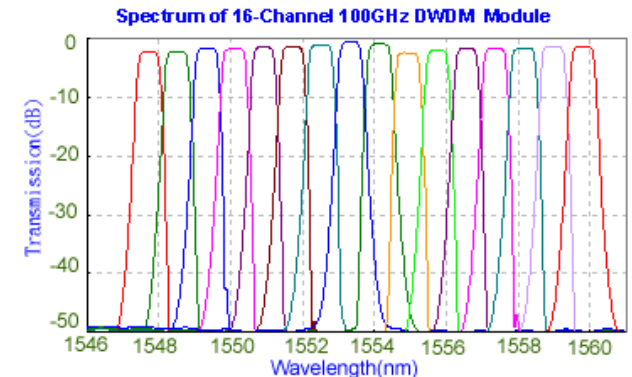


THE SECOND INTERNATIONAL

WWW CONFERENCE '94
Mosaic and the Web

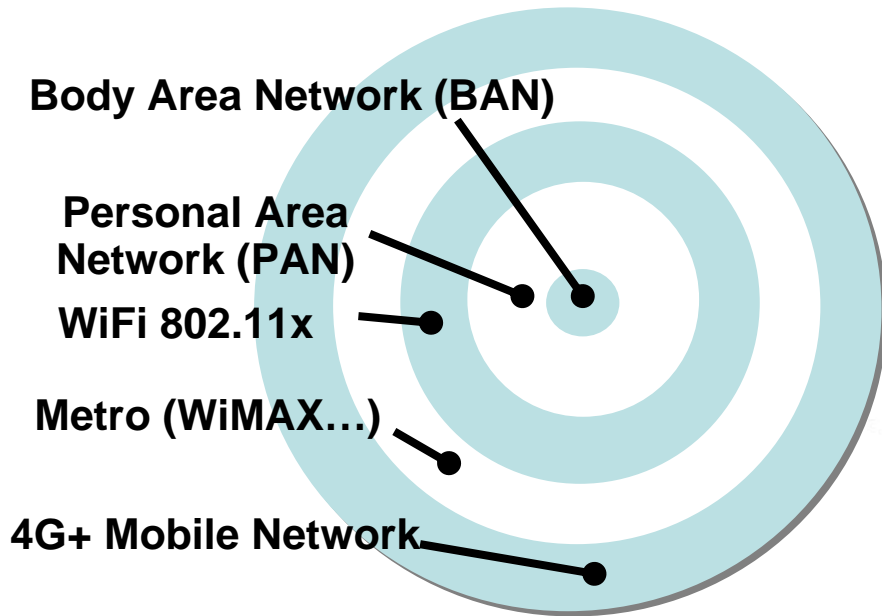


National Lambda Rail (NLR) and Beyond



- **Wavelength division multiplexing (WDM)**
 - multiple 10 Gb/s “lambdas” on each fiber
- **Multiple terabit capacity on each fiber**
 - terabit to the home/office in the future

Mobility by Range



Body Area Network (BAN)

Personal Area Network (PAN)

WiFi 802.11x

Metro (WiMAX...)

4G+ Mobile Network

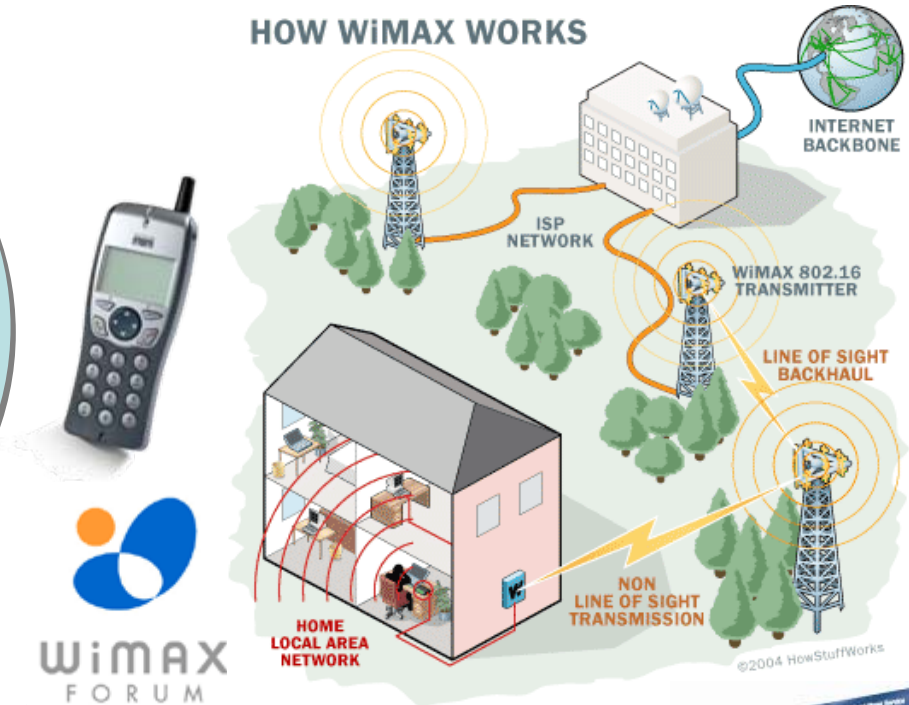
- **Revolution**

- explosion of wireless access points
- Voice over IP (Vonage, Skype, ...)
- satellite radio, mobile device fusion

- **WiMAX (aka IEEE 802.16)**

- Worldwide Interoperability for Microwave Access
 - ~70 Mb/s (peak), but 50 Kb/s to 2 Mb/s (in practice)
- 4-5 mile range (non-line of sight) and 10+ miles (line of sight)

HOW WiMAX WORKS



Explosive Sensor Growth

- **Technology drivers**

- wireless communications
- embedded processors

- **Electronic tags and intelligent objects**

- tags on everyday things (and individuals)
 - secure, inexpensive and disposable
- RFID, smart dust, ...

- **Smart cars**

- OBD II standard/Controller Area Network
 - manufacturer failure mode analysis
- Bluetooth, navigation, active cruise control
- EFI and variable timing, road tracking, drowsy warning
- entertainment (roadcasting) www.roadcasting.org
 - *ad hoc*, mobile radio meets podcasting

- **Medical devices**

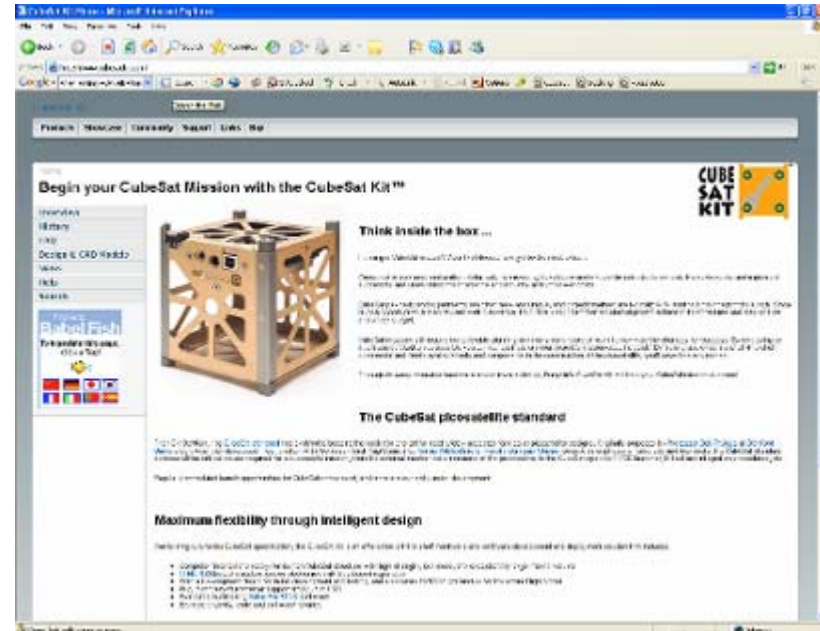
- capsule endoscopy, ECG, pacemakers, ...



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For the Price of an SUV: Picosatellite Kit



www.cubesatkit.com

“Don’t leave Earth without it.”

- **Attributes**

- ~\$10K-\$40K construction cost and ~\$50K launch cost
 - secondary payload on commercial launcher
- 10 cm cube (one liter) to 10x10x30 cm
 - industry standard PC-104 boards

- See showcase.netins.net/web/wallio/CubeSat.htm



Presentation Outline

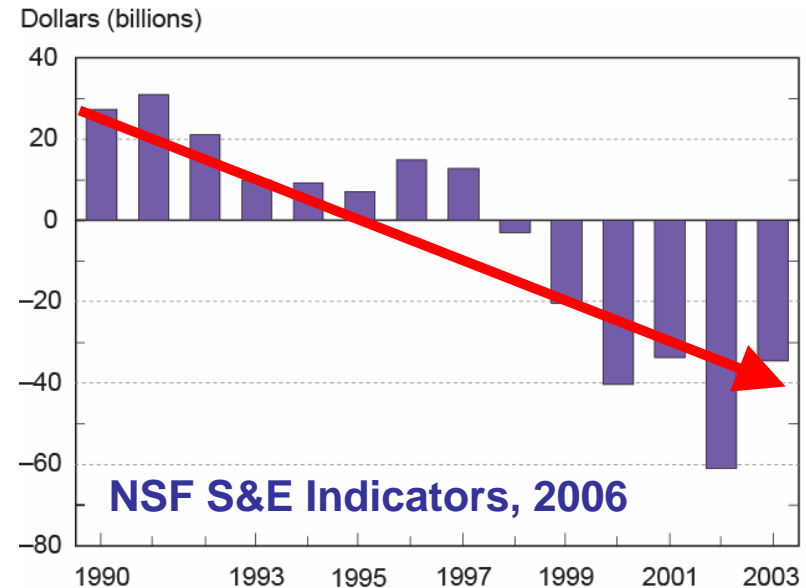
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- Future challenges
- Partnerships
- Innovation

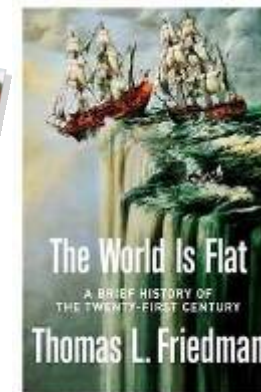


Structural Economic Change

- **The new free market economy**
 - WTO (2004)
 - 147 countries
 - China, Russia, India & Eastern Europe
 - half the world's labor market
- **Major trends**
 - decline in manufacturing
 - shift to a service economy
 - rise of international trade
 - shift in job skill mix required
- **Challenges**
 - educational uplift
 - skills for employment
 - innovation engines
 - horizontal integration



NOTE: Includes aerospace, pharmaceuticals, office and computing equipment, communications equipment, and scientific instruments.



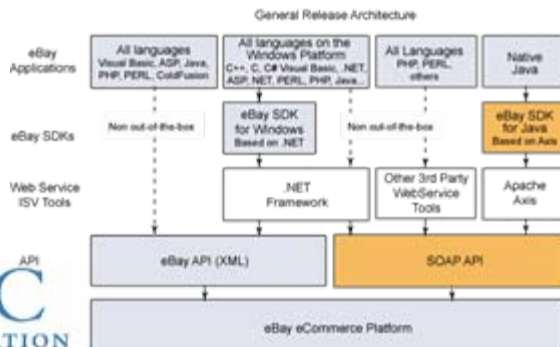
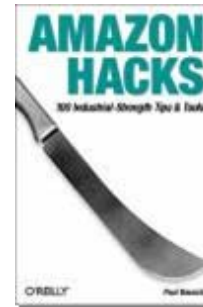
Fast Company

- **Focus on core competence**
 - relentless shedding of all else
- **Partnerships, outsourcing and licensing**
 - others who have core competencies
- **Innovation investments**
 - calculated bets on ROI
- **Global teams and partnerships**
 - talent knows no geographic boundaries
- **Flat world and democratized data**
 - innovators exploit global knowledge base
- **Mass customization**
 - tailored services and capabilities



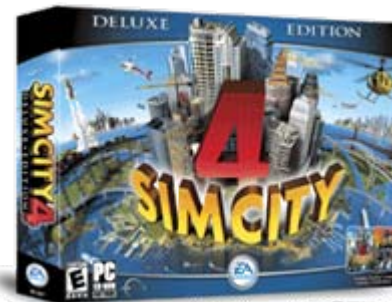
Amazon and eBay

- **From browser-centric to service-centric**
 - structured negotiation and response
- **Amazon**
 - more than 13,000,000 products
 - >1,000,000 associates drive traffic
 - Amazon web services (AWS)
- **eBay**
 - similar API for customer interfaces
 - over 40% of listings are via API calls



Shifting Personal Habits

- **Social communication**
 - Google, blogs, instant messaging
- **MP3 players**
 - mobile and home
- **Cell phones**
 - digital images and video
 - elimination of home land lines
- **Digital video**
 - YouTube to cell phone
 - ubiquitous news stringers
- **TiVo and HDTV**
 - time shifting and digital video
- **Multiplayer computer games**
 - social communities



Geolocation Services

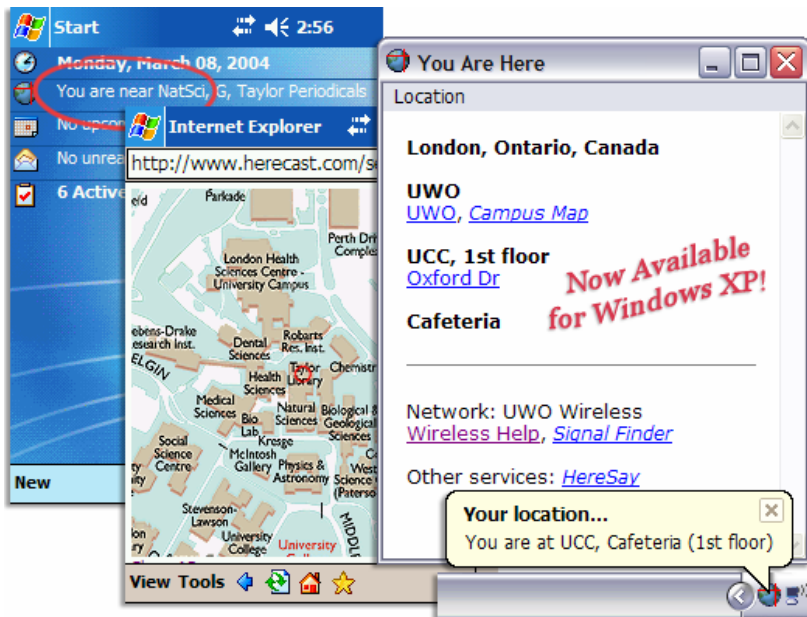
- **Intersection**
 - Google Earth, blogs
 - video, GPS
- **IP address**
 - latitude/longitude
- **511 telephone services**
 - travel time and parking





Physical/Electronic Co-Residence

- **Geolocation meets interface**
 - electronic PostIt™ notes
 - community location/knowledge
 - cell phone/PDA and location



www.herecast.com



www.earthcomber.com



UNC
INFORMATION
TECHNOLOGY SERVICES



Herecast

An open infrastructure for location-based services using WiFi

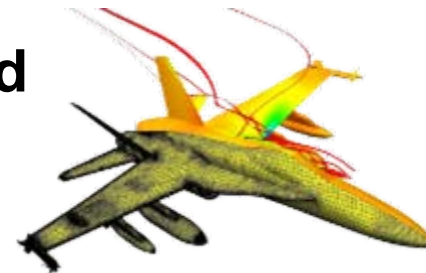
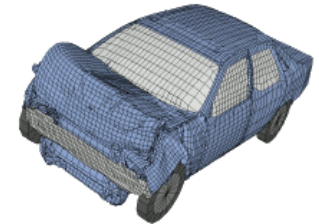
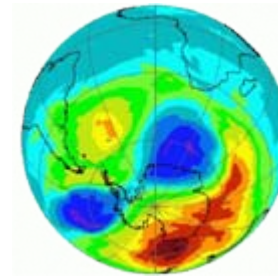


renci
renaissance computing institute

Science 2020

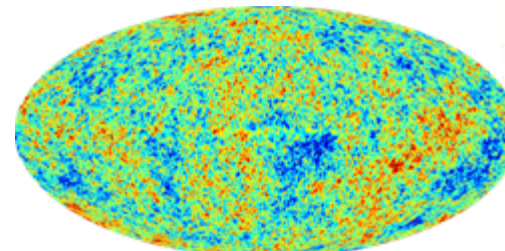
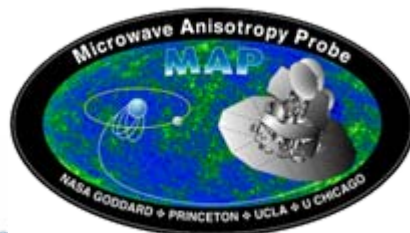
“In the last two decades advances in computing technology, from processing speed to network capacity and the internet, have revolutionized the way scientists work.

From sequencing genomes to monitoring the Earth's climate, many recent scientific advances would not have been possible without a parallel increase in computing power - and with revolutionary technologies such as the quantum computer edging towards reality, what will the relationship between computing and science bring us over the next 15 years?”

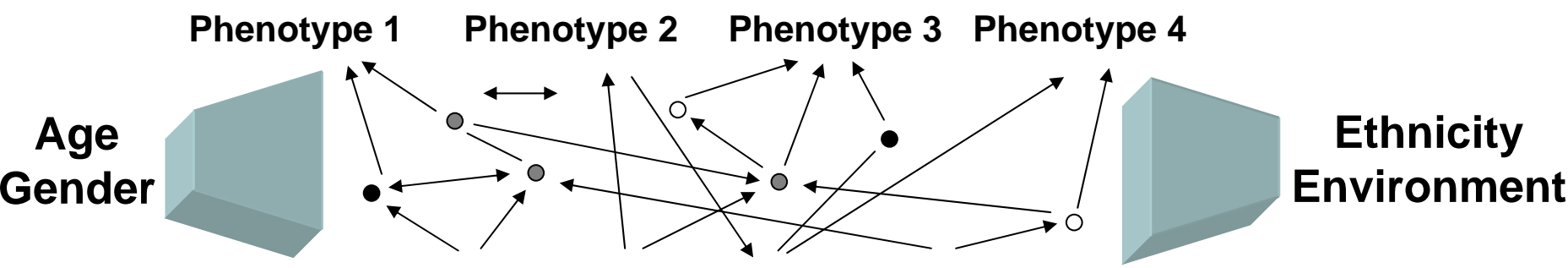


Lessons from Astronomy

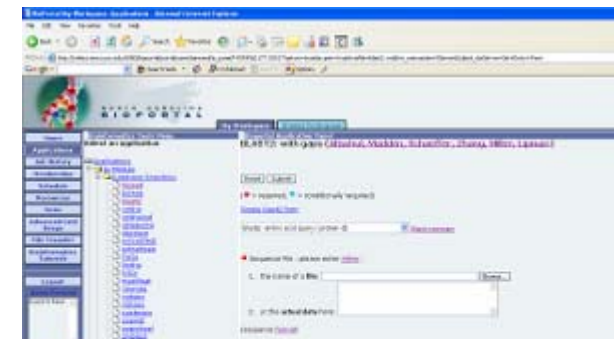
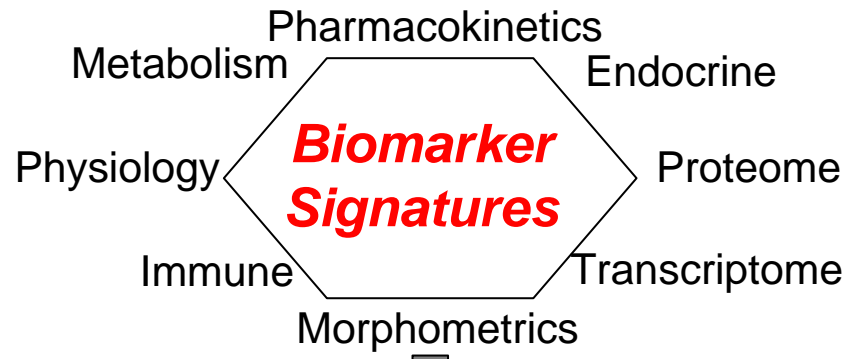
- **Historically, discoveries accrued to those**
 - with access to unique data
 - who built next generation telescopes
- **Two things changed**
 - growing costs and complexity of telescopes
 - emergence of whole sky surveys
- **The result – virtual astronomy**
 - discovering significant patterns
 - analysis of rich image/catalog databases
 - understanding complex astrophysical systems
 - integrated data/large numerical simulations



Genetics and Disease Susceptibility



Identify Genes



HAP-SAMPLE:
An Association Simulator for Candidate Regions or Genome Scans

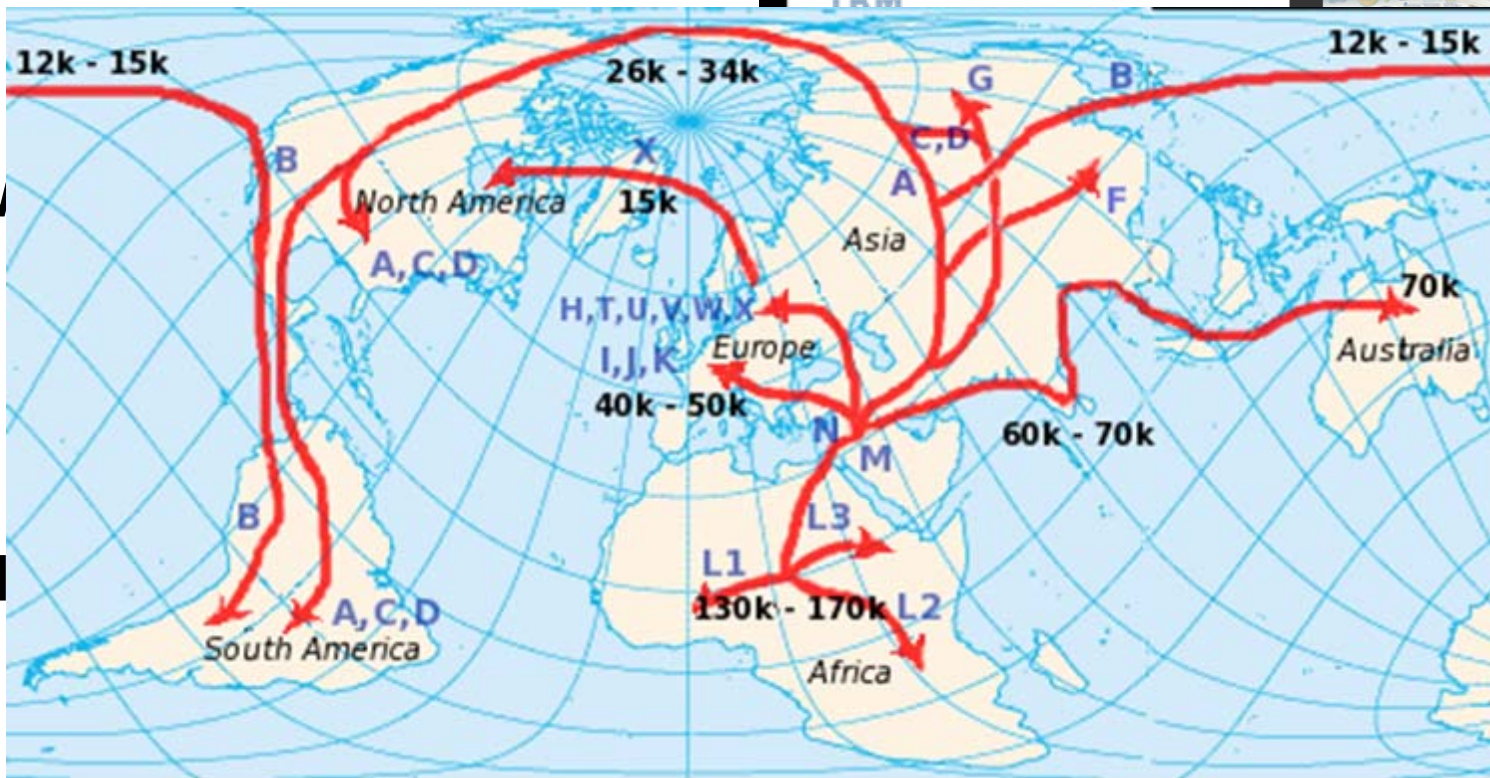
Predictive Disease Susceptibility

Genographic Project

- Five year project goal



- TV



- \$1

- See www.nationalgeographic/genographic

Canada International

Following

Geographic

Brochure
Envelope
Project

includes the cost of
International
note below.



Education: Past and Future

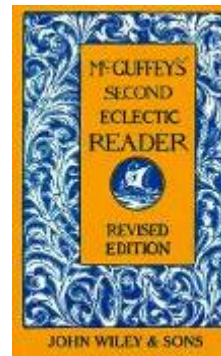
- Today's students have
 - 10,000 hours of video games
 - 250,000 email messages
 - 10,000 hours on cell phones
 - 10,000 hours of television
 - 500,000 commercials
 - *less than 5000 hours reading books*

CMU/EA Partnership



Asthma

www.socialimpactgames.com



Remember ...



Our 2016 undergraduate is 8-12 years old now

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Proverbs 29:18

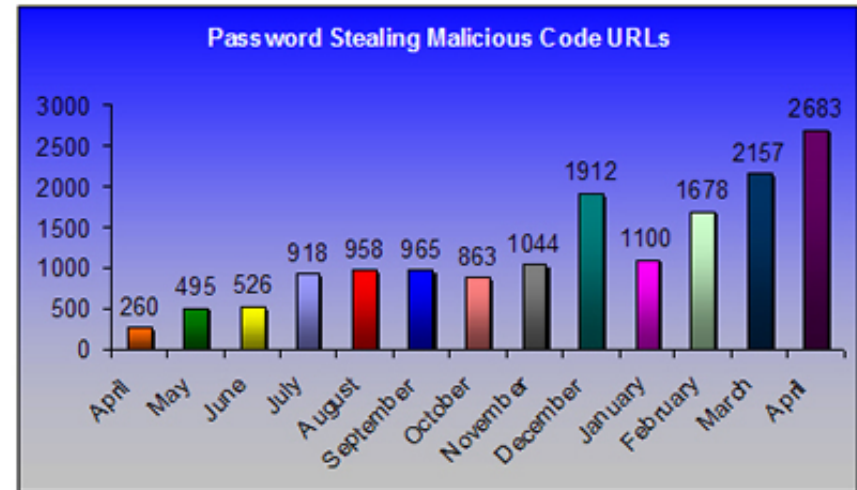
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Efficiency, Privacy and Security

“We know how many 2.4-ounce tubes of toothpaste sold yesterday, and what was sold with them. Our database grows because we capture data on every item, for every customer, for every store, every day”

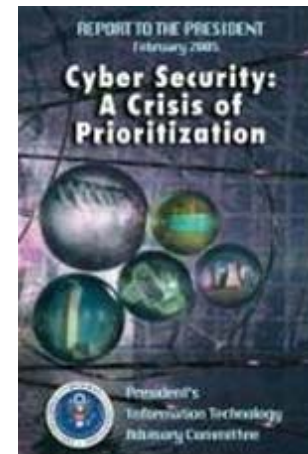
Dan Phillips, VP of IS, Wal-Mart



FROM XYZ MFG 3925 N. Hastings Eau Claire, WI 54703	TO: ACME Retailer 6534 MAIN STREET Ship to Addr 2 HOME TOWN, IL 60091
Ship to Postal Code: (420) 60091 	Carrier: ROAD RUNNERS R/L NUMBER: 123409476
PO: 000952452 DEPT: 06	
FOR: ACME RETAILER ST# 3005 ACME Store #3005 HOME TEXTILES	
 (00) 1 0041062 0991234569 	

RFID Tag

See anti-phishing.org



Revolutions Bring Upsets

- **Agricultural adoption**
 - coordinated agriculture
 - metal working and handmade tools
- **Industrial revolution**
 - manufacturing
 - steam and railroads
 - steel and electricity
 - oil and the automobile
- **Information age**
 - service economy
 - multinational supply chains
 - information democratization
 - rapid change



Evolving University Roles

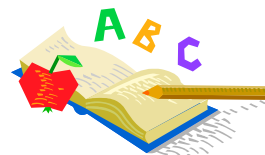
- **American university “eras”**
 - pre and post-colonial, land grant, post World War II
 - in the 21st century, the fourth wave
 - economic drivers and continual re-education
- **Universities are in the knowledge business!**
 - creation, preservation, transmission, and application
- **IT is about knowledge management and creation**
 - education, research, service and business processes
- **A new compact with the citizens**
 - *knowledge economy leverage*
 - *value chain enhancement*
 - *lifelong education and competitiveness*



Understanding Driven

Bohr	Pasteur
	Edison

Use Driven

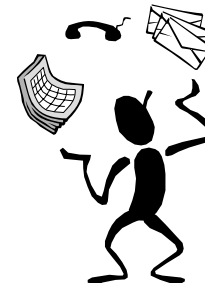
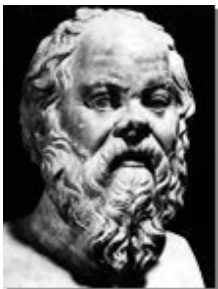


UNC
INFORMATION
TECHNOLOGY SERVICES



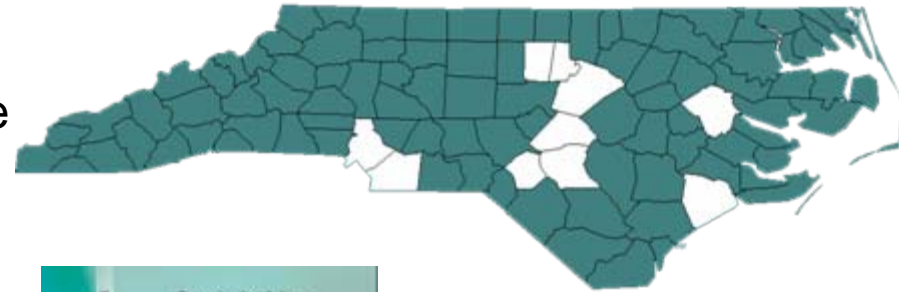
21st Century Workforce Skills

- **Classical education**
 - *trivium*
 - grammar, logic and rhetoric
 - *quadrivium*
 - arithmetic and geometry
 - music and astronomy
 - fluency in Latin and Greek
- **Natural philosophy emerged ...**
 - Boyle, Bacon, and Newton
 - *disciplinary decomposition*
- **State of the art skills**
 - no substitute for competence
- **Teaming and collaboration**
 - real problems are solved in teams
- **Oral/written communication**
 - sharing/marketing ideas is critical
- **Multidisciplinary knowledge**
 - domain skill plus other discipline(s)
- **Social engagement skills**
 - empathy, understanding & patience
- **Learning skills**
 - the technical constant is change



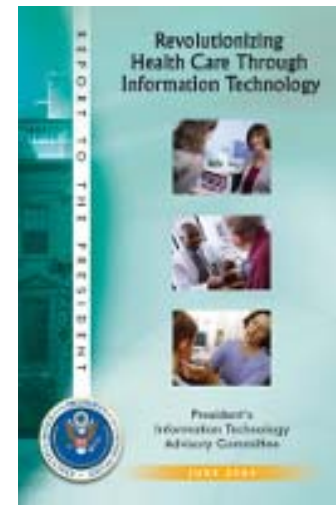
Demographics and Health Care

- **North Carolina (65 years+)**
 - 12% (1990) and 17% (2020)
- **Smart infrastructure**
 - electronic health records
 - reduced cost and improved care
 - homes and assistive technology
 - biometric measurements



“If 40% of my passengers check in on the Internet before coming to the airport, why do I have to fill out another clipboard every time I visit the doctor?”

Major Airline CEO



Innovation: Creative Practice

- **Collaborations for performance**

- intercontinental dance
 - www.digitalworlds.ufl.edu/projects/dbb
- University of Florida Digital Worlds Institute
 - joint initiative between fine arts and engineering
- remote participation
 - University of Minnesota and University of Campinas (Brazil)



- **Art as a social experience**

- participant interests determine exhibition
 - number, age distribution, size, ...
- interaction shapes evolution
 - e.g., “linger time” or emotional state
- coupled history and social context
- “New exhibits” on each visit



Innovation: Integrated Disaster Response

- **Multimodal models**
 - water (ocean and storm surge)
 - atmospheric (weather and hurricanes)
 - environment and geo-biology
 - transportation and communications
 - logistics planning
- **Sensor and observational data**
 - weather and transportation
 - communication and environment
- **Scenario assessment**
 - end-to-end evaluation of alternatives
- **Virtual organizations**
 - come as you are response and coordination

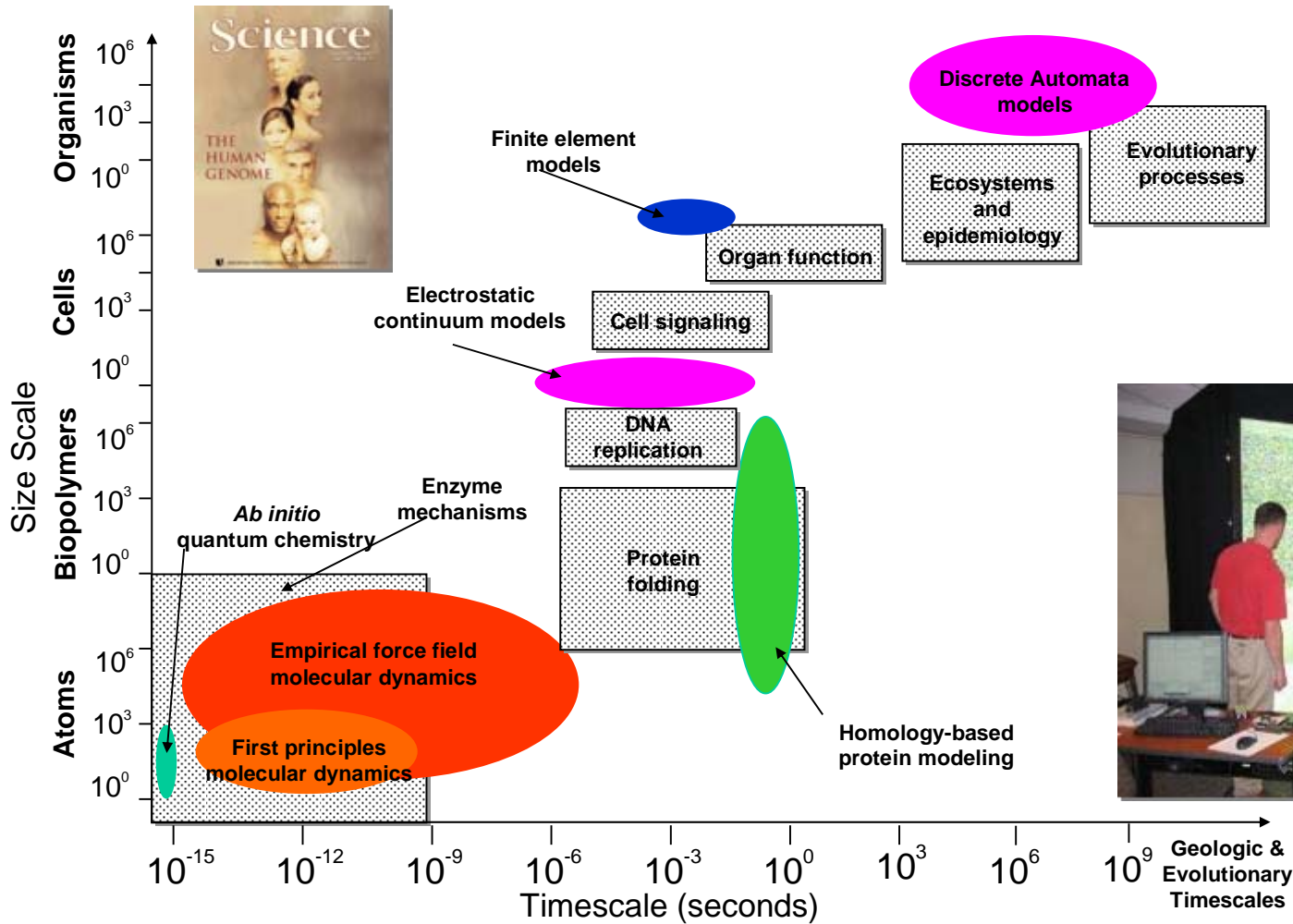
Hurricane Floyd



NASA/GSFC



Innovation: Integrated, Predictive Biology



Presentation Outline

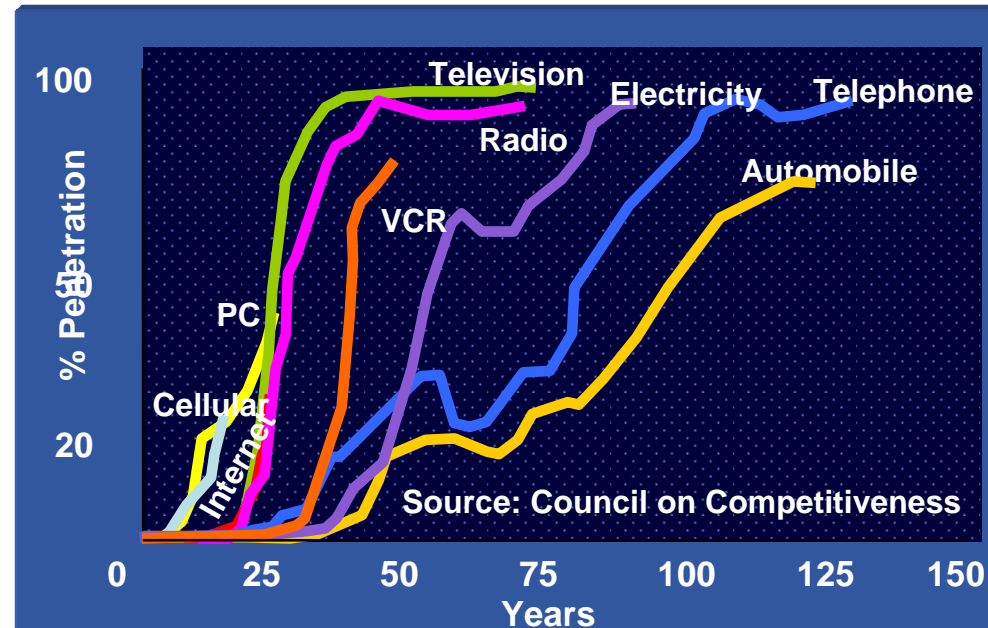
“Where there is no vision, the people perish.”
Proverbs 29:18

- Imagine the future
- Technology drivers
- Changes in flight
- Future challenges
- *Partnerships*
- Innovation



Faster, Faster, Faster, ...

- “Real world” change is accelerating
 - five years is an eternity
 - information friction is declining
- **University adaptation is not**
 - some hysteresis is good ...
 - there are verities
 - but, we risk irrelevance
 - obsolete technologies
 - cultural dissonance
- **Frame debate by innovating**
 - approaches, applications
 - collaborations, benefits
- **Innovation accrues from risks**
 - failure to risk is itself a risk



“He was so learned that he could name a horse in nine languages; so ignorant that he bought a cow to ride on.”
Ben Franklin

Exemplar 21st Century Challenges

- **Katrina ramifications**

- NEXRADs failed during Katrina

- data was inaccessible
- Why? The New Orleans MCI hub failed
 - spawned tornadoes untracked

- flooding and utility outages

- closed petrochemical facilities
- limited southeast pipeline capacity
- short-term gas purchases, shortages

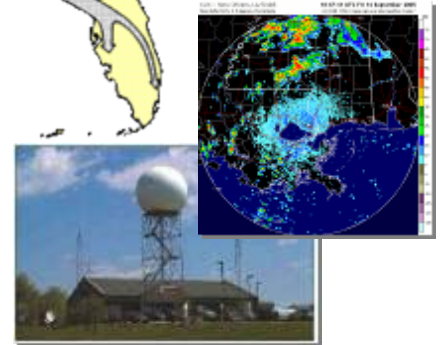
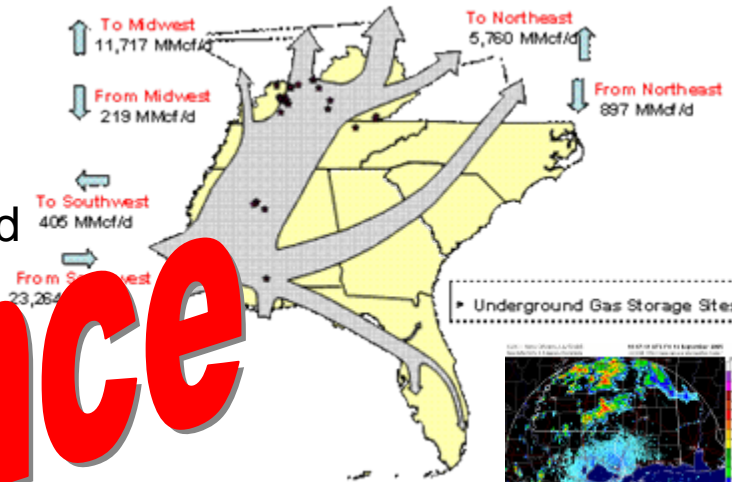
- **Economics of health care**

- longitudinal public health data

- environmental interactions
- genetic susceptibility
 - heart disease, cancer, Alzheimer's

- privacy and insurance

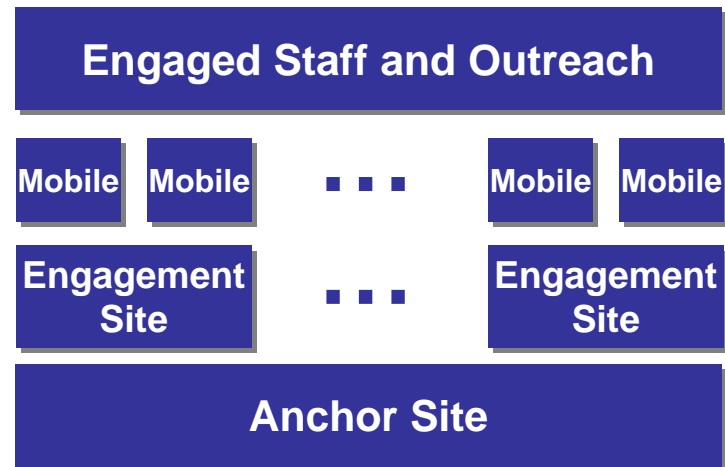
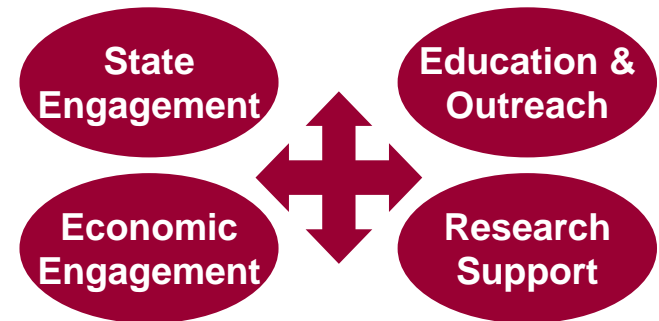
- public policy and coordination



consilience

Renaissance Computing Institute

- **Statewide objectives**
 - create benefit in a competitive world
 - engage industry and academia
 - couple with government and citizens
- **Four target areas**
 - public benefit
 - supporting disaster response, ...
 - economic development
 - helping people with innovative ideas
 - research engagement
 - catalyzing projects/increasing success
 - building multidisciplinary partnerships
 - education and outreach
 - providing hands on experiences
 - broadening participation



Catalyst
for
Innovation

RENCI and Digital Repositories

ENCYCLOPEDIA of CHICAGO
Embrios|Historical Sources|Maps|Special Features|User's Guide

SEARCH Full Use

Chicago Historical Society
Images, Books, Available online.

ENCYCLOPEDIA of CHICAGO
CHICAGO HISTORICAL SOCIETY, THE NEWBERRY LIBRARY, AND NORTHWESTERN UNIVERSITY
EDITORS: JANICE L. REIFF, ANN DURKIN KEATING, AND JAMES R. GROSSMAN

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SILS Library Search		
Search Worldwide ETDs		
Related Links	How to Submit	
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Networked Digital Library of Theses and Dissertations	Coming Soon	
Contact Us	<ul style="list-style-type: none">DissertationTechnical PaperJournal or Conference Paper	
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Triangle Petascale Archive

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California Institute of Technology

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Library, Archives, and Records Section

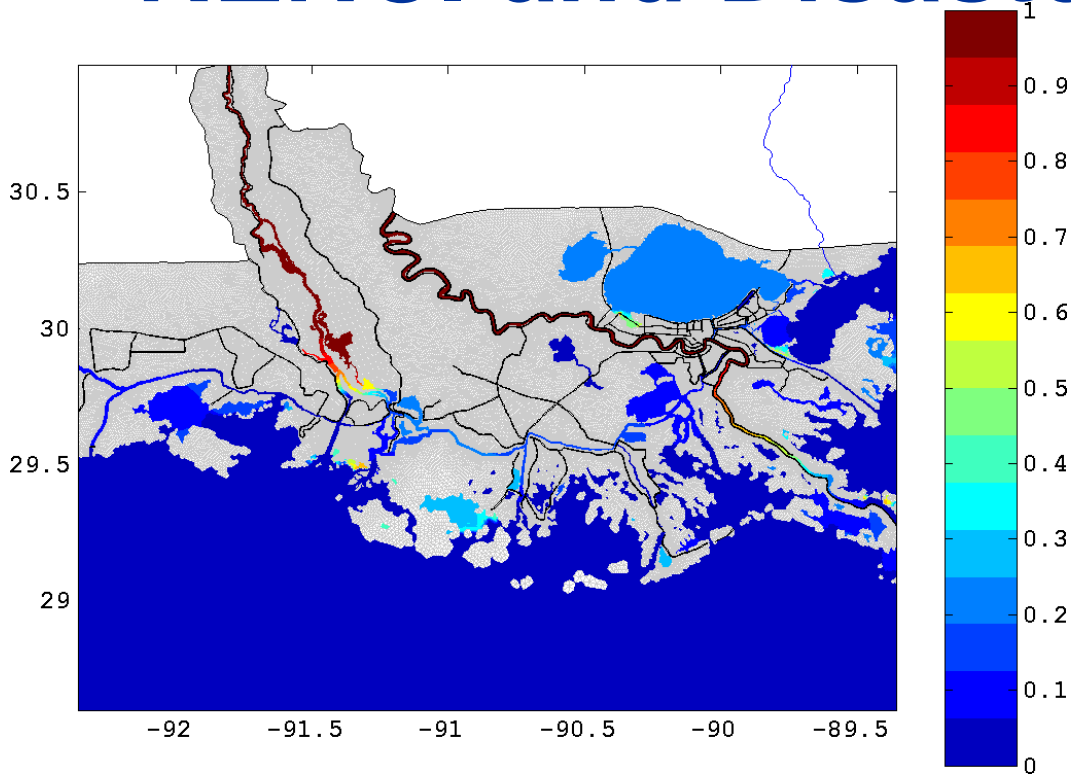
The Library, Archives, and Records Section provides easy access to information

its collections.

- [Performance and Risk Analysis](#)
- [OGV](#)
- [manicities](#)
- [Study of Upper Midwestern Cultures and Man Made](#)
- [Non-American Studies](#)
- [Library, UN-River Falls](#)
- [erlog, University of Wisconsin--Madison](#)
- [man's Book Center](#)

to capture, store, index, distribute, and preserve the intellectual output of the university.

RENCI and Disaster Response

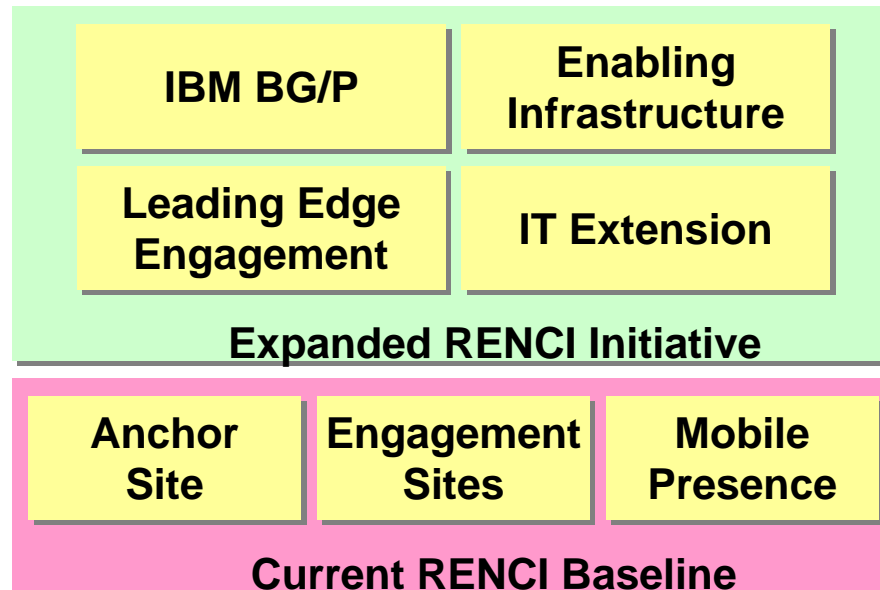


- **Post-Katrina NOAA challenge**
 - petrochemical spillage and remediation
 - water levels determine dissemination
- **UNC Marine Sciences and RENCI**
 - ADCIRC storm surge model predicts water levels
 - HPC system yields model predictions



Proposed Ultrascale Initiative

- **Lever for the 21st century knowledge economy**
- **Two parallel tracks**
 - an innovation magnet (and bragging rights)
 - competitive advantage for North Carolina companies
 - research intensive/extensive university accelerant
 - a globalization equalizer
 - enabling infrastructure and IT extension (B2B training/support)



Infrastructure 2016

- **Storage**

- personal petabytes
 - inexpensive and “disposable”
- institutional storage
 - operationally infinite

- **Networks**

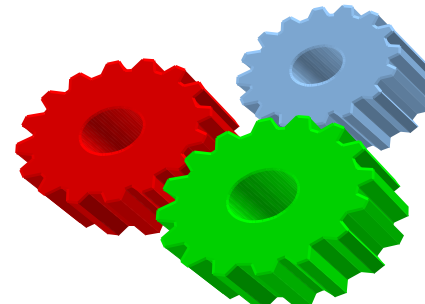
- ubiquitous >100 Mb/s wireless
 - always on, always available
- >1 Gb/s to the home
 - driven by consumer economics
- >1 Tb/s research networks

- **Computing**

- teraflop “personal computers”
 - >100-way multicore chips
 - complex and heterogeneous
- >100 petaflop research systems
 - >1 million way parallelism

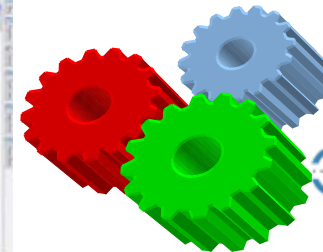
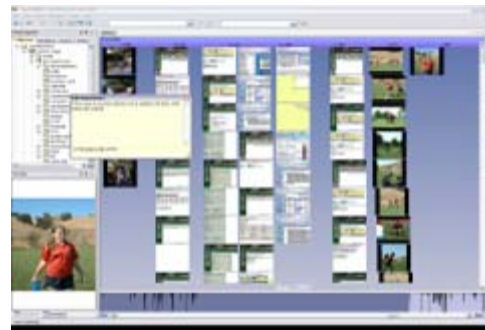
- **Situational sensors**

- disposable, ~1 mm²
- ambient powered



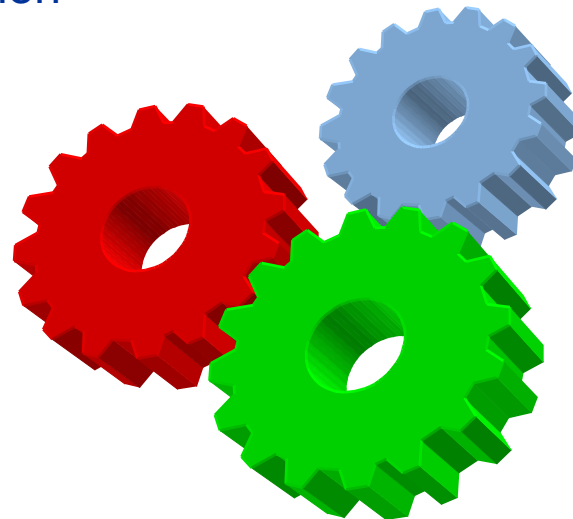
Services 2016

- **Semantic repositories**
 - deep(er) search
 - versioning and context
- **Infinite recall**
 - life experiences and context
- **Just in time education**
 - skill/insight nuggets
 - *a non sequitur*
 - distance education
- **Social networks**
 - blurred boundaries
 - electronic and physical
- **Geolocation**
 - contextual awareness
 - behavioral response
- **Digital convergence**
 - device transparency
 - contextual roaming
- **Peer-to-peer cooperation**
 - electronic agents
 - mass customization
- **Multidisciplinary modeling**
 - plug and play interaction
 - semantically coupled
- **Continuous awareness**
 - smart objects
 - deep telemetry



Engagement 2016

- **Knowledge miners**
 - learning what is known
- **Multidisciplinary matchmakers**
 - risk cultivation and engagement
- **Flash mob educators**
 - just in time context education
- **Infrastructure plumbers**
 - capability coupling and integration
- **IT extension agents**
 - entity-to-entity service education
- **Chronicle of Higher Education**
 - IT Intensive Factors in 2015
- ***Blending***
 - *education, work and flex time*
- ***Aging***
 - *older students needing new skills*
- ***Vulnerability***
 - *science and technology*



Carolina 2016



- **The nation's leading public university?**
 - a worthy and laudable goal, but ...
 - our “competitors” are unlikely to stumble
 - Michigan, UC Berkeley, Virginia, ...
 - therefore, difficult on the current path
- **Increasing the odds**
 - play a new and better game
 - not just the same game better
 - force others to adapt to our game
- **In a phrase, redefine the future**
 - frame the debate
 - not just debate the questions
- **Implications**
 - *define and invest in strategic priorities*
 - *adapt nimbly and rapidly (months, not years)*
 - *define success broadly, not narrowly*

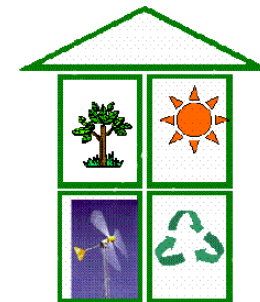
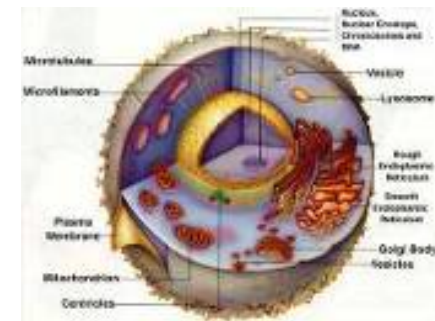


its.unc.edu/strategic



Carolina 2016

- 1. Ubiquitous, mobile invisibility**
 - successful technologies become “invisible”
 - composable, interoperable systems
- 2. Intelligence amplification (Memex)**
 - the right information at the right time
 - seamless modality transduction, situated and mobile
- 3. Predictive *in silico* biological models**
 - multidisciplinary modeling and integration
 - drug design and health care
- 4. The cultural encyclopedia**
 - cultural history, context and the digital village
- 5. The scientific knowledge base**
 - integrated, multidisciplinary knowledge content
- 6. The smart campus**
 - contextually adaptive infrastructure
 - energy and resource efficiencies
- 7. Digital arts**



Presentation Outline

“Where there is no vision, the people perish.”
Proverbs 29:18

- Imagine the future
- Technology drivers
- Changes in flight
- Future challenges
- Partnerships
- *Innovation*

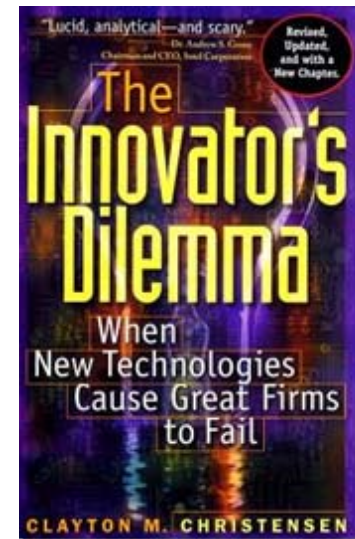
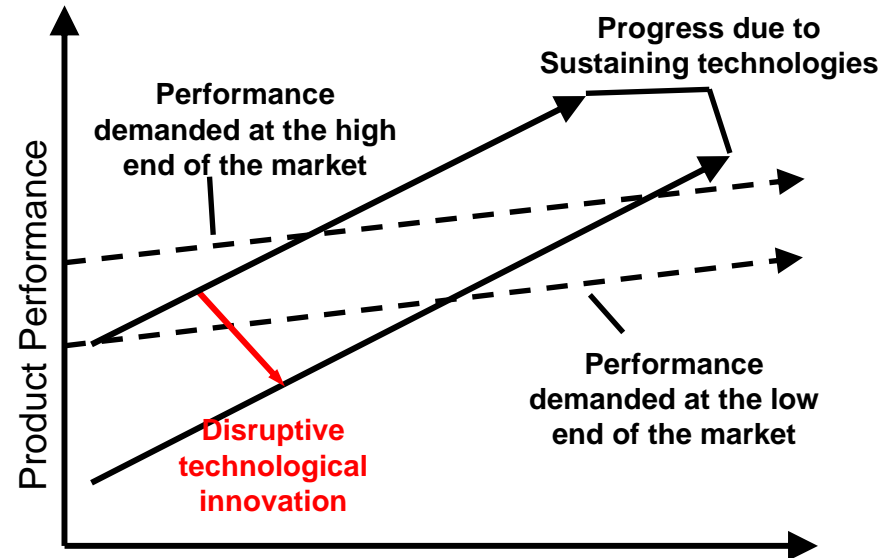


Innovation and Disruptive Technology



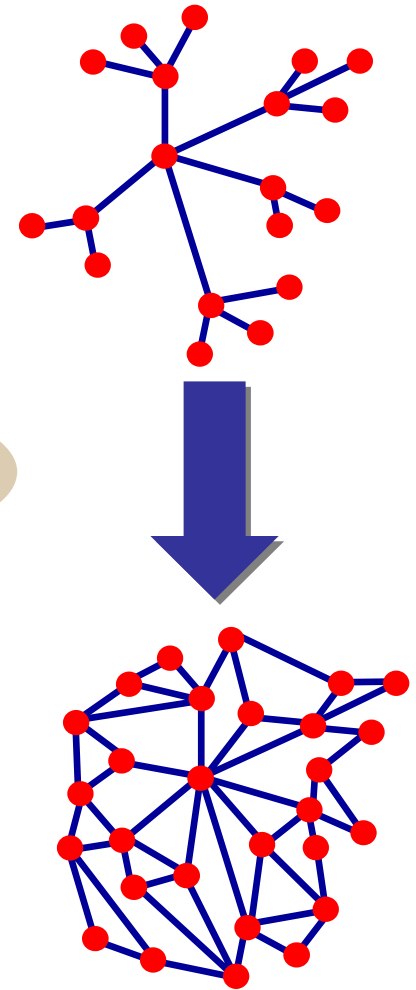
“Businessmen go down with their businesses because they like the old way so well they cannot bring themselves to change. ...Seldom does the cobbler take up with a new fangled way of soling shoes and seldom does the artisan willingly take up with new methods of his trade.”

Henry Ford



Changing Structures and Needs

- **Sandboxing ideas**
 - faculty, staff and infrastructure
- **Harvesting potential**
 - prototypes and approaches
- **Deploying capabilities**
 - production services and staff
- **Nimble resource allocation**
 - across organizational boundaries
 - in response to identified opportunities
 - free institutional energy



Dream, Strategize, Realize

“Twenty years from now, you will be more disappointed by the things you didn't do than by the ones you did. So throw off the bow lines. Sail away from the safe harbor. Catch the trade winds in your sails. Explore. Dream.”

Mark Twain

