Networking Research Challenges Workshop

Seattle, Washington
September 28-30, 2008

Chris Greer
Director, U.S. National Coordination Office
Networking and Information Technology Research and Development Program

Acronyms:

NITRD

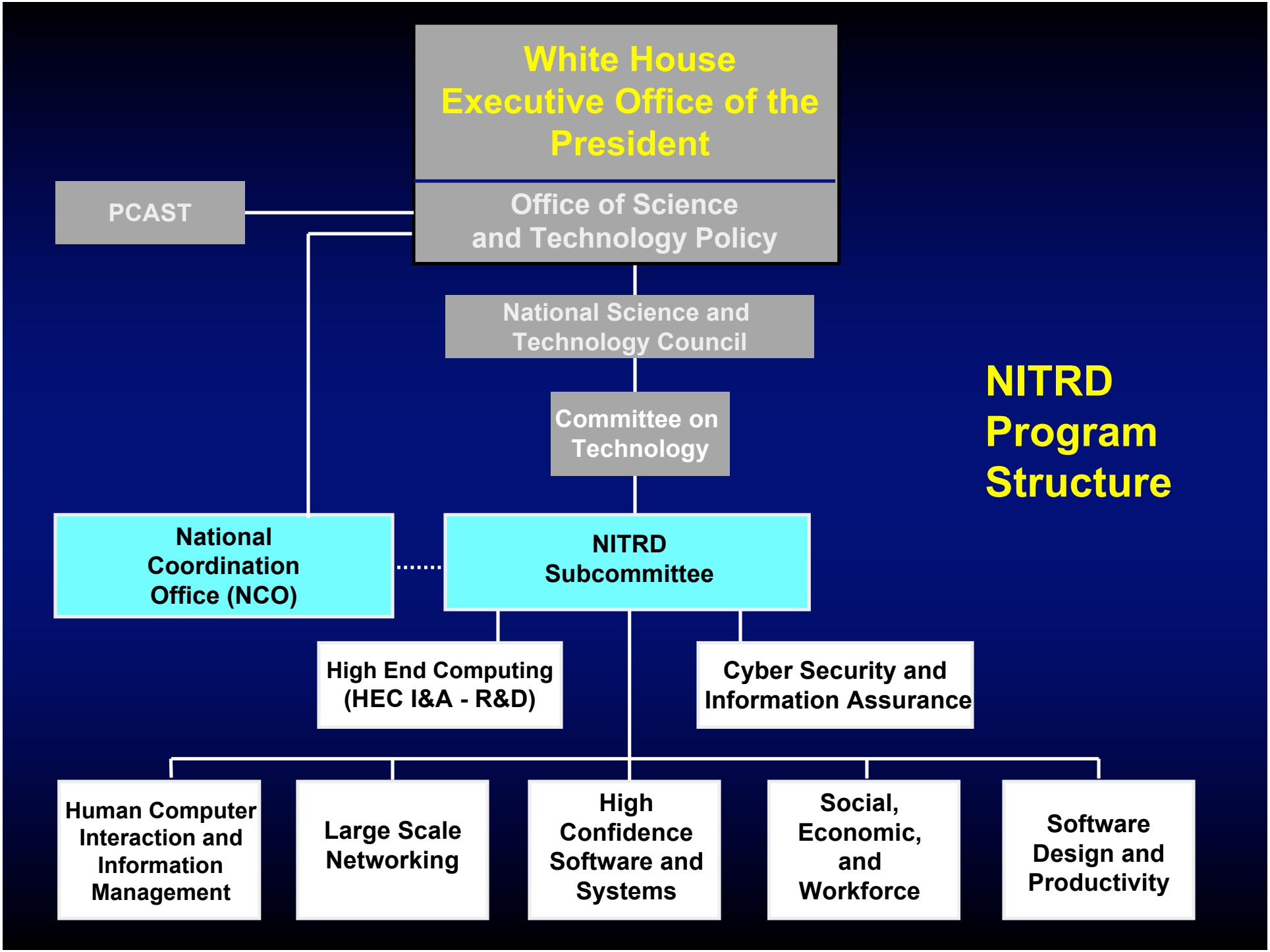
Networking and Information Technology Research and Development Program

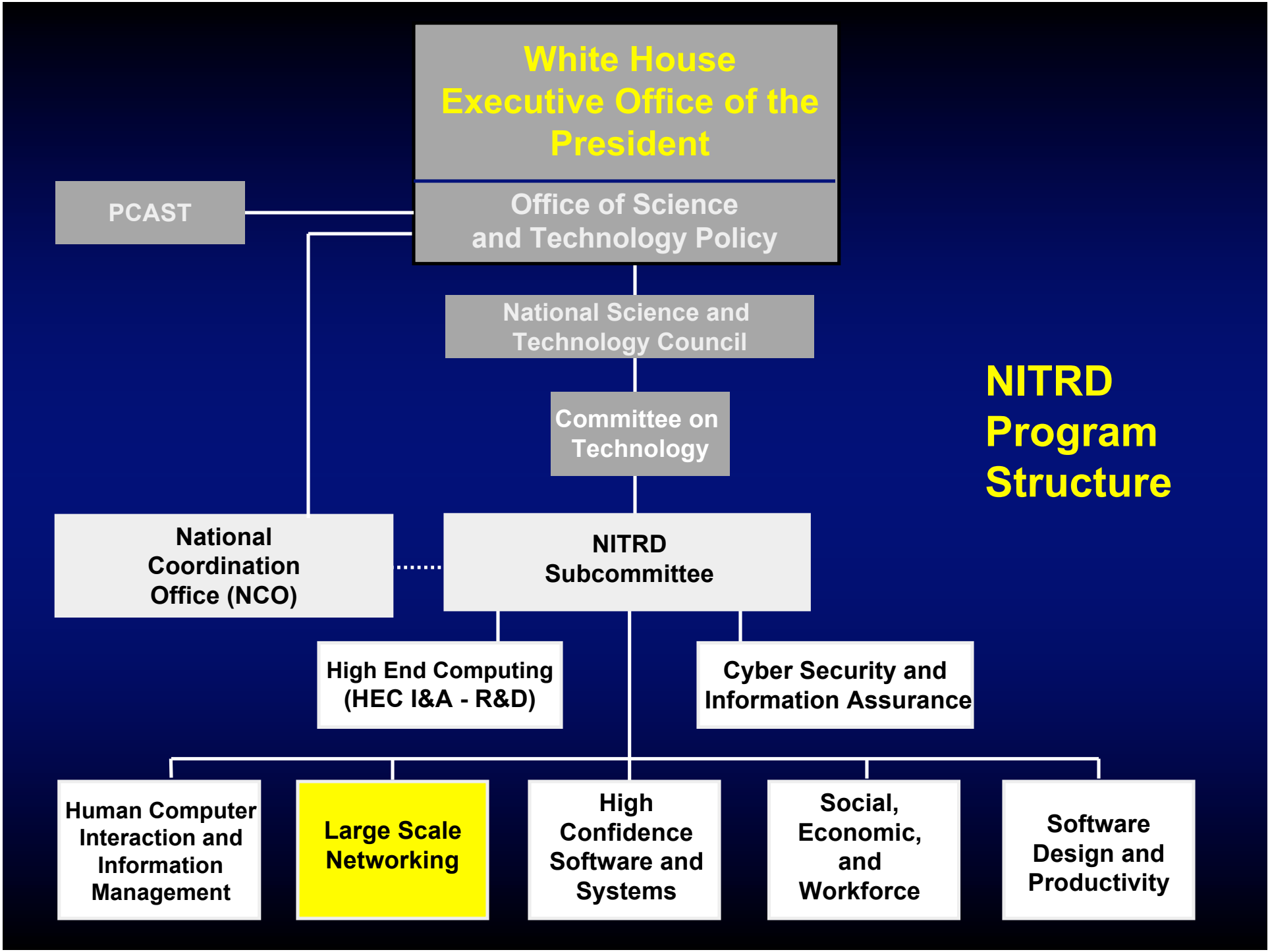
NCO

National Coordination Office

LSN

Large Scale Networking Coordinating Group


White House
Executive Office of the President
PCAST
Office of Science and Technology Policy
National Science and Technology Council
Committee on Technology
NITRD Program Structure
National Coordination Office (NCO)
NITRD Subcommittee
High End Computing (HEC I&A - R&D)
Cyber Security and Information Assurance
Human Computer Interaction and Information Management
Large Scale Networking
High Confidence Software and Systems
Social, Economic, and Workforce
Software Design and Productivity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AHRQ Agency for Healthcare Research and Quality

DARPA Defense Advanced Research Projects Agency

DOE/NNSA Department of Energy - National Nuclear Security Agency

DOE/SC Department of Energy - Mathematical, Information, and Computational Science Division

EPA Environmental Protection Agency

NARA National Archives and Records Administration

NASA National Aeronautics and Space Administration

NIH National Institutes of Health

NIST National Institute of Standards and Technology

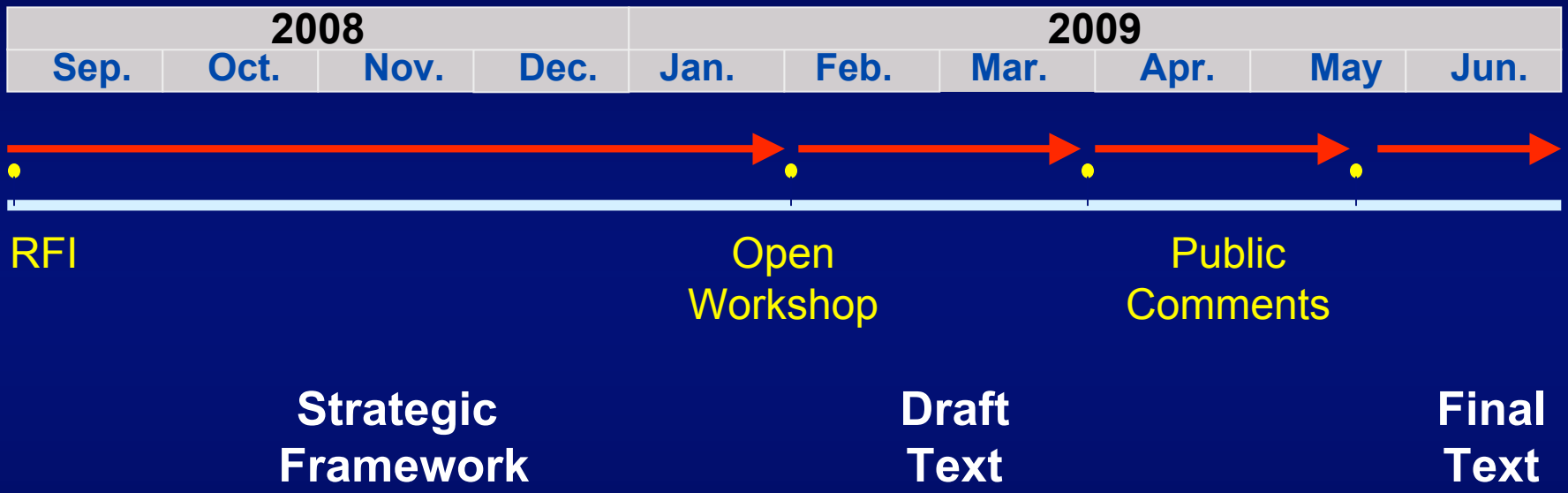
NOAA National Oceanic and Atmospheric Administration

NSA National Security Agency

NSF National Science Foundation

OSD and DoD Service research organizations, Office of the Deputy, Under Secretary of Defense (Science and Technology)

NITRD Strategic Planning Timeline



www.nitrd.gov

Networking and information technologies create a world that is not limited to 4-dimensions

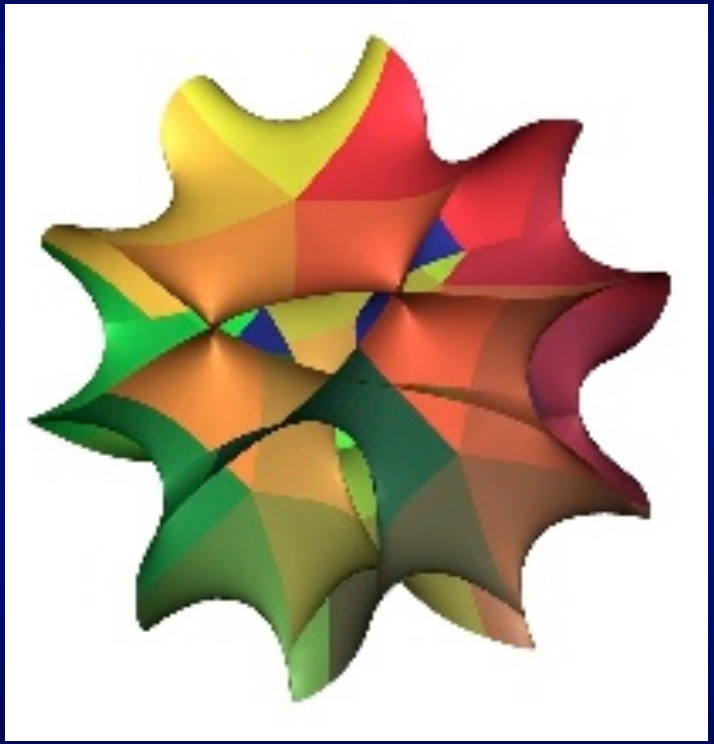
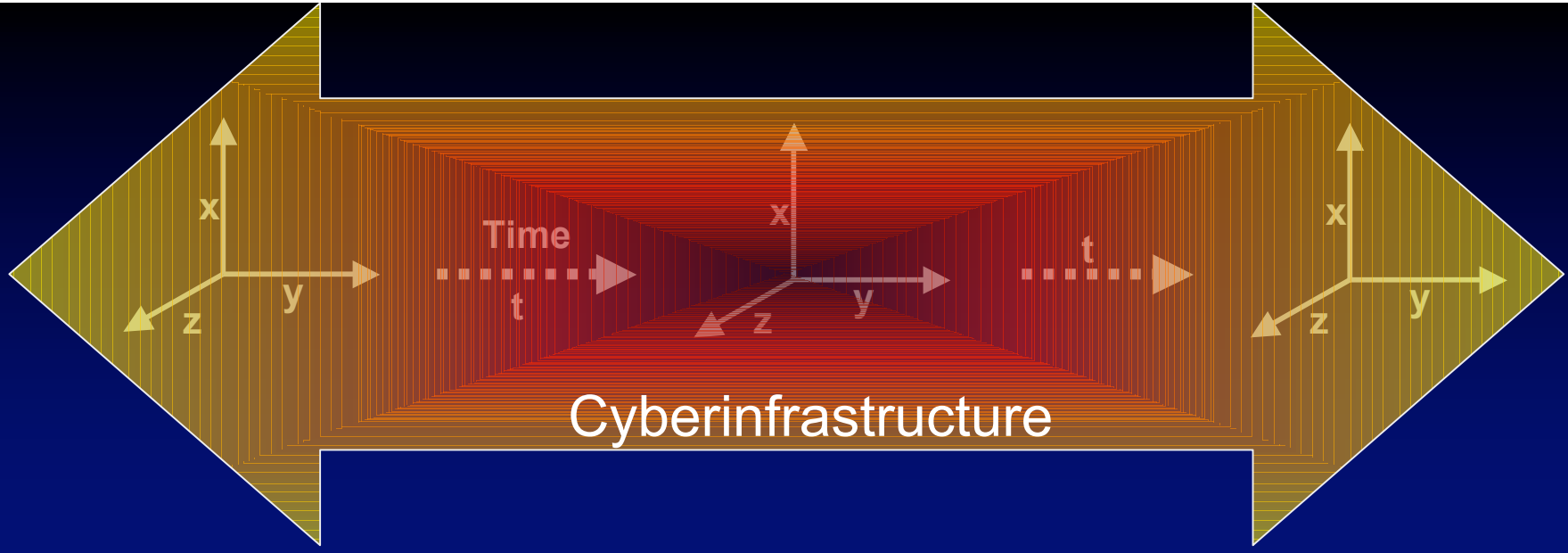
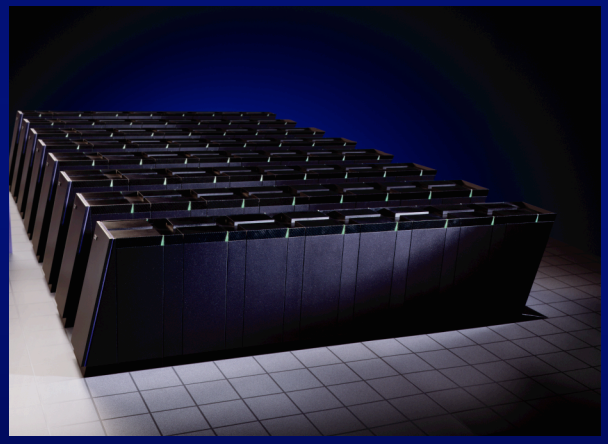


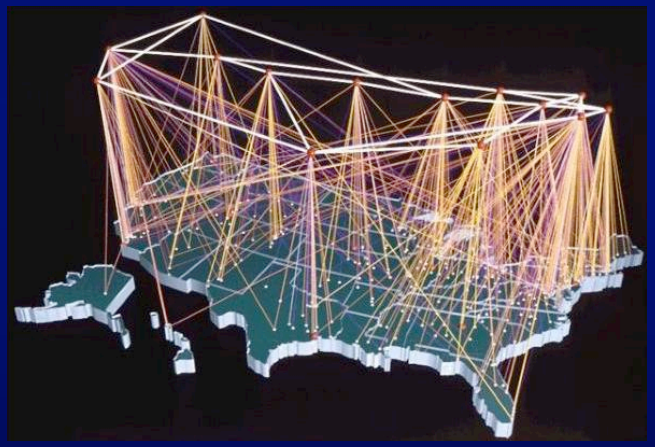
Image: Andrew J. Hanson
www.cs.indiana.edu/~hanson/



Cyberinfrastructure

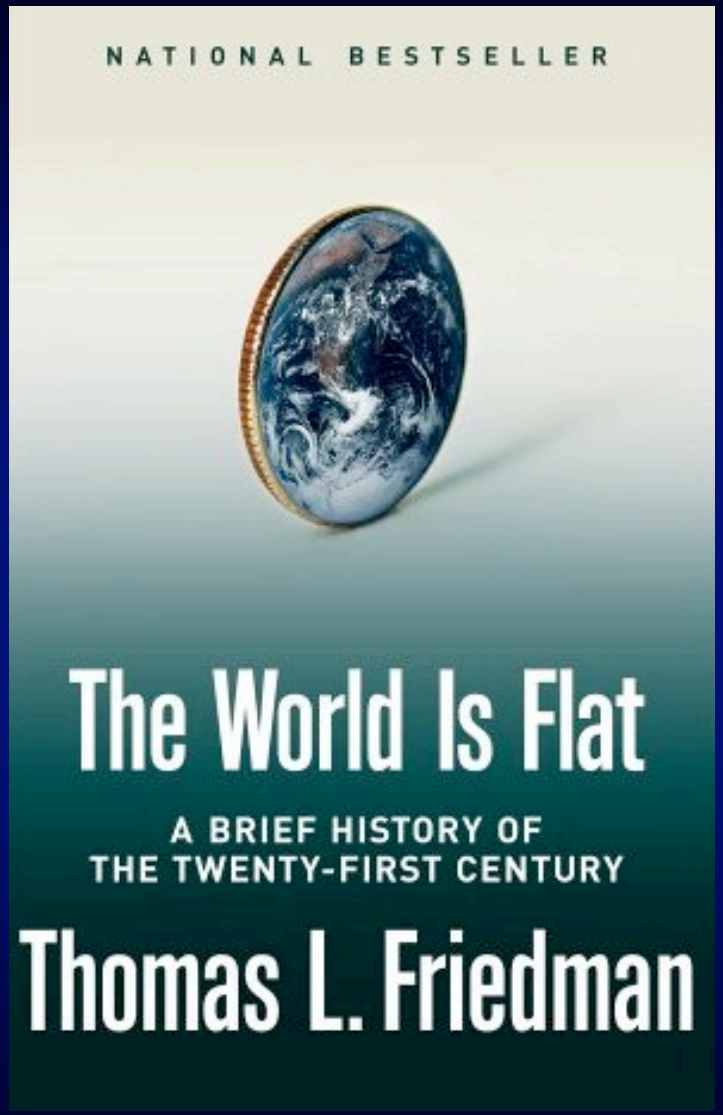


Computational capacity and capability



Connectivity for access and interaction

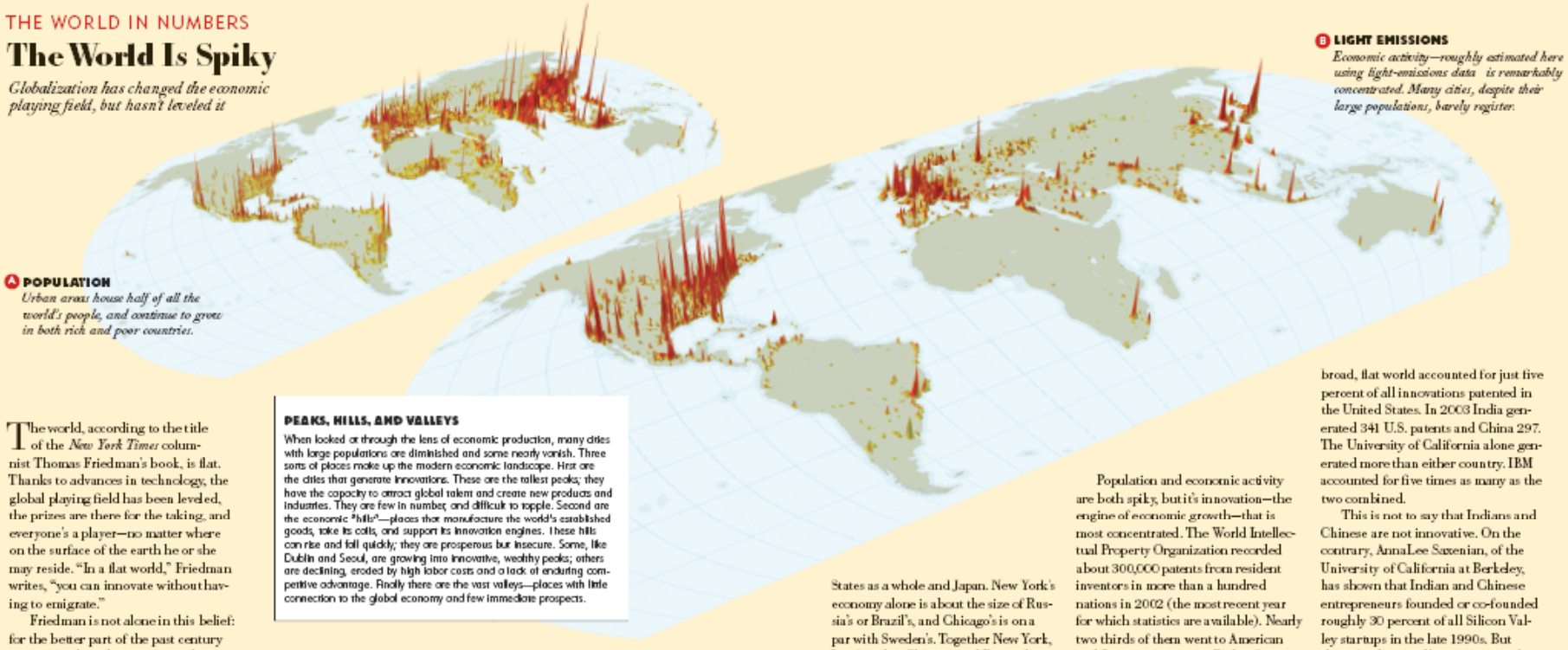
Information for innovation and discovery



The power of connectivity:

"A point Bill Gates made to me is that if you had a choice, thirty-five years ago, between being a B student in the Bronx or a genius born in Bangalore, there is no question; your life opportunities would be so much better if you were a B student in the Bronx ….[Today] You do not want to be a B student in the Bronx, because every genius in Bangalore can now plug and play more directly than ever."

A Spiky World



THE WORLD IN NUMBERS

The World Is Spiky

Globalization has changed the economic playing field, but hasn't leveled it

A POPULATION
Urban areas house half of all the world's people, and continue to grow in both rich and poor countries.

B LIGHT EMISSIONS
Economic activity—roughly estimated here using light-emissions data—is remarkably concentrated. Many cities, despite their large populations, barely register.

PEAKS, HILLS, AND VALLEYS

When looked at through the lens of economic production, many cities with large populations are diminished and some nearly vanish. Three sorts of places make up the modern economic landscape. First are the cities that generate innovations. These are the tallest peaks; they have the capacity to attract global talent and create new products and industries. They are few in number, and difficult to topple. Second are the economic "hills"—places that manufacture the world's established goods, take its colds, and support its innovation engines. These hills can rise and fall quickly; they are prosperous but insecure. Some, like Dublin and Seoul, are growing into innovative, wealthy peaks; others are declining, eroded by high labor costs and a lack of enduring competitive advantage. Finally there are the vast valleys—places with little connection to the global economy and few immediate prospects.

The world, according to the title of the *New York Times* columnist Thomas Friedman's book, is flat. Thanks to advances in technology, the global playing field has been leveled, the prizes are there for the taking, and everyone's a player—no matter where on the surface of the earth he or she may reside. "In a flat world," Friedman writes, "you can innovate without having to emigrate."

Friedman is not alone in this belief: for the better part of the past century economists have been writing about the leveling effects of technology. From the invention of the telephone, the automobile, and the airplane to the

surprisingly few regions truly matter in today's global economy. What's more, the tallest peaks—the cities and

of the world's population. Five megacities currently have more than 20 million inhabitants each. Twenty-four

States as a whole and Japan. New York's economy alone is about the size of Russia's or Brazil's, and Chicago's is on a par with Sweden's. Together New York, Los Angeles, Chicago, and Boston have a bigger economy than all of China. If U.S. metropolitan areas were countries, they'd make up forty-seven of the big-

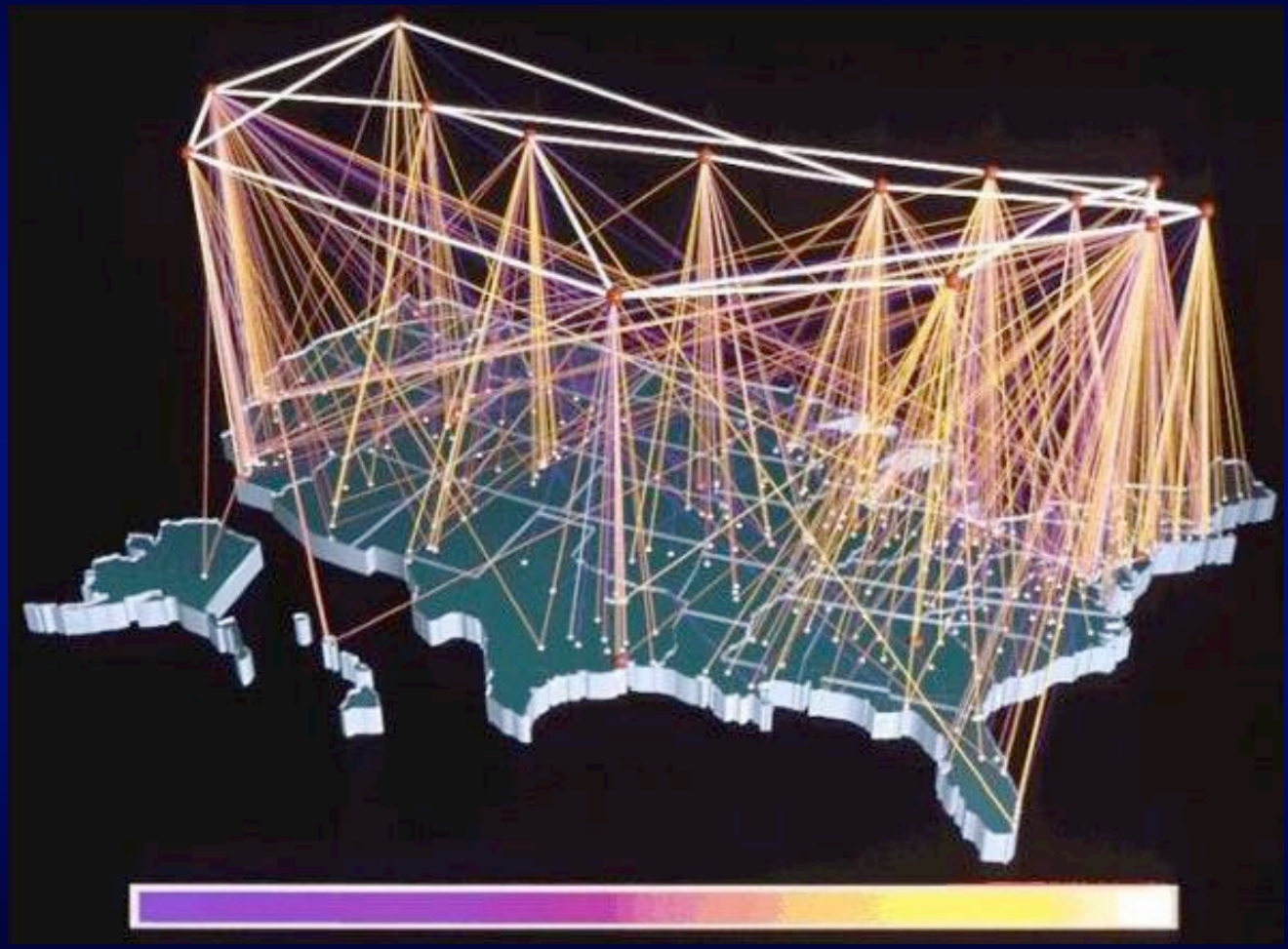
Population and economic activity are both spiky, but it's innovation—the engine of economic growth—that is most concentrated. The World Intellectual Property Organization recorded about 300,000 patents from resident inventors in more than a hundred nations in 2002 (the most recent year for which statistics are available). Nearly two thirds of them went to American and Japanese inventors. Eighty-five percent went to the residents of just five countries (Japan, the United States, South Korea, Germany, and Russia).

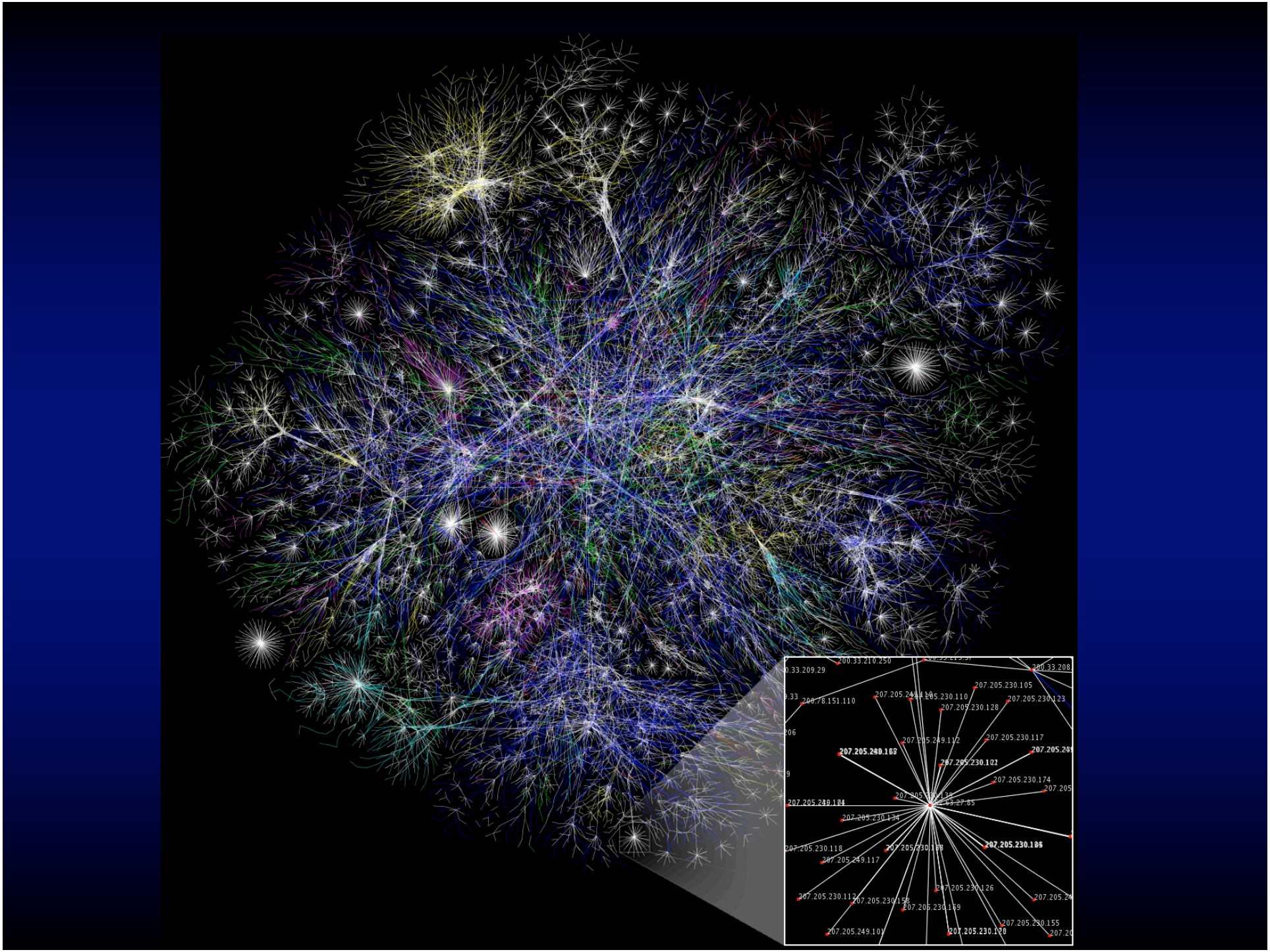
broad, flat world accounted for just five percent of all innovations patented in the United States. In 2003 India generated 341 U.S. patents and China 297. The University of California alone generated more than either country. IBM accounted for five times as many as the two combined.

This is not to say that Indians and Chinese are not innovative. On the contrary, AnnaLee Saxenian, of the University of California at Berkeley, has shown that Indian and Chinese entrepreneurs founded or co-founded roughly 30 percent of all Silicon Valley startups in the late 1990s. But these fundamentally creative people had to travel to Silicon Valley and be absorbed into its innovative ecosystem before their ideas became economi-

Richard Florida, The Atlantic Monthly, October 2005

NSFNet Traffic– September 1991

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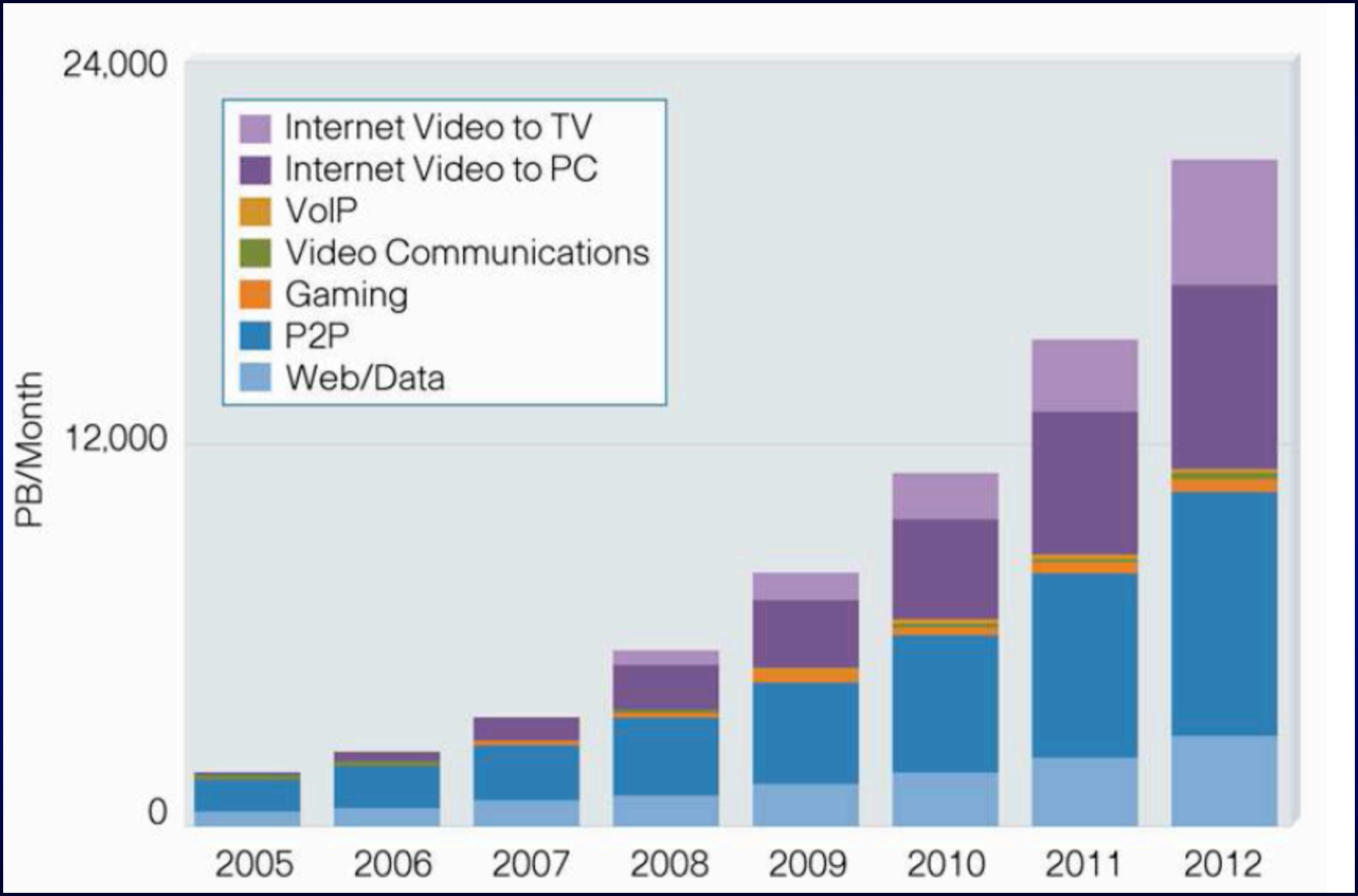
Growth of the Digital Dimension

- 100 million devices connected to Internet in 2000
- Expect 14 billion devices connected to Internet in 2010
- Global population growth: 4 births/sec
- Global cell phone growth: >30 connections/sec

"*Approaching the Zettabyte Era*"



Source: Cisco White Paper, June 2008
http://www.cisco.com/

“Progress”

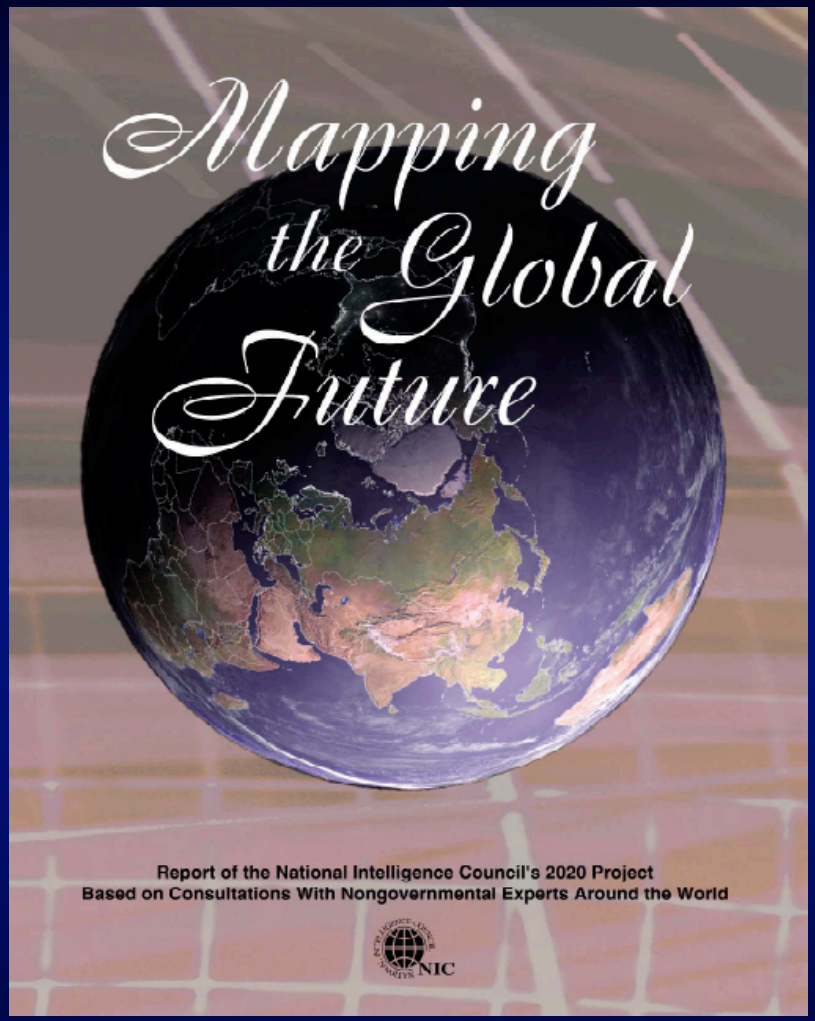
- "I think there is a world market for about four or five electronic computers."
  -- Thomas J. Watson, President, IBM, 1943

- "There is no reason for an individual to have a computer in their home."
  -- Ken Olsen, DEC, 1977

- “For the full year [2007], IDC said 269 million PCs were shipped worldwide”
  -- International Herald Tribune, January, 2008.

- "In a sense, there are only five computers on earth."
  -- Yahoo Research Chief Prabhakar Raghavan, December, 2007.

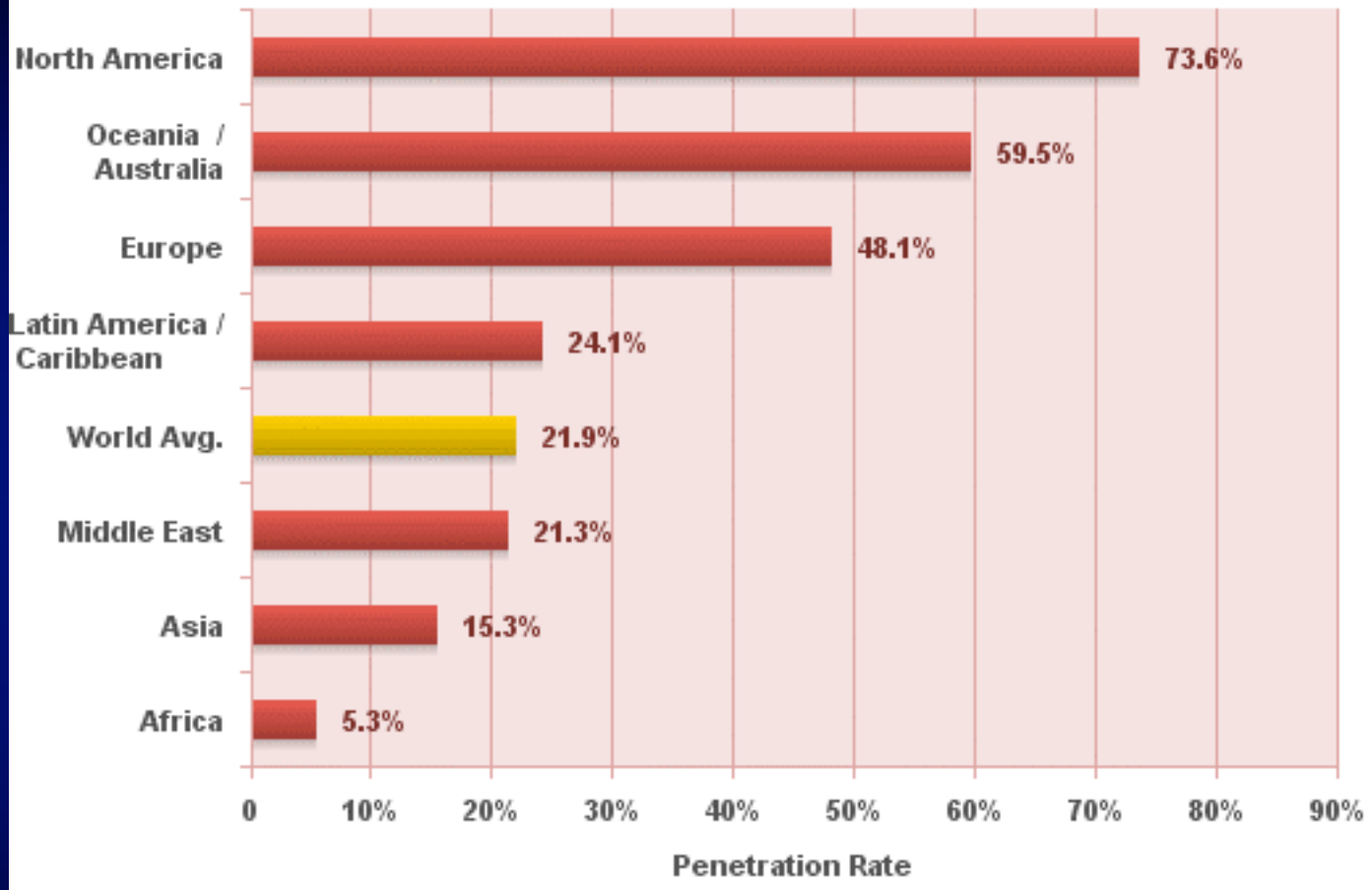
- “…some researchers at IBM believe that five computers may be four too many.”
  -- Nick Carr, The Guardian, February 21, 2008.



"We see globalization [as] a force so ubiquitous that it will substantially shape all the other major trends in the world of 2020 …The greatest benefits of globalization will accrue to countries and groups that can access and adopt new technologies."

National Intelligence Council
2020 Project

World Internet Penetration Rates by Geographic Regions



Source: Internet World Stats - www.internetworldststs.com/stats.htm

Interagency Task Force on Advanced Networking (ITFAN)

ITFAN charged with developing an interagency *Federal Plan for Advanced Networking R&D* that provides:

- a strategic vision of current and future needs in the Federal, commercial, and academic sectors;
- recommended scope, objectives, and priorities for Federal advanced networking R&D; and
- a process for developing an implementation roadmap to guide future advanced networking R&D activities.

Interagency Task Force on Advanced Networking (ITFAN)

ITFAN comprised 11 organizations:

- Department of Defense (DoD)
- Department of Energy's Office of Science (DOE/SC)
- National Archives and Records Administration (NARA)
- National Aeronautics and Space Administration (NASA)
- National Coordination Office for NITRD (NCO/NITRD)
- National Library of Medicine (NIH/NLM)
- National Institute of Standards and Technology (NIST)
- National Security Agency (NSA)
- National Science Foundation (NSF)
- Office of Science and Technology Policy (OSTP)
- Department of Justice (DoJ)

Four major Networking Goals

A proposed coordinated research effort across Federal agencies focused on four goals:

- *Goal 1*: Provide network services anytime, anywhere
- *Goal 2*: Make secure global federated networks possible
- *Goal 3*: Manage network complexity and heterogeneity
- *Goal 4*: Foster innovation through development of advanced network systems and technologies

Example Visionary Scenarios for Advanced Networking

- Support for inter-domain/international secure scientific collaborations with massive data transfers
- Ad hoc, heterogeneous, dynamic, secure networking to support a highly dynamic mission with sensornets, priority communications, and autonomous resource discovery and management with centralized oversight
- Automated detection and response to system attack across a complex system
- Smart wireless-phone based networking to support crisis response.

Reconfigurable Ubiquitous Networked Embedded Systems (RUNES)

Dimensions of Networking Research

For each networking goal, the plan considered five dimensions of networking research:

- ***Foundations***: Architectural principles, frameworks, and network models
- ***Design***: Secure, near-real-time, flexible, adaptive services with built-in intelligence
- ***Management***: Management methods and tools for effective deployment, control, and utilization of networks and resources
- ***Security***: A high degree of security even in complex, heterogeneous federation and policy environments, while respecting privacy
- ***Usability***: Adaptable, user-centered services and interfaces

Federal Plan Conclusions

- Improved networking security and reliability are strategic national priorities
- New paths to advanced networking are needed
- Federal R&D efforts will support a spectrum of advanced networking capabilities
- Close cooperation is needed to integrate Federal R&D efforts with the full technology development cycle
- Testbeds and prototype networks enable research on network challenges in realistic environments.
- Cooperation and collaboration among university, commercial, international, Government laboratory, and Federal Program Manager communities are essential

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Workshop Goals

(1) Next-generation heterogeneous networking

- Network virtualization in federated networks
- Optical networks and large scale data transport
- Heterogeneous network testbeds for global scale experimental concepts
- Middleware to couple web-scale applications to heterogeneous networks

Workshop Goals

(2) Network security

- Security for wireless technology in dynamic, heterogeneous, federated, networking environments
- Testbeds for security capabilities
- Distributed intrusion detection
- Federation authentication systems

Workshop Goals

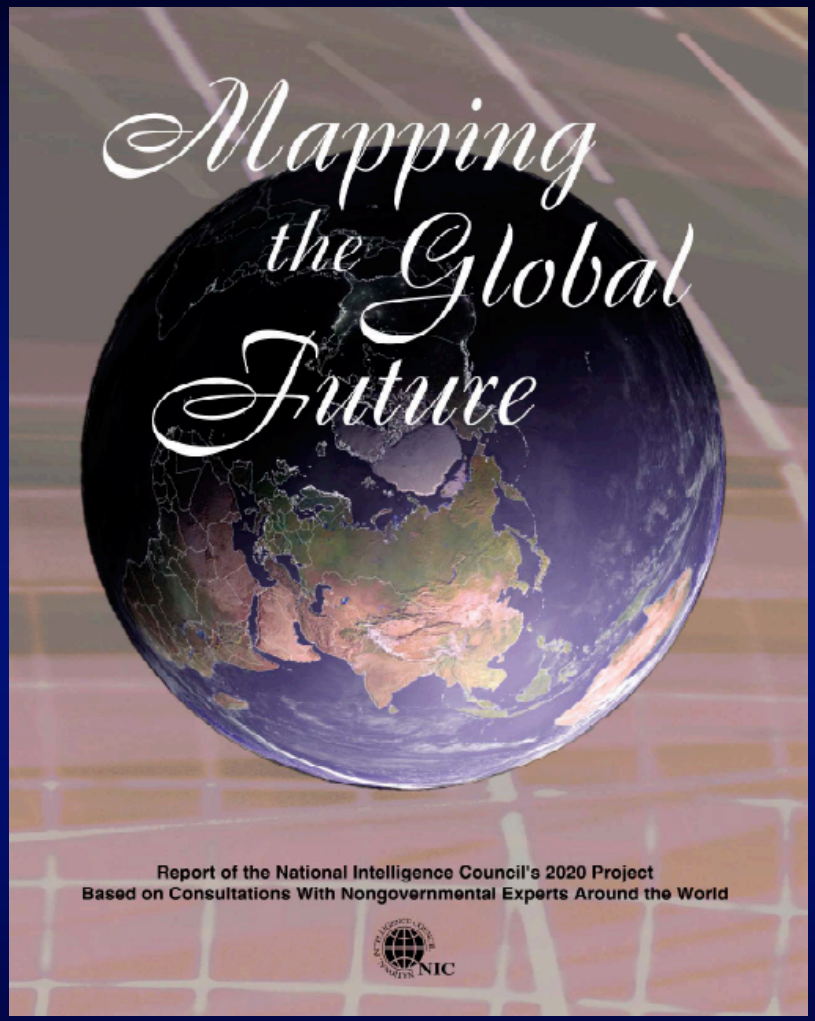
(3) Federated optical networking

- Resource identification, reservation and allocation
- End-to-end performance monitoring and fault management
- Network security
- Hybrid VLAN technologies

Workshop Goals

(4) Network Science and Engineering

- Secure dynamic networking in heterogeneous networks
- 100 Gb+ data transport
- Sensornets and high-end applications
- Programmable, reconfigurable networks



"Over the next 15 years, a growing range of actors, including terrorists, may acquire and develop capabilities to conduct both physical and cyber attacks against nodes of the world's information infrastructure …

…The ability to respond to such attacks will require critical technology to close the gap between attacker and defender."

National Intelligence Council
2020 Project

Comprehensive National Cybersecurity Initiative(CNCI):

R&D Coordination and Leap-Ahead Activities

Vision for R&D under CNCI

A high-priority, high-intensity, focused, and *coordinated* set of Federal government activities over the next 10 years to:

"transform the cyber infrastructure so that critical national interests are protected from catastrophic damage and our society can confidently adopt new technological advances."

Request for Information (RFI)

Change the Game:

- Change the rules
- Morph the board
- Raise the stakes

Web Site:

www.nitrd.gov

Contact:

greer@nitrd.gov