

NETWORKING AND INFORMATION TECHNOLOGY
RESEARCH AND DEVELOPMENT

COORDINATING FEDERAL R&D IN IT:
THE NETWORKING COMMUNITY

MARK LUKER
DEPUTY DIRECTOR
NATIONAL COORDINATION OFFICE

ALL OPINIONS EXPRESSED ARE
THOSE OF THE SPEAKER



Networking and Information Technology R&D Program



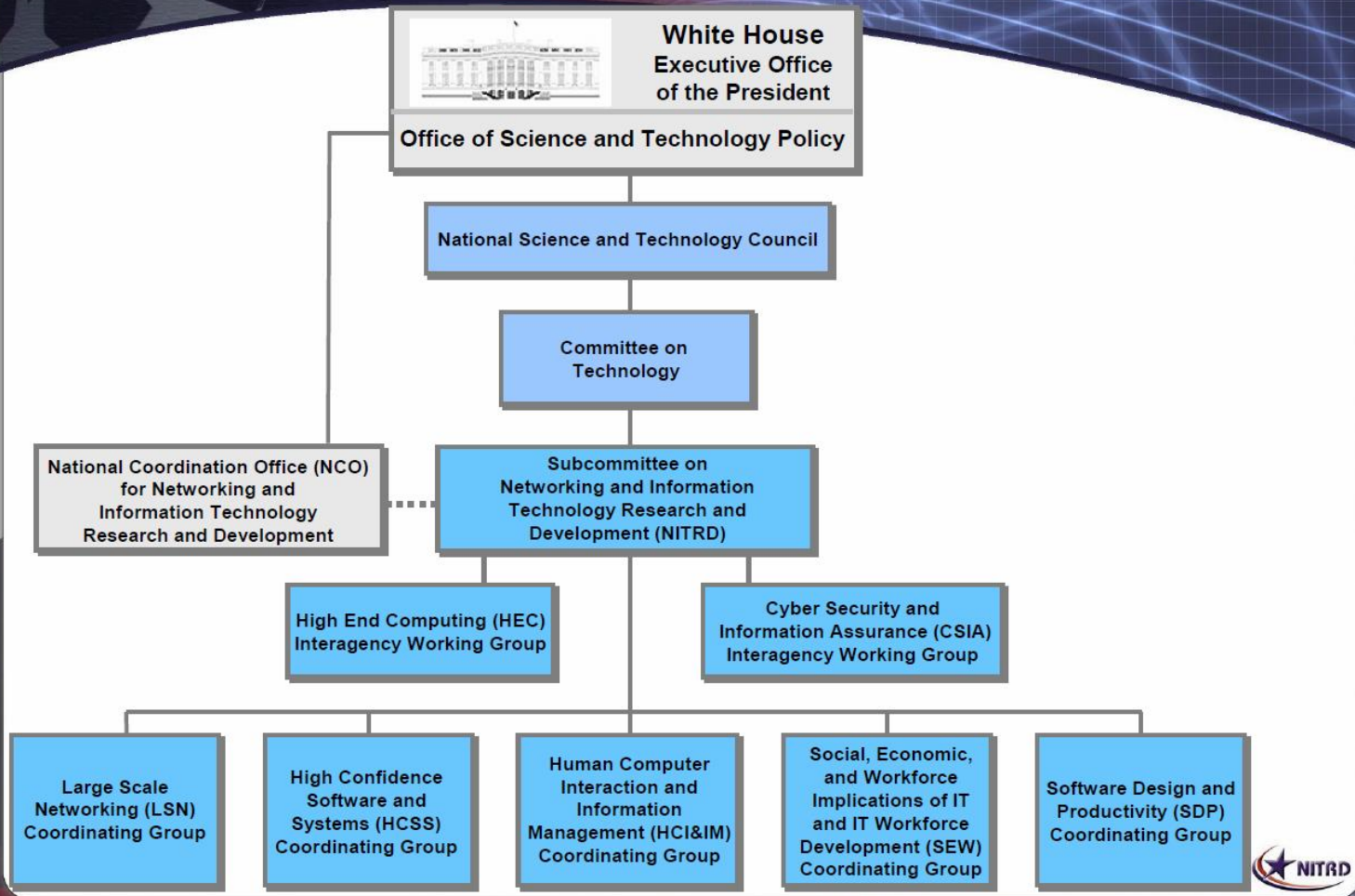
Office of Science



NITRD AND THE NCO

- **NITRD:** an interagency program to enhance coordination and collaboration of the Networking and Information Technology (was *High-Performance Computing*) R&D that is performed or supported by Federal agencies
- **NCO:** National Coordination Office-- provides support for the NITRD Program, reports to OSTP, and interfaces for NITRD with OMB, GAO, Congress, etc.

NITRD Program Coordination



20TH ANNIVERSARY WORKSHOP

[HTTP://WWW.NITRD.GOV/NITRDSYMPOSIUM/INDEX.ASPX](http://www.nitrd.gov/nitrdsymposium/index.aspx)



ANNUAL REPORT OF UNCLASSIFIED FEDERAL INVESTMENTS IN NIT R&D

The “BLUE BOOK”

THE NETWORKING AND
INFORMATION TECHNOLOGY
RESEARCH AND DEVELOPMENT
PROGRAM

Supplement to the President's Budget

FY 2013



FEBRUARY 2012

BY PROGRAM COMPONENT AREAS

- Cyber Security and Information Assurance
- High-End Computing (R&D and I&A)
- High Confidence Software and Systems
- Human Computer Interaction and Information Management
- **Large Scale Networking**
- Social, Economic, and Workforce Implications
- Software Design and Productivity

FY 2012 BUDGET ESTIMATES

(\$ MILLIONS)

	HEC i&a	HEC r&d	CSIA	HCI im	LSN	HCSS	SDP	SEW	TOTAL
NSF	250	103	98	292	122	85	78	110	1138
DoD	211	49	145	111	112	36	30		694
NIH	222	18		215	12	10	54	22	553
DOE SC	317	92	34		74	4	16	6	543
DARPA		75	223	138	53				489
NIST	14	5	47	15	8	6	4	1	100
NASA	61			14	1	18	9		103
DHS			43		1		3		47
AHRQ				25	1				26
NOAA	19				2		1		22
DOE NNSA	9	5						4	18
EPA	3			3					6
NARA				1					1

INTERACTIVE DASHBOARD

[HTTP://ITDASHBOARD.NITRD.GOV/](http://ITDASHBOARD.NITRD.GOV/)

View By: **PCA Group** ▼

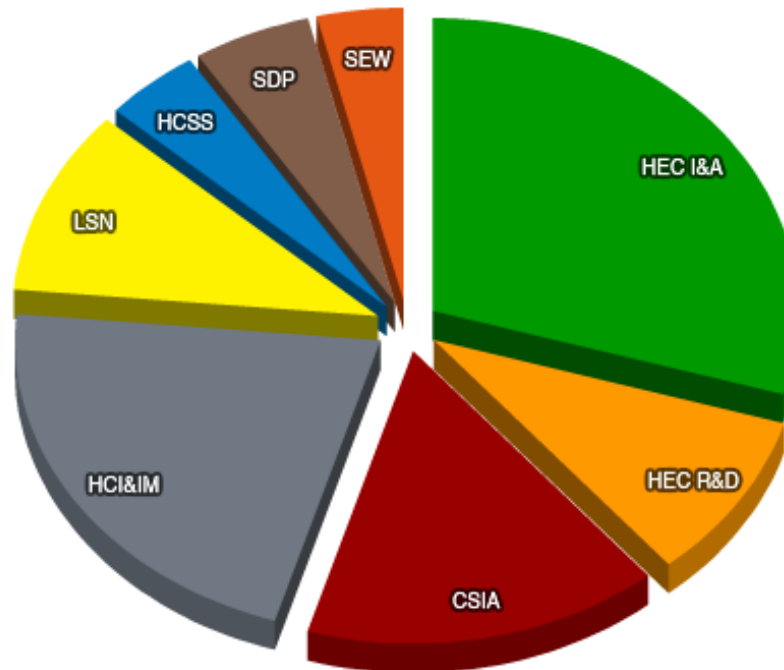
Period: **Post 2000** ▼

Agency NITRD Budget Estimates

2012 > All Agencies >

Note

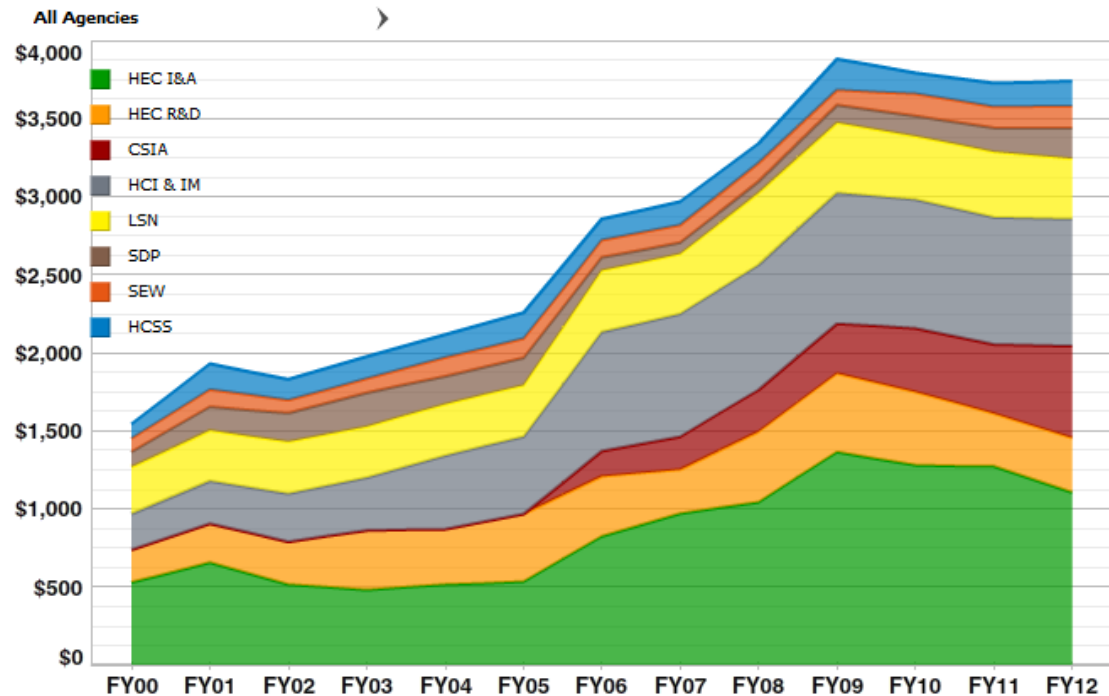
FY2010 and FY2011
are budget actuals.
The rest of the years
are budget estimates



TRENDS



Agency NITRD Budget Trends



All Agencies

Fiscal Year	Total Budget	HEC I&A	HEC R&D	CSIA	HCI & IM	LSN	SDP
FY00	\$1,543.0	\$528.9	\$208.6	\$0.0	\$230.0	\$299.8	\$98.7
FY01	\$1,928.4	\$656.6	\$250.1	\$0.0	\$272.6	\$322.4	\$151.3

ONGOING COORDINATION OF R&D

- Agency R&D leaders for PCAs share strategies, plans, developments monthly
- Document activities and results
- Shared interface with industry and academia through workshops and public comments
- Increase opportunities, speed results of Federal R&D investments

PRESIDENT'S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY (PCAST)

2010 Recommendations for NITRD:

- Health IT R&D
- Energy and Transportation
- More Cybersecurity
- “Fundamental Research Frontiers”
- Big Data
- Engineering Large Software Systems

NITRD NOW INTRODUCING SENIOR STEERING GROUPS

- Cybersecurity and Privacy
- Health IT
- Big Data
- Wireless Spectrum Efficiency
- Cyber-Physical Systems and Robotics
- Video & Image Analytics (proposed)

THE ROLE OF R&E NETWORKING

- NITRD LSN then ...
 - Discrete Federal networks
 - NSFnet, vBNS, ESNET, DREN, ...
 - Regionals, labs, campuses
 - 1.5 Mbps, 45 Mbps, ...
 - A few overseas connectors
 - Heated debate on “IP vs. ATM”
 - Financial data on the net?
 - The Internet Scout

ROLE OF NETWORKING STILL EVOLVING RAPIDLY

- LSN now ...
 - Consolidated Federal networks
 - Complex ecosystem of partner networks
 - 100G, Science DMZ
 - Network security, TICs
 - **SDN, Network Virtualization, NDN**
 - **Wireless, Mobility**

LARGE INCREASE IN COMPLEXITY AND OPPORTUNITY

- JET – Joint Engineering Team
 - Then ...
 - Mission driven Federal R&E Nets
 - Explore interconnections
 - Now ...
 - Globally interconnected
 - High-performance virtual components
 - Interoperability and reconfiguration

E.G. DEMOS AT SC14

LEADING EDGE / REAL MOTIVATION

- Software Defined Networking Exchanges (SDXs) for 100 Gbps Services
- International Software Defined Networking Exchanges (SDXs) for Data Intensive Science With International Federation
- A Global Environment for Network Innovations (GENI) Multi-Service Multi-Layer Exchange via a Software Defined Networking Exchange (SDX)

SC14: EXPANDING OPPORTUNITIES

- Global Distance InfiniBand Interconnections for Supporting RDMA
- Software Defined Networking Exchange (SDX) Services for Data Intensive Computational Bioinformatics
- Research on Demand $OP(n)$ 100G International Tested: Led by Ciena Research Labs
- Remote I/O and Controlled Pipelining Over 100 Gbps WANs

LARGE INCREASE IN COMPLEXITY AND OPPORTUNITY

- MAGIC – Middleware and Grid
 - Then ...
 - IdM, PKI, CAs
 - Now ...
 - Virtual communities for science
 - Supported by collaborations, federations
 - Tool kits, repositories, “standards”
 - InCommon, OSG, OGF, GENI, Net+
 - Distributed computing evolution

SUCCESS OF THE R&E MODEL

- Campus, Regional, National, Global
- Public, private, commercial
- BTOP style “anchor institutions” in Gov, K-12, Healthcare, Safety, Citizens, ...
- Operations, applications, innovation
- Discipline and standards based
- Owned fiber model is a game changer, both cost effective and powerful

THE DISRUPTIVE REVOLUTION WIRELESS

- Then ...
 - Patchy last mile (or last yards)
 - “Affordable”, rugged long haul
- Now ...
 - Almost everywhere
 - Inexpensive, leaping generations
 - Greatly augmented by unlicensed spectrum
 - Mobility
 - Car, body, indoors, outdoors, in space
 - Explosion of apps and customers with BYOD
 - Kudos to telephones and computers again!

COORDINATE WIRELESS R&D

- WSRD – Wireless Spectrum R&D
 - Federal R&D in
 - Technologies to Share Spectrum
 - Detection, Measurement, Control
 - Applications, security, privacy
 - Policies, Economics

2011 EXECUTIVE MEMORANDUM

“This new era in global technology leadership will only happen if there is adequate spectrum available to support the forthcoming myriad of wireless devices, networks, and applications that can drive the new economy.” –President Barack Obama



- Goal - One way to make spectrum available for useful purposes is to increase spectrum efficiency and sharing
- Purpose - Fulfill the EM's 3rd objective
 - Create a US Government-wide approach for R&D in spectrum-related activities
 - US Government participants, but working with industry and academia

WSRD STRATEGIC OBJECTIVES

- **Transparency:** Communicate to both Federal agencies and the private sector the research and development activities currently being pursued or planned, and help identify areas that still need to be addressed.
- **Smart investment:** Develop strategies that can supplement funding for research and development and/or increase the efficiency of existing investments.
- **Solicit opportunities:** Identify opportunities for spectrum technology transfer between Federal agencies and the private sector.

WSRD COORDINATION

- **Inventoried** over **600 Federal R&D projects** in spectrum-sharing
- Government, academic, and private sector dialog in report, ***Toward Innovative Spectrum Sharing Technologies***

WSRD COORDINATION

- *Examining the Need for a National Spectrum Sharing Testing Environment*, reported in 2012
- **Online portal of testbed information** that shows the **locations** and **capabilities** of existing spectrum testing facilities, and indicates the status and **availability** of each facility to federal, academic, and private sector researchers.
- <http://www.nitrd.gov/Subcommittee/wsrld/Testbeds/map.aspx>



The Networking and Information Technology
Research and Development (NITRD) Program

HOME | NITRD PROGRAM | NITRD COUNCIL | MEMBER AGENCIES | NITRD EVENTS | NITRD BY STATEMENTS | FEEDBACK | FAQ | LISTS | PUBLICATIONS

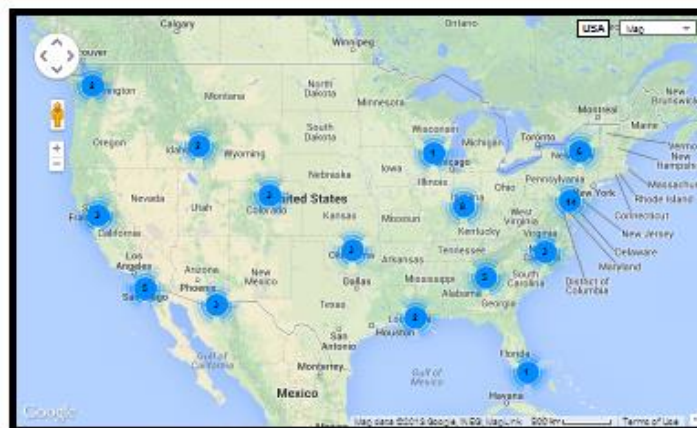
Wireless Spectrum Research and Development (WSRD)

The Wireless Spectrum R&D (WSRD) Senior Steering Group (SSG) has been formed to coordinate spectrum-related research and development activities across the Federal government.

[More »](#)



WSRD TESTBED INVENTORY | BROWSE DATA | ABOUT | FEEDBACK



Aberdeen Test Center (US Army Test Ranges)
AFRL Aerial Layer Networking Facilities
BGMUX, DTunnels
Calit2 Ericsson Wireless Access Network Research Test-bed
CLOUD-CTL, VISE
CMUlab
Cognitive Radio Network Testbed (CORNET)
CR-GENI
CRON-T
D Mass, LEARN
Design of Information Subs
Digital Object Registry

Welcome to the Wireless Spectrum Research & Development Senior Steering Group's Testbed Information Portal. Designed for the purposes of information exchange, it is our hope that this will prove useful for government, academic, and industry researchers in need of spectrum testing facilities.

There are several ways of finding the right facility for your needs:

- 1) search geographically using the map.
- 2) search using full-text search:
- 3) find labs by a particular characteristic that you require using the drop-downs:

*Available to:

Indoor/Outdoor

Frequency

Available Technology

GENI/others

We invite you to contribute information on testing facilities that are not currently listed, and that are available for use. Please contact wsrd@nitrd.gov for more information.

*Facility is available, but charges may apply. Please contact the individual facility for details.

- <http://www.nitrd.gov/Subcommittee/wsrld/Testbeds/map.aspx>

COORDINATION ACTIVITIES

- Report: ***Research Proposals that Facilitate Spectrum Sharing Adoption***
- Report, ***Promoting Economic Efficiency in Spectrum Use: the economic and policy research agenda.***
- Workshop: ***Understanding the Spectrum Environment: Using data and monitoring to improve spectrum utilization***
- Report: ***Federal-Commercial Spectrum Data: Understanding Information Exchange Needs, Issues, and Approaches***

WSRD BOTTOM LINE

- Great demand for spectrum
- Surmountable technical barriers
- Many opportunities here now
- Need trust and business models
- What is the best role for Government?

LARGER PICTURE IN NITRD

- Enablers:
 - Cybersecurity, Privacy, SDP, HCS, HEC
- Applications:
 - Health IT, Big Data, CPS
 - Players in cities and states, paloozas
 - IGNITE
- Infrastructure
 - Campus, Regional, National, International
 - Partners, Consortia, Gov, Commercial

CHALLENGES

- Many independent players
 - Cylinders of excellence
 - Overlapping “turf”
 - “Collabotition” at multiple levels
- Diverse constraints
 - Missions, Customers
 - Management, Business models
 - Schedules
 - Legal

CHALLENGES

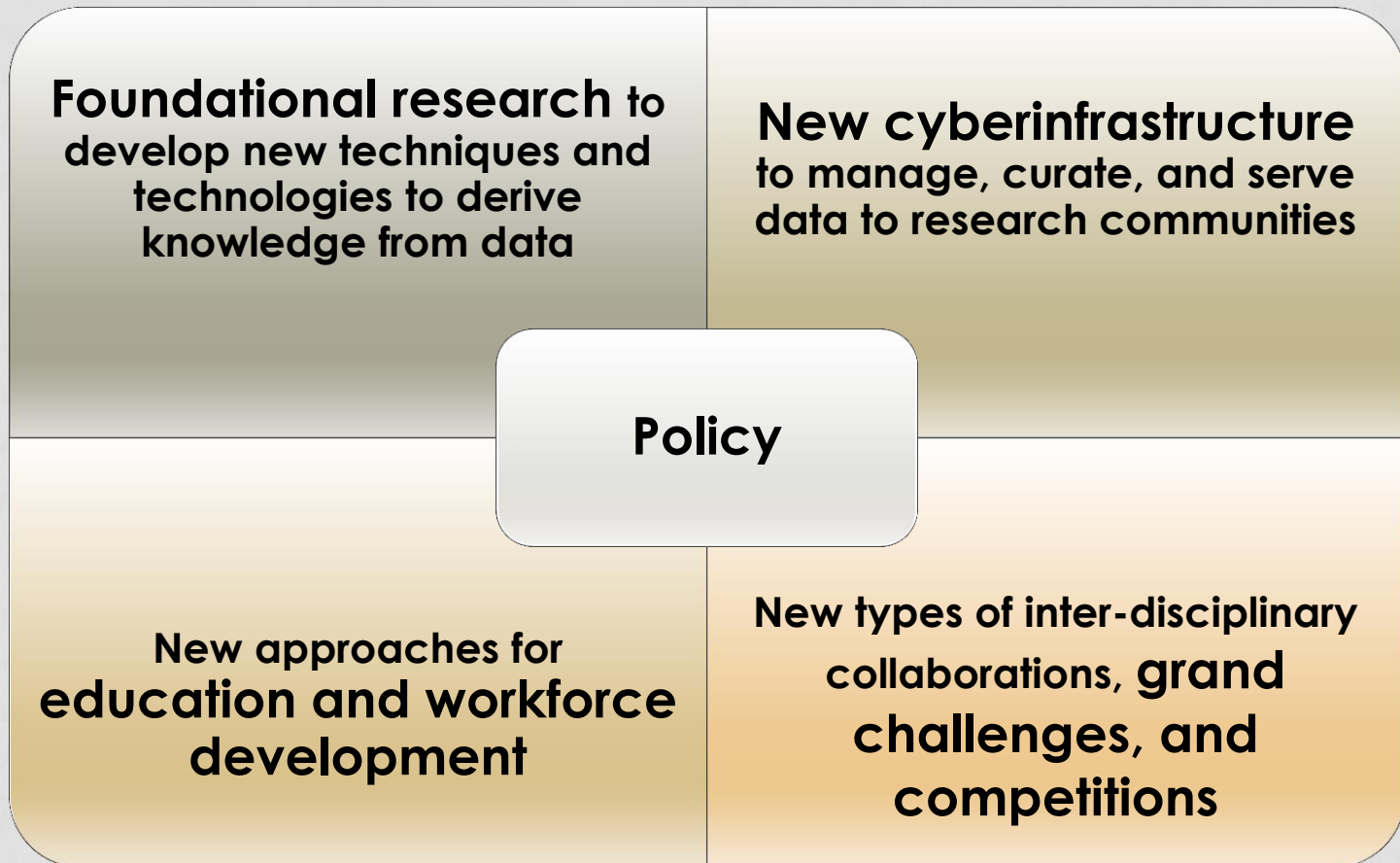
- Technological exuberance
 - Too many opportunities
 - Blossoming incompatible approaches
- Not invented here
- The Valley of Death
 - Translational R&D

OVERCOMING CHALLENGES

E.G. BIG DATA

- White House convening power
 - http://www.whitehouse.gov/sites/default/files/microsites/ostp/big_data_press_release_final_2.pdf
- Tailor to agency missions
 - NSF and NIH- Core Techniques and Technologies for Advancing Big Data Science & Engineering
 - DoD – Data to Decisions
 - NIH – 1000 Genomes Project Data Available on Cloud
 - USGS – Big Data for Earth System Science

SHARED STRATEGIC PLANNING



PROMOTE JOINT PROGRAMMING

Foundational research to extract knowledge from data

Foundational research to advance the core techniques and technologies for managing, analyzing, visualizing, and extracting useful information from large, diverse, distributed and heterogeneous data sets.

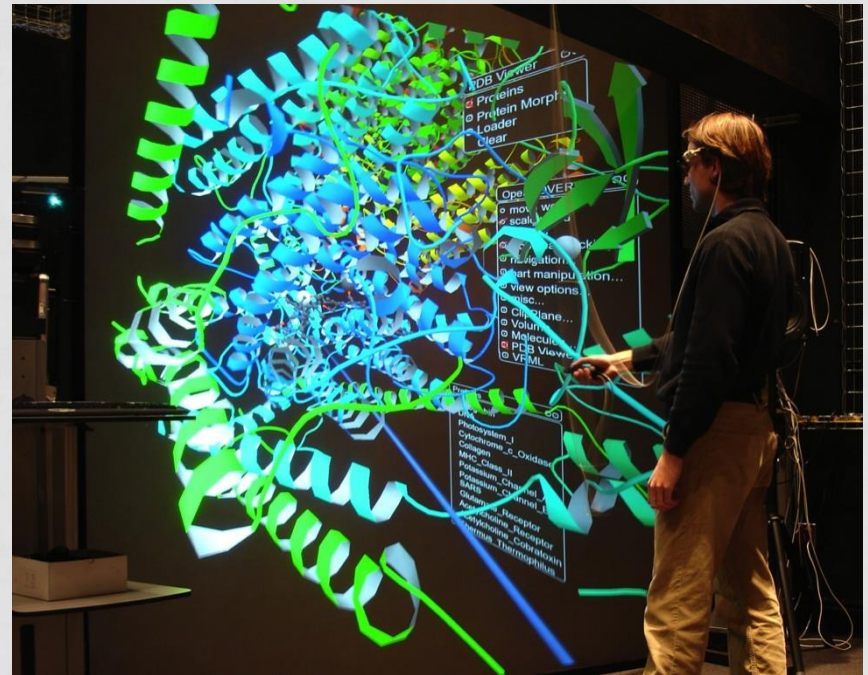


Image Credit: Jurgen Schulze, Calit2, UC-San Diego

Cross-Directorate Program: NSF Wide
Multi-agency Commitment: NSF and NIH

WHAT NEXT?

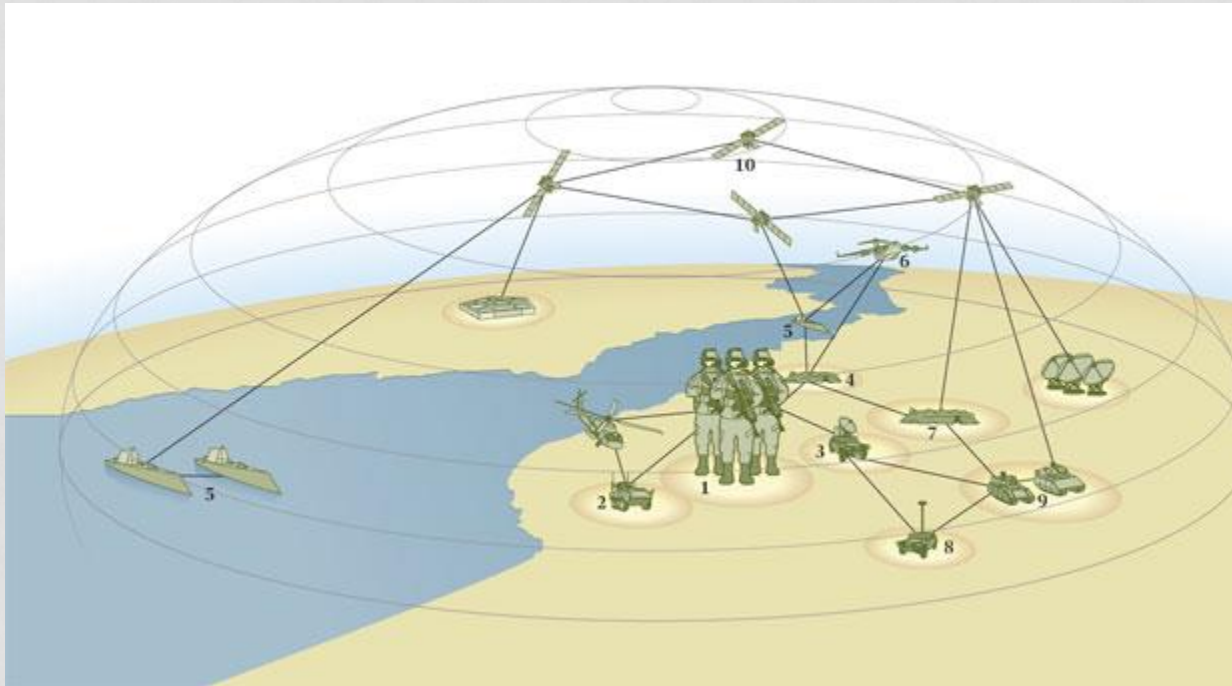
LATEST PCAST RECOMMENDATIONS

*Big data, **NIT-enabled interaction with the physical world**, health IT, and cybersecurity continue to be important, and while there is noticeable progress on interagency coordination since 2010, these areas remain as critical focal points in 2012 and beyond.*

BRING IT ALL TOGETHER IN CPS



DEFENSE, SAFETY ...



POWER, RESOURCES, CLIMATE ...

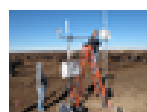


AGRICULTURE, INDUSTRY ...

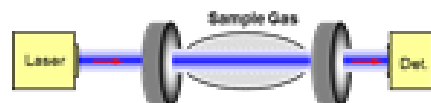
Robotics for Managing Air Emissions of Ammonia at Livestock Operations

Goal: Develop a robotic air-quality management system for dairies and cattle feedlots that will help managers reduce ammonia (NH₃) emissions.

Rationale: Livestock in cattle feedlots and dairies are the nation's largest source of atmospheric ammonia. The reactive nitrogen can be deposited back to the surface during precipitation events and have negative environmental consequences, especially in pristine alpine ecosystems like Rocky Mountain National Park, Colorado. New technology is needed to help livestock producers reduce the impact of NH₃ emissions.



Objective: Develop a novel MIR laser instrument for measuring ammonia that is customized for robotic applications at livestock operations (low cost, low power, rugged, etc.)



- The proposed sensor is based on optical absorption in the mid-infrared (MIR) spectral region and uses a quantum cascade laser (QCL) as the light source.
- The sensor will be configured for very high ammonia concentrations typically observed at beef feedlots and dairies (500 to 2000 ppbv) and have a detection limit around 30 ppbv.
- As a means to increase detection sensitivity we will employ wavelength modulation spectroscopy (WMS)

Objective: Develop a wireless sensor network for monitoring ammonia at livestock facilities.



Robotic deployment of passive NH₃ samplers



Arduino-based wireless sensor node

Data from the sensor network will be combined with weather forecasts to initiate counter measures for reducing air emissions and communicating with farm-workers who will alter management practices on the ground.

Objective: Design weather forecast retrieval/modeling systems to predict NH₃ transport.

Weather forecast information from NOAA's National Digital Forecast Database (NDFD) will be retrieved on an hourly basis by the project server.



General Information

NDFD
National Digital
Forecast Database



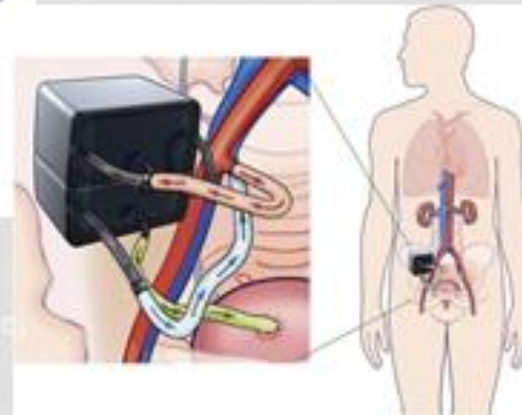
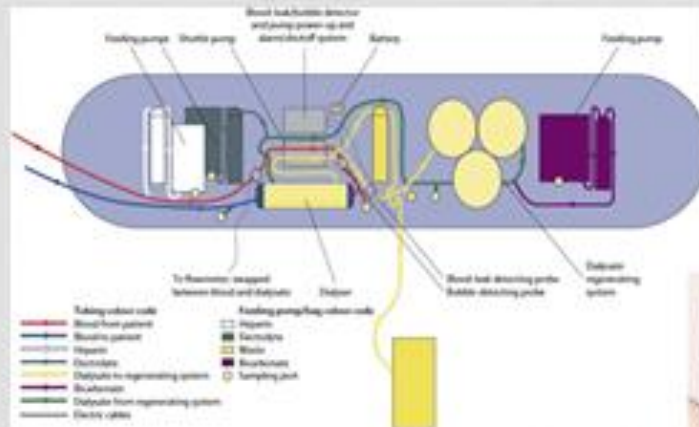
Colorado State University

HEALTHCARE, SENSORS ...

Artificial Organs

Artificial Kidney

- Implantable Devices
- MEMS-based systems

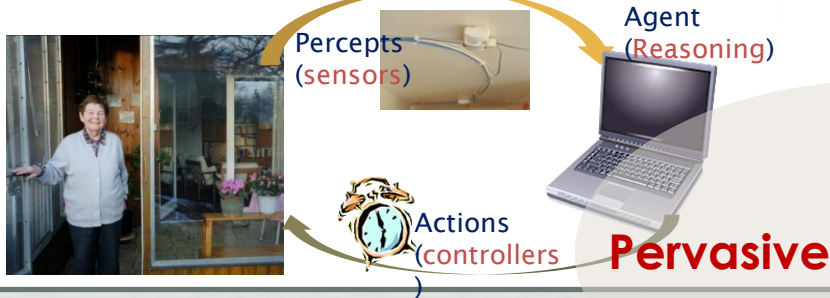


[Davenport A, et al., Lancet 370 (9604), 2007, pp. 2003-2010]

[Kim & Roy S, Adv Chr. KG, Dis., 23(6):516-535, 2018]

The Age of Observation: Smart Sensing, Reasoning and Decision

Environment Sensing



Emergency Response

Credit: Photo by US Geological Survey



Situation Awareness:
Humans as
sensors
feed multi-
modal data
streams



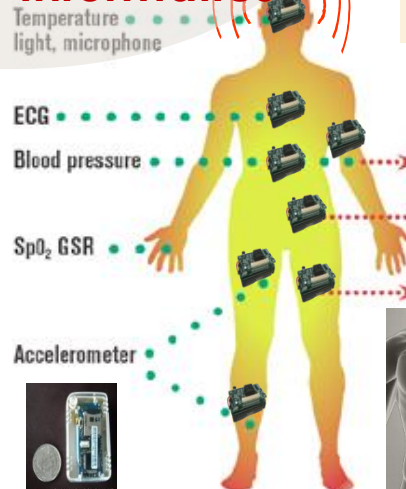
Computing

People-Centric Sensing

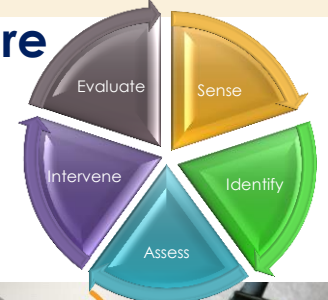
Social



Informatics



Smart Health Care



Credit: Image courtesy of University of Florida

NETWORKING FOR CPS

- Tremendous demand
 - Everywhere, all the time, “Internet of things”
- Not well understood
 - Evolving, competing technologies, business models, and players
 - Simultaneous R&D and critical applications
- High stakes
 - Absolute game changers
 - You bet your life
- (Un)anticipated, revolutionary results

CONCLUSION

- Networking, and the networking community, play a critical role in these plans and developments
- This is a team sport!
- Challenging barriers of technology, policy, politics, and business
- Rich opportunities for participation and leadership for all
- How to do it? Coordinate!

?



CONTACTS

- luker@nitrd.gov
- www.nitrd.gov