Why Should DoD Invest in Basic Research?

A Presentation for GOMAC Tech 2008

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Office of the Director
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Context

- The growth rate of the world population is declining
- 90% of population growth is in developing and poorer countries
- 40% of the world's population – 2.5 billion people – live on less than $2 per day
- Proportion of working age adults (15-59) is expected to decrease in every area except Africa
- 880 million people were illiterate, 250 million children worked and 110 million school age children did not attend school, as of 2000
- By 2030, China is expected to have 348 million people over 60, nearly as many as the entire projected population of the US

Source: "Joint Operating Environment" United States Joint Forces Command, December 2007,

Context

- 13% of the global population lived in cities in 1900. Today the global proportion of the urban population is 49%. 60% of the globe's population - 4.9 billion people - will live in urban areas by 2030
- Massive urbanization – 17 of 22 "mega cities" will be in the developing world by 2015.
- Since the 1970's, weather/climate-related losses have increased about 10% per year and accounted for 88% of all property losses covered by insurers from 1980 to 2005
- India and China will develop "first world" energy appetites
- Many oil exporting countries may use production for their own economies

Source: "Joint Operating Environment" United States Joint Forces Command, December 2007

Context

- Current major supplies of petrochemical products will not keep pace with projected demand
- Only 12 years from now, machine intelligence could equal or surpass that of humans – eventually, it will become impossible to differentiate between man and machine
- Weapons of mass effect will shrink and proliferate: nuclear, bio, directed energy, nanotechnology, and CYBER

Source: "Joint Operating Environment" United States Joint Forces Command, December 2007

Context

- Science, technology, and engineering are available globally
- US scientific leadership is at risk
- Multi-disciplinary technologies will have revolutionary impact - 70 % of world R&D is conducted outside the US
- China is now the third largest investor in R&D (adjusted for purchasing power), behind only the US and Japan
- The United States is today a net importer of high technology products (+$54B in 1990 to -$50B in 2001)

Source: "Joint Operating Environment" United States Joint Forces Command, December 2007

OUTLINE

- DoD Basic Research
- DoD STEM Education
- Prize Competition

Leaders support Basic Research

- President Bush acknowledged the importance of Basic Research in his January 2008, State of the Union address:

> ***"To keep America competitive into the future, we must trust in the skill of our scientists and engineers and empower them to pursue the breakthroughs of tomorrow… I ask Congress to double federal support for critical basic research in the physical sciences and ensure America remains the most dynamic nation on Earth.."***
>
> ***President George W. Bush, State of the Union address, January 28, 2008***

- The Secretary of Defense supports Basic Research

> ***"As changes in this century's threat environment create strategic challenges – irregular warfare, weapons of mass destruction, disruptive technologies – this request places greater emphasis on basic research, which in recent years has not kept pace with other parts of the budget."***
>
> ***Secretary of Defense Posture Statement on the FY09 Budget, February 2008***

Basic Research

- Basic research is systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts ***without specific applications towards processes or products in mind.*** It includes all scientific study and experimentation directed toward increasing fundamental knowledge and understanding in those fields of the physical, engineering, environmental, and life sciences related to long-term national security needs. ***It is farsighted high payoff research that provides the basis for technological progress***. Basic research may lead to: (a) subsequent applied research and advanced technology developments in Defense-related technologies, and (b) new and improved military functional capabilities in areas such as communications, detection, tracking, surveillance, propulsion, mobility, guidance and control, navigation, energy conversion, materials and structures, and personnel support. Program elements in this category involve pre-Milestone A efforts.

Source: *DoD Financial Management Regulation,* Volume IIB, Chapter 5, June 2004, 050201 RDT&E Budget Activities.

Why Does DoD fund Basic Research?

- DoD is perpetually, permanently in the capability business
- By choice, DoD's capabilities depend on technology
- Technology is the fruit of science
- Basic Research produces the new, transcendent ideas
- Threats are multiplying, ramifying
- Science is burgeoning outside the US spawning new technologies
- Technologies move rapidly across borders
- If technology exists, it will be used, first in weapons

We cannot know when a discovery will become a capability but we know with absolute certainty that without discovery, our capabilities remain static.

Why Does DoD fund Basic Research?

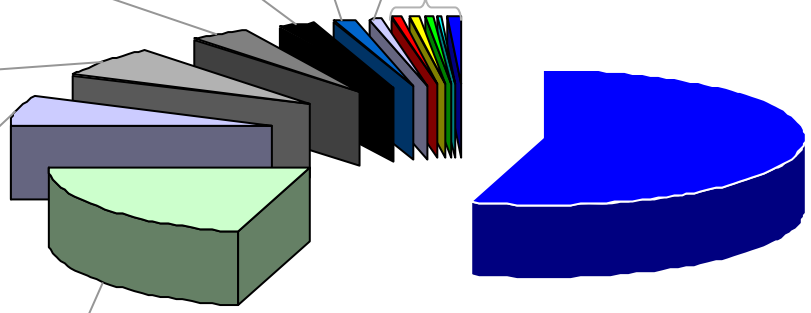
- Generates discoveries, new knowledge, and improved understanding
- Achieves technological superiority
- Prevents technological surprise
- Educates scientists and engineers in physical science disciplines
- Ensures that scientific expertise and engineering rigor supports DoD technical decisions
- Sustains the human talent and research infrastructure

Don't expect Basic Research to solve all problems

Federal R&D Funding

PBR FY2009

$M



Agriculture, 1,952

Commerce, 1,157

DHS , 3,287

NSF, 5,201

Energy, 10,558

NASA, 10,737

HHS, 29,480

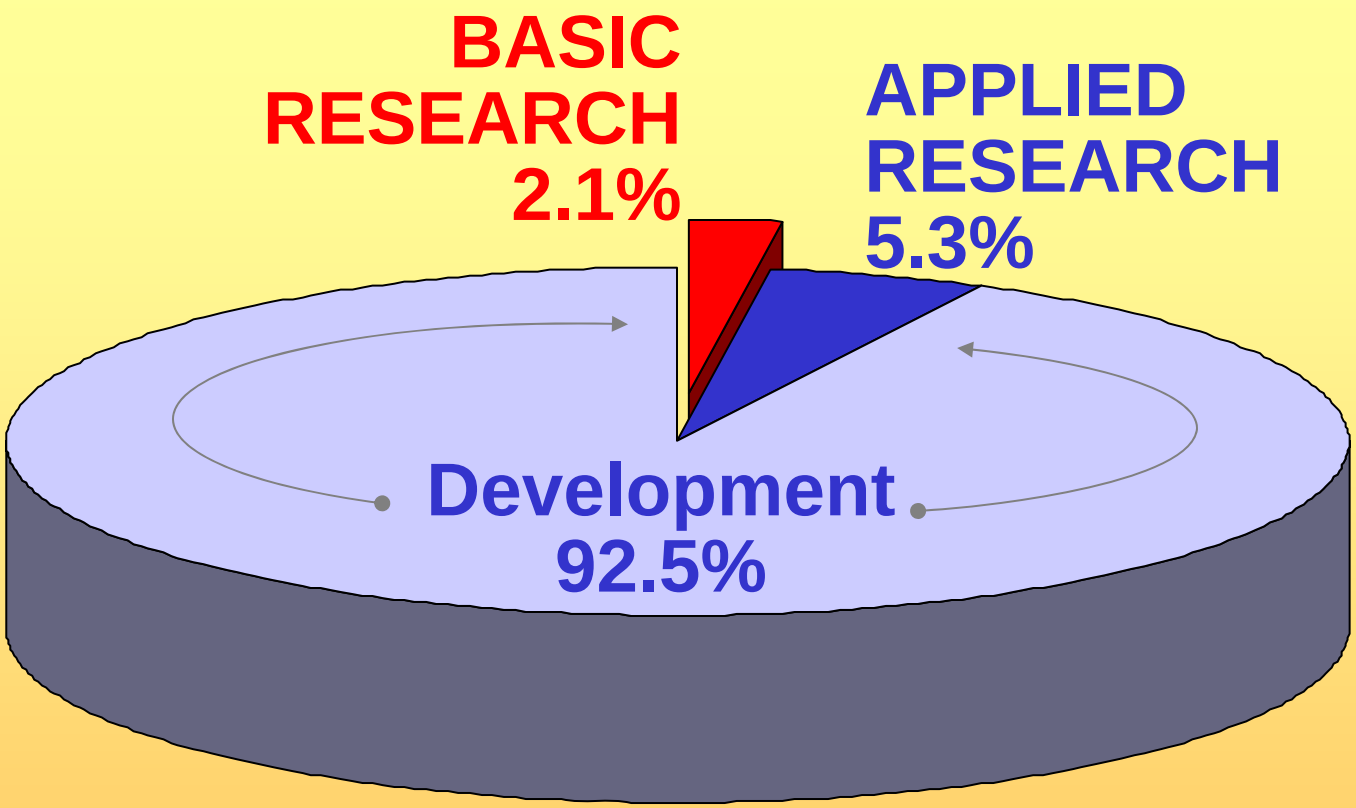
- Transportation 901
- Veteran's Affairs 884
- Interior 617
- EPA 550
- All others 1,145

Defense, 79,615

President's FY 2009 Budget showing Agency Federally funded Research and Development

Source: Federal Budget FY 2009 Analytical perspective, pg 52+ available at http://www.whitehouse.gov/omb/budget/fy2009/pdf/apers/crosscutting.pdf. The DoD total is from the DoD Comptroller, FY09 R-1 page II

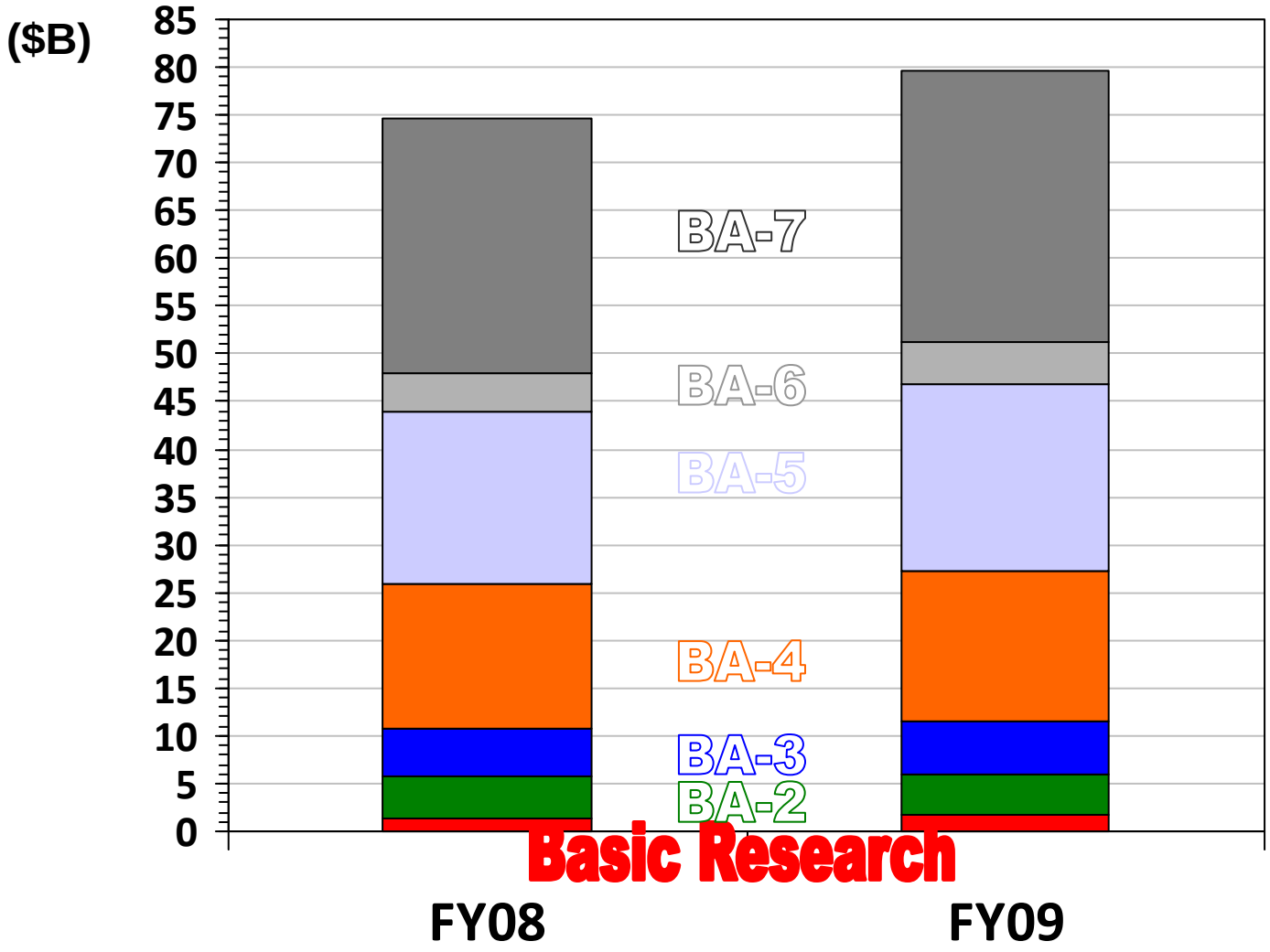
DoD Research, Development, Test & Evaluation FY 2009



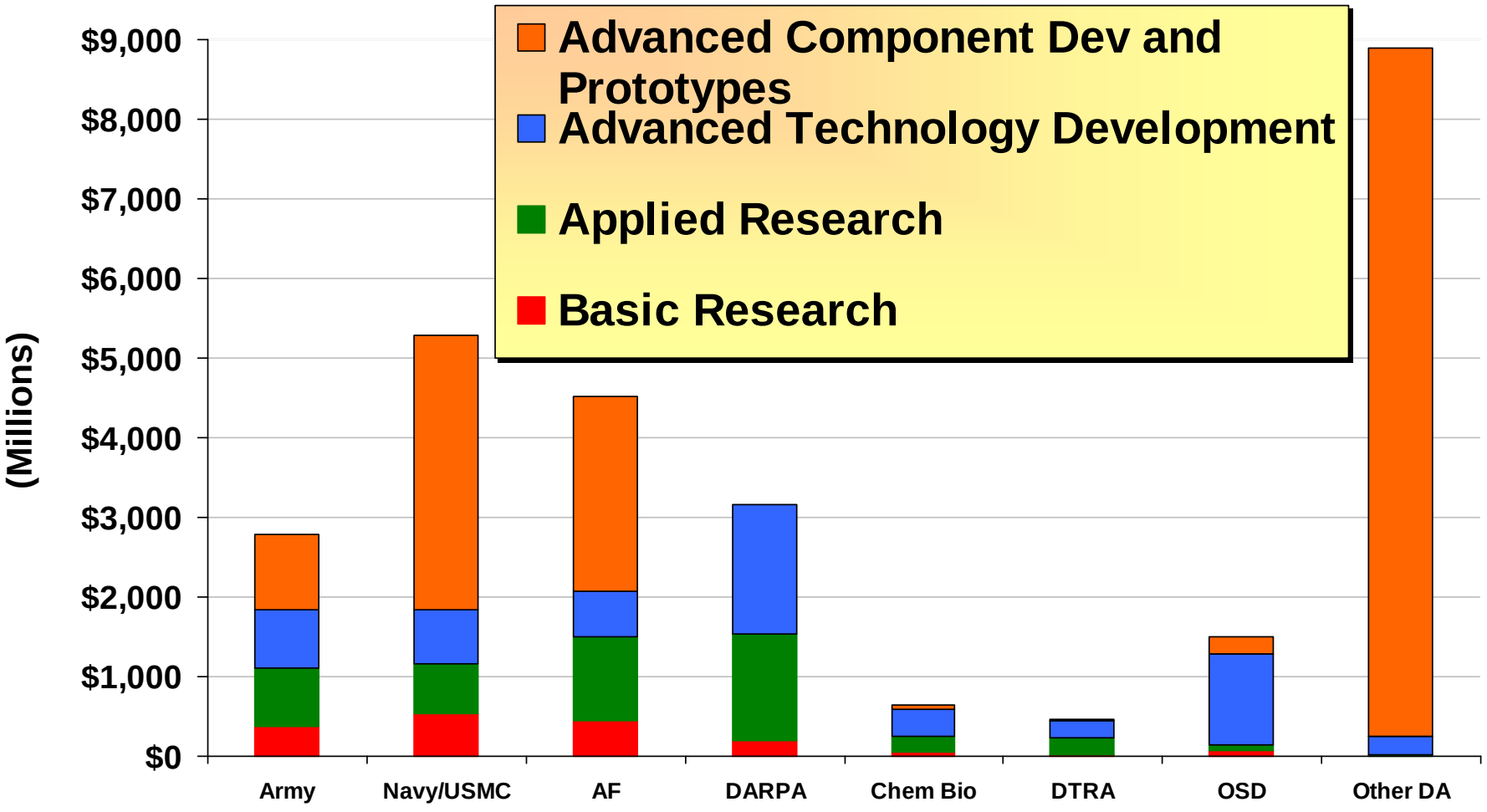
FY09 RDT&E request = $79.62B
(Budget Activities 1→7)

Source: DoD Comptroller R-1 page III

FY08 & FY09 DoD RDT&E
Budget Request Comparison BA-1➔BA-7

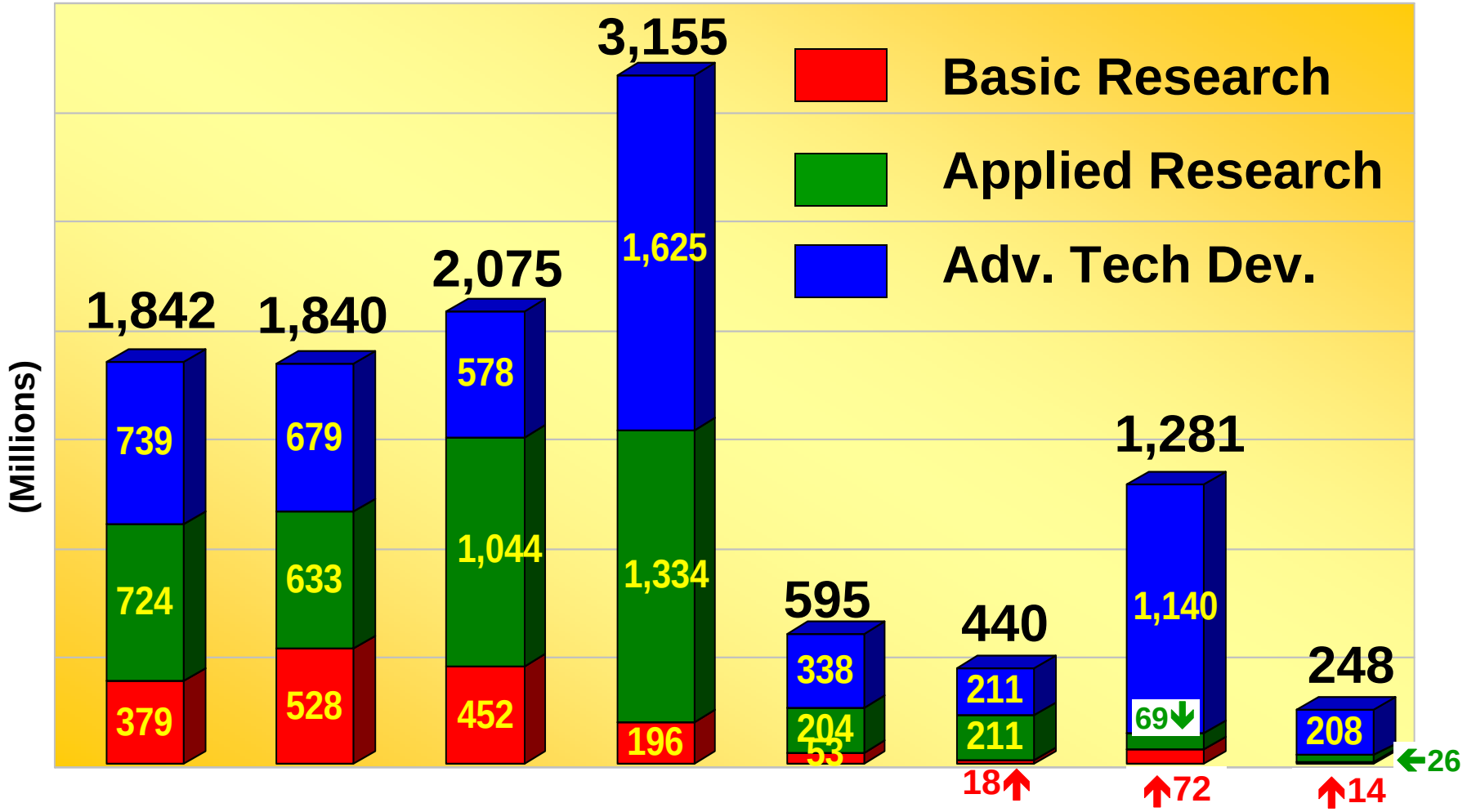


FY09 DoD R&E Budget Request $27.25B

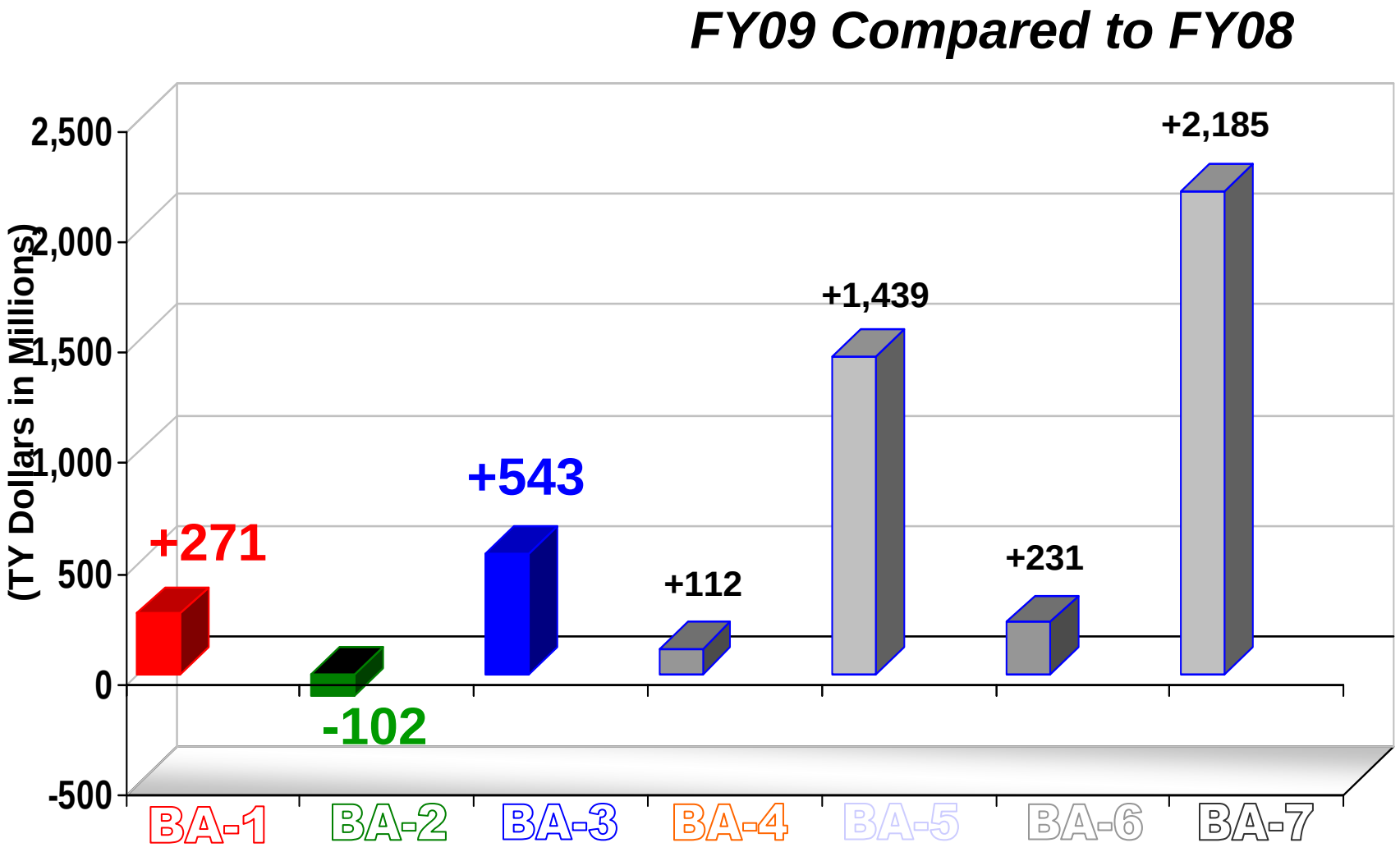


Note: R&E= RDT&E minus System Development and Demonstration (BA-5), Management Support (BA-6), and Operational Systems Development (BA-7)

FY09 DoD S&T Budget Request $11.48B

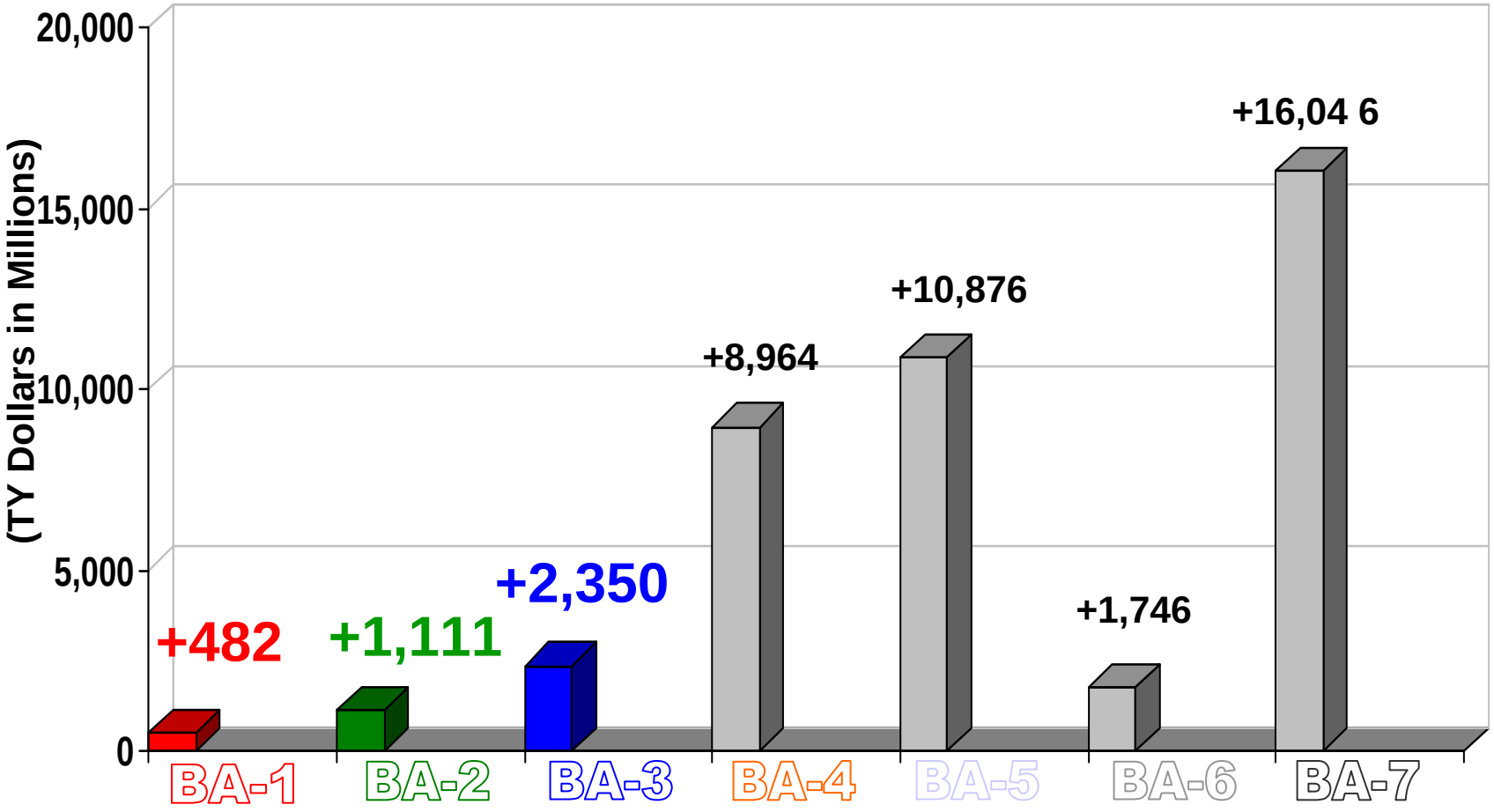


RDT&E Budget Request Growth

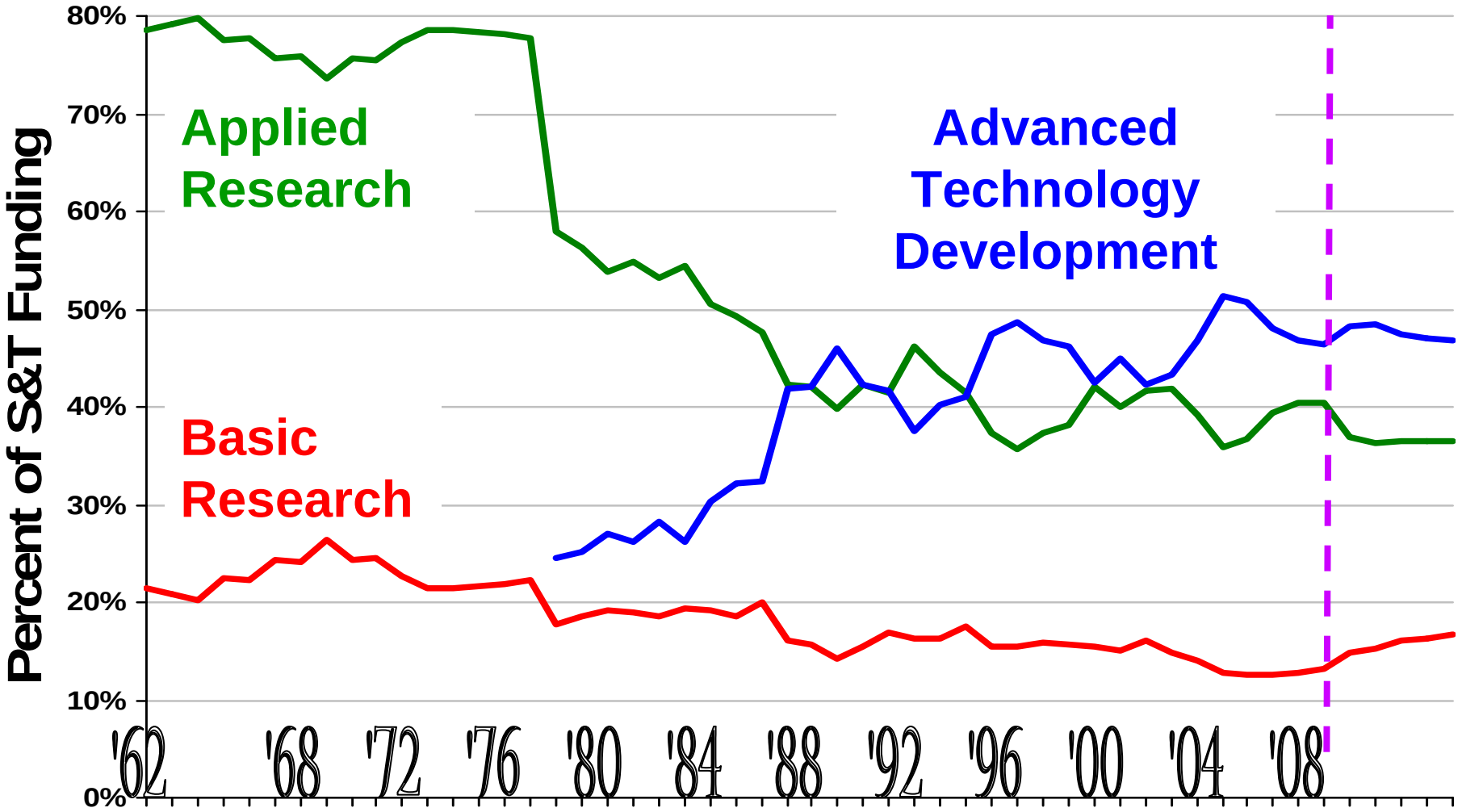


RDT&E Budget Request Growth

FY09 Compared to FY01

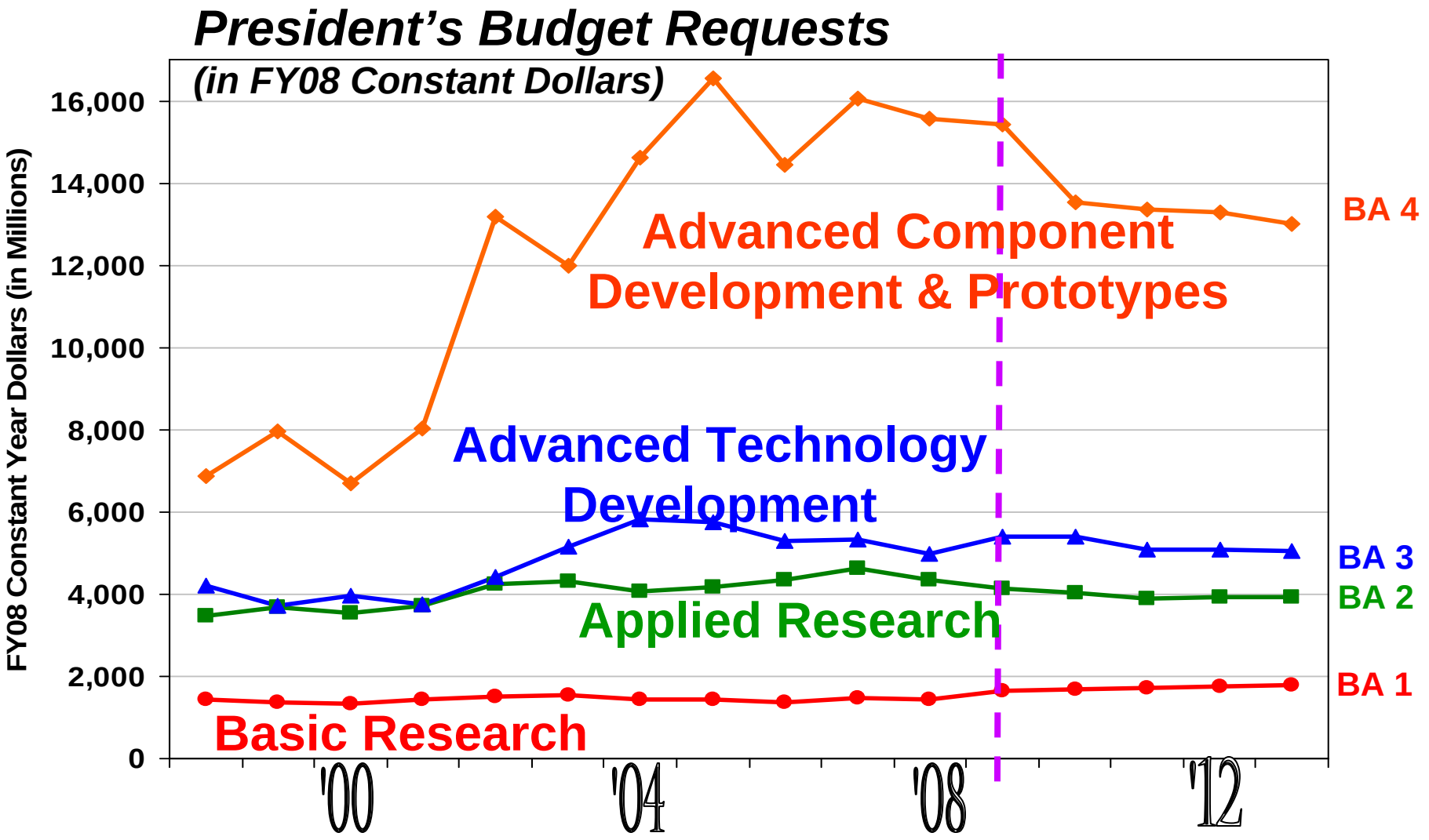


DoD S&T Requests

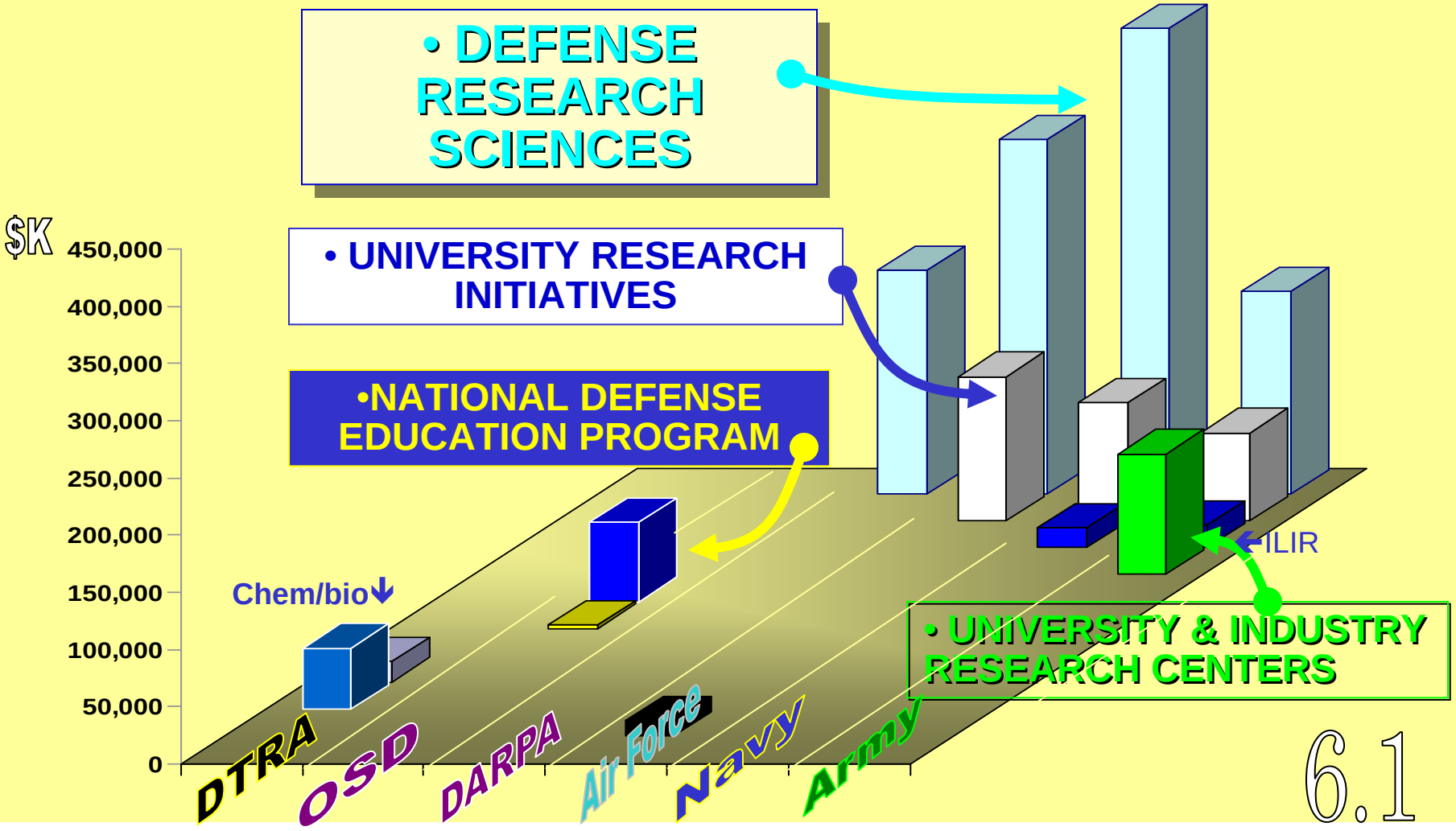


Note: Advanced Technology Development funding began in FY78

DoD R&E Funding By Budget Activity

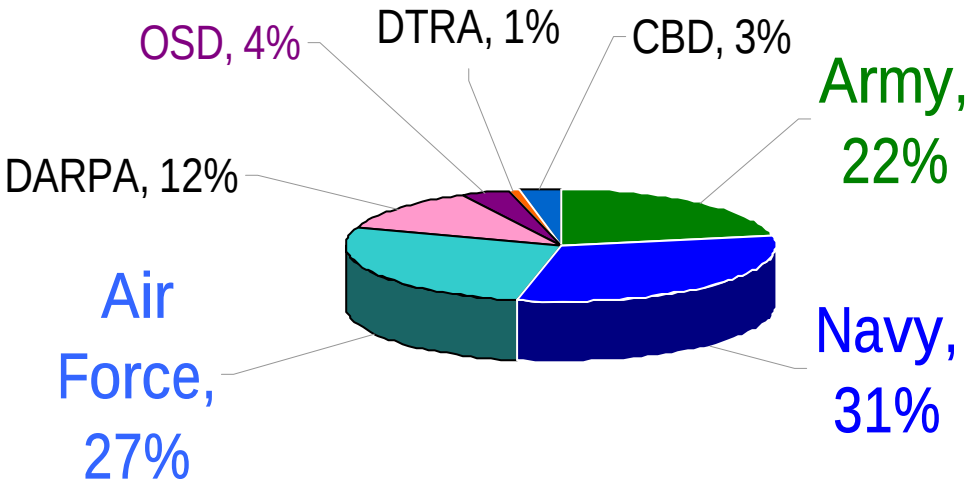


FY09 President's Budget Request for DoD Basic Research



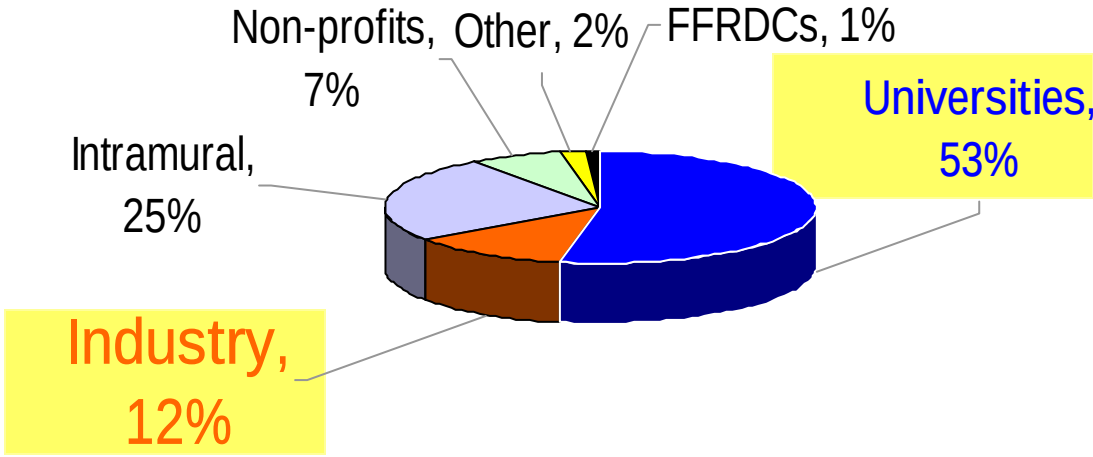
Source: DoD Comptroller R-1

Sources & Destinations of Defense Basic Research Funding



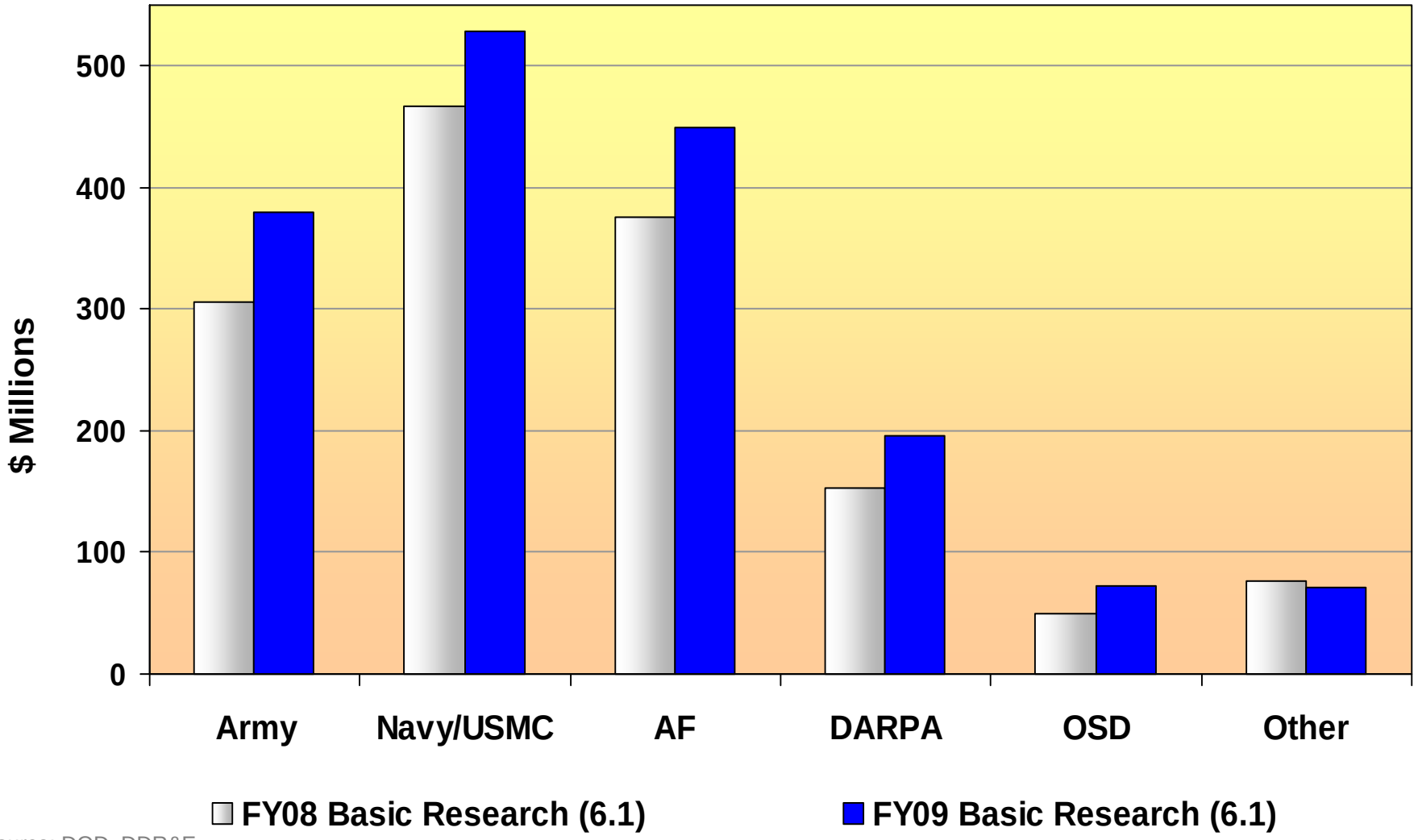
←Source 80% of Defense Basic Research is Investments by Military Departments

Destination→
Performers of Defense Basic Research - 65% to Universities & Industry



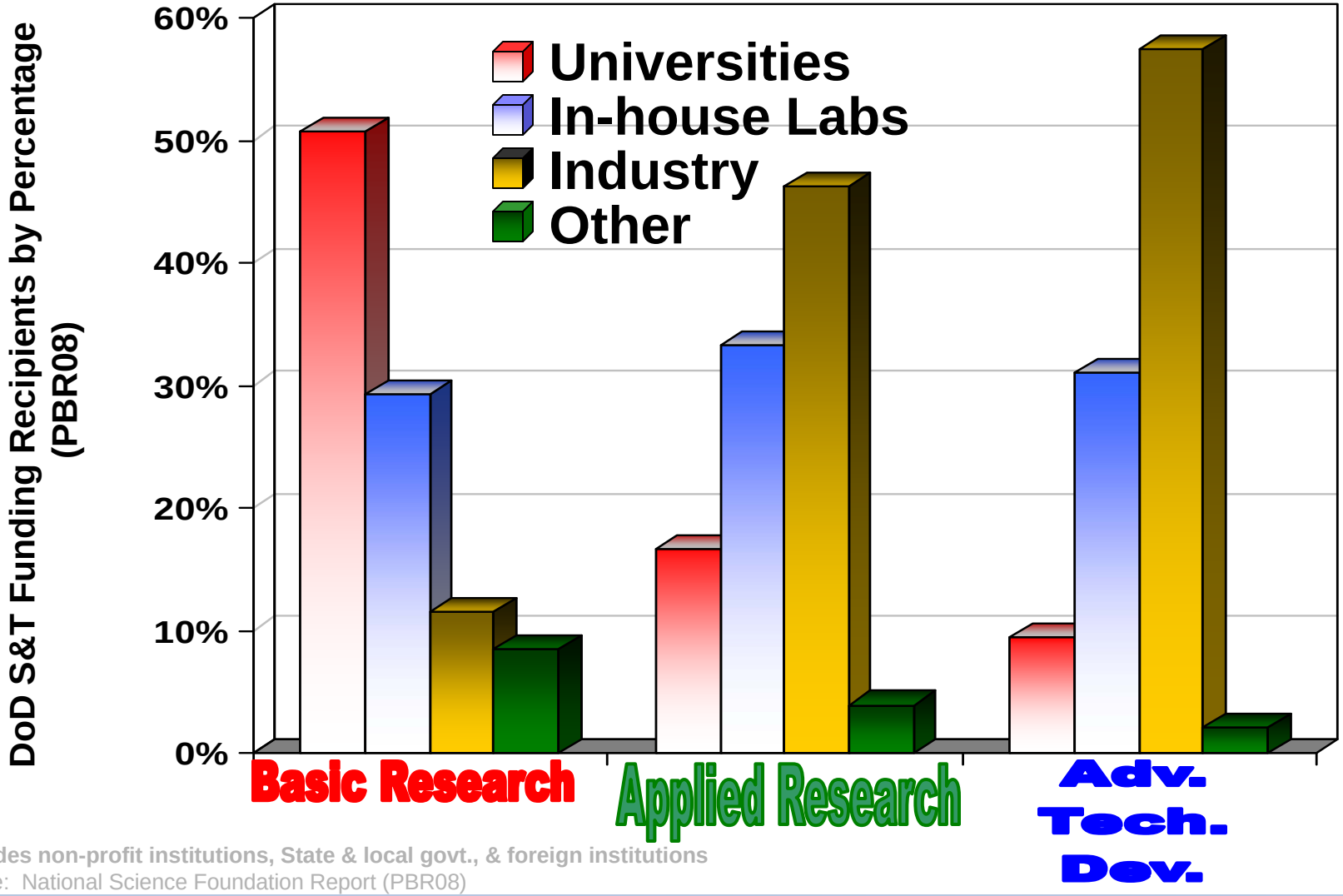
Sources: FY09 President's Budget & DoD component inputs to NSF Federal Funds for R&D survey (1 Y06 - latest available)

FY08 & 09 DoD 6.1 Budget Request



Source: DOD, DDR&E

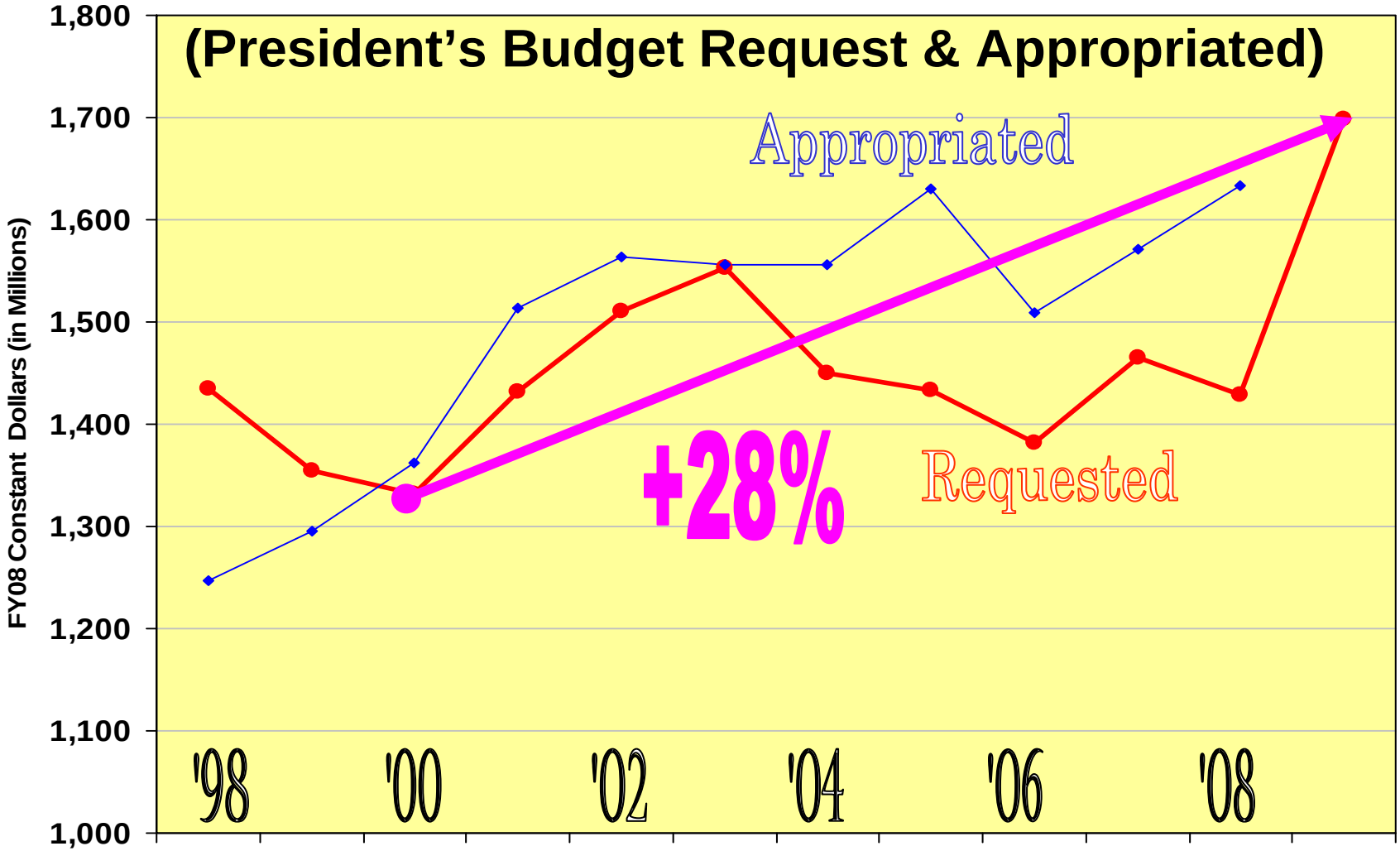
Recipients of DoD S&T Funds



*Includes non-profit institutions, State & local govt., & foreign institutions

Source: National Science Foundation Report (PBR08)

DoD Basic Research Funding FY1998-2009



Source: DOD, DDR&E

Addition to DoD Basic Research

$M	FY08 PBR	FY08 Appropriation	FY09 PBR	Change from PBR 08	Real Change from PBR 08
Army	305.8	381.5	379.4	24.06%	21.36%
Navy	467.2	506.1	528.3	13.06%	10.61%
Air Force	375.2	407.7	452.3	20.55%	17.93%
Defense-Wide	279.9	338.3	338.7	21.00%	18.37%
Total Basic Research	1,428.1	1,633.7	1,698.6	18.94%	16.36%

Conceptual Strategic Planning Process

Joint Operational Capability Gaps

QDR, SPG

classified

Not all joint operational capability gaps will have S&T capability gaps

Joint S&T Capability Gaps

JWSTP

Extant Service specific Basic Research program

Not all joint S&T capability gaps will demand basic research investment

Map S&T Gaps Against Services' Basic Research Programs

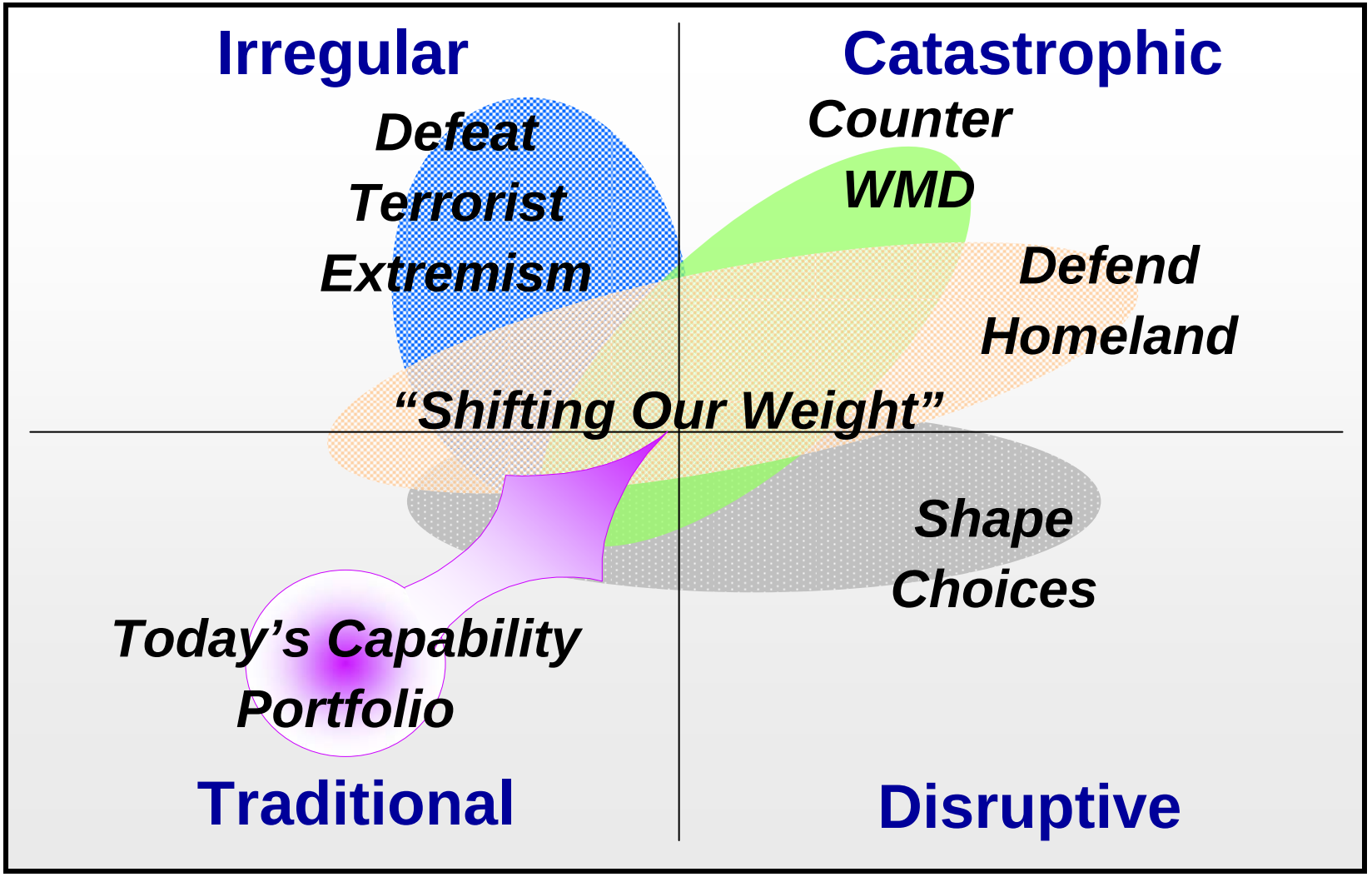
Joint, Basic Research investment gaps

Some Service basic research initiatives address enterprise-wide issues

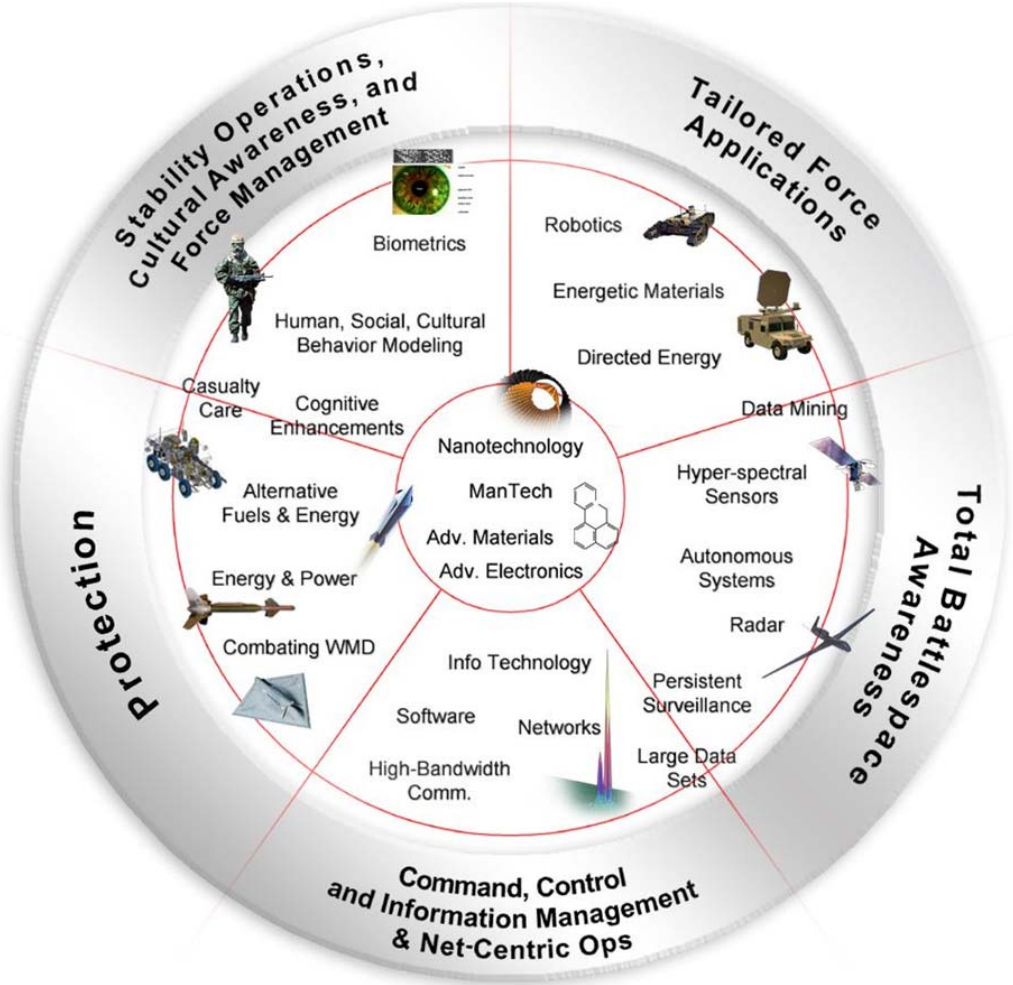
Department-level Basic Research Investment Guidance

unclassified

Quadrennial Defense Review



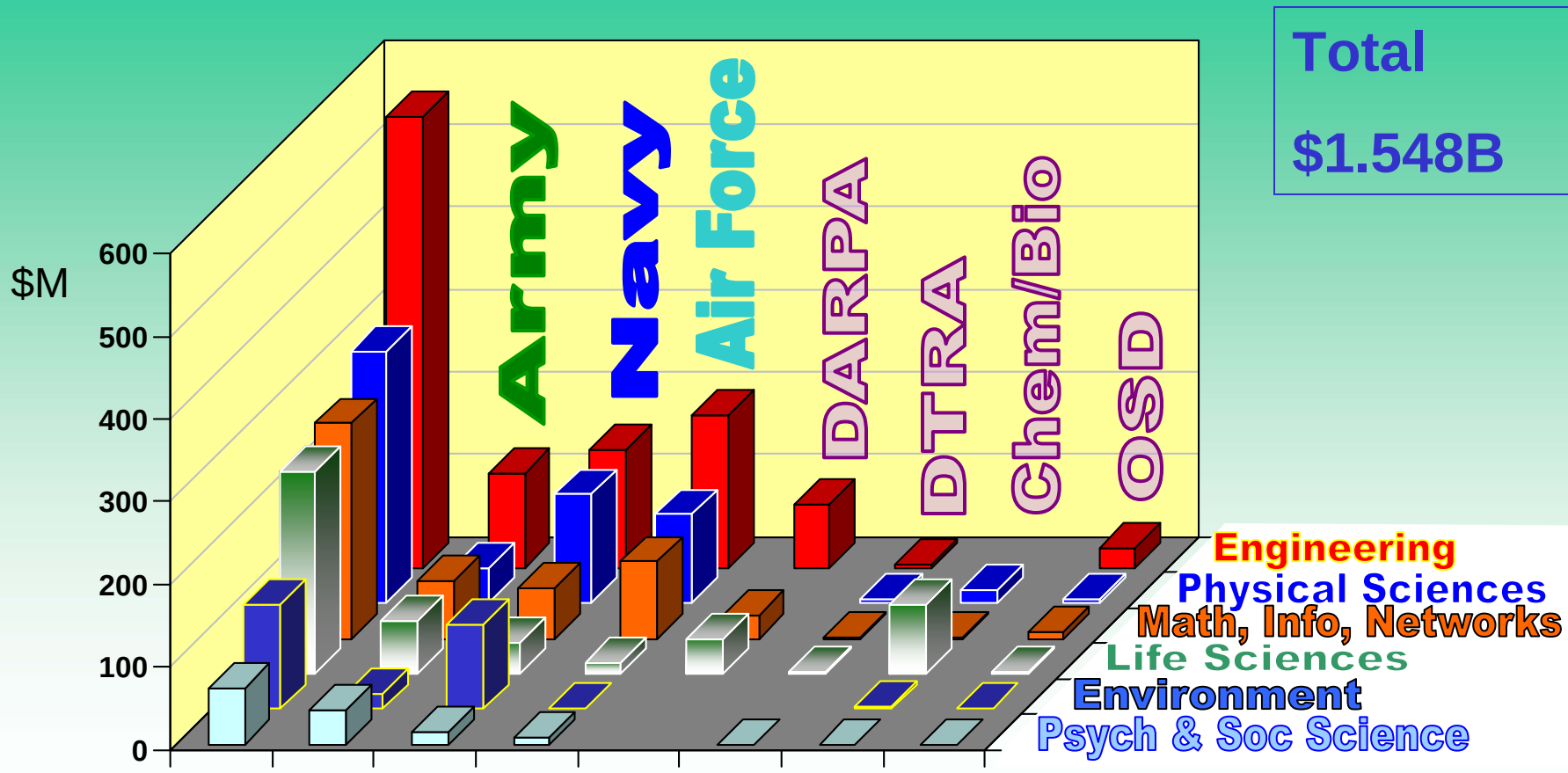
Desired S&T Investment Areas



(Joint Training is Ubiquitous)

FY07 DoD Basic Research

(by Taxonomy Category)



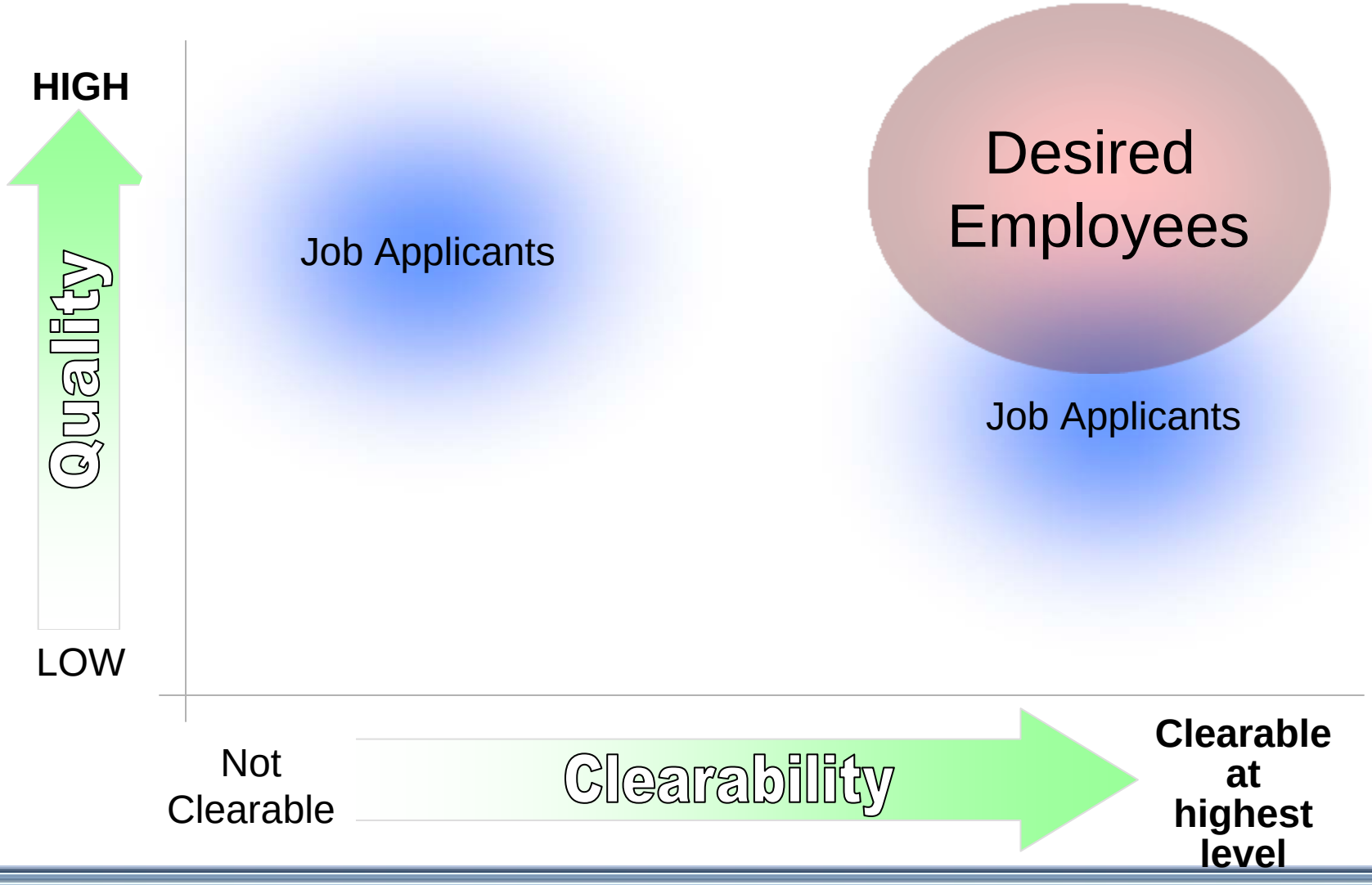
Total

$1.548B

OUTLINE

- DoD Basic Research
- DoD STEM Education
- Prize Competition

A Unique National Security Problem



Opportunities

- "The development of a strategic S&T scouting effort linked to the US university and private R&D communities may allow the US to exploit "leapfrog" technologies developed elsewhere."
- Challenge of new technological powers may encourage greater investment in science, technology, and engineering education in the United States."

"When I compare our high schools to what I see when traveling abroad, I am terrified for our workforce of tomorrow."

- Bill Gates

Source: "Joint Operating Environment" United States Joint Forces Command, December 2007, page 53
Rising Above the Gathering Storm, National Academy of Sciences, 2006

Millennials are tomorrow's workforce

- They watch wars and revolutions live on TV and the Internet
- Elvis died 20 years before they were born
- Satellite radio has been around since they were 5
- They have only known two presidents
- WWI started nearly a century before they were born
- They have never seen a film camera
- There have always been hybrid cars
- They have always been online
- They have never known a world without digital phones or DVDs
- Soviet Union fell 7 years before they were born
- When Sputnik was launched, *their parents* were in kindergarten
- Their buddy lists span the globe.
- There has always been one Germany
- One electronic device does it all: TV, Internet, Phone, Music, Data, Computing

Source: "**Millennial: About them"** Navy Recruiting Command briefing, 7 Feb 2008

Millennials are tomorrow's workforce

Globalism

- Millennials grew up seeing everything in the world as:
  - Global
  - Connected
  - Open for business 24/7

Source: "**Millennial: About them"** Navy Recruiting Command briefing, 7 Feb 2008

Millennials are tomorrow's workforce

- They are taking longer to graduate from college
- Only 37% of first-time freshmen at four-year schools earned their bachelor's degrees in four years
- Another 6% took up to six years

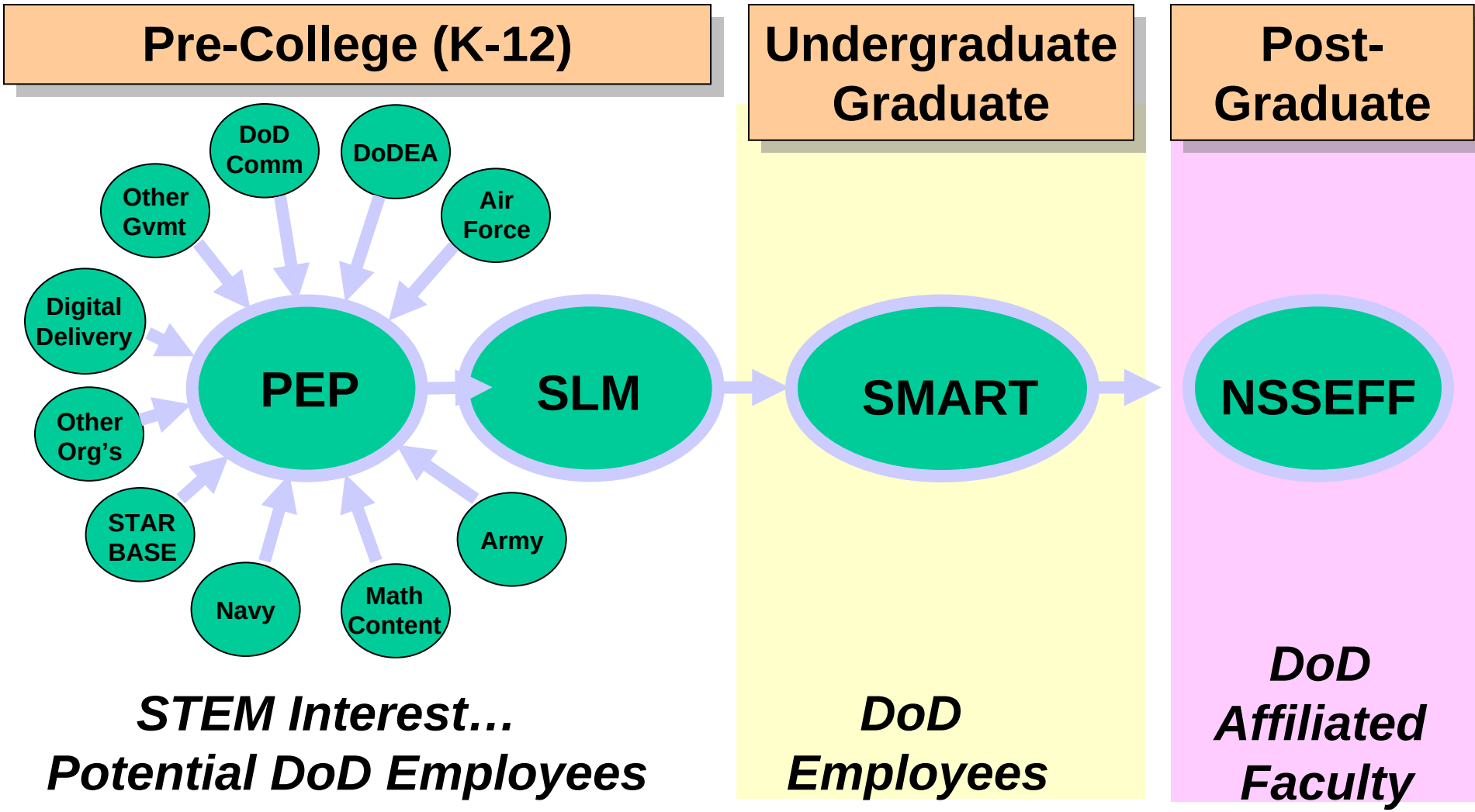
Source: "**Millennial: About them"** Navy Recruiting Command briefing, 7 Feb 2008

Millennials are tomorrow's workforce

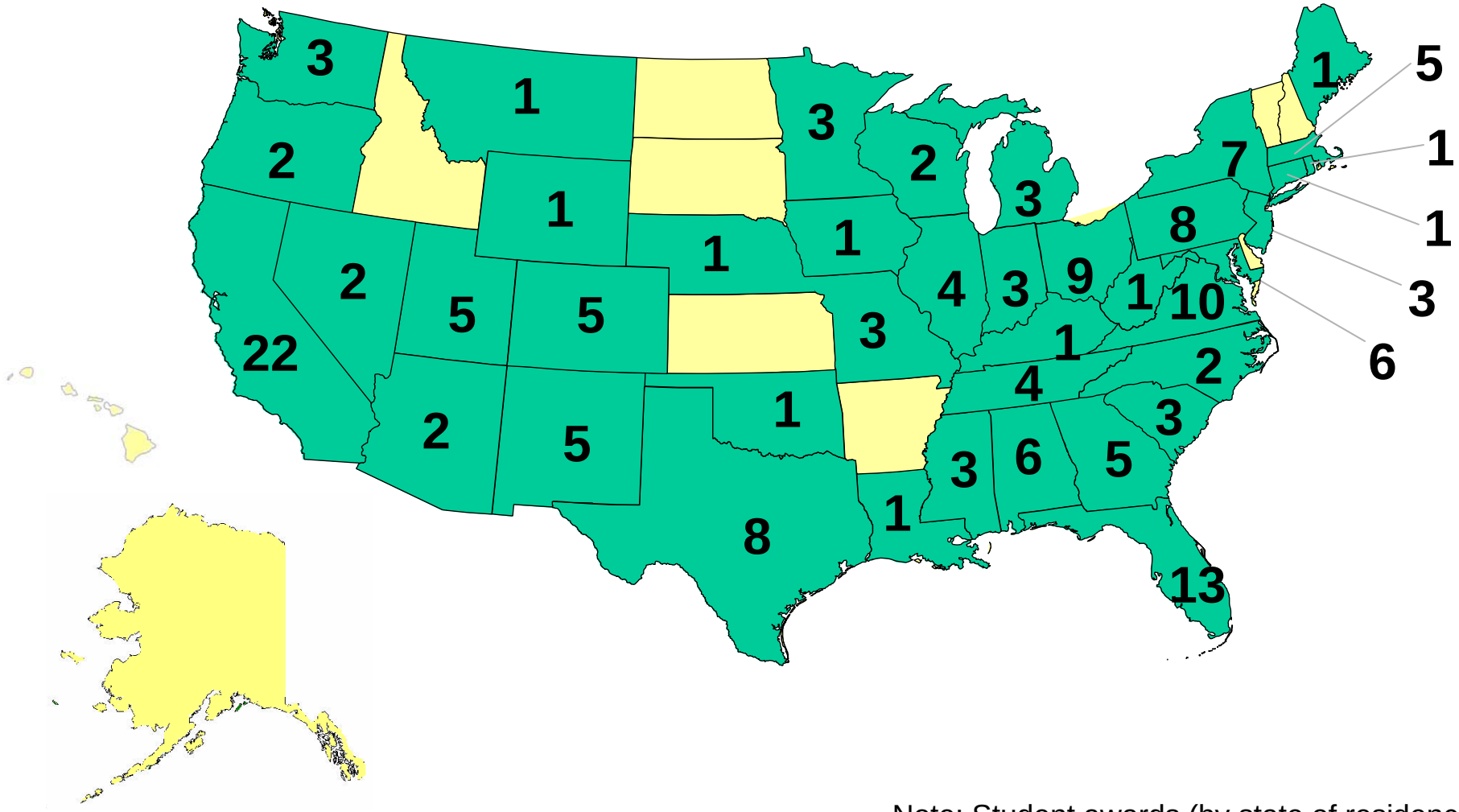
- They are technology sophisticates
- Through media multitasking kids are spending 6.5 hours a day with media, but are packing more than 8.5 hours worth of exposure into that time
- Younger kids have more and more media devices; of those 8-14 years old -
  - 39% have cell phones
  - 24% have a hand-held Internet device or PDA
  - 12% have a laptop computer

Source: "**Millennial: About them"** Navy Recruiting Command briefing, 7 Feb 2008

NDEP Portfolio Components

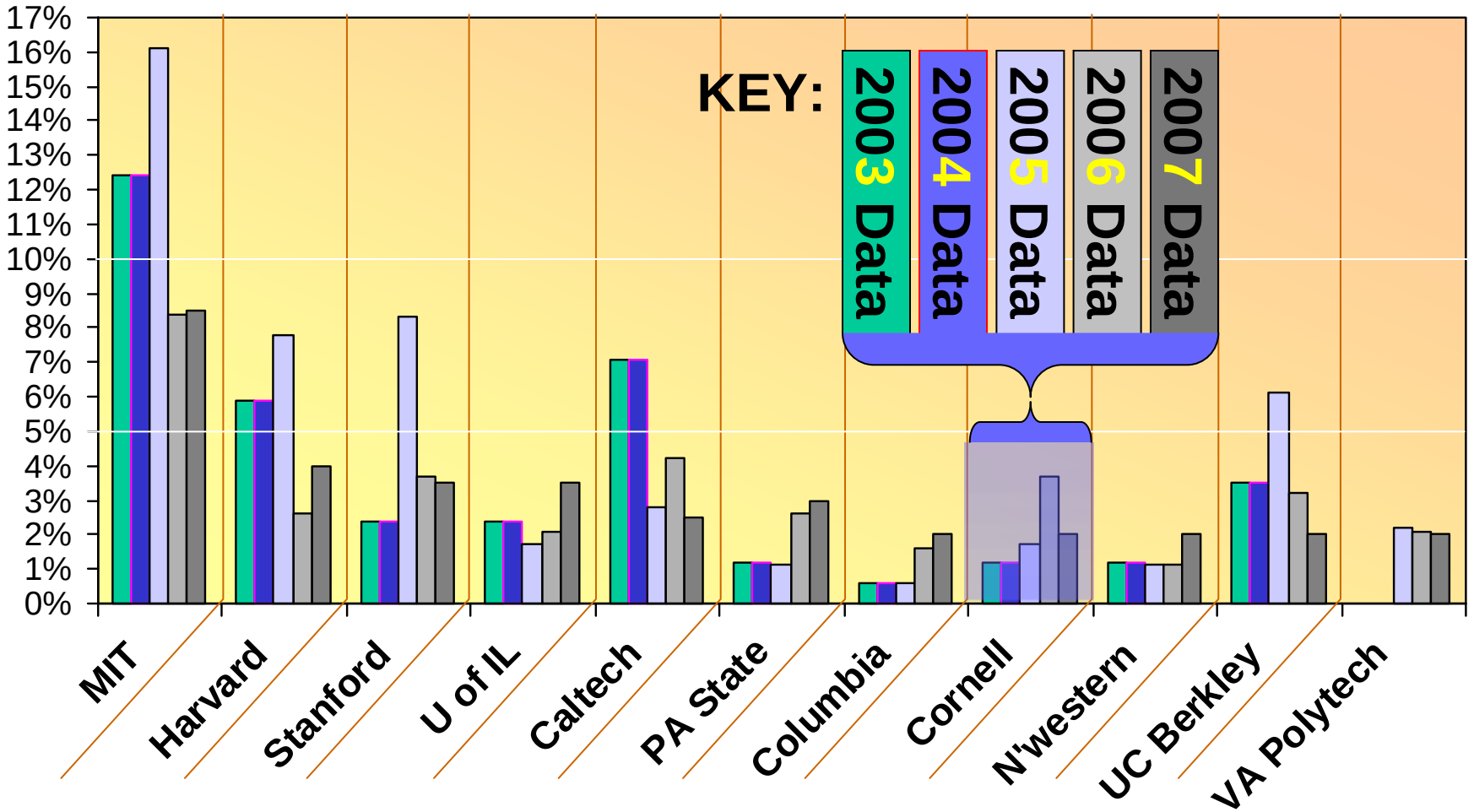


SMART's National Impact



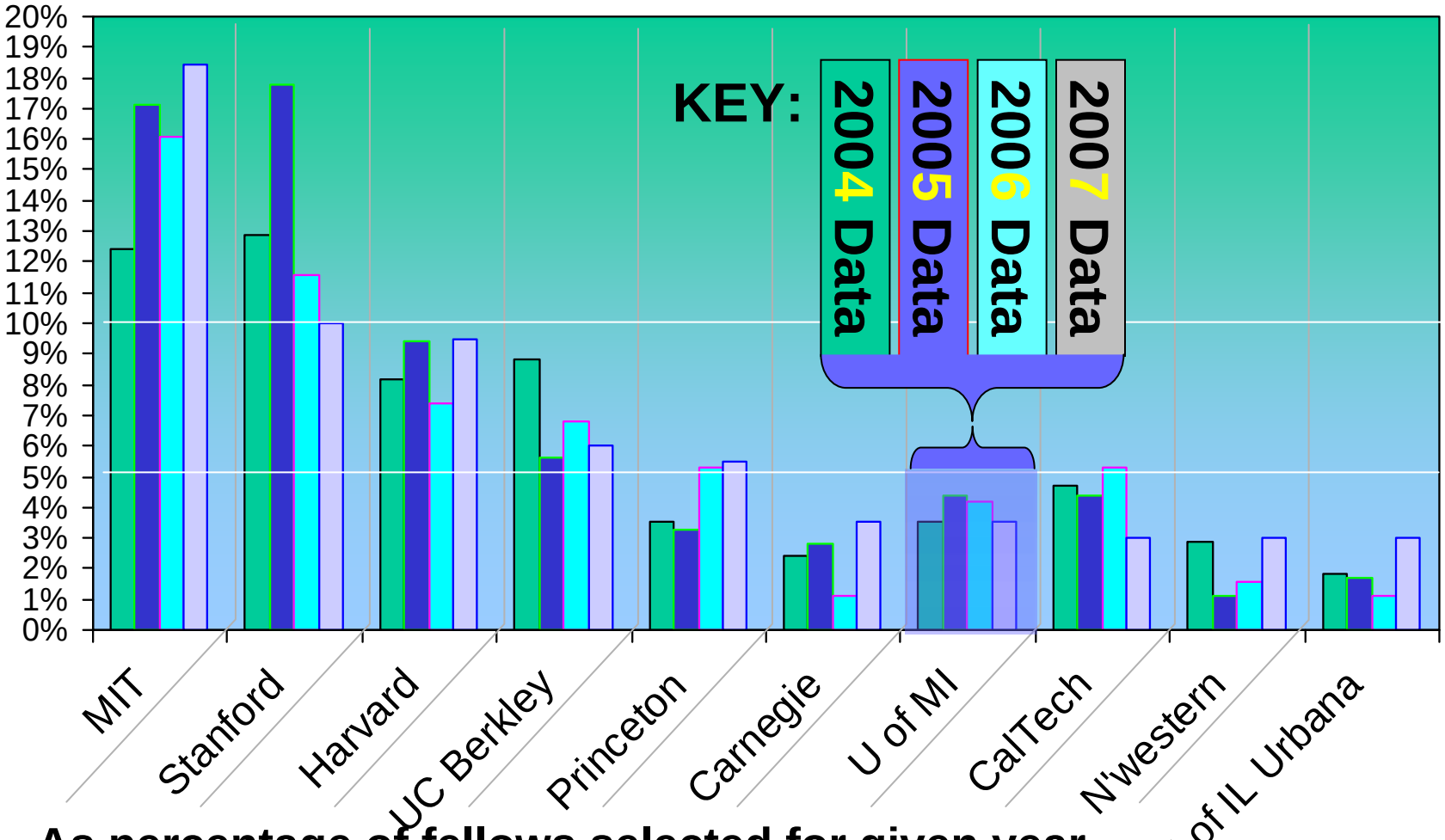
Note: Student awards (by state of residence)

NDSEG –Fellows' Undergraduate Schools



As percentage of fellows selected for given year, with respect to FY07 top numbers

NDSEG –Fellows' Graduate Schools



As percentage of fellows selected for given year, with respect to FY07 top numbers

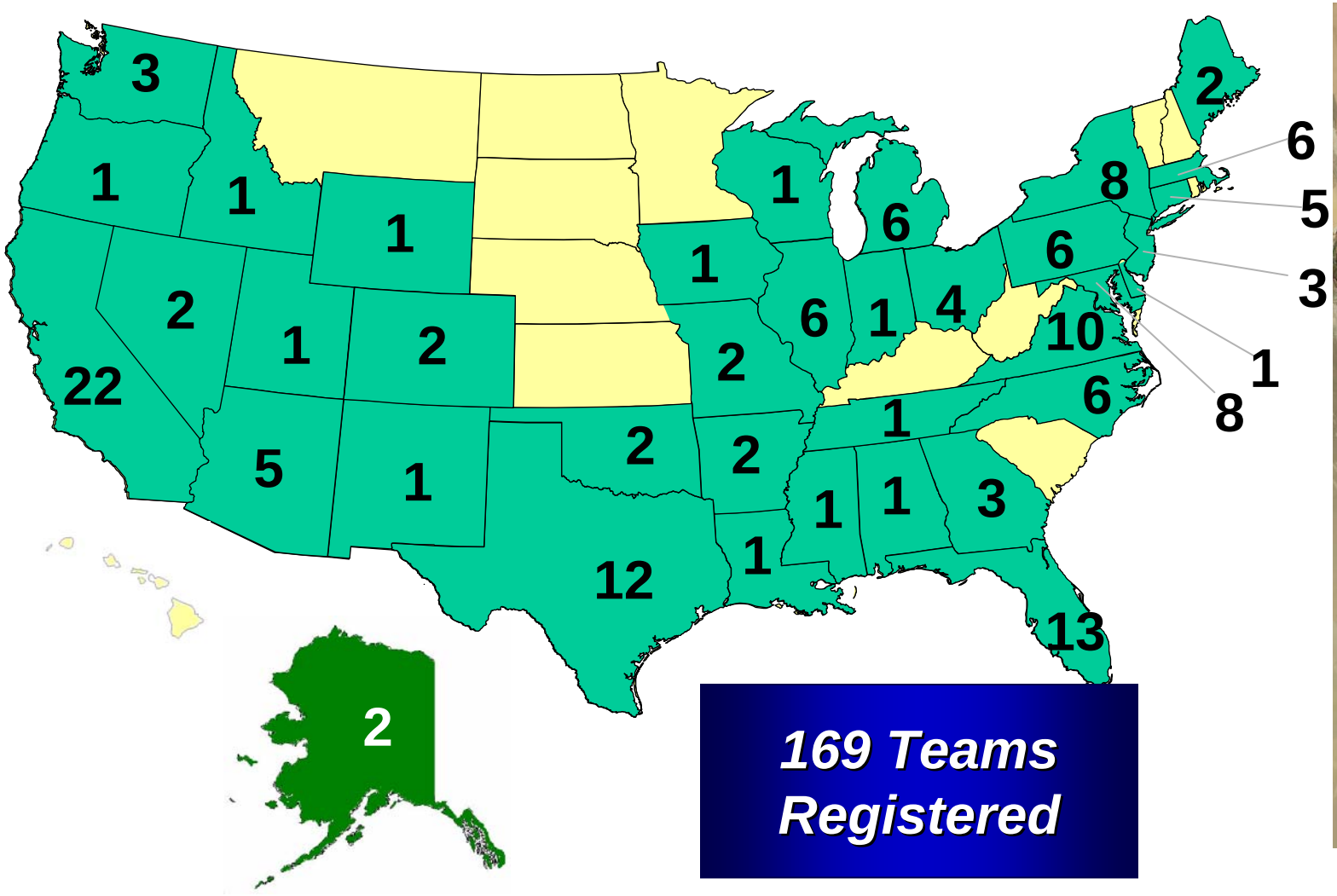
OUTLINE

- DoD Basic Research
- DoD STEM Education
- Prize Competition

Wearable Power Prize

- 1st Prize $1M, 2nd prize 500K, 3rd prize: $250K
- Goal: Reduce weight of Warfighters' power systems
- Competitors will produce prototypes that provide 20W average electric power continuously for 4 days, attach to a vest, and weigh 4 kg or less
- Capstone event will be held on October 4th, 2008, at the Marine Corps Air-Ground Combat Center, Twentynine Palms, California. See: http://www.dod.mil/ddre/prize

Wearable Power Prize Team Registrations

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