



# AFA Technology Symposium

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# Technology Challenges

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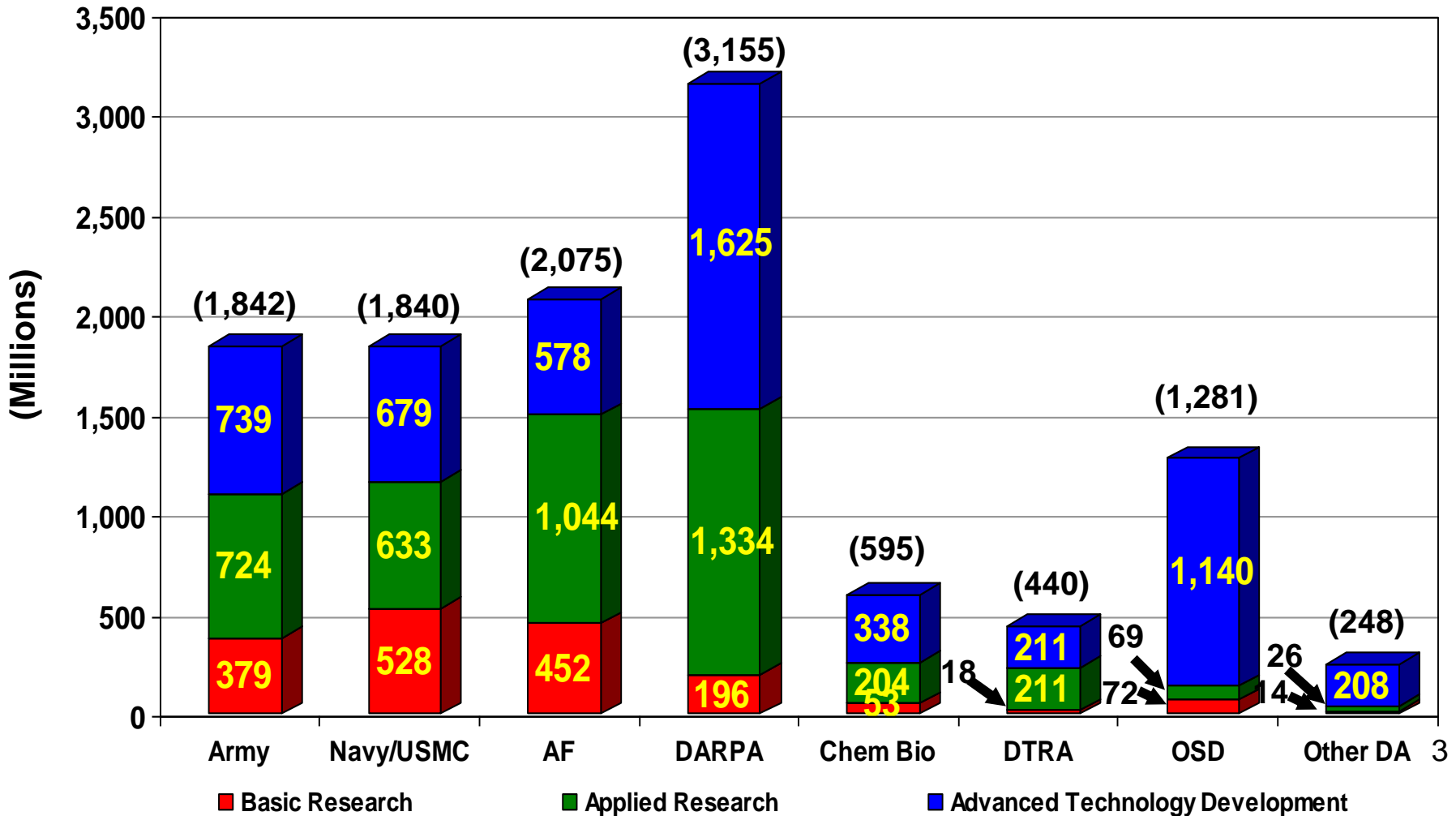
Explore challenges in future technologies, and how the Department of Defense is attacking this issue with limited funding; discusses the need for collaboration among S&T leaders



# FY09 DoD S&T Budget Request

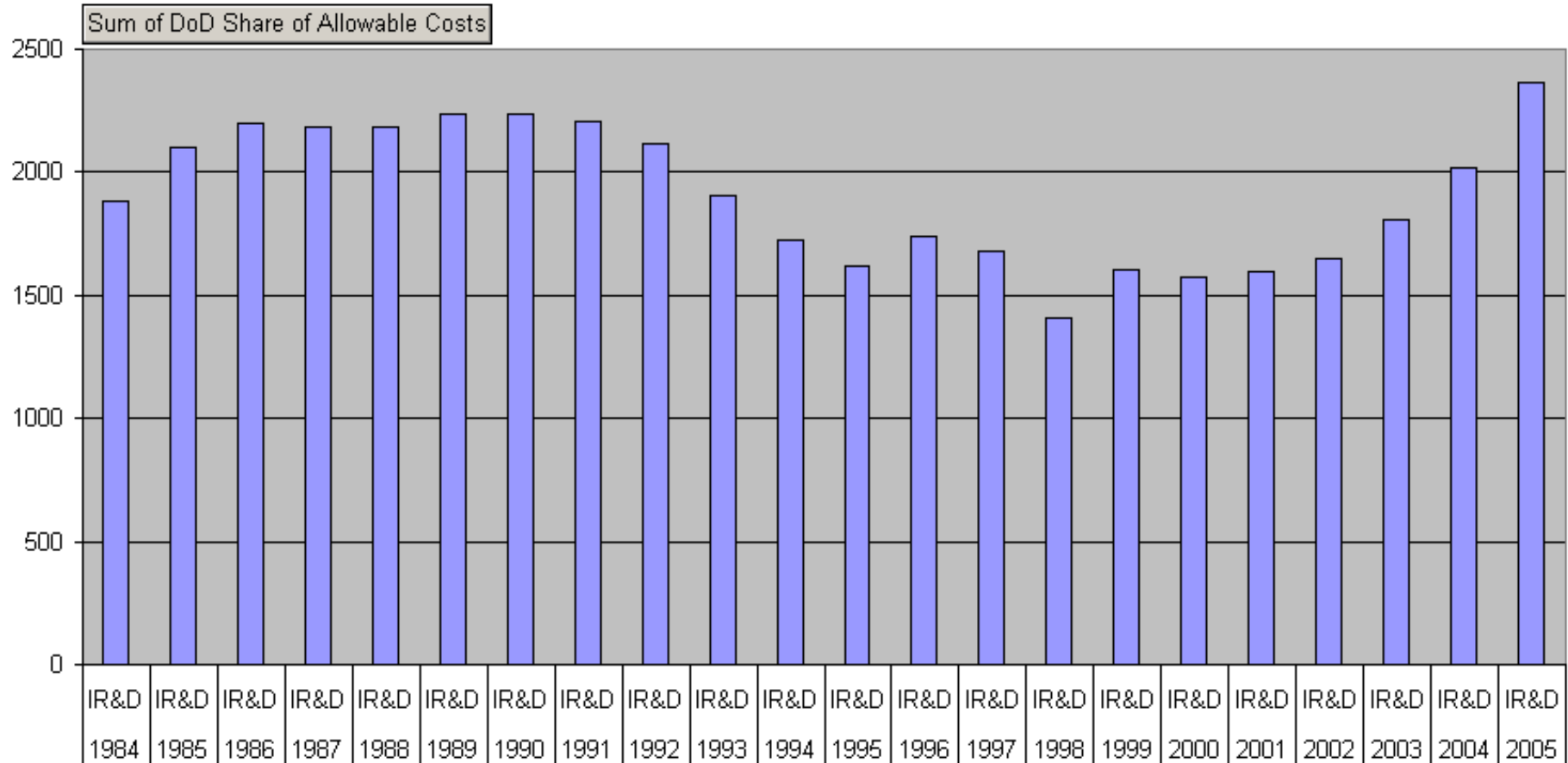
**Total FY09 S&T request = \$11.48B**

**Total FY08 S&T Request = 10.77B**  
 Army = 1,728, Navy = 1,667, AF = 1,964, DARPA = 3,033, ChemBio = 610, DTRA = 401, OSD = 1,166, Other DA = 201





# DoD IRAD by Major Contractors

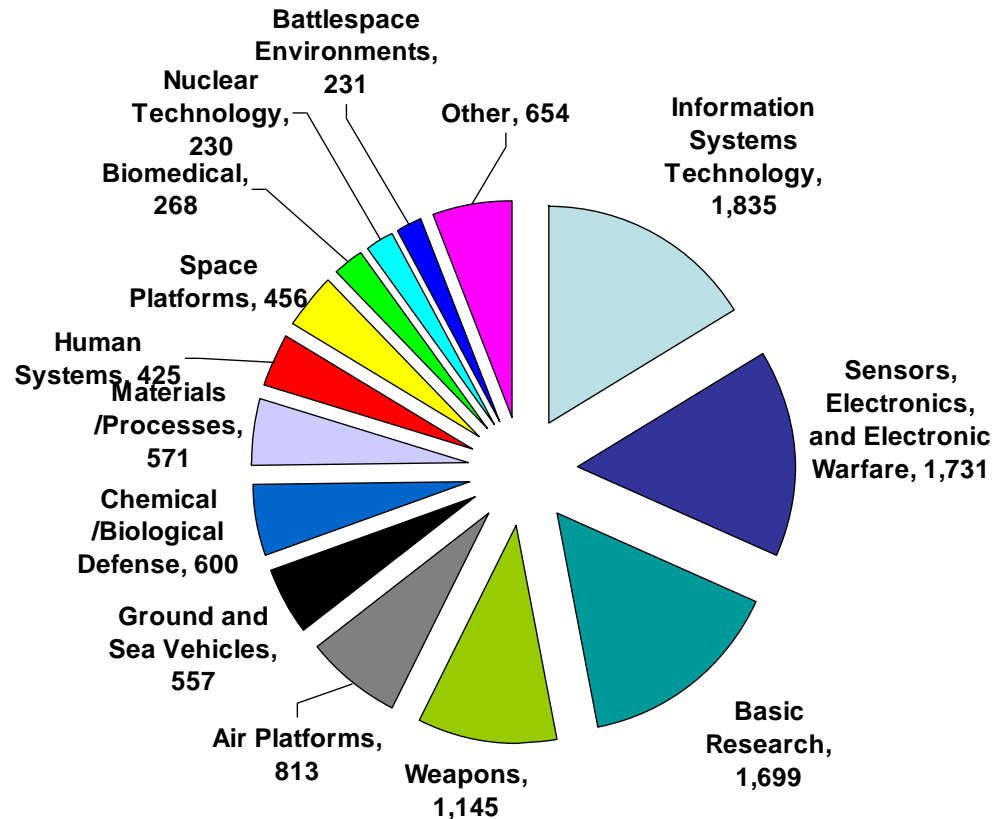




# Where is the DoD S&T money going

- **Funding: FY08**

- Current year S&T dollars: \$10.77B FY08 to \$11.48B FY09
- Percent of DoD funding: 2.24% FY08 to 2.22% FY09
- Over 50% of total investment in 4 functional areas:
  - Information Systems (1.8B)
  - Sensors, Electronics / EW (1.7B)
  - Basic Research (1.7B)
  - Weapons (1.1B)



***DoD S&T program is focused on “sensing and shooting”  
But is changing...***



# MRAP – CAT I



**GDLS-C - RG-31 MK 5E CAT I**



**FPII - Cougar CAT I**



**BAE RG-33 - USSOCOM CAT I**



**MRAP II BAE TVS Caiman CAT I**



**MRAP II I-3 Bull CAT I**



**IMG MaxxPro CAT I**



**BAE TVS Caiman CAT I**



# MRAP – CAT II and III



**BAE – RG-33L CAT II**



**FPII – Cougar CAT II**



**BAE RG-33L - HAGA CAT II**



**FPII - Buffalo CAT III**



# MRAP Team - Transportation

- TRANSCOM

## Shipping Totals as of September 9, 2008



**Airlift 2913**

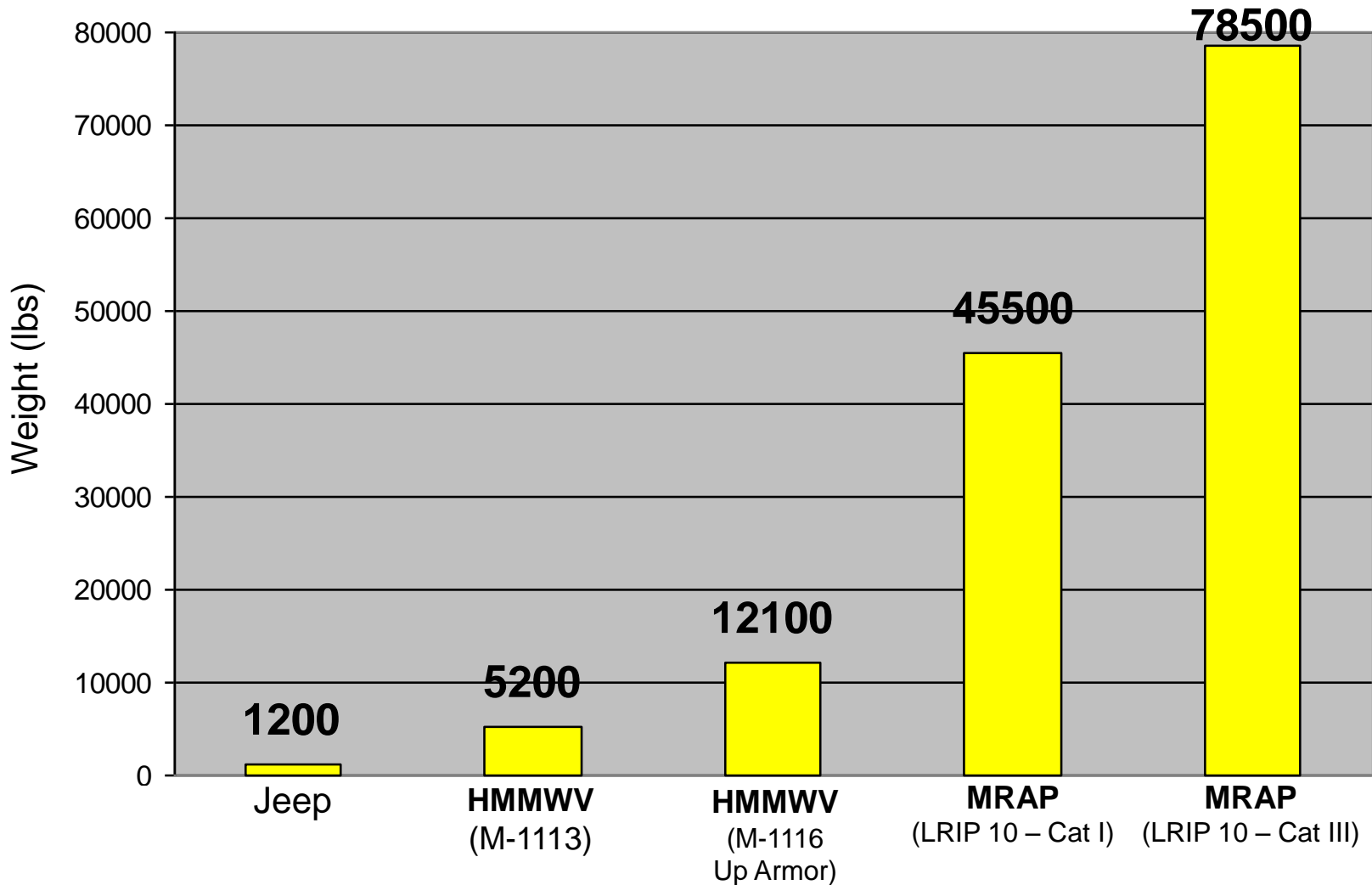


**Sealift 7351**





# Military Vehicle Weights





# MRAP “System” – Program View

**ENVIRONMENT**

**SYSTEM**



→ **ENVIRONMENTAL BOUNDARY**



# MRAP "System" – Systems Engineering View

ENVIRONMENT



→ ENVIRONMENTAL BOUNDARY



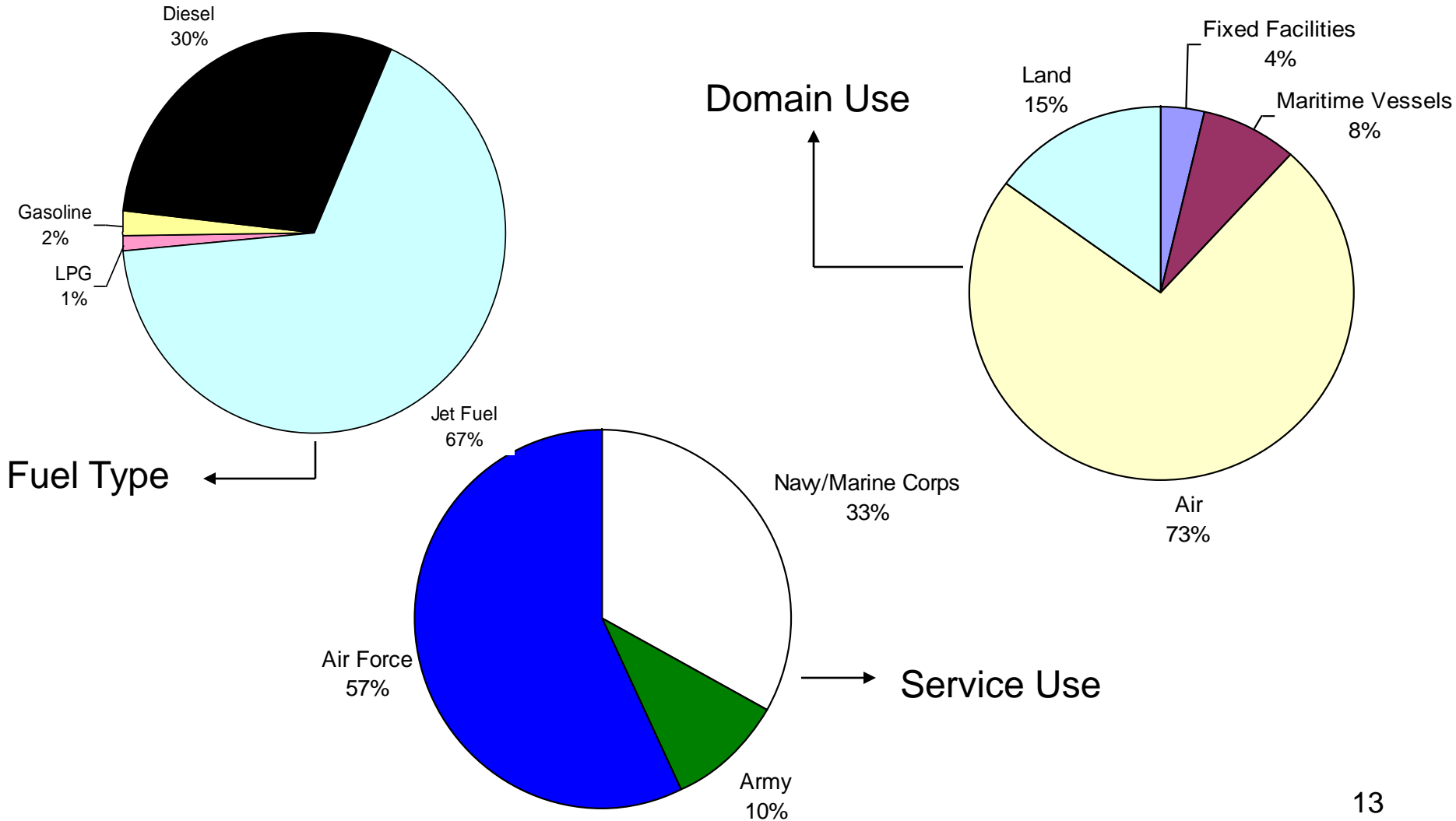
# Fuel Logistics: DoD's Soft Underbelly

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- Logistics consumes roughly half of DoD's personnel and a third of DoD's budget
- ~70% of the tonnage moved (when the Army deploys) is fuel
- About half the current casualties in theater are associated with convoys
  - We loose a lot of people moving fuel around



# Approx. Fuel Use by DoD in FY05





# Fuel Savings: Enormously Valuable

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- More-fuel-efficient platforms offer major warfighting, logistics, and budget benefits
- Force protection: far fewer convoys at risk of attack
- Force multiplier: trigger-pullers can win battles without the deadly distraction of protecting fuel
- Force enabler: unprecedented persistence (dwell), agility, mobility, maneuver, range, reliability, and autonomy—at low cost, so many small units can cover large areas—needed for asymmetrical, dispersed, elusive, remote, irregular adversaries
- Can unlock vast transformational gains (multidivisional tail-to-tooth realignment, 10s of \$B/year)

**THIS IS WHERE YOU GET THE MONEY YOU  
NEED TO DO OTHER THINGS**



# Common DoD Views on Energy

- We exist to be *effective*, not efficient, so platform performance always trumps fuel cost—and rightly so
- DoD energy technology and innovation will be driven by the civilian marketplace, and need no attention from us
- DoD has no significant rewards for energy efficiency, no penalties for energy inefficiency\*, and sparse energy-use data; that's OK
- We don't "do" energy; we buy it
- Energy is a necessary expense, not an investment issue
- Energy's supporting infrastructure is not a major factor in requirements and procurement choices
  - Fuel logistics is invisible, free, and invulnerable
  - Its burden can be ignored when we make decisions that determine DoD's fuel use
  - Existing KPPs like range, speed, and payload implicitly include all worthwhile energy goals, so "energy KPPs" would be superfluous

\*However, Congressional and Executive mandates drove ~30% drops in Service facilities' J/m2-y



# Challenge to S&T Community

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- How do we make our force more fuel efficient while retaining existing capabilities?
- How do we make lightweight armor that is at least as effective as our current steel based solutions?
- How do we do maneuver warfare, while protected, without the weight?



# Force Structure Implications

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- “Nobody kicks ass without tanker gas”
- What if we reduced the weight and improved the fuel efficiency of our combat systems
- Fuel costs approx \$5/gallon in the CONUS and \$45/gallon delivered via air-air refueling



# Where to Find Winners

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1. The most total *fuel* can be saved in aircraft: Since aircraft use 73% of DoD oil, a 35% saving in aircraft would equal the total fuel use by all land and maritime vehicles plus facilities
  - Improvements in aerodynamics, materials, systems, and propulsion all needed
2. The greatest gains in *combat effectiveness* will come from fuel-efficient ground forces (land and vertical-lift platforms, land warriors, FOBs)
3. Savings *downstream*, near the spear-tip, save the most total fuel: delivering 1 liter to Army speartip consumes ~1.4 *extra* liters in logistics
4. Savings in aerially refueled aircraft and forward-deployed ground forces save the most *delivery cost* and thus *realignable support assets*



# Dramatic Gains in Combat Effectiveness and Energy Efficiency are Available:

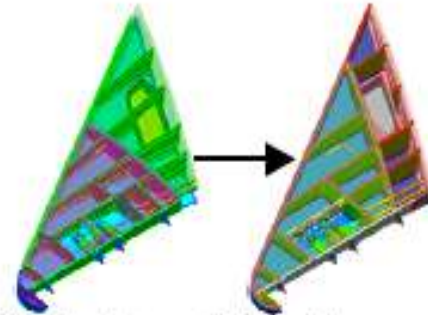


(scaled-down wind-tunnel model)

BWB quiet aircraft:  
range & payload  $\times$   
 $\sim 2$ , sorties  $\div$  5–10,  
fuel  $\div$  5–9 ( $\Sigma$  2–4)



Re-engine *M1* with  
modern diesel, range  
 $\times \geq 2$ , fuel  $\div$  3–4



25% lighter, 30% cheaper  
advanced composite  
structures; aircraft can  
have  $\sim 95\%$  fewer parts,  
weigh  $\geq 1/3$  less, cost less



Hotel-load retrofits  
could save  $\sim 40\text{--}50\%$   
of onboard electricity  
(thus saving  $\sim 1/6$  of the  
Navy's non-aviation fuel)



# Reduce Consumption - Air Platforms

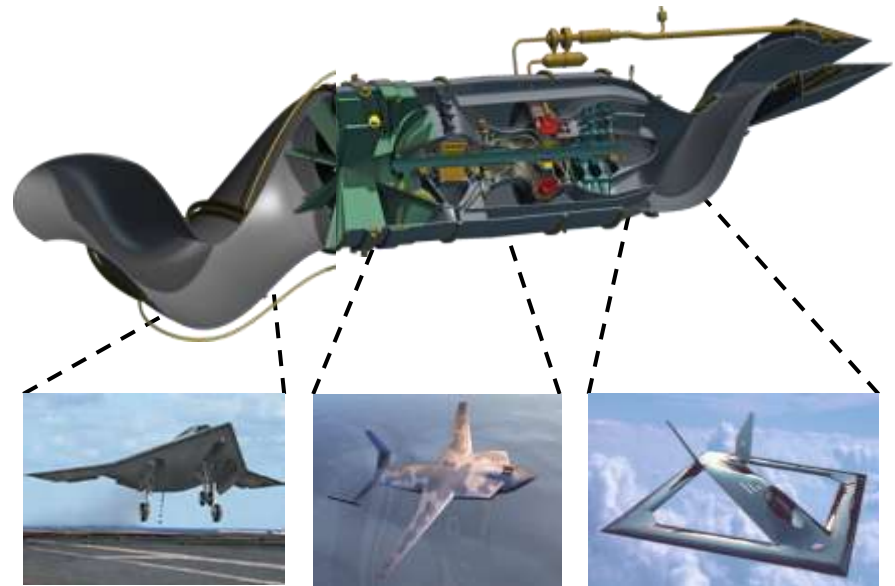
## - Highly Efficient Embedded Turbine Engine -

### DESCRIPTION

- High-bypass subsonic propulsion in an embedded configuration
- Supports future ISR, mobility, and UCAV extreme endurance and range requirements
- High power extraction for multi-sensor suites
- Addresses more than 80% of the aircraft fleet (mobility, fighters, etc.)

### BENEFITS

- Theoretical performance enhancements are:
  - 25% reduction in fuel consumption
  - 100-400 kW power extraction capability



UAV's

Transports

ISR



# Reduce Consumption - Operational Efficiencies

## - Increased Use of Simulators (Study) -

### DESCRIPTION

- Identify realistic/full emersion technologies that could substitute for live training
- Determine surplus capacity for simulators
- Identify additional capability required to trade hands-on hours for simulator time
- Determine the cost of enhancements
- Recommend if next generation simulators are required

### BENEFITS

- Potential major impact on fuel consumption
- Savings resulting from less maintenance and platform "wear & tear"



Boeing C- 130 Aircrew Training Simulator



# Non-Trivial Oil Facts

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- In WWII, heavy steel forces “floated to victory on a sea of oil,” and 6/7ths of oil to defeat Axis came from Texas; today, Texas is a net importer of oil
- In WWII, the average fuel consumption per service member was about 1.67 gallons/day. In Iraq, it is 27.3 gallons/day
- Each \$10/bbl increase in oil price directly costs AF ~\$0.8B/year, DoD ~\$1.3B/year



# S&T Challenge

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**Make our force produce  
more “effect” for less  
“effort”**



# Back-Up

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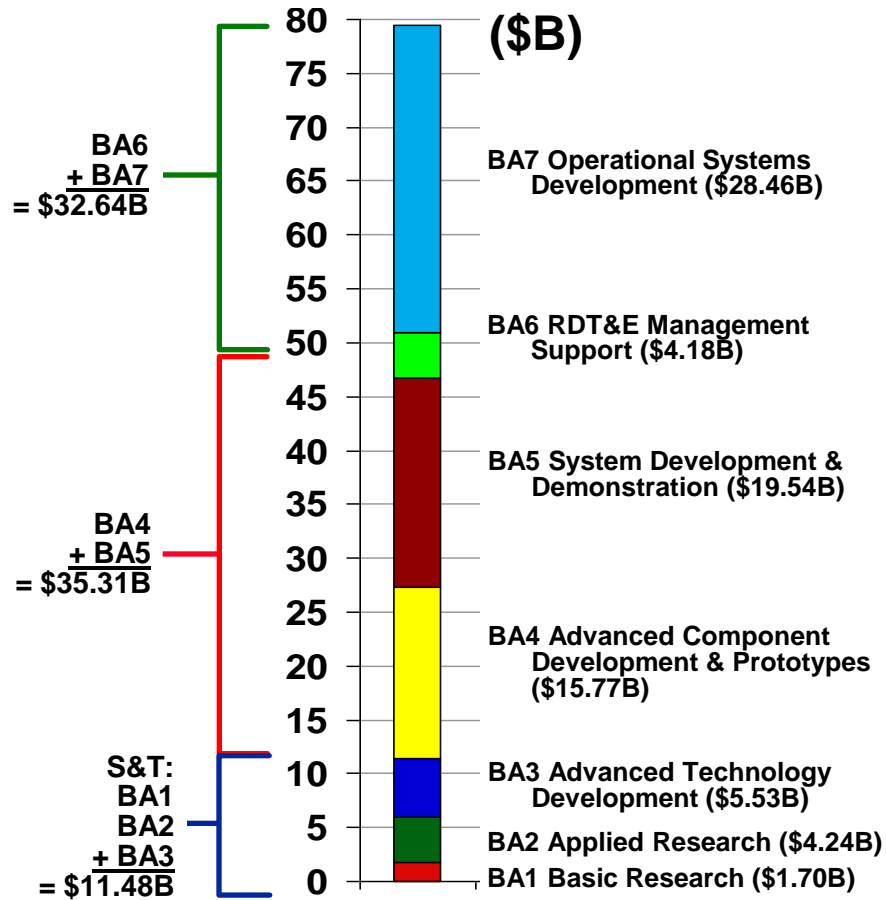
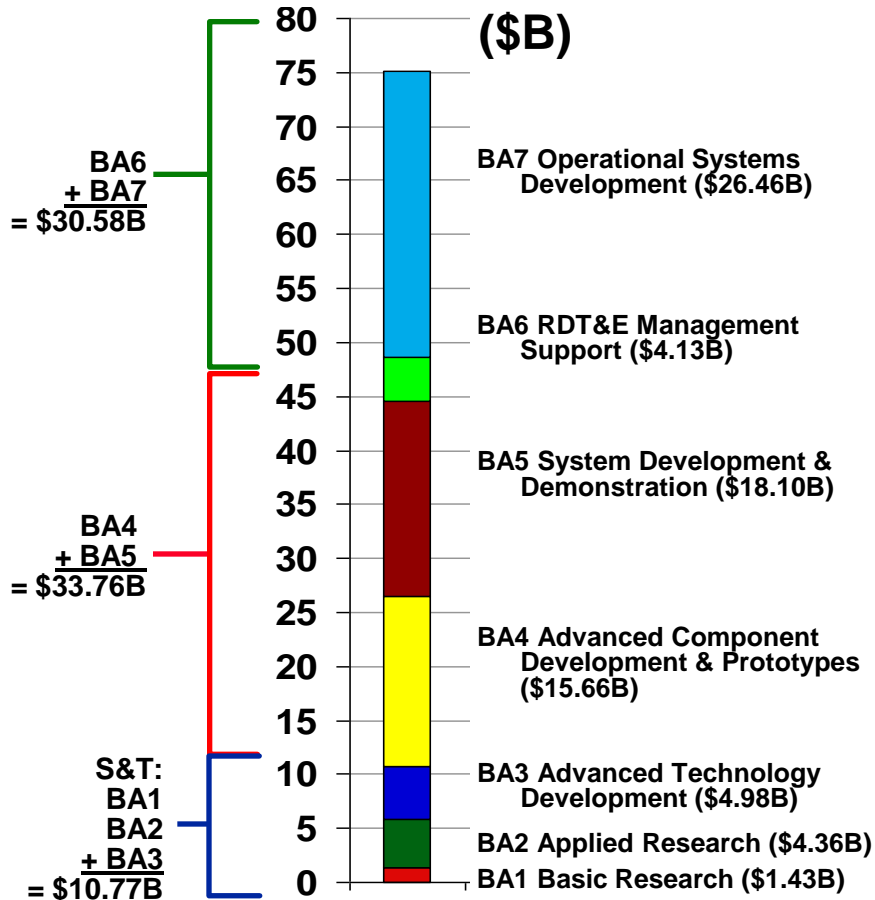


# FY08 and FY09 RDT&E Budget Request Comparison

- in Then Year Dollars -

**FY08 RDT&E request = \$75.12B**  
(Budget Activities 1-7)

**FY09 RDT&E request = \$79.43B**  
(Budget Activities 1-7)



Technology Base (BA1 + BA2) = \$5.78B

Technology Base (BA1 + BA2) = \$5.94B

**PBR08 S&T is 14.3% of RDT&E**

**PBR09 S&T is 14.5% of RDT&E**



# Increase Alternatives - Power Systems

## - Fuel Cells -

### DESCRIPTION

- Develop and demonstrate compact & mobile 10kW high temp fuel cell system
- Powers all critical equipment (e.g. GPS, Radio/Comms, Computers, C4ISR gear, Laser Designator , etc.)
- Silent, portable power system eliminating dependence on large generator/grid power for battery charging
- Provides a better power source (weight and available energy) to the Soldier and APU applications for vehicles for missions >24 hours

### BENEFITS

- Provides onboard mobile power generation for increasing power demands
- Highly fuel efficient, approximately 55%
- Compatible with future fuel (synthetic and desulfurized JP-8)
- Enables quick recharging of batteries



Solid Oxide Fuel Cell Stack



Solid Oxide Fuel Cell Auxiliary Power Unit



# Batteries

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- Today's soldiers average 5.9 kgs of batteries for a 72 hour mission and 7.9 kgs of batteries for a 96 hour mission—based on 10.3 watts/hours
- TRADOC's goal (10-15 years into future) is 50 watts/hour
- Clearly something has got to change



# Because...

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DoD planning ***processes*** undervalue fuel and its delivery costs

and

DoD business ***practices and culture*** disincentivize strategic investment or savings

so

***We don't yet do what we know we must***