Strategic Imperatives for the DoD Science & Technology Program

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The Next Phases of Development
--Thoughts from the Secretary of Defense--

"I believe the Department should seek increasing competition, use of prototypes, and ensure technology maturity so that our programs are ready for the next phases of development…"

Secretary Gates before the SASC, January 27, 2009

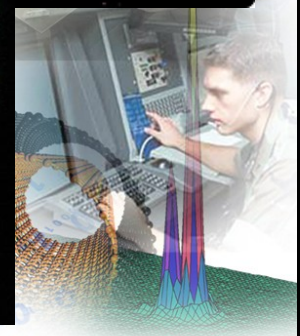
The strategy (National Defense Strategy) strives for balance in three areas: between trying to prevail in current conflicts and preparing for other contingencies, between institutionalizing capabilities such as counterinsurgency and foreign military assistance and maintaining the United States' existing conventional and strategic technological edge against other military forces, and between retaining those cultural traits that have made the U.S. armed forces successful and shedding those that hamper their ability to do what needs to be done.

Foreign Affairs Magazine Jan / Feb 2009

DDR&E VISION: To develop technology to defeat any adversary on any battlefield

Any Battlefield includes physical, cyber, space, undersea, etc

Any adversary includes both State & non-State actors



Forces of Change…

Changing International Factors

Defense S&T for Persistent Conflict

Changing Warfare Factors

NEW TECHNOLOGY NEEDED

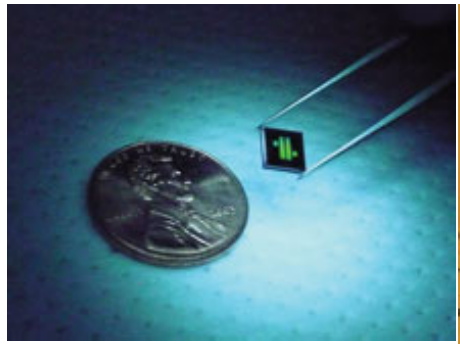
What does this mean for the Department…?

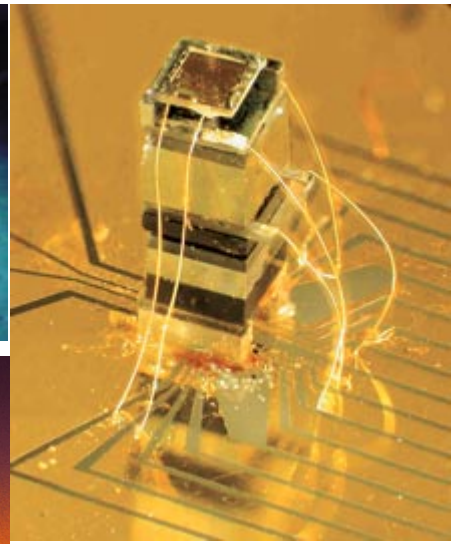
Expanding Knowledge Base

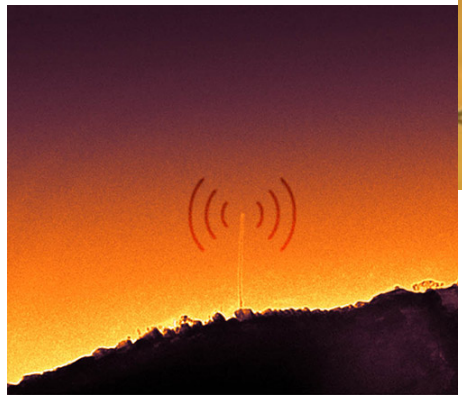
Science Becoming Global, Multidisciplinary

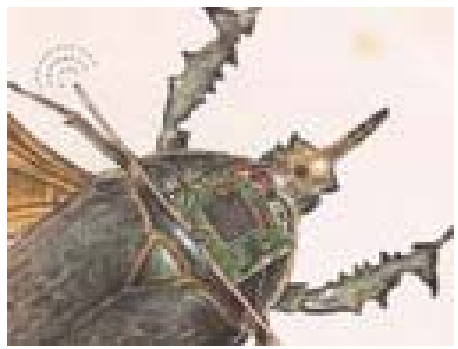
2009 MIT Innovations List of Top 10 Emerging Technologies:

- ***Biological Machines***
- ***Traveling Wave Reactor***
- ***Racetrack Memory***
- ***$100 Genome***
- ***Software Defined Networking***
- ***Intelligent Software Assistance***
- ***Liquid Battery***
- ***HashCache***
- ***Nanopiezotronics***
- ***Paper Diagnostic Tests***
- ***Nanoradios (2008 holdover)***





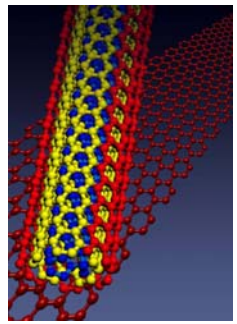


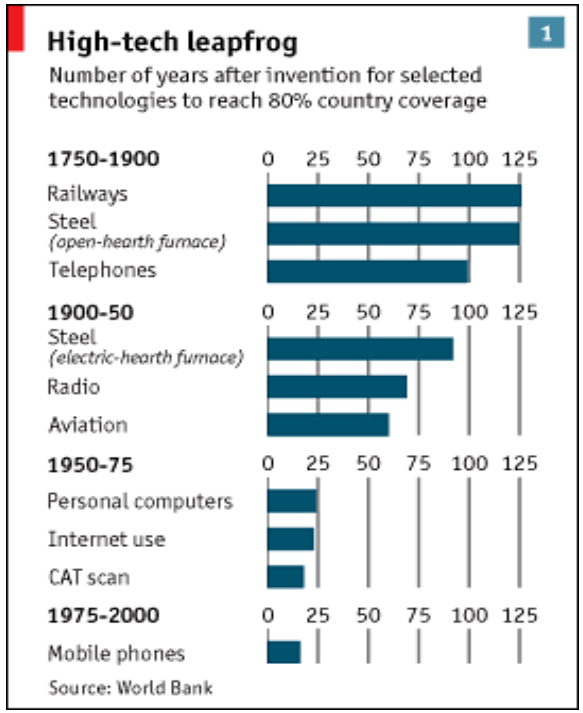


Technology opportunities are expanding, but not well understood…

Pace of Technology Continues to Increase

- **Time between modeling of semiconducting properties of germanium in 1931 and first commercial product *(transistor radio)* was 23 years**
- **Carbon nanotube**
  - **Discovered by Japan (1991)**
  - **Researchers recognized carbon nanotubes were excellent sources of field-emitted electrons (1995)**
  - **"Jumbotron lamp" - nanotube-based light source available as commercial product (2000)**
- **Information Technology**





***The Economist*, Feb. 9, 2008**

Strategic Plans Drive Strategic Imperatives

FY2010 Budget will contain "recommendations that are the product of a holistic assessment of capabilities, requirements, risks and needs for the purpose of shifting this Department in a different strategic direction" *

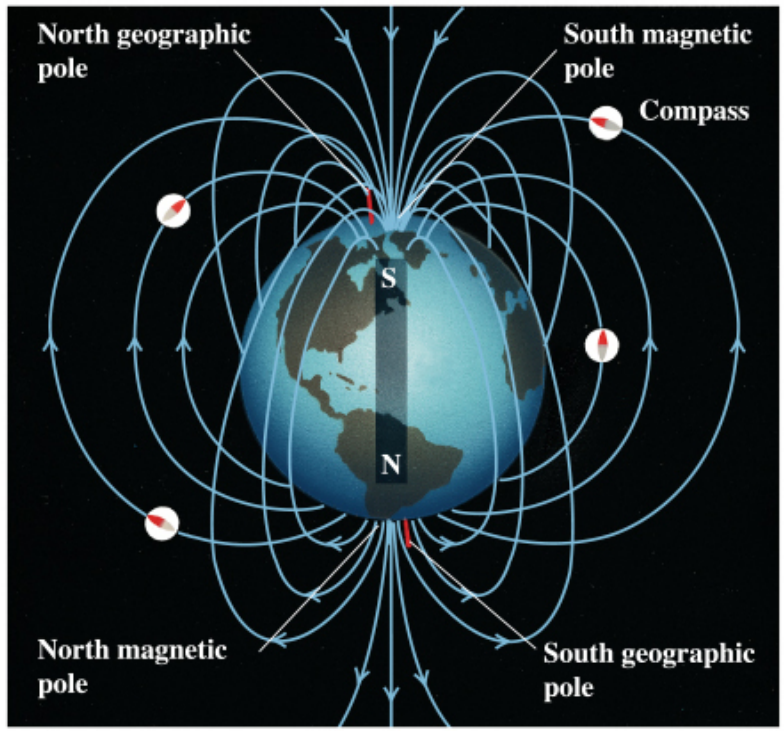
* *Secretary Gates, Defense Budget Recommendation Statement, Arlington, VA, April 6, 2009*

Shifting away from an emphasis on ships, tanks, and planes—to focus on protection, information, knowledge, and timely, actionable intelligence

Rise of the Commons

- **Military operations increasingly depend on being able to operate in places “no one owns” – The Commons**

- **U.S. DoD science and technology is increasing to assure capability to operate in the commons.**



The Fallout From Desert Storm

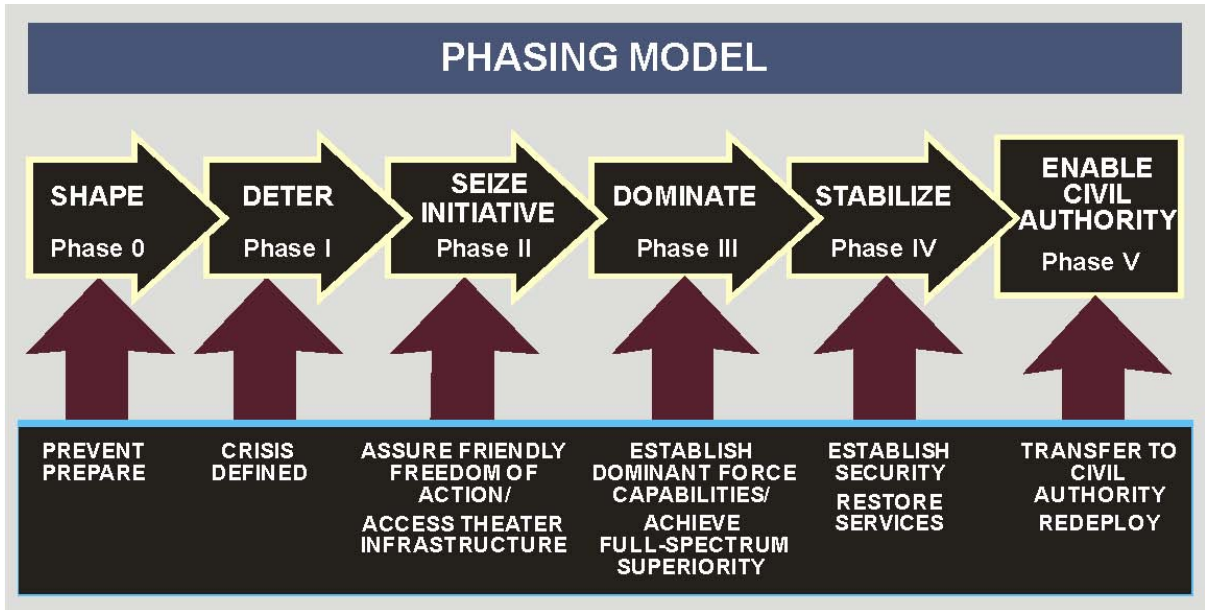
- **US dominance over Soviet-era systems "shocked" potential adversaries and combined to give US conventional superiority**
  - **Precision Weapons**
  - **Night Vision**
  - **Low Observability**
  - **Networked Systems**
  - **Space**
  - **Command and Control**

- **The advent of information-based warfare fed the emergence of irregular warfare**

Led To Resurgence of Irregular Military Operations

Implications

- US and Allies have unquestioned advantage With Conventional Systems
- World wide resurgence of Tribal Alliances
- New Capabilities Needed to Deal with the New Strategic Framework
- Engagement Includes Soft Power
- Phase 0, 1, 4, and 5 Coming to the Force

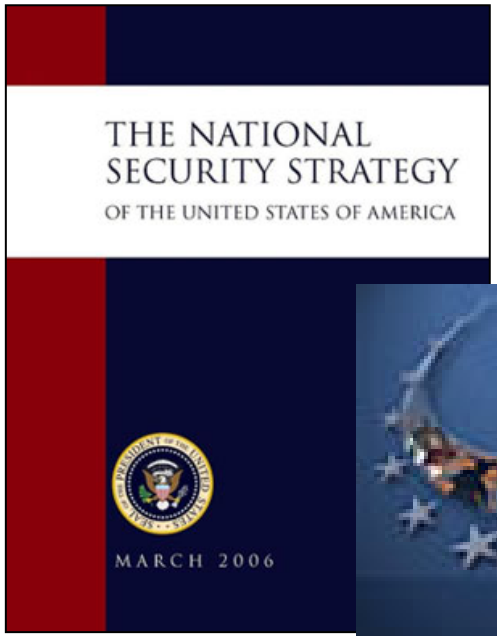


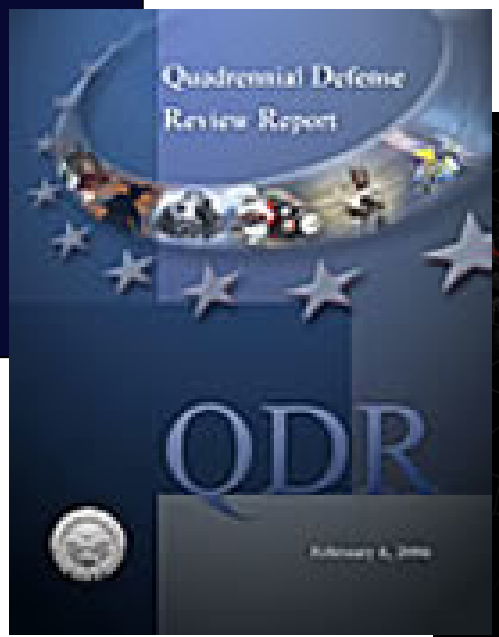
Complex Operating Environment

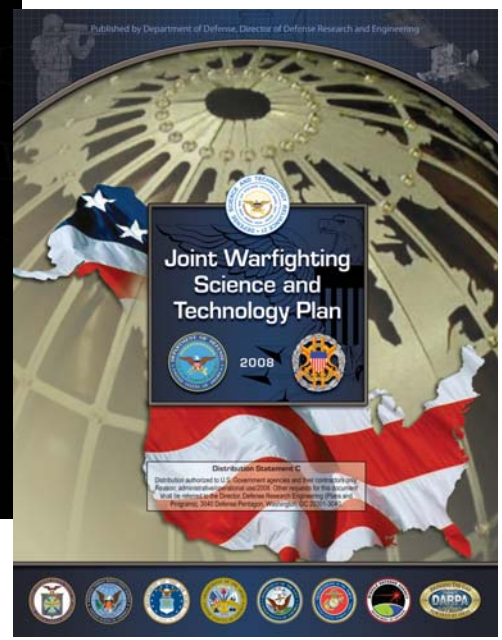
- **Today's global economy is technology driven**
- **Adversaries will increasingly leverage technology to challenge U.S Armed forces capabilities**
- **Irregular and asymmetric forms of warfare are likely**
- **Economic, demographic, resource, technology, and climate trends will present new challenges**

Strategic Plans

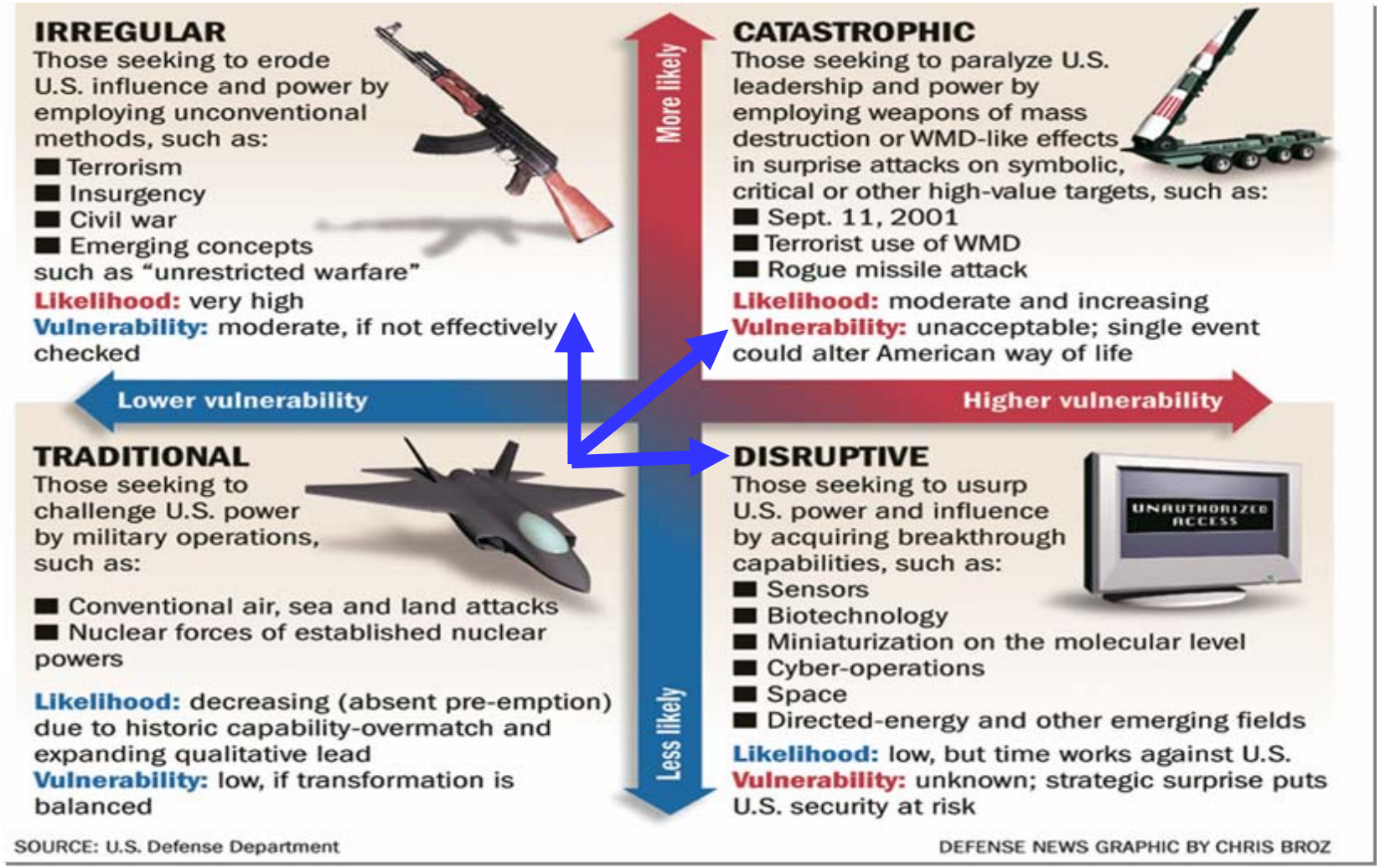
Defense Science and Technology Strategy and Planning







National Defense Strategy Drives Investment Strategy



S&T Enabling Technology Priorities
-Supporting the QDR Strategic Outcomes-

- **Technology focus areas:**
  - **Human, Social, Cultural, and Behavioral Modeling**
  - **Biometrics and Biological exploitation**
  - **Information Technology and applications**
  - **Persistent Surveillance Technologies**
  - **Networks and Communication**
  - **Language Translation Technologies**
  - **Manufacturing Technologies**
  - **Cognitive Enhancement**
  - **Directed Energy Technologies**
  - **Autonomous Systems Technologies**
  - **Hyperspectral Sensors**
  - **Nanotechnology**
  - **Advanced Materials**
  - **Energy and Power Technologies**
  - **Organization, Fusion, & Mining Data**
  - **Combating WMD Technologies**
  - **Energetic Materials**

Blue Text—Areas with substantial increases in FY08/09 President's Budget Request

Strategic Imperatives

Four Principal Objectives

- Basic Research and Three DoD Strategic Imperatives

Secretary of Defense Posture Statement on the FY2009 Budget, February 2008

"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, Budget Recommendation Statement, Arlington, VA, April 6, 2009

1. **Take care of our people**
2. **Develop the right capabilities for today and tomorrow**
   - **Persistent surveillance**
   - **Cyberspace operations/protection**
   - **Combating weapons of mass destruction**
   - **Irregular warfare**
3. **Reform the Procurement, Acquisition, and Contracting processes**

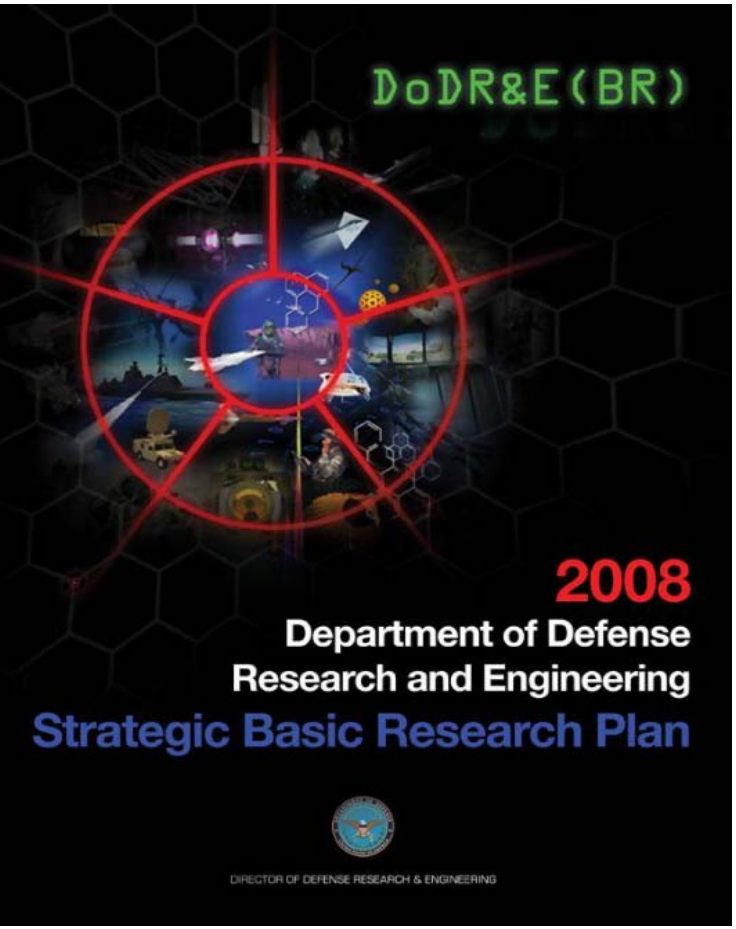
Connecting Researchers to the Warfighter

President Obama, Science Debate, September 2,2008

"My administration will put basic defense research on a path to double and will assure strong funding for investments in DoD's applied research programs. We will enhance the connections between defense researchers and their war-fighting counterparts."

Investment in Basic Research is a commitment to the future warfighter

Strategic Basic Research Plan (BRP)



- **$270M Basic Research Increase (PBR 09)**
  - **Enhance the science and engineering personnel base and Emphasize research to address Grand Capability Challenges:**
    - **Cyber protection/ information assurance**
    - **Network sciences**
    - **Science of autonomy**
    - **Information fusion and decision sciences**
    - **Biosensors and biometrics**
    - **Human sciences (cultural, cognitive, behavioral, neural)**
    - **Software sciences and materials**
    - **Immersive sciences for training and mission rehearsal**
    - **Power and energy management**
    - **Counter directed energy weapons**
  - **About 500 focused research efforts**

A Strategic plan guiding DoD research, built around National Science Foundation (NSF) Taxonomy

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- Imperative 1: Take care of our people -

- **Personnel & Platform Protection**
- **Advanced Medical Research**
- **Education**

Example – Protection
Lightweight Armor

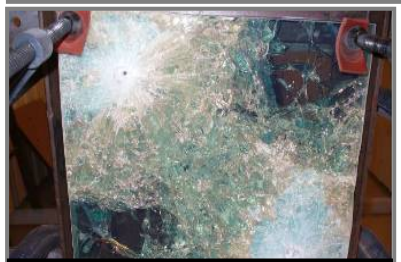
Objective: To overcome the traditional cost/performance tradeoff through innovative arrangement (topology) of known materials, rather than invention of new materials

Improved Strike-face: Transparent Spinel (MgAlO)

Glass Coated
6” x 6” Spinel Plate

Topological Features
on Back Face

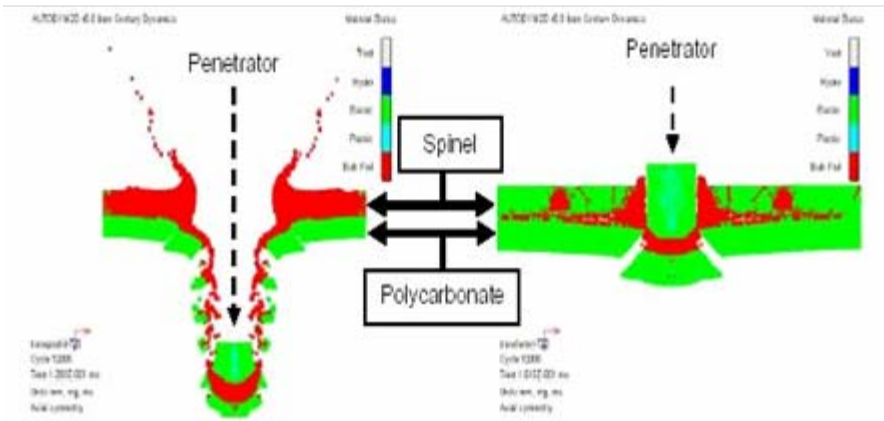
Improved Backing Materials: Glass Ceramics and Transparent Polymers



Glass Ceramic

Glass Fiber
Reinforced Polymer

Ballistic testing completed at Army Research Lab with areal density ~18 lbs/ft^2



Transparent Armor System

Increase Performance, Reduce Weight, and Maintain Optical Requirements of Transparent Layered Armor

Example – Medical R&D

Military Operational Medicine Research Program

- **Capabilities structured into four key focus areas:**
  - **Injury Prevention**
  - **Psychological Health and Resilience**
  - **Physiological Health and Well-Being**
  - **Environmental Health and Protection**

Priority 1
Injury Prevention

Priority 2
Psychological Health

Priority 3
Physiological Health

Priority 4
Environmental Health

Example – Educating Our Force
National Defense Education Program (NDEP)
Building Science, Technology, Engineering & Math (STEM) Skills

Challenge:

- Downward trend in S&E degrees at all levels of education
- General erosion of US competency in math and science at mid/high school

STEM Development:

- Science and Math competence is gained in K-12
- Forms foundation of educated, capable, and technical workforce for DoD

Path Forward:

- Promote STEM Education in mid/late educational years combined with defense community employment

NDEP website = http://www.ndep.us

DoD employs nearly half of all Federal physical scientists, technologists, engineers, and mathematicians

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- Imperative 2 -

Develop the right capabilities for today and tomorrow

- **Combating Weapons of Mass Destruction**
- **Advanced Tagging, Tracking, & Locating**
- **Cyberspace Operation/Protection Technologies**
- **Battlespace Awareness**
- **Energy & Power**
- **Unmanned Vehicles**
- **Advanced Electronics**
- **Advanced Materials**
- **Processing Large Data Sets**
- **Intelligence, Surveillance & Reconnaissance**
- **Human, Social, Cultural, Behavior Modeling**
- **Software Development**

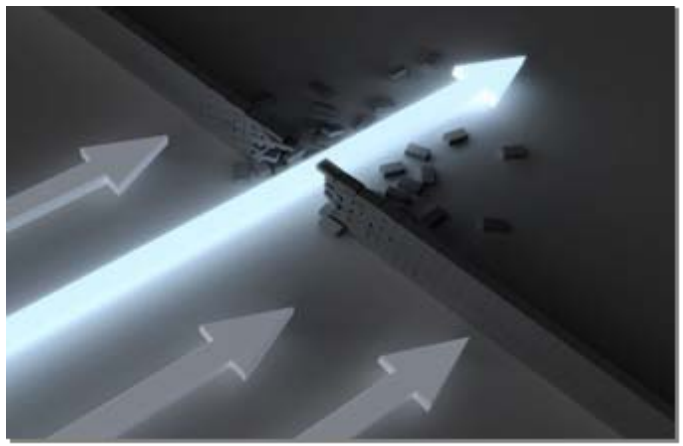
April 2009 Budget Statement
- Imperative 3 - Reform the Procurement, Acquisition, and Contracting processes

- **Joint Analysis Teams**
- **Milestone Development Decisions**
- **Information Access**
- **DoD Challenge Programs**
- **Technology Transition Initiatives**
- **Operational Prototyping**

DoD Techipedia

Why a Wiki for DoD Technology Collaboration?

- **Break across community barriers**
  - **Foster communication between those with needs and those with potential solutions**
- **Success of Wikipedia, Intelipedia make Wikis more familiar, especially to Generations X and Y**
  - **Builds on how people are interacting at home, and at schools**
  - **Increasing awareness of wiki's in the DoD S&T users community are through interaction with Intelipedia's S&T areas**
- **Low technical barriers to entry**
  - **Browsers based - no specialized tools**
  - **Low bandwidth**



https://www.dodtechipedia.mil

2008 DDR&E Wearable Power Prize

The Challenge

Demonstrate a Wearable Power System that provides 20 watts of power on average for 96 hours weighing 4 kg or less (minimum 480 W-hr/kg)

Prize Purse

1st $1,000,000
2nd $500,000
3rd $250,000

Competition Description

- **Competition Announced** **July 2007**
- **169 Teams Registered** **Nov 2007**
  (> 500 competitors/ ~ 20 countries)
- **Fuel Plans Due** **Mar 2008**
- **System Description Due** **Jun 2008**
- **Capstone Events** **Sep – Oct 2008**
  - Competition Sep 22 – Oct 4
  - Kids' Day Oct 3rd
  - Awards Ceremony Oct 4th

$1,000,000 3.762 Kg

DuPont SFC/Smart Fuel Cell M-25 Team
Wilmington, DE

Direct Methanol Fuel Cell/Li-Ion Battery/ Power Electronics Hybrid
Fuel – Liquid Methanol

$500,000 3.790 Kg

Adaptive Materials Inc. - Ann Arbor, MI

Solid Oxide Fuel Cell/ Li-Ion Battery/ Power Electronics Hybrid
Fuel – Pressurized Propane &

$250,000 3.865 Kg

Jenny 600S – Middleburg, VA

Direct Methanol Fuel Cell/ Li-Ion Battery/ Power Electronics Hybrid
Fuel – Liquid Methanol

92-Hour Bench Test

4-Hour Field Test

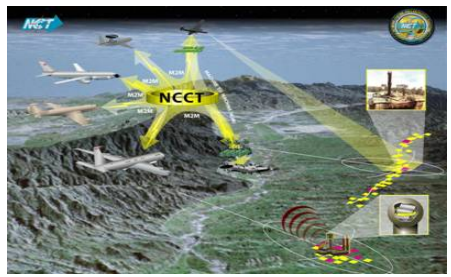
Joint Capability Technology Demonstration (JCTD)

- **Improves ACTD process/replaces ACTDs (Oversight--not Program Management)**
- **Designed to speed transformational, joint and coalition capabilities**
- **Works with combatant commands to identify solutions emerging/validated needs**
- **Partners with services/agencies to push technology solutions**
- **Final demonstration phase reached in two years for most JCTDs**
- **Majority of JCTD start up and transition costs centrally funded in DDR&E/AS&C**

Transformational

The SPARTAN ACTD demonstrates a multi-mission unmanned surface vessel (USV) capability that will can transform the way our forces provide ship/harbor security.

Joint



U.S. Army, Navy, and Air Force are working with UK on the Network Centric Collaborative Targeting ACTD to horizontally integrate intelligence, surveillance, and reconnaissance platforms for target identification and geolocation.

Coalition

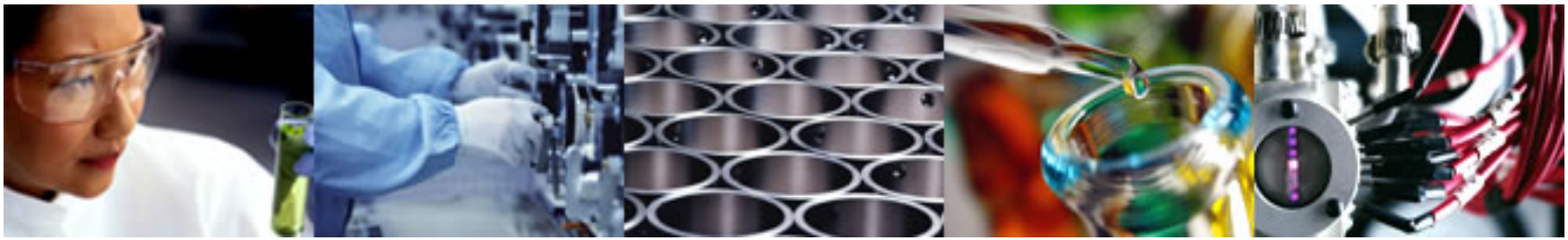
Pakistani troops deploying for Tsunami relief effort with help from Coalition Theater Logistics ACTD

***"We are encouraged by recent actions taken by DOD to initiate a Joint Capabilities Technology Demonstration business process as it is intended to meet joint and coalition forces needs we have outlined." GAO*--Michael Sullivan, Director Acquisition & Source Mgt, HASC sub-committee on Tactical Air and Land Forces Subcommittee, 9 March 2005.**

Director of Defense Research & Engineering Vision

VISION:
To develop technology to defeat any adversary on any battlefield

Example – Educating Our People



STEM Education Delegated to DDR&E - New Initiative to Develop a Strategic Plan

Vision:

- **Build and develop science, technology, engineering, and mathematics (STEM) talent that is sustainable for national security**

Mission Includes:

- **Attract, engage, and stimulate a global national security STEM community to meet the needs of the Department of Defense (DoD)**
- **Organize and coordinate Department-wide policies and resources in support of education and outreach**
- **Ensure the Department's portfolio is synchronized with the whole of government**

DoD employs nearly half of all Federal physical scientists, technologists, engineers, and mathematicians

Theater Support Vessel (TSV)

Problem: Need for a joint expeditionary capability to deliver combat ready units configured for immediate employment in JOA.

- **High Speed Rapid Littoral Maneuver and Force Closure**
- **Rapid Unassisted Ingress and Egress Enables Austere Port Operations**
- **Reduction of Reception and Staging Times in Theater of Operations**
- **Mitigate Anti-Access and Area Denial Efforts**

Solution:

- **High Speed Vessel Capable of:**
  - **Intra-Theater Movement of Combat Ready Units**
  - **Ship-to-Ship and Ship-to-Shore Operations**
  - **Supporting Operations in the Littorals**

Quick Reaction Special Projects (QRSP)
(PE 0603826D8Z~$115M/Yr)

- **Technology Transition Initiative – For DoD S&T Community**
  - **Establishes a Technology Transition Council**
  - **Jump starts selected components/subsystems into systems**
  - **Bridges the "Valley of Death"**
- **Quick Reaction Fund**
  - **Provides flexibility to respond to emergent DoD needs within budget cycle**
  - **Takes advantage of technology breakthroughs in rapidly evolving technologies**
  - **Completion of projects within a 6-12 month period**
- **Rapid Reaction Fund**
  - **Develops, procures, tests, and fields critical force protection needs in Iraq**
  - **Enhances force protection to counter Improved Explosive Devices (IEDs)**

JOINT HIGH SPEED VESSEL

DIMENSIONS

LENGTH	**103.0 m**	**(337.9 ft)**
BEAM	**28.5 m**	**(93.5 ft)**
DRAFT	**3.83 m**	**(12.57 ft)**

MATERIAL

ALUMINUM

PERFORMANCE

SPEED

Average — **35 knots @ 90% MCR with 635 mt (700 st) Payload**

Maximum — **43 knots without Payload**

RANGE

Maximum Transit — **1200 nm**

Self-Deployment — **5600 nm**

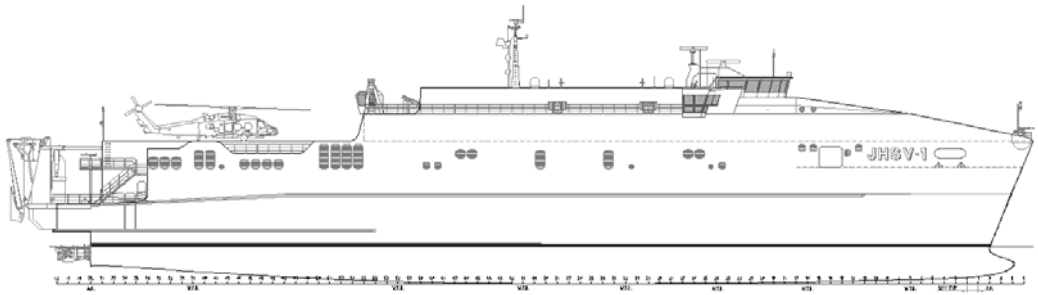
SURVIVAL THROUGH — **SS-7**

ACCOMMODATIONS

CREW	**41 p**
Single SR	**2**
Double SR	**6**
Quad SR	**7**
TROOP SEATS	**312 p**
TROOP BERTHS	
Permanent	**104 p**
Temporary	**46 p**
GALLEY & MESSING	**48 p**

MACHINERY

- **(4) MTU 20V8000 M71L Diesel Engines (9.1 MW each, 36.4 MW total)**
- **(4) ZF 60000NR2H Reduction Gears**
- **(4) Wartsila WLD 1400 SR Waterjets**
- **(4) IF V1312C2ME-HPCR Diesel Generators (600 kW each, 2.4 MW total)**



WEIGHTS

LIGHTSHIP	**1453 mt**	**(1430.0 Lt)**
FULL LOAD	**2397 mt**	**(2359.1 Lt)**
FUEL	**682 mt**	**(671.2 Lt)**
JP-5	**148 mt**	**(145.7 Lt)**
PAYLOAD	**635 mt**	**(700.0 st)**

MISSION BAY

AREA (with Tie-Downs)	**1863 m^2**	**(20053 ft^2)**
CLEAR HEIGHT	**4.75 m**	**(15.6 ft)**
TURNING DIAMETER	**26.2 m**	**(86.0 ft)**
ISO TEU STATIONS	**6 Interface Panels**	

AVIATION FACILITIES

- **NAVAIR Level 1 Class 2 Certified Flight Deck for one helicopter**
- **Centerline parking area for one helicopter**
- **NAVAIR Level 1 Class 4 Type 2 Certified VERTREP**
- **Helicopter Control Station**

C4I SYSTEMS

- **IFF / TACAN / MORIAH**
- **Aviation VLS / Stabilized GSI**
- **Integrated Shipboard LAN /NIPRNET / SIPRNET**
- **VMS / ECDIS-N, Four-Node**
- **Fiberoptic Gyrocompass MK-27F and UPS**
- **Surface Search RADAR (X-Band and S-Band)**
- **Dual GPS,**
- **Vessel Automatic Identification System (AIS)**
- **Autopilot**
- **Voyage Data Recorder**

AUXILIARY SYSTEMS

ACTIVE RIDE CONTROL

Transom Interceptors

Foils: 3.24 m^2 (34.9 ft^2) each, forward on inboard sides of demi-hulls

VEHICLE RAMP

Articulated Slewing Stern Ramp

Straight Aft to 45° Starboard

TELESCOPING BOOM CRANE

12.3 mt @ 15m, 18.2 mt @ 10 m

(13.6 Lt @ 49.2 ft, 20.1 Lt @ 32.8 ft)

ARMAMENT

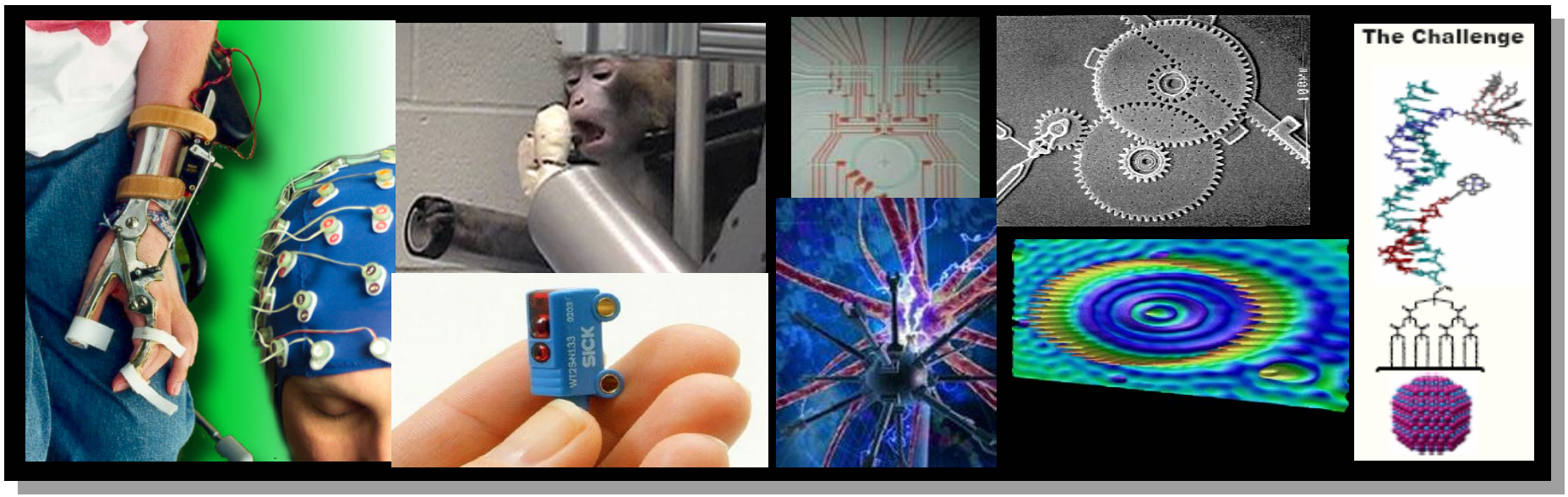
- **(4) .50 Caliber Machine Guns**
- **Reservation for AT/FP System**
- **Reservation for Non-Lethal Effectors**

FIREFIGHTING

- **High Expansion Foam in Mission Bay**
- **AFFF on Flight Deck, Mission Bay and in Machinery Spaces**

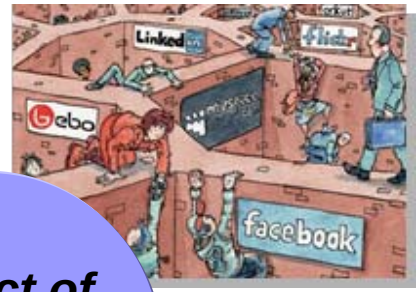
Implications

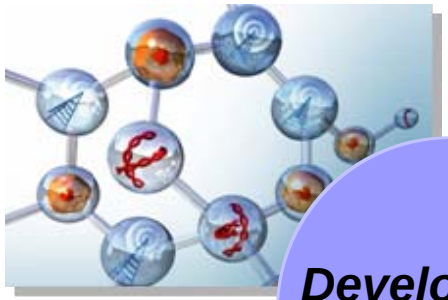
- **Greater base of technology development, more agility than previous**
- **Probability of technology surprise – rapidly**
- **Technology increasingly hybrid, commercial/military**



All factors drive to enhanced ambiguity.

A Changing World . . .





Disruptive Military Uses of Commercial Tech

Impact of Mass Collaboration

Development Pace

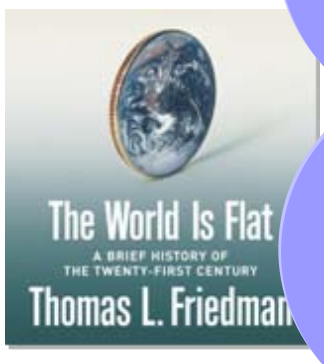
Emerging Technology

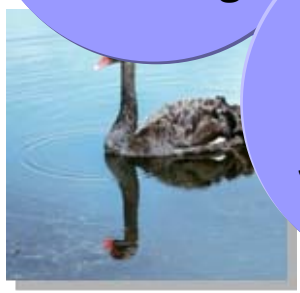
Economic Mega Trends

Expansion Of R&D Funding

The Black Swan Syndrome

The Expanding Education Base





Dictates More Agility / Technology Options

Example – Medical R&D
Combat Casualty Care Research Program

…technologies that save lives far forward on the battlefield, maintain critical care at all levels of the battlefield, and enhance recovery from combat trauma.

Meet demands on first responders
- Warrior Medic Diagnostic System
- Warfighter Physiological Status Monitor
- Decision assist tools for lifesaving interventions

Improve en route care
- Oxygen conservation
- Closed-loop algorithms
- Lightweight modules

Reduce the number of deaths on the battlefield
- Recombinant Factor VIIa
- Freeze-Dried Plasma
- Damage control resuscitation
- Enhanced resuscitation fluids
- Cryopreserved Platelets

Restore full function
- Armed Forces Institute of Regenerative Medicine

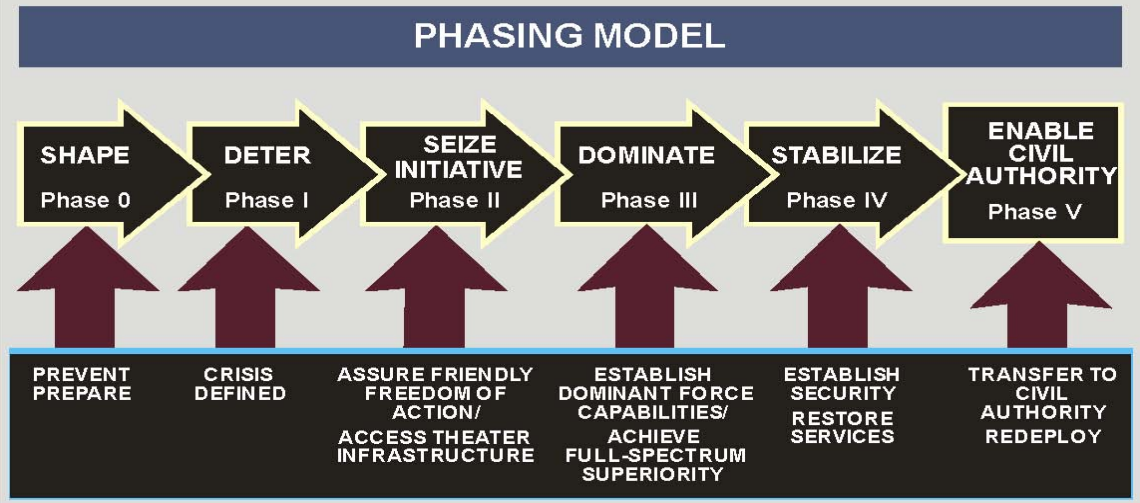
Fingertip regeneration in a 78-year-old man

Limit brain damage
- Biomarkers
- Diagnostic device
- Neuroprotective drugs
- Silent seizure drug

Explore treatments for blast injury
- Pneumothorax detector
- Restoration of hearing loss
- Blast lung

6 Phase Model of Joint Operations

From Joint Pub 3-0



Phase 0 – ***Shape*** – Operations designed to assure success by shaping perceptions and influencing the behavior of both adversaries and allies

Phase 1 – ***Deter*** – Operations to deter undesirable adversary action by demonstrating the capabilities and resolve of the joint force

Phase 2 – ***Seize Initiative*** – Operations to gain access to theater infrastructure and to expand friendly freedom of action while degrading enemy capabilities

Phase 3 – ***Dominate*** – Operations focused on breaking the enemy's will for organized resistance

Phase 4 – ***Stabilize*** – Operations to perform limited local governance, integrating the efforts of other multinational, OGA, IGO, NGO participants

Phase 5 – ***Enable Civil Authority*** – Operations by the joint force to support legitimate civil governance

The Minerva Initiative

A DoD-sponsored, university-based social science research initiative focusing on areas of strategic importance to U.S. national security policy

Initial research in the following areas:

- **Chinese Military and Technology Studies**
- **Iraqi and Terrorist Perspectives Projects**
- **Religious and Ideological Studies**
- **New Approaches to National Security, Conflict and Cooperation**