



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

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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...?

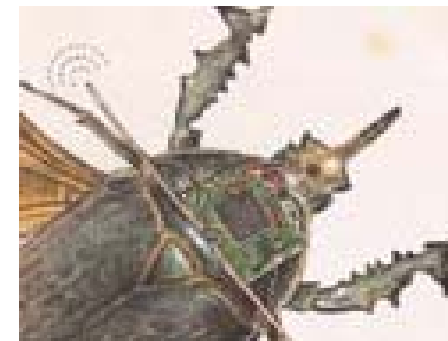
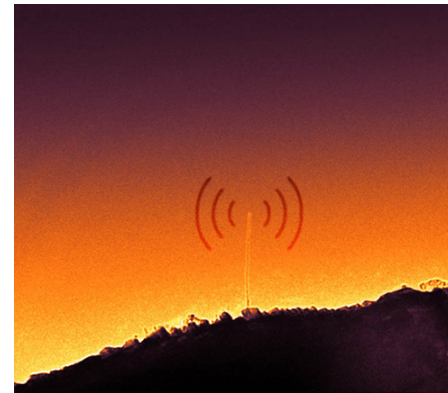
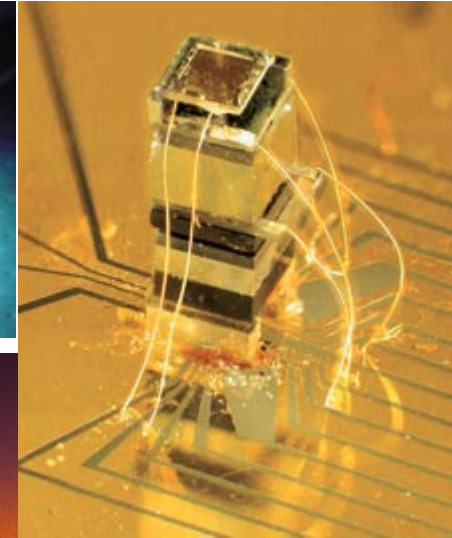
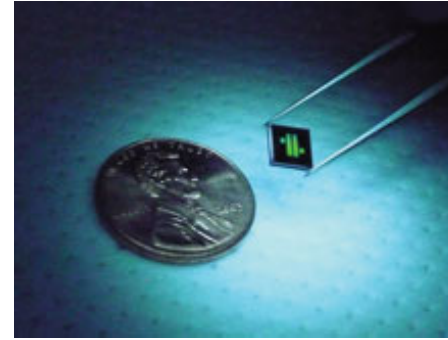
Expanding Knowledge Base

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)*

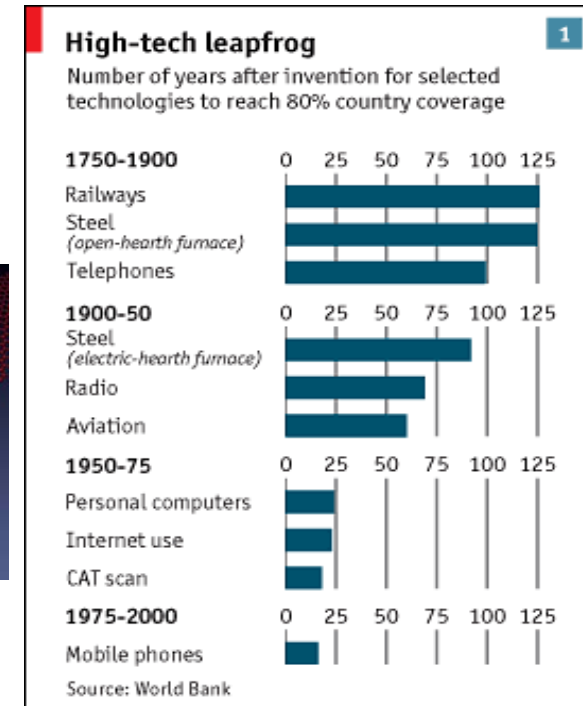
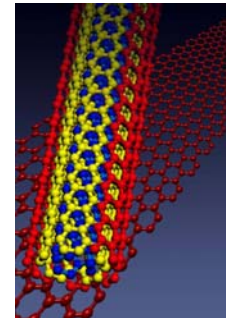


Technology opportunities are expanding, but not well understood...

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



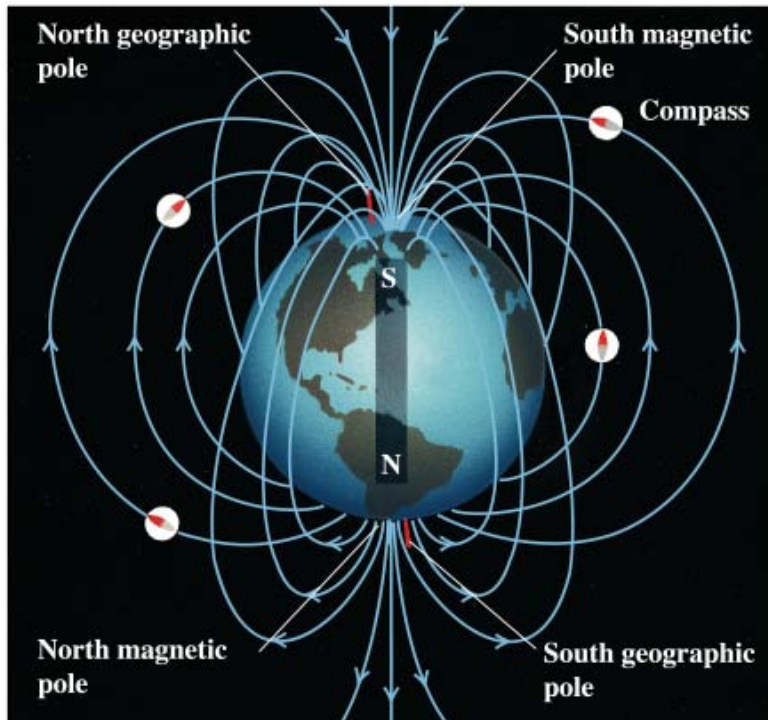
FY2010 Budget will contain “recommendations that are the product of a holistic assessment of capabilities, requirements, risks and needs for the purpose of shifting this Department in a different strategic direction” *

*** 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**

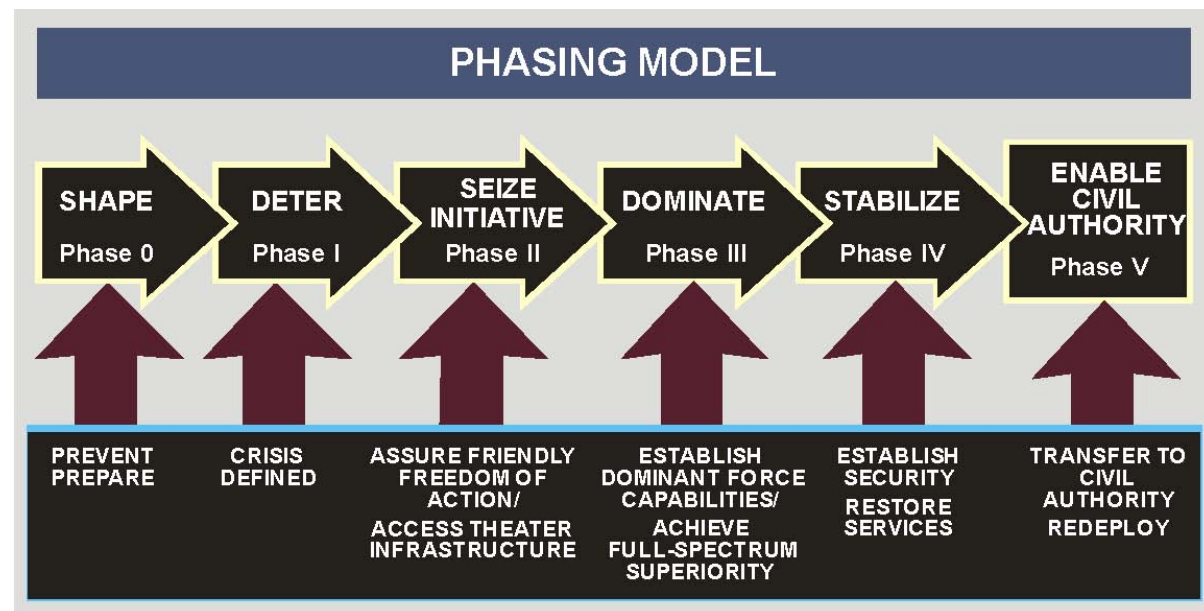


Led To Resurgence of Irregular Military Operations



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

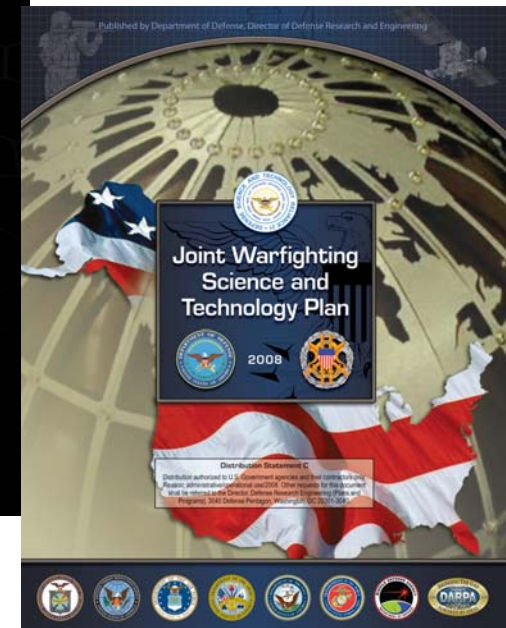
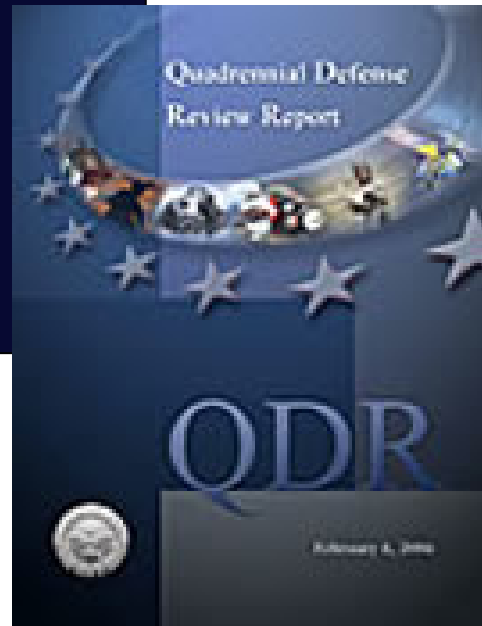
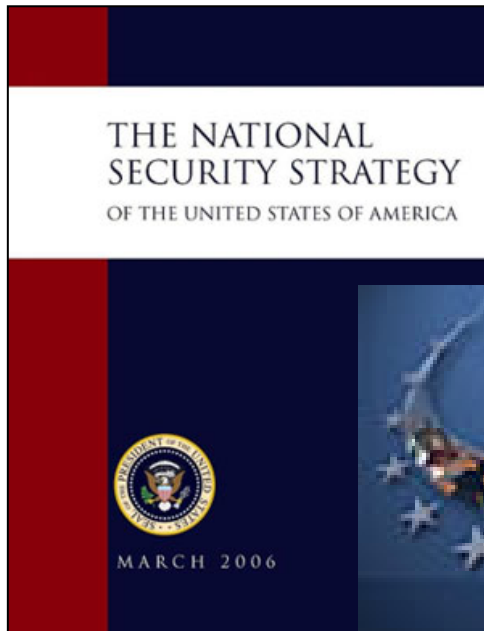
- **Today's global economy is technology driven**
- **Adversaries will increasingly leverage technology to challenge U.S Armed forces capabilities**
- **Irregular and asymmetric forms of warfare are likely**
- **Economic, demographic, resource, technology, and climate trends will present new challenges**



Strategic Plans

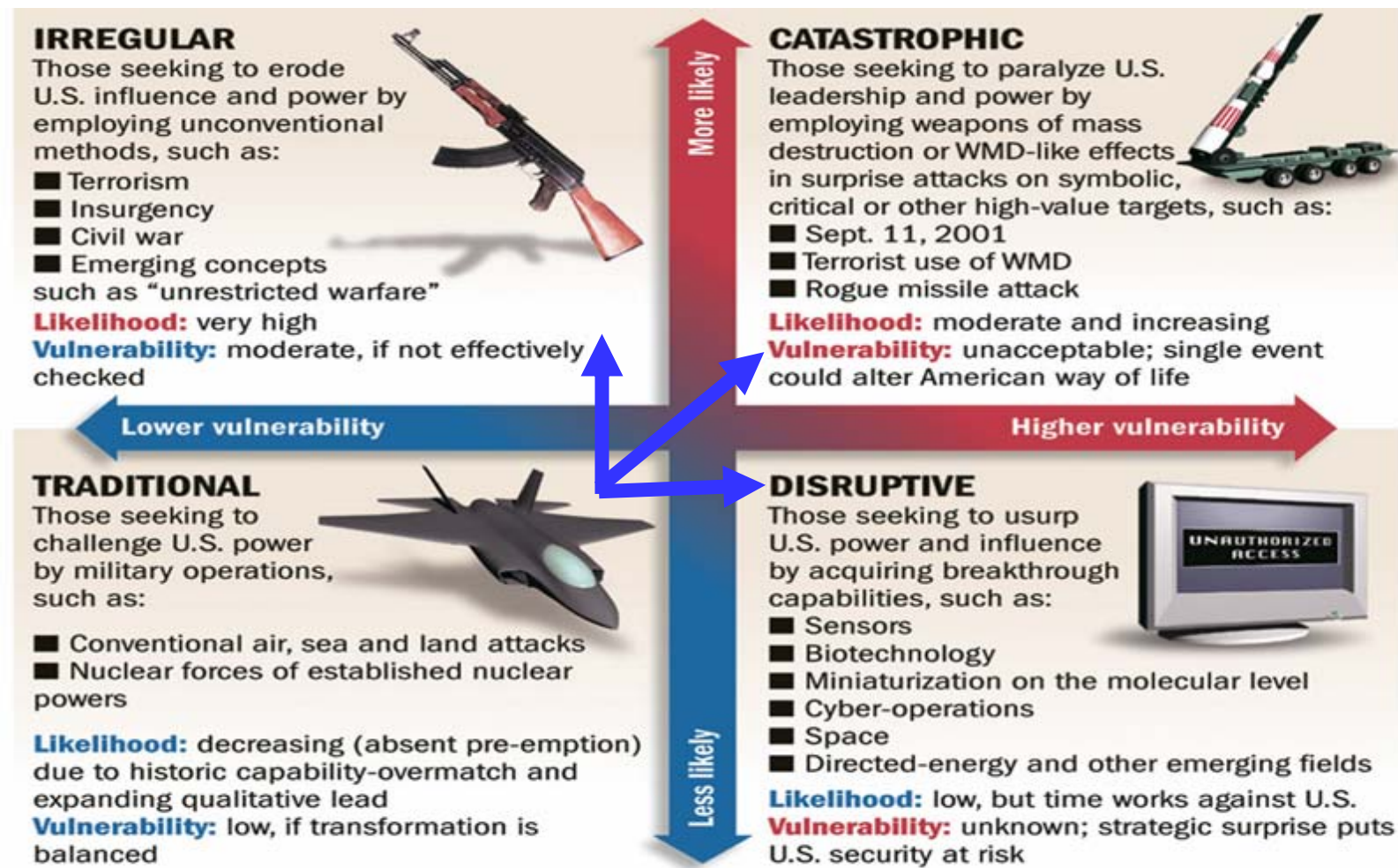


Defense Science and Technology Strategy and Planning





National Defense Strategy Drives Investment Strategy



SOURCE: U.S. Defense Department

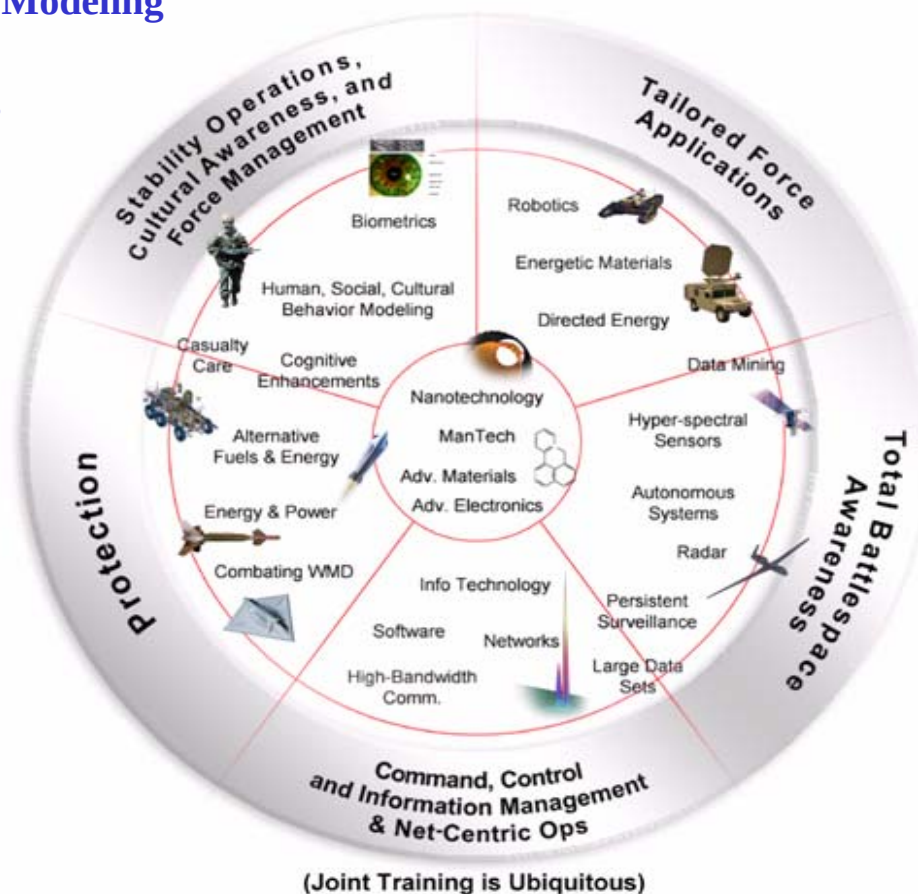
DEFENSE NEWS GRAPHIC BY CHRIS BROZ



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

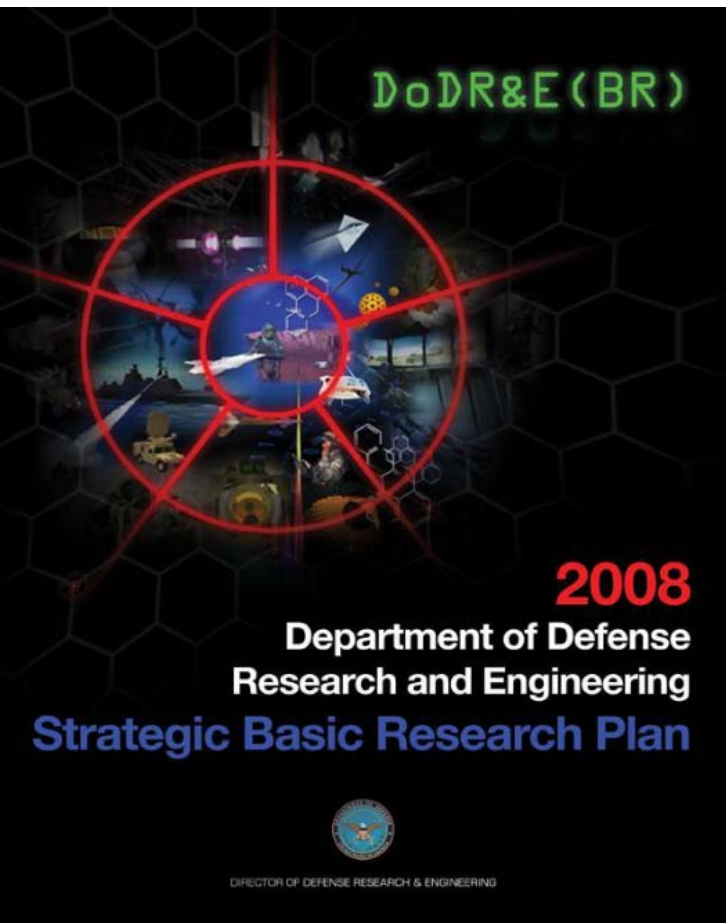
President Obama, Science Debate, September 2, 2008



"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



April 2009 Budget Statement

- *Imperative 1: Take care of our people* -

- Personnel & Platform Protection
- Advanced Medical Research
- Education

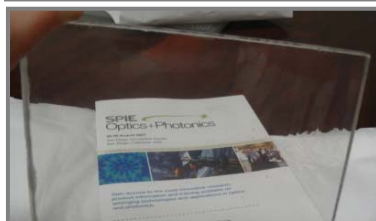




Example – Protection Lightweight Armor

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**

**Ballistic testing completed at Army
Research Lab with areal density ~18 lbs/ft²**

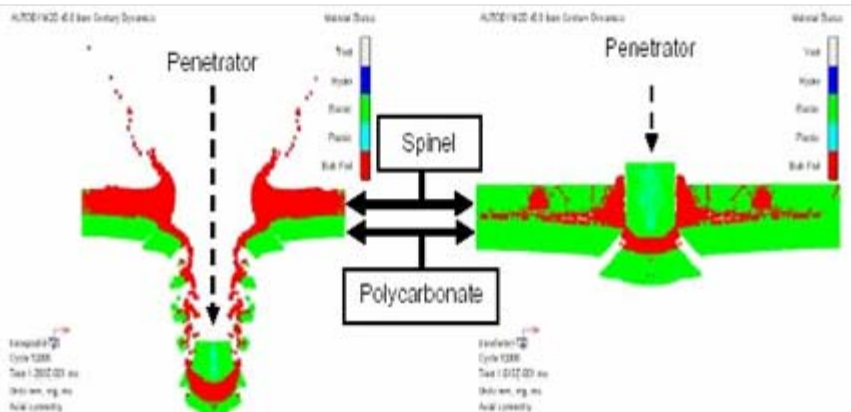
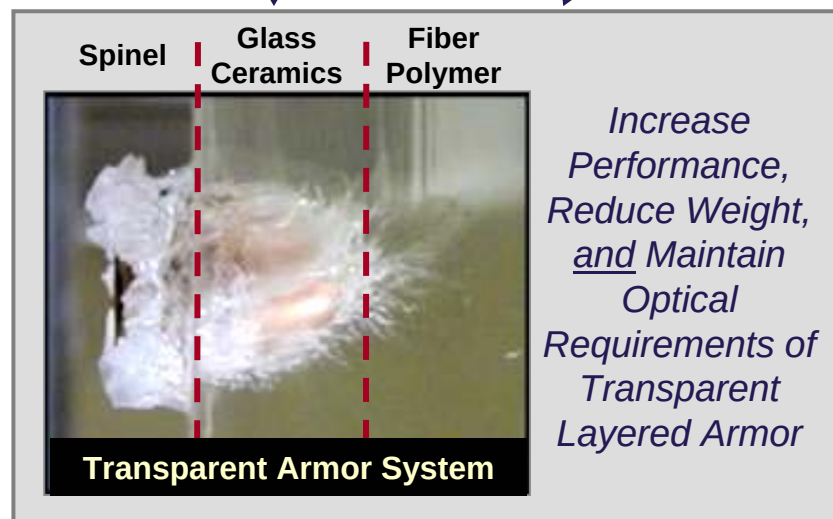
Improved Backing Materials: Glass Ceramics and Transparent Polymers



Glass Ceramic



**Glass Fiber
Reinforced Polymer**





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

April 2009 Budget Statement

- 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



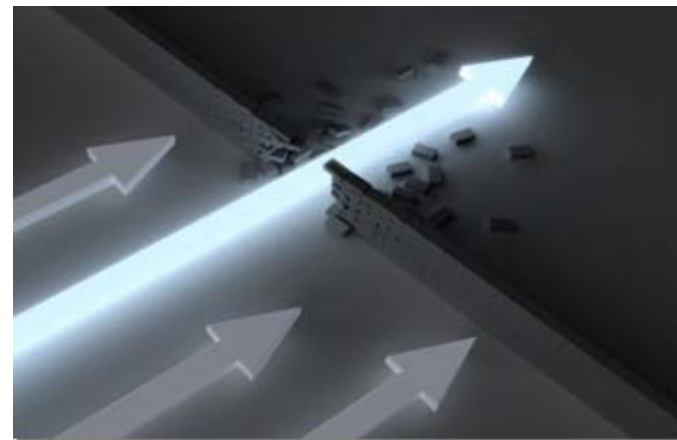
- **Joint Analysis Teams**
- **Milestone Development Decisions**
- **Information Access**
- **DoD Challenge Programs**
- **Technology Transition Initiatives**
- **Operational Prototyping**



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 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

Single SR	41 p
Double SR	2
Quad SR	6
Quad SR	7

TROOP SEATS

312 p

TROOP BERTHS

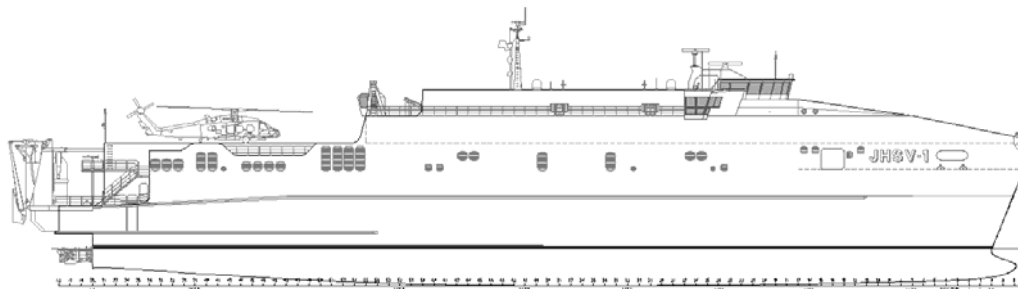
Permanent	104 p
Temporary	46 p

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)



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

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)

AUXILIARY SYSTEMS

ACTIVE RIDE CONTROL

Transom Interceptors

Foils: 3.24 m² (34.9 ft²) 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

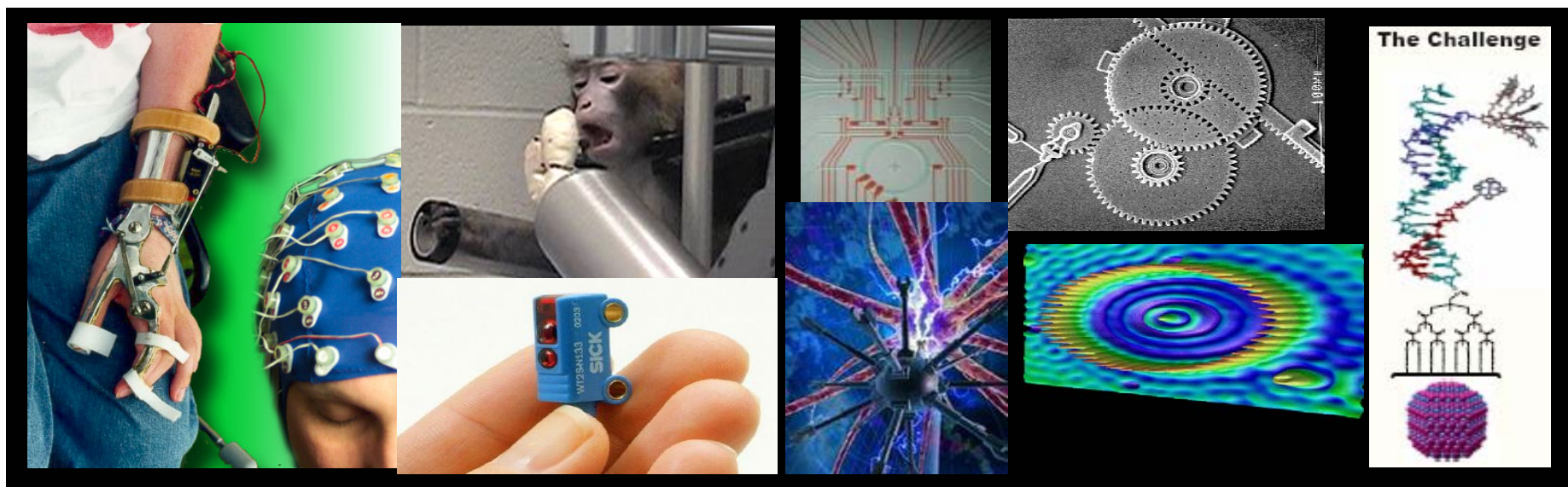
- (4) .50 Caliber Machine Guns
- Reservation for AT/FP System
- Reservation for Non-Lethal Effectors

FIREFIGHTING

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

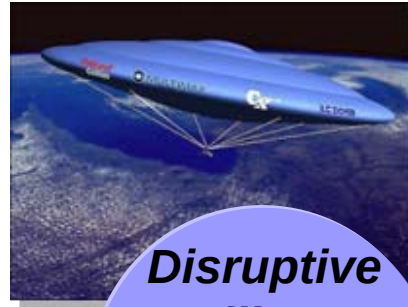
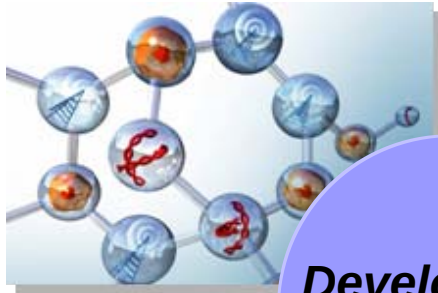
Implications

- 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 . . .



**Development
Pace**

**Disruptive
Military
Uses of
Commercial
Tech**

**Impact of
Mass
Collaboration**

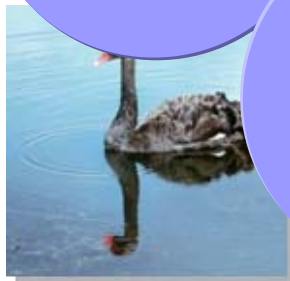
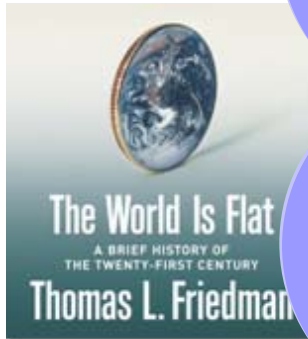
**Emerging
Technology**

**Expansion
Of
R&D
Funding**

**Economic
Mega
Trends**

**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

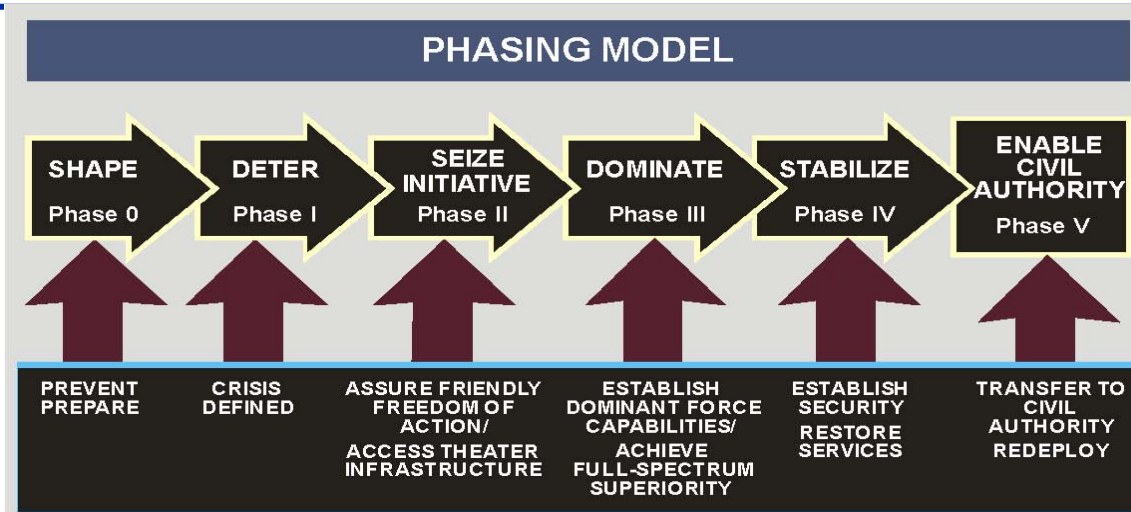


Explore treatments for blast injury

- 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**