2007 Disruptive Technologies Conference

"Disruptive Technologies: Turning Lists into Capabilities"

4 – 5 September 2007

Washington, DC

Agenda

Tuesday 4 September 2007

Keynote Speaker: Mr. Rich Engel, Deputy National Intelligence Officer for Science & Technology, National Intelligence Council

Lessons and Successes: Adapting Technology to Enhance the Warfighter

Evolving Joint Needs and Desired Joint Military Capabilities:

Moderator: Mr. Mike Knollmann, Assistant Deputy Under Secretary of Defense (Joint & Coalition Operations Support)

- USSOCOM: Mr. Doug Richardson, USSOCOM Washington Office Liaison for Advanced Technology
- USPACOM: Mr. Mel Chaloupka, Chief, Transformation and Joint Experimentation
- USSTRATCOM: Mr. Shawn Spencer, Director, Technologies & Capability Development

Panel 1: Industry's Disruptive Technologies

- ***"Weaponizing the Spectrum,"*** *Mr. Kalle Konston,* Alion Science & Technology
- "***Self-Powered Autonomous Next Generation Chem-Bio Sensors***," *Dr. Richard Waters,* SPAWAR Systems Center
- "***Robots: Changing the Way We Fight and Live,"*** *VADM Joseph Dyer*, USN (Ret), iRobot Corp.

Panel 2: The Need for Blue Force Disruptive Technologies

- ***"Informatics as the Next Engine of Innovation,"*** *Dr. Zachary Lemnios*, Chief Technology Officer, MIT Lincoln Laboratory
- ***"Perspectives on Disruptive Technology,"*** *Dr. Frank H. Akers*, Junior Chairman, Army Science Board and Associate Laboratory Director for National Security, Oak Ridge National Lab
- ***"Science & Technology for Naval Warfare, 2015-2020,"*** *Dr. Mark Lister*, Member, Naval Research Advisory Council

Wednesday, 5 September 2007

Panel 3: Technology Challenges: Ultra Hard Problems

- ***"Predictive Human Behavior,"*** *CDR Sean Biggerstaff*, USN Assistant Director, Human Systems, Office of the Director, Defense Research & Engineering
- **"Stand-off *Biometric Identification,"*** *Mr. Thomas Dee*, Director, Biometrics, Rapid Reaction Technology Office, Office of the Director, Defense Research & Engineering

Panel 4: Disruptive Technology: Happenings and Prospects

- ***"Disruptive Sensor & Electronic Technologies for Land Operations,"*** *Dr. John Pellegrino*, Director for Sensors and Electron Devices, Army Research Laboratory
- ***"Propulsion/Hypersonic Technologies,"*** *Dr. William Borger*, Director, Air Force Research Laboratory/ Propulsion Directorate
- ***"Naval Innovation & Disruptive Technology,"*** *Dr. Lawrence C. Schuette*, Director of Innovation, Office of Naval Research
- "Training and Mission Rehearsal," *Mr. Frank DiGiovanni*, Office of the Under Secretary of Defense for Personnel & Readiness

Disruptive Technologies Conference

"Disruptive Technologies: Turning Lists into Capabilities"

September 4-5, 2007

Hyatt Regency Washington
on Capitol Hill

Event #7920
On-Site Brochure

NDIA
NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

TUESDAY, SEPTEMBER 4

All briefings and panel discussions will take place in the Capitol Room

7:00 am Registration and Continental Breakfast in the Capitol Room Foyer

8:00 am Welcome Remarks and Introductions
Mr. Sam Campagna, Director, Operations, NDIA;
Dr. Steve Kimmel, NDIA C4ISR Division Chairman, Senior Group Vice President, Alion Science & Technology

8:15 am Assessment—Worldwide Disruptive Technology Developments: Metrics and Threats
Keynote Speaker: Mr. Rich Engle, Deputy National Intelligence Officer for Science & Technology, National Intelligence Council

9:15 am 4th Generation Nuclear S&T
Guest Speaker: Mr. David Crandall, Assistant Deputy Administrator for Research, Development & Simulation, Department of Energy

10:00 am Break

10:30 am **Lessons and Successes: Adapting Technology to Enhance the Warfighter**

10:30 am Evolving Joint Needs and Desired Joint Military Capabilities: *Moderator: Mr. Mike Knollmann, Assistant Deputy Under Secretary of Defense (Joint & Coalition Operations Support)*

10:45 am USSOCOM: *Mr. Doug Richardson, USSOCOM Washington Office Liaison for Advanced Technology*

11:10 am USPACOM: *Mr. Mel Chaloupka, Chief, Transformation and Joint Experimentation*

11:35 am USSTRATCOM: *Mr. Shawn Spencer, Director, Technologies & Capability Development*

12:00 pm Lunch in the Columbia Room

1:00 pm **[Panel 1] Industry's Disruptive Technologies**
Moderator: Mr. Mike Gulli, Director, Technology Marketing and Transition, Planning Systems, Inc.

1:00 pm	Night Vision Countermeasures and Response	Mr. William Parker *The O'Gara Group*
1:20 pm	Weaponizing the Spectrum	Mr. Kalle Konston *Alion Science & Technology*
1:40 pm	Self-Powered Autonomous Next Generation Chem-Bio Sensors	Dr. Richard Waters *SPAWAR Systems Center*
2:00 pm	Robots: Changing the Way We Fight and Live	VADM Joseph Dyer, USN (Ret) *iRobot Corp.*
2:20 pm	Panel Q&A	

2:30 pm Break

3:00 pm **[Panel 2] The Need for Blue Force Disruptive Technologies**
Moderator: Mr. Ed Patton, PriceWaterhouseCoopers

3:00 pm	Informatics as the Next Engine of Innovation	Dr. Zachary Lemnios *Chief Technology Officer, MIT Lincoln Laboratory*
3:30 pm	Perspectives on Disruptive Technology	Dr. Frank H. Akers *Junior Chairman, Army Science Board and Associate Laboratory Director for National Security, Oak Ridge National Lab*
4:00 pm	Science & Technology for Naval Warfare, 2015-2020	Dr. Mark Lister *Member, Naval Research Advisory Council*
4:30 pm	Resourcing Disruptive Technologies	Mr. Alan Shaffer *Director, Plans & Programs, Office of the Director, Defense Research & Engineering*

5:00-6:00 pm No-Host Reception in the Thornton Room, 11th Floor

WEDNESDAY, SEPTEMBER 5

All briefings and panel discussions will take place in the Capitol Room

7:00 am Registration and Continental Breakfast in the Capitol Room Foyer

8:00 am Featured Presentation: Disruptive Intelligence Gathering From Technology to Systems for National Security
Hon. James Clapper, Jr., Under Secretary of Defense for Intelligence

8:30 am **[Panel 3] Technology Challenges: Ultra Hard Problems**
Moderator: Dr. Melissa Flagg, Director, International Liaison Office, Office of Naval Research Global

8:30 am	Loose Nucs	Dr. Gabriel Sampoll-Ramirez *Nuclear Technologies Detection Division Chief, Defense Threat Reduction Agency*
8:45 am	Predictive Human Behavior	CDR Sean Biggerstaff, USN *Assistant Director, Human Systems, Office of the Director, Defense Research & Engineering*
9:00 am	Continuous Tagging, Tracking & Locating	Mr. Doug Richardson *USSOCOM*
9:15 am	Stand-off Biometric Identification	Mr. Thomas Dee *Director, Biometrics, Rapid Reaction Technology Office, Office of the Director, Defense Research & Engineering*

9:30 am Break

10:00 am High Integrity Global Positioning System (iGPS): *Dr. David Whelan, Member, Air Force Scientific Advisory Board*

10: 30 am **[Panel 4] Disruptive Technology: Happenings and Prospects**
Moderator: Mr. Robert Baker, Deputy Director, Plans & Programs, Office of the Director, Defense Research & Engineering

10:30 am	Disruptive Sensor & Electronic Technologies for Land Operations	Dr. John Pellegrino *Director for Sensors and Electron Devices, Army Research Laboratory*
11:00 am	Propulsion/Hypersonic Technologies	Dr. William Borger *Director, Air Force Research Laboratory/ Propulsion Directorate*
11:30 am	Naval Innovation & Disruptive Technology	Dr. Lawrence C. Schuette *Director of Innovation, Office of Naval Research*
12:00 pm	Training and Mission Rehearsal	Mr. Frank DiGiovanni *Office of the Under Secretary of Defense for Personnel & Readiness*

12:30 pm Conference Adjourns

Notes

“Disrupt the Culture by Culturing the Disruption”

Frank H. Akers, Jr., Ph.D.
Chairman, Army Science Board
Associate Laboratory Director
for National Security
Oak Ridge National Laboratory

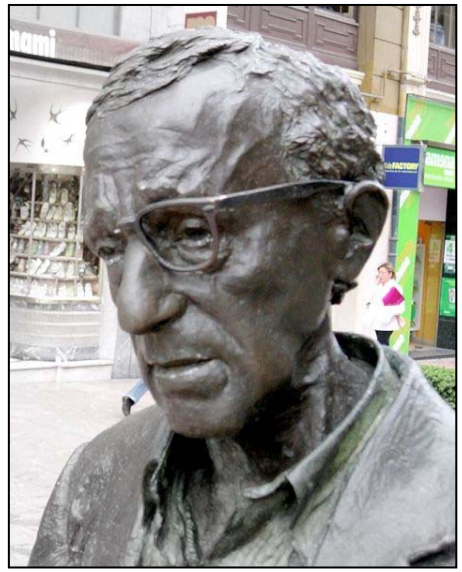
September 4, 2007
Washington, DC

“All I’m saying is, <u>now</u> is the time to develop the technology to deflect an asteroid.”

OAK RIDGE National Laboratory

OAK RIDGE National Laboratory

“More than any other time in history, we face a crossroads. One path leads to despair and utter hopelessness. The other, to total extinction. Let us pray we have the wisdom to choose correctly.”



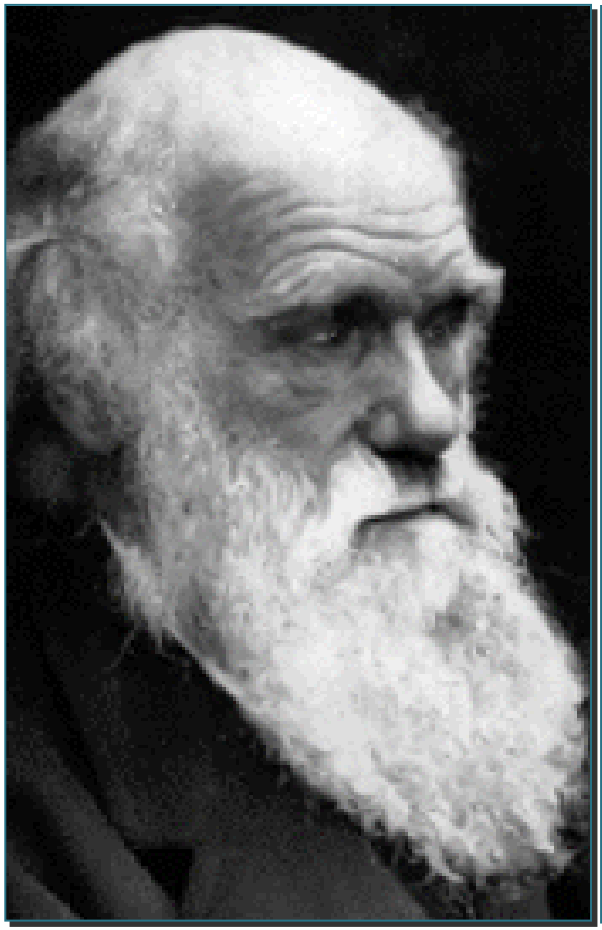
Woody Allen

OAK RIDGE National Laboratory

“The illiterate of the 21st Century will not be those who cannot read and write, but those who cannot learn, unlearn and relearn.”

Alvin Toffler

OAK RIDGE National Laboratory



“It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change.”

– Charles Darwin

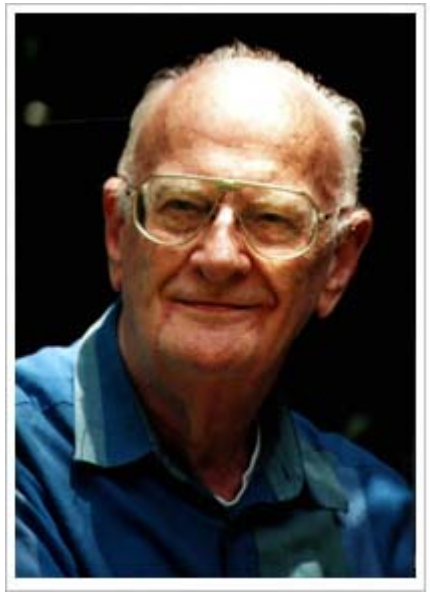
OAK RIDGE National Laboratory

“Every revolutionary idea seems to evoke three stages of reaction. They may be summed up by the phrases…

(1) It’s completely impossible.

(2) It’s possible, but it’s not worth doing.

(3) I said it was a good idea all along.”



Arthur C. Clarke

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I NEVER DID THAT…. AND …..

I'LL NEVER DO IT AGAIN

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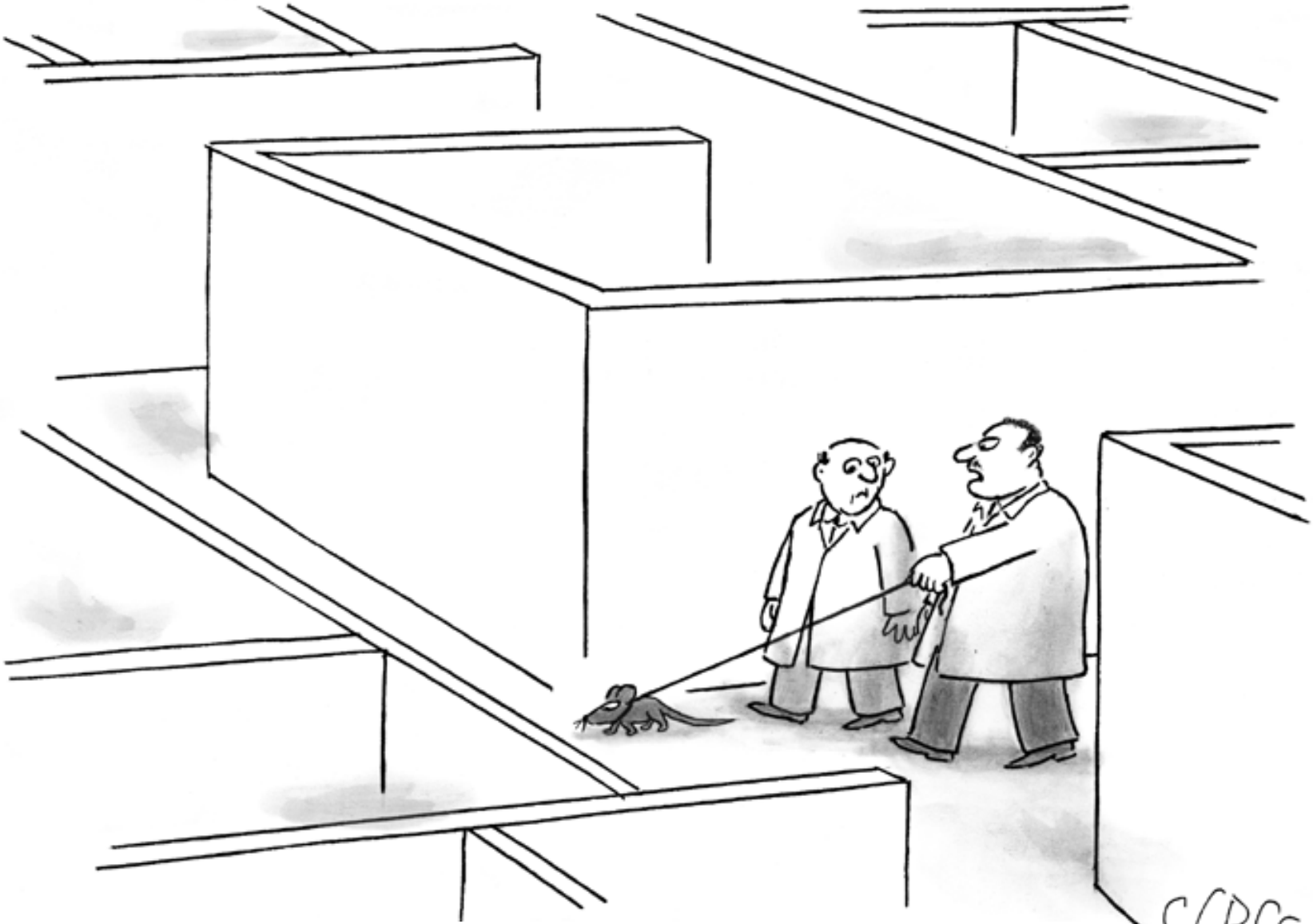

"Genetic engineering got us into this mess, and genetic engineering will get us out of it."

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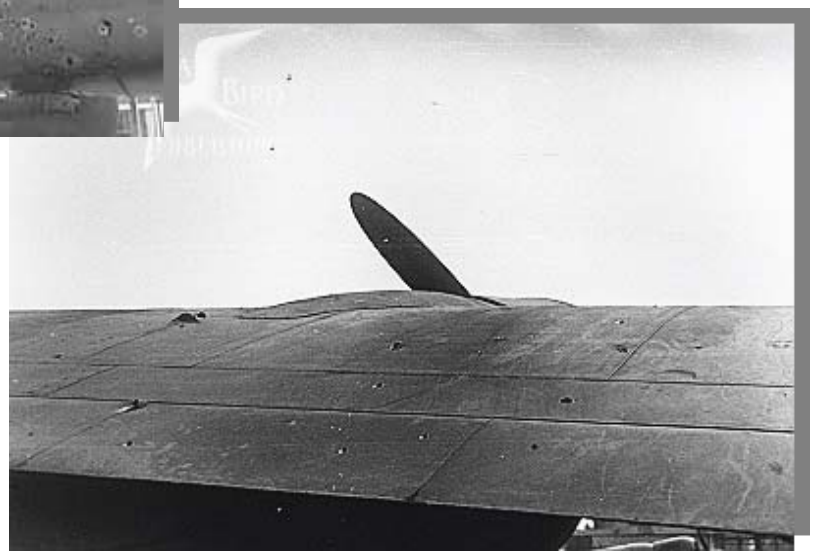
From The New Yorker Book of Technology Cartoons.

“Vu ja de”



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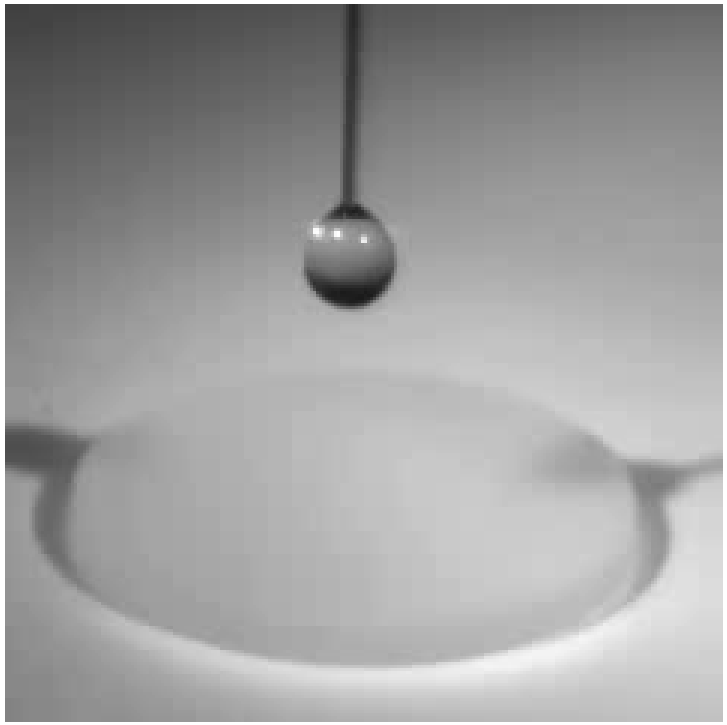
Reverse The Process



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THE PENTAGON'S NEW MAP

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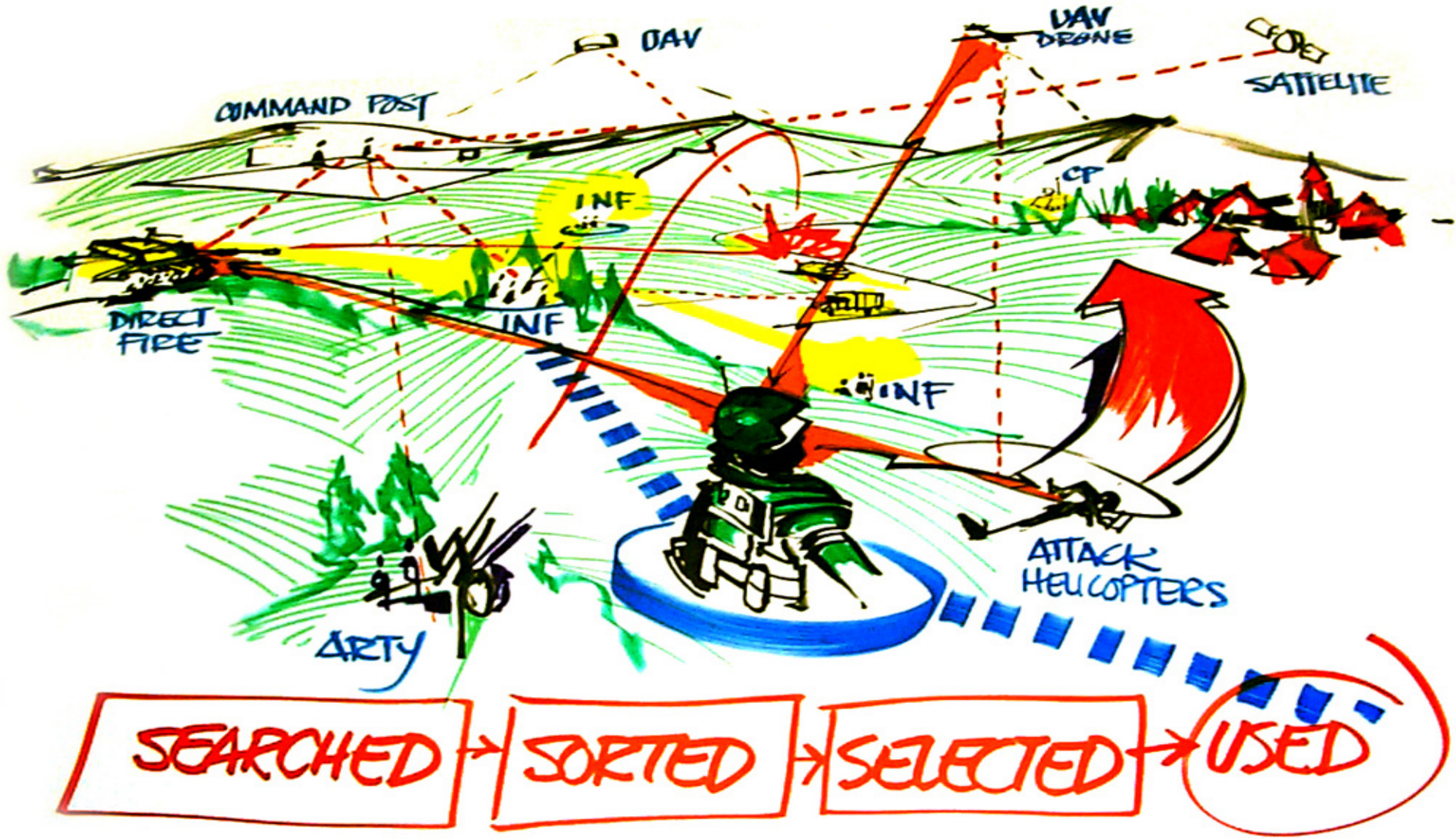
The Art of the Possible – The Visioning Process



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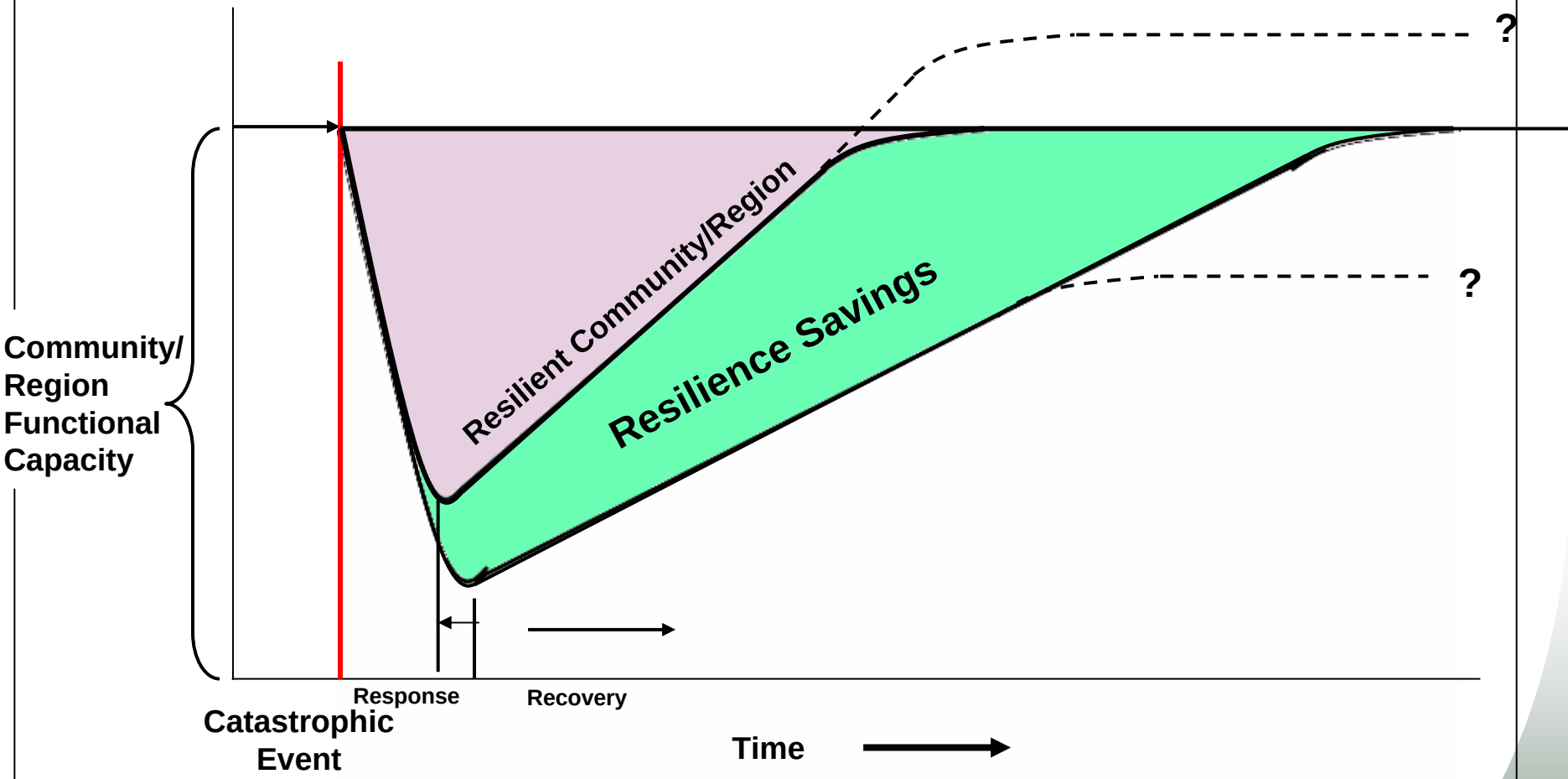
Regional Resilience Impact…



Regional Resilience is an Economic Driver

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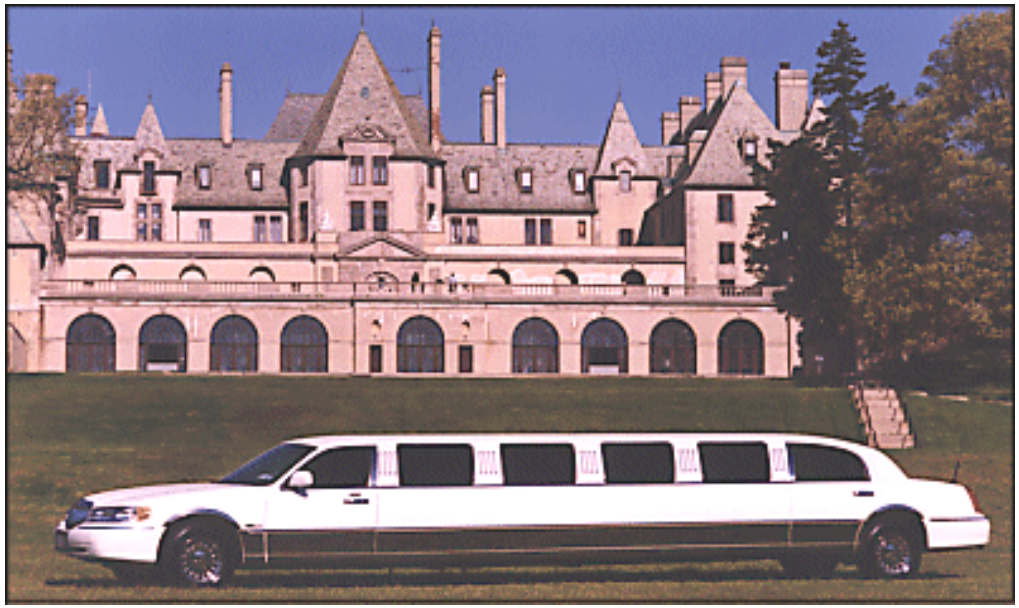
“Man’s mind stretched to a new idea never goes back to its original dimensions.”

-- Oliver Wendell Holmes



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“Never be afraid to try something new. Remember, amateurs built the Ark. Professionals built the Titanic!”

-- Unknown

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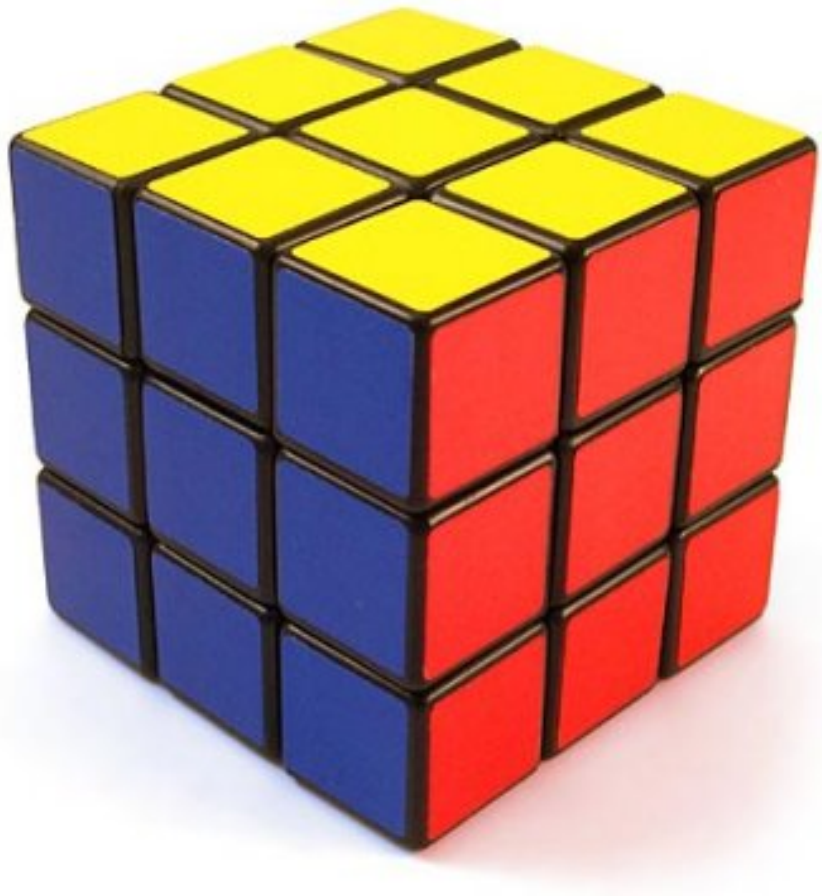

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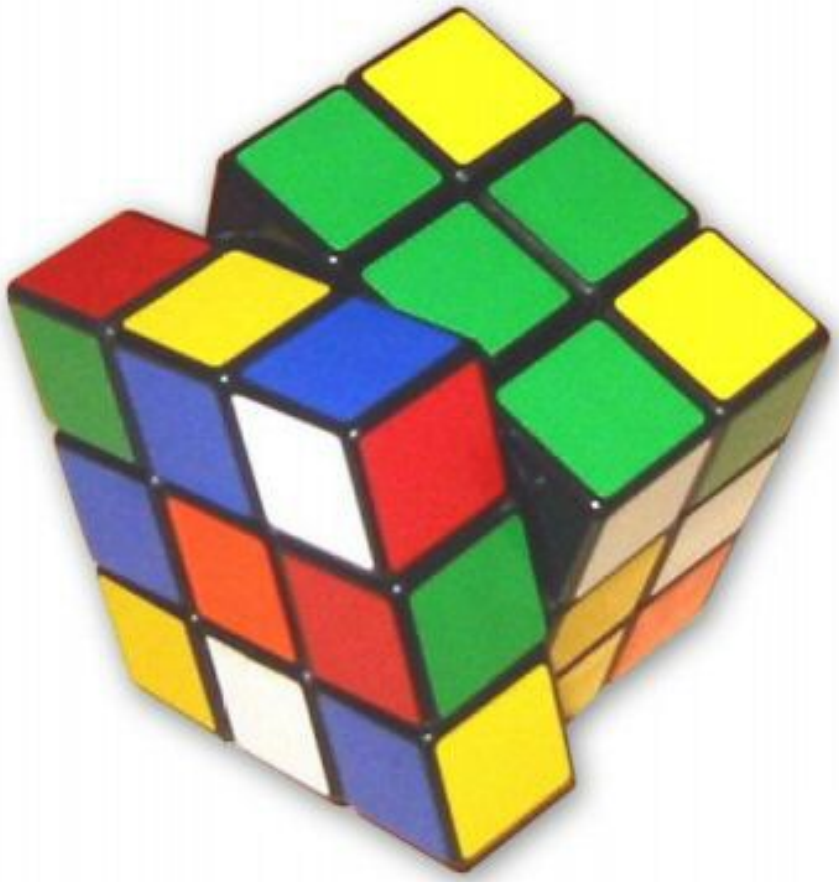

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"There is still a tendency in each separate unit … to be a one-handed puncher. By that I mean the rifleman wants to shoot, the tanker wants to charge, the artilleryman to fire … That is not the way to win battles. If the band played a piece first with a piccolo, then with the bass horn, then with the clarinet, and then with the trumpet, there would be a hell of a lot of noise, but no music. To get harmony in music, each instrument must support the other. Team play wins! You musicians of Mars must come into the concert at the proper place and at the proper time."

-- MG George S. Patton, Jr.
Fort Benning, GA 1941

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"Trust me Mort—no electronic-communications superhighway, no matter how vast and sophisticated, will ever replace the art of the schmooze."

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“Blessed are the flexible, for they shall not be bent out of shape.”

-- Anonymous

OAK RIDGE National Laboratory

Human Social Culture Behavior Modeling (HSCB) Program

CDR Sean Biggerstaff
Assistant Director, Human Systems
ODUSD (Science & Technology)

Human Social Culture Behavior Modeling
- Background -

- **2006 QDR:**
  - **"….the importance of early measures to prevent problems from becoming conflicts and conflicts from becoming crises (pp.17-18)"**
  - **"..This war is both a battle of arms and a battle of ideas – a fight against terrorist networks and against their murderous ideology (p.24)"**
  - **"..considerably improved language and cultural awareness to develop a greater understanding of emerging powers and how they may approach strategic choices (p.31)"**
  - **"..Human intelligence, language skills and cultural awareness to understand better the intentions and motivations of potential adversaries and to speed recovery efforts (p.35)"**
  - **"..foster a level of understanding and cultural intelligence about the Middle East and Asia comparable to that developed about the Soviet Union during the Cold War (p. 78)"**

- **DoDD 3000.05 (Military Support for Stability, Security, Transition and Reconstruction Operations):**
  - **"Stability operations are a core U.S. military mission…given priority comparable to combat operations…."**
  - **"U.S. military forces shall be prepared to perform...stability operations tasks…Rebuild indigenous institutions…..bottom-up economic activity and constructing necessary infrastructure… "**

Human Social Culture Behavior Modeling
- Background -

- **Recognized Operational Need:**

  – "..the QDR acknowledges that victory in this long war depends on information, perception, and how and what we communicate as much as application of kinetic effects. These cultural and language capabilities also enhance effectiveness in a coalition setting during conventional operations." Gen. P. Pace (2006 QDR: Commander's Assessment)

  – "I asked my Brigade Commanders what was the number one thing they would have liked to have had more of, and they all said cultural knowledge." Lt. Gen. P. Chiarelli (Dec 06)

  – "Must develop the ability to understand the complex human factors and must incorporate them into all facets of operations." Maj. Gen. L. Freakley, CG 10th Mountain Div (Operational Needs Statement, Feb 06)

Human Social Culture Behavior Modeling
- Description -

- Reason for Initiative: DoD has gone beyond its traditional role/capabilities in large force-on-force scenarios to support GWOT. Current and future operations demand the capability to understand the social & cultural terrain and the various dimensions of human behavior within these terrains.

- Description: Initiative will develop a military science base and field technologies that support socio-cultural understanding and human terrain forecasting in intelligence analysis, operations analysis/planning, training, and joint experimentation.

‘Predicting’ Human Behavior

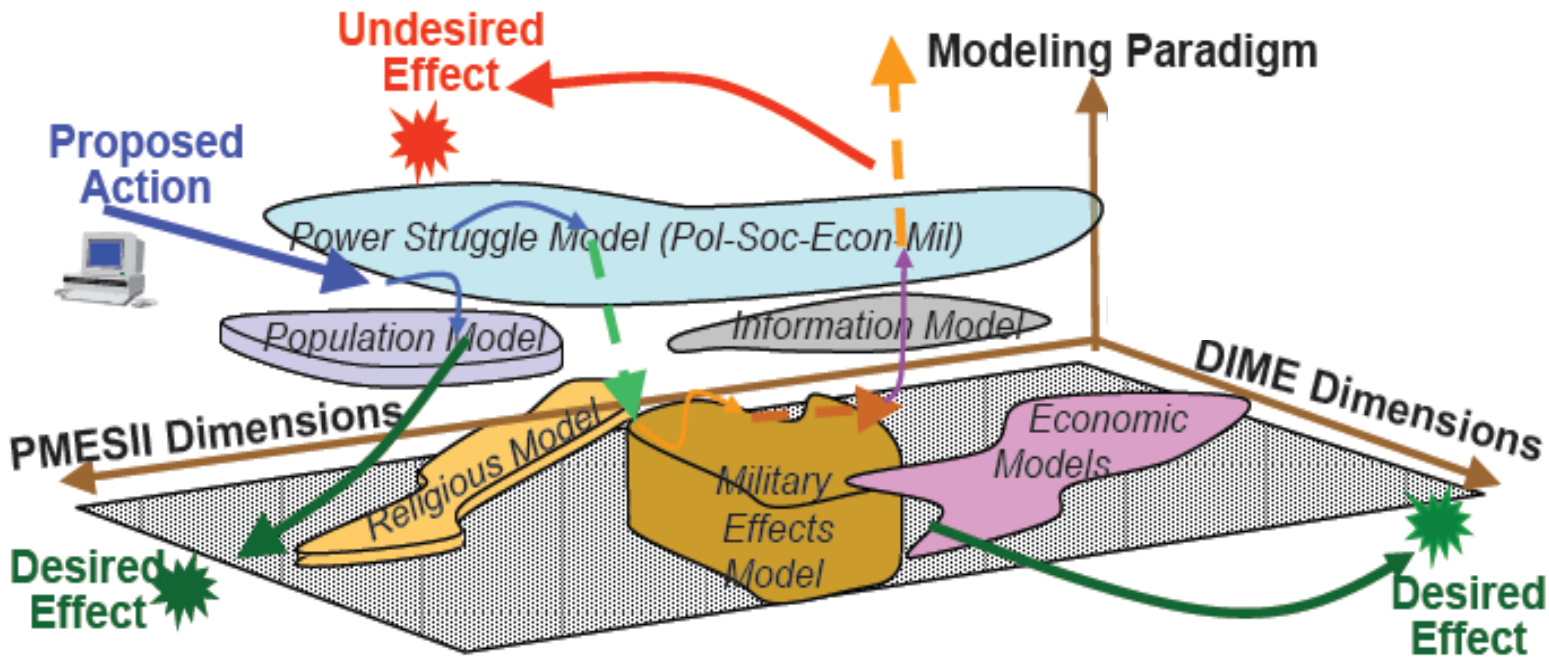
- Science is more than a mere description of events as they occur. It is an attempt to discover order, to show that certain events stand in lawful relation to other events…If we are to use the methods of science in the field of human affairs, we must assume that behavior is lawful and determined. (B.F. Skinner)

- …..when human beings act in certain ways and it seems that the acts are not predetermined and therefore there’s an element of free will, perhaps more likely we are acting from hidden motives than because we have a quantum mechanical random number generator concealed within us. (M. Gell-Mann)

- …we have noted that as we proceed from the…physical through to biological, psychic and sociocultural, the system becomes “looser”, the interrelationships among parts more tenuous, less rigid, and especially less directly tied to physical events as energy relations and transformations are overshadowed by symbolic relations and information transfers….Complex systems are open systems in intimate interchange with an environment characterized by a great deal of shifting variety…the concept of equilibrium developed for closed physical systems is quite inappropriate and usually inapplicable to such a dynamic situation. (W. Buckley)

Human Social Culture Behavior Modeling

“Infinitely (?) complex problem space……”



Human Social Culture Behavior Modeling
- Reasoning Behind the Program -

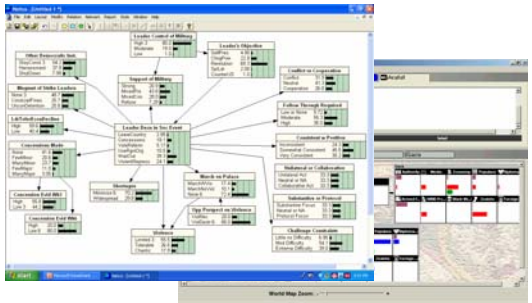
- **No existing U.S. technical HSCB core (in academics, government labs, or industry) for the military domain**
  - Need to develop U.S. commercial and government capability to support GWOT
  - Need to be able to immediately tap HSCB understanding/experiences outside the U.S.

- **Growing ad hoc investment in expedient tools (2003-2006)**
  - Unorganized demand for work in this area
  - Over-focus on near term deliverables that support OEF/OIF specific Phase 4 operations
  - Narrow customer base (e.g., Intelligence Analysts)
  - Half of current technical capability gaps in HSCB are unfunded

- **Limited 'reuse' of data & software and no life-cycle management plan for products**
  - No resources to port and/or extend relevant data, knowledge and tools from one system to another
  - Products being designed with limited capability, and not to receive deeper cultural understanding/future capability
  - Tools and models not designed to generalize to new regions, new tribal/societal structures
  - Tools and models not designed for broader application areas (strategic to tactical)

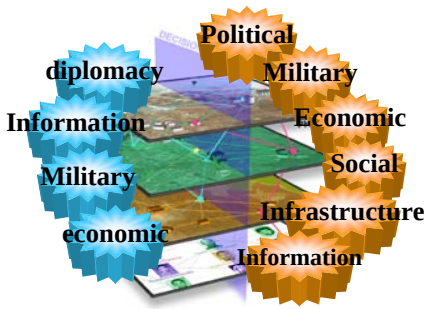
Operational Environments for HSCB Product Use

Intelligence Analysis



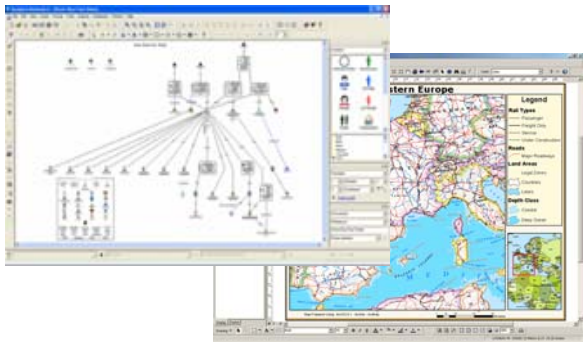
Apollo/Athena
Analysts Notebook
Skope

Experimentation



Multinational experiments
Joint Doctrine Experiments

Operations Planning

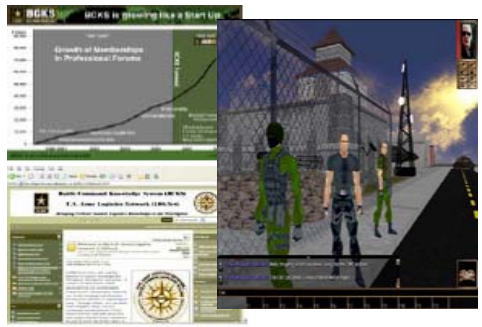


Analysts Notebook
MAP-Human Terrain toolkit
Joint Integrative Analysis and Planning Capability (JIAPC)

Influence Operations

Assymetrical software kit
Situational Influence Assessment Module
JCURE data collection system

Training & Mission Rehearsal



Tactical Language Trainer
Battle Command Knowledge System

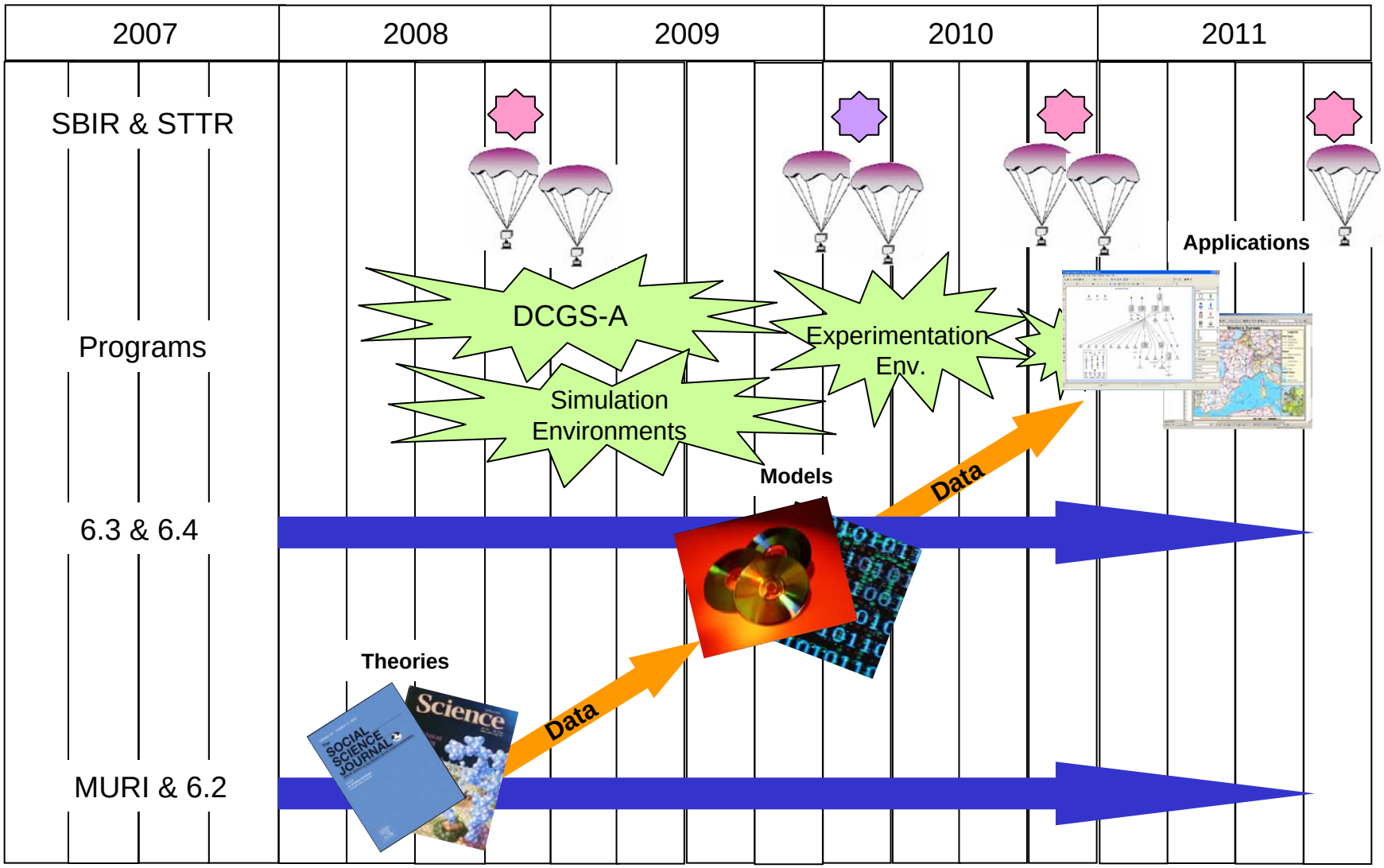
Human Social Culture Behavior Modeling
- Program Overview -

Program Motivation: ***Response to QDR and CoCOMS*** **-** models and understanding of societies, cultures, and human behavior for individuals and groups are complex, not fully understood, accurate for use in DoD planning and decision making for “Phase 0” (Pre-planning/shaping) to “Phase 4” (Stabilization) military activities

Approach: Developed an integrated Research and Engineering (R&E) Initiative, encompassing Basic Research through Prototype/Transition (BA 1 to BA 4), to understand and model HSCB factors

- Develop models to forecast societal, and cultural behaviors and display options for decision makers
- Known need for better capabilities in four areas:
  - Database Infrastructure/Framework
  - Theory
  - Visualization
  - Education and Training

HSCB Program Plan



Human Social Culture Behavior Modeling - Funding & Technical Goals (FY08-13) -

Applied Research (BA2): Data and Visualization frameworks/Infrastructure

- **Generate data and database architectures that provide vertical & horizontal dissemination of social/cultural information**
- **Create quantitative models of social/cultural factors in coalition, enemy, and neutral forces and validate models for military applications**

Advanced Research (BA3): Demonstration in relevant environment

- **Creation of valid, dynamic synthetic adversaries for U.S. and coalition planning and Joint Experimentation**
- **Integration and demonstration of decision support tools that include political, religious, cultural and other factors within battle command planning/re-planning and Command and Control (C2) systems**
- **Demonstration of a battle command/C2 common visualization tool that vertically integrates cultural information into operational planning**
- **Demonstration of operational/tactical training systems that use flexible cultural models/entities.**

Human Social Culture Behavior Modeling
- Funding & Technical Goals (FY08-13) -

Research and Engineering (BA4): Mature and harden models, tools and products for transition

- **Maturation of data collection tools and software into program of record (POR) to support tactical level collection and dissemination of social/cultural data**
- **Maturation of visualization software into POR that supports cultural referenced, actionable information within operational-tactical level C2**
- **Maturation and delivery of training and mission rehearsal systems and software that provide pre-deployment and deployed, scenario-based social/cultural experience to forces for combat, security, stability, transition, and reconstruction operations**
- **Delivery into POR of validated, generalized societal and culture behavior models, with supporting software architectures, applied within multiple user domains**

Human Social Culture Behavior Modeling
- Categories of Anticipated Deliverables -

- **Theory & Science Base**: A military science of societies, cultures, and associated human social dynamics and behaviors

- **Data Models and Methodologies**: Techniques and procedures for data collection, management and dissemination
  - **Formal data models and enabling data collection tools**
  - **Protocols for meta-data tagging**
  - **Protocols for geospatial visualization for planners and analysts**

- **Computational Models**: Software for Command and Control (C2), intelligence and simulation systems
  - **Validated models to support Human Terrain understanding within existing military planning and analysis systems**
  - **Software delivered to new and existing training systems**
  - **Validated models that supports AOR-specific Joint Experimentation exercises**

Questions?

CDR Sean Biggerstaff
Assistant Director, Human Systems
ODUSD (S&T)
Phone: 703-588-7404
Email: sean.biggerstaff@osd.mil

Disruptive Technology: Hypersonic Propulsion

September 2007

Dr. William U. Borger

Director

Propulsion Directorate

Air Force Research Laboratory

Cleared for Public Release: # AFRL HQ 07-0083

Outline

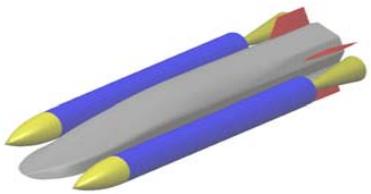
- **The value of speed**
- **What does it take**
- **Summary**

Potential Air Breathing Hypersonic Applications

Source: SAB, Why and Whither of Hypersonic Research in USAF, Dec 2000

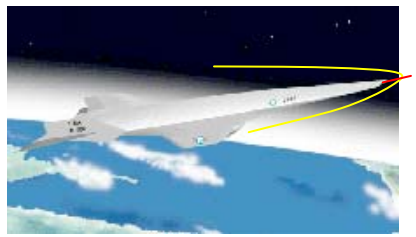
Weapons (missiles)

- Time Critical Mobile targets
- Hard and Deeply Buried Targets
- Suppression of Enemy Air Defense
- Ballistic Missile Defense / Theater Ballistic Missile Defense



Aircraft

- Global Strike/Recce



Space Operations

- Routine launch
- Replace & maintain key satellites

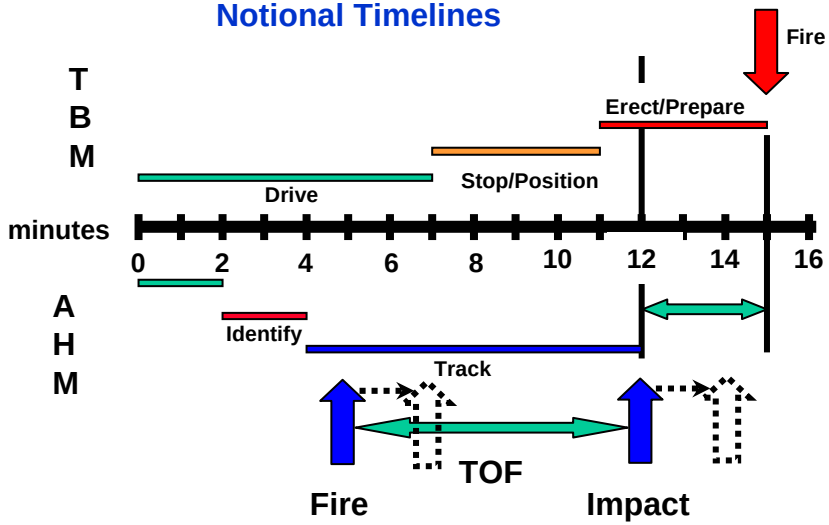
SAB: Scientific Advisory Board

SAB TR 00-03, Cleared for Open Distribution

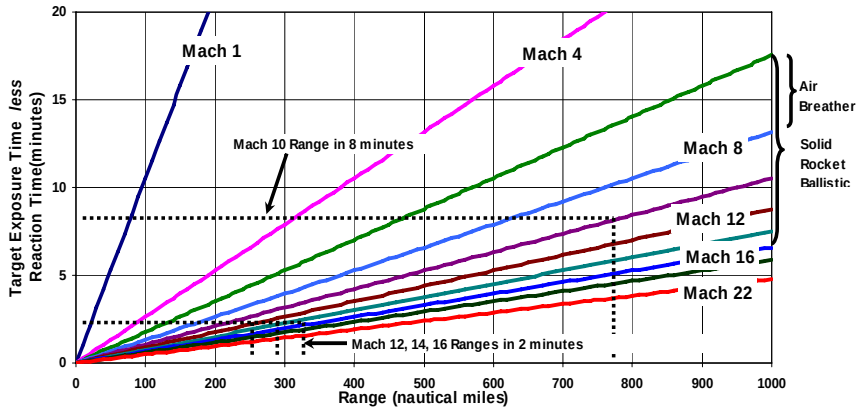
Air Breathing Hypersonic Missile

Source: SAB, Why and Whither of Hypersonic Research in USAF, Dec 2000

Notional Timelines



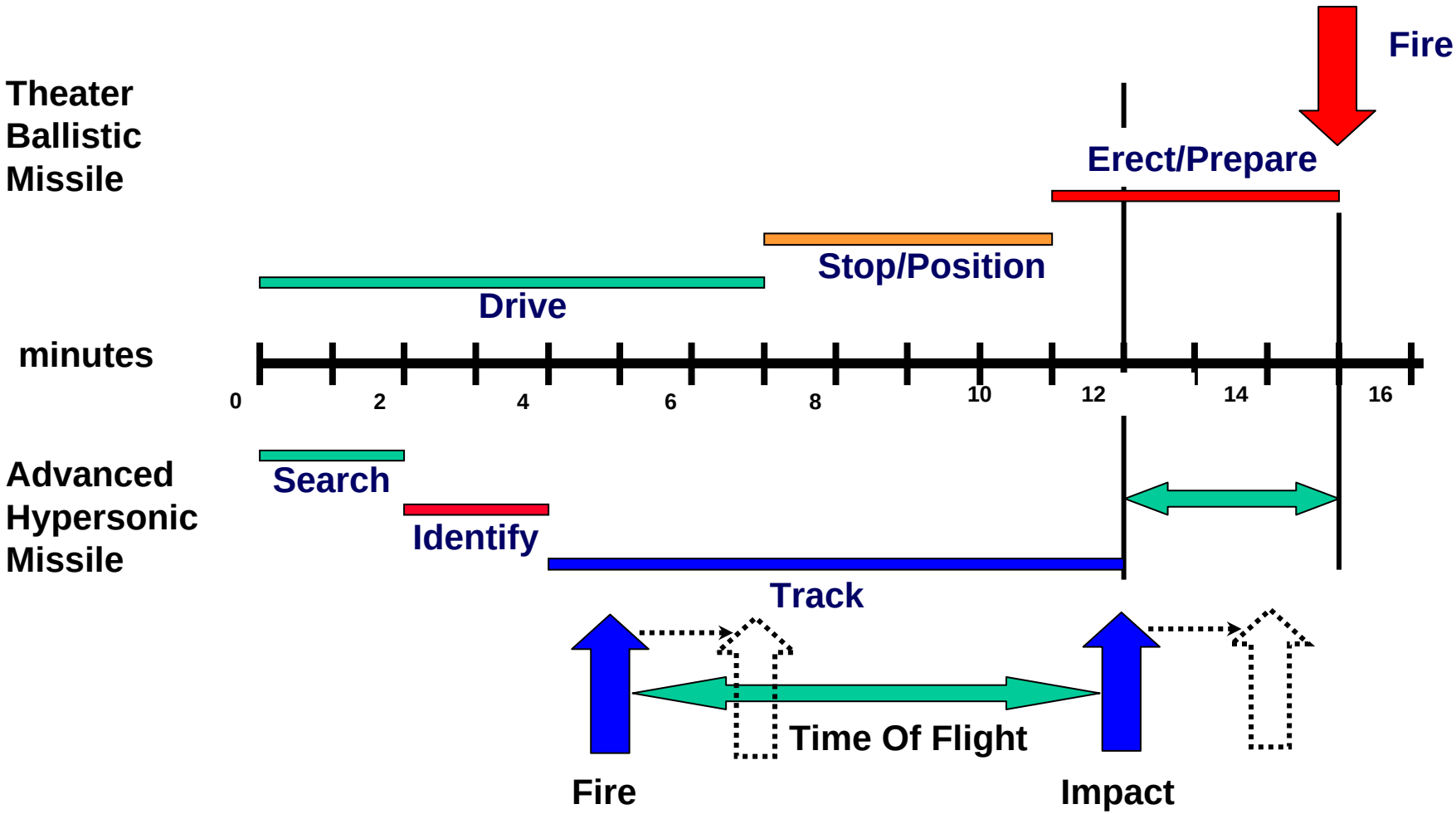
Relies on robust ISR



SAB TR 00-03, Cleared for Open Distribution

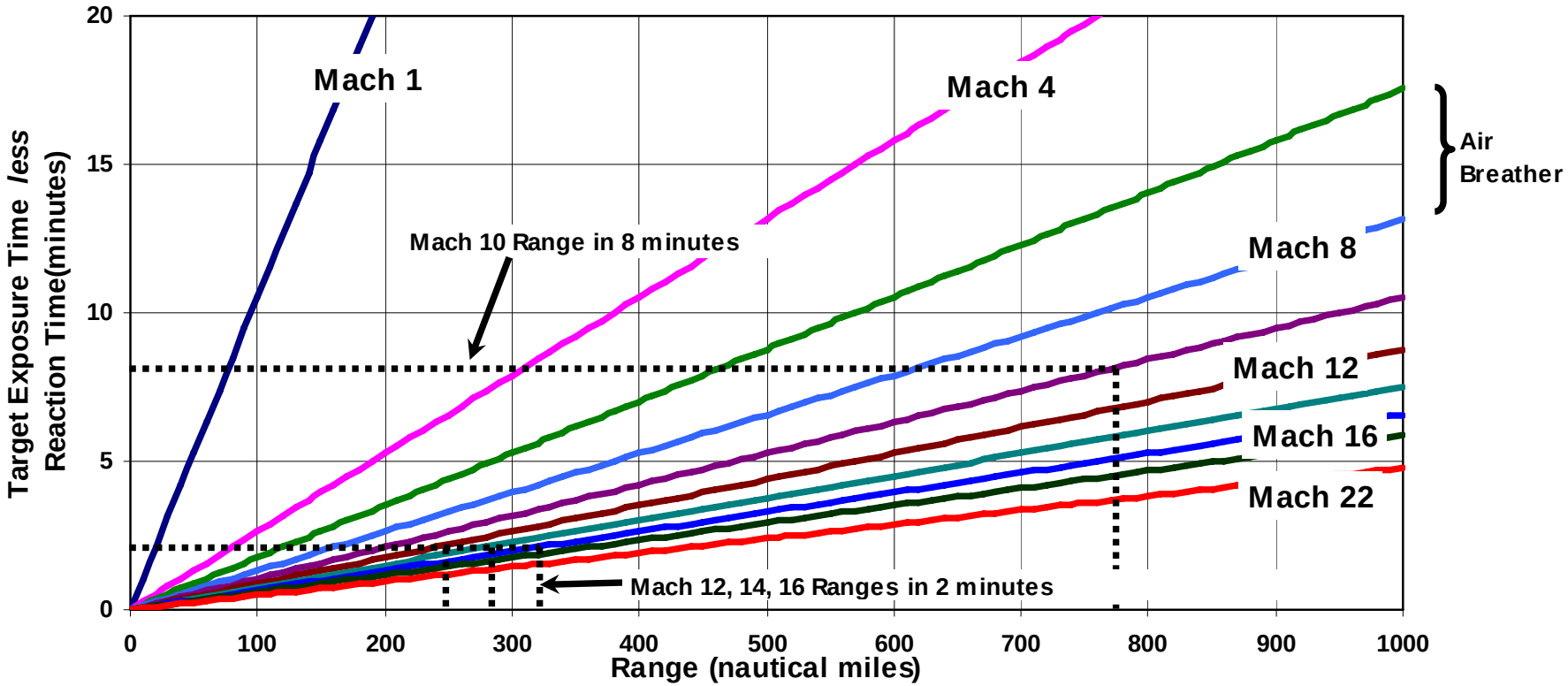
Notional Timelines

Source: SAB, Why and Whither of Hypersonic Research in USAF, Dec 2000



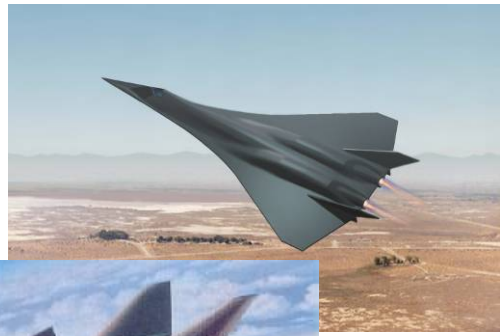
Relies on Robust ISR

Source: SAB, Why and Whither of Hypersonic Research in USAF, Dec 2000



SAB TR 00-03, Cleared for Open Distribution

Aircraft: Mach 5-7 Strike/Recce Vehicles

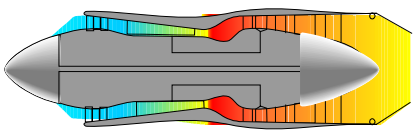


Pros:

- Limited infrastructure impact
- Very fast response times
- Increased speed helps survivability
- Storable fuels - capable of standing alert

Cons:

- High production costs
- Some R&D needed: combined cycle engines, materials, and cooling
- Increased cost for maintenance, logistics



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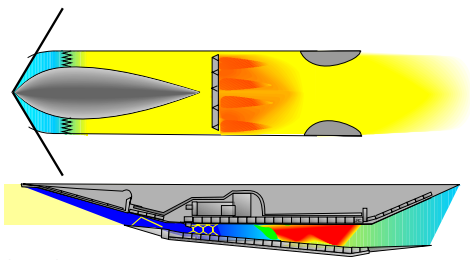
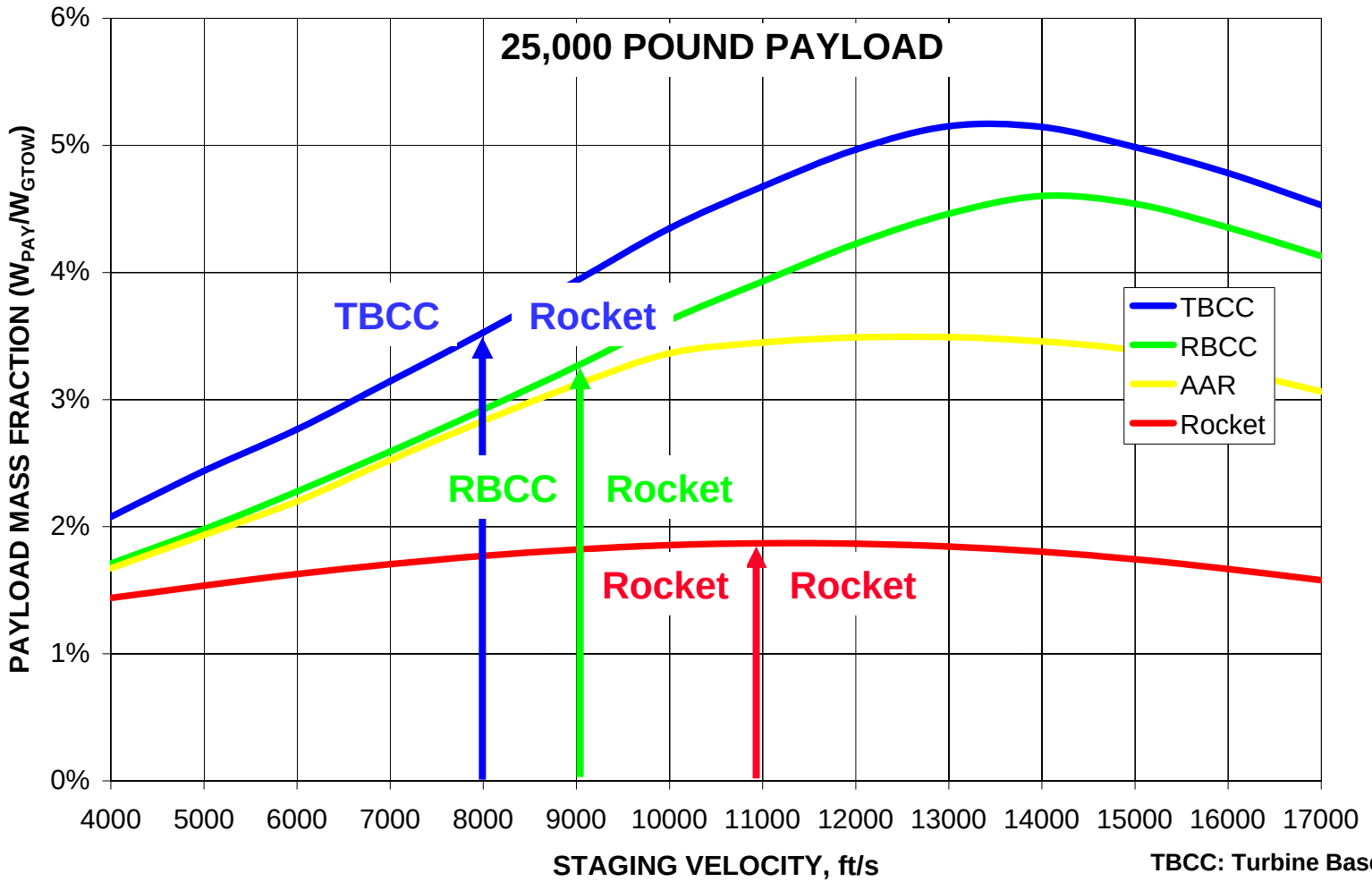


Typically Turbojet and Ramjet or Scramjet

Cleared for public release: ASC 03-2959

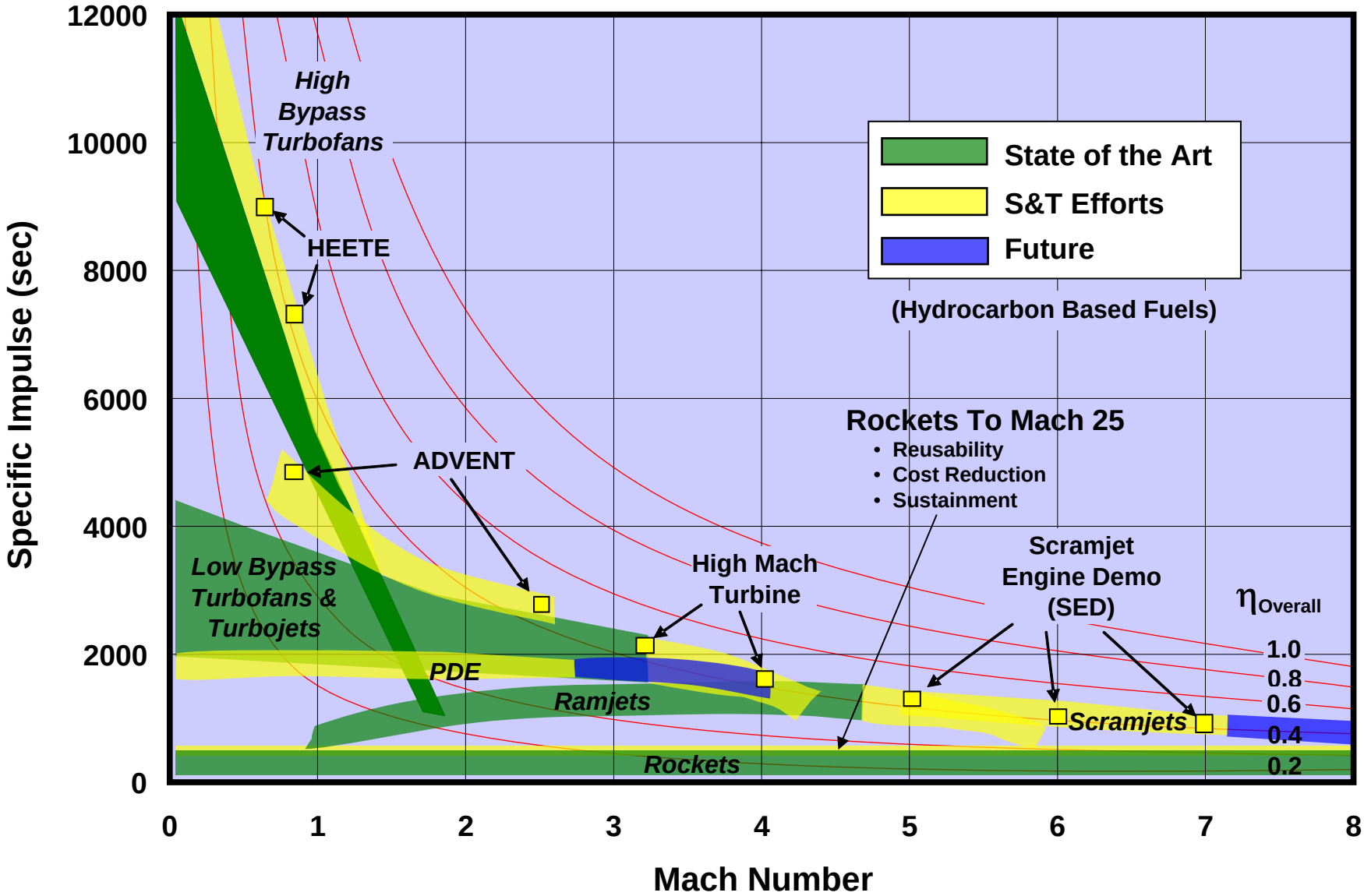
Mach 8 Air-Breathing Propulsion Doubles Payload Fraction to LEO



TBCC: Turbine Based Combined Cycle
RBCC: Rocket Based Combined Cycle
AAR: Air Augmented Rocket

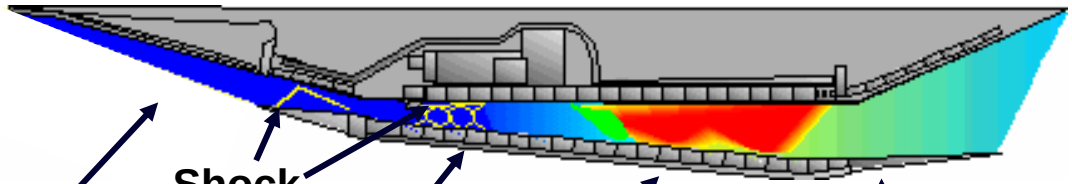
Cleared for public release: ASC 03-3191

Aerospace Propulsion Domain
Improving Fuel Efficiency Across Flight Spectrum



Scramjet Propulsion

Scramjet Engine



Shock waves

Compression Surface

Isolator

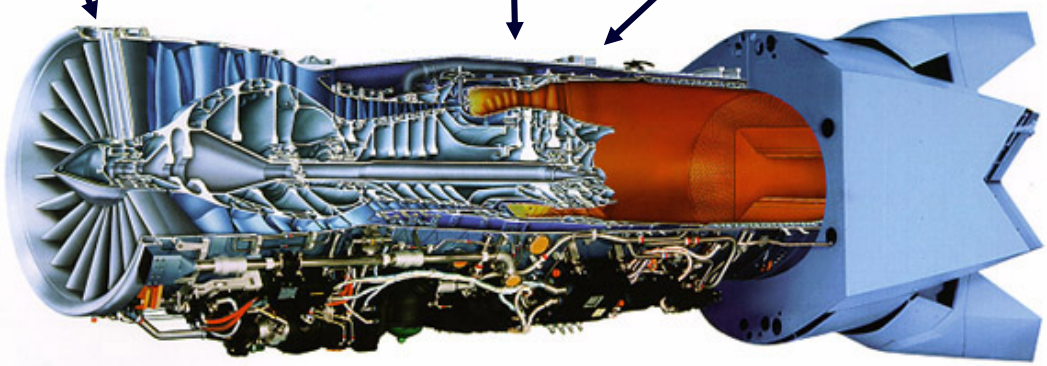
Compressor

Combustor

Nozzle

Turbine

Turbine Engine



Cleared for Public Release: # DOD 06-S-2154

AFRL's Hypersonic Technology Development Approach

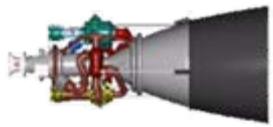
Stair-step approach builds upon prior successes.

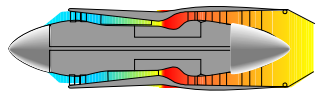
Multiple Roles
(Robust, Responsive)

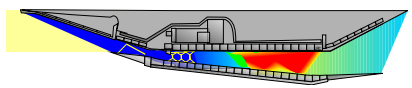
Expendable Space Lift
(On Demand)

Hypersonic Missiles
(Time-Critical Targets)

Large Scramjets and CCEs





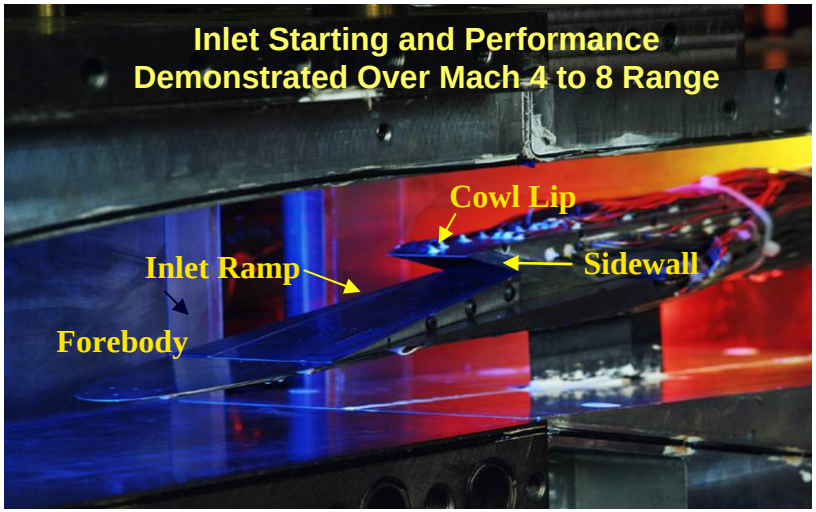


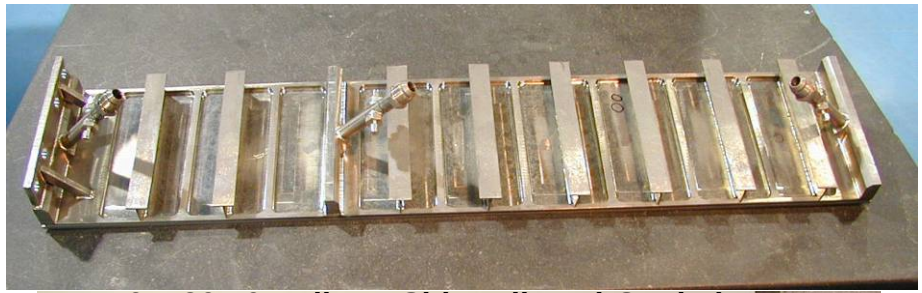
Medium Scramjets

Small Scramjets

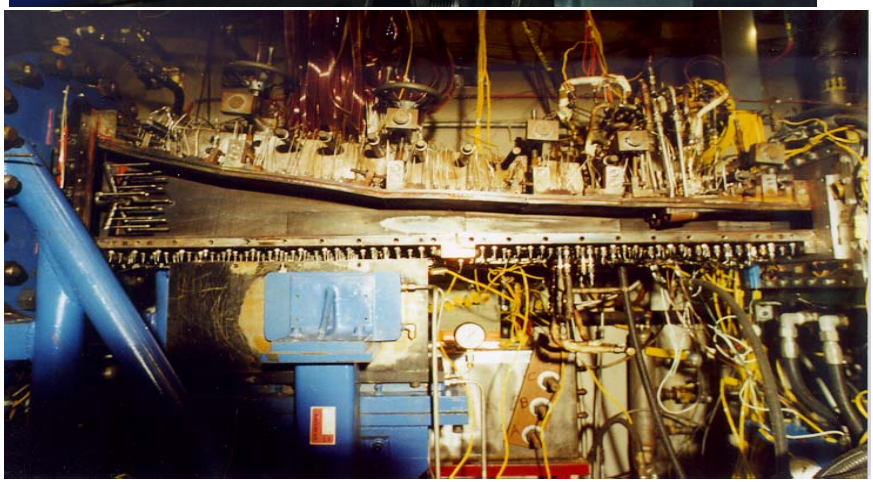
Cleared for Public Release: # DOD 06-S-2154

HyTech: HYDROCARBON SCRAMJET COMPONENT TECHNICAL CHALLENGES HAVE BEEN MET





6”X30” & Full 75” Sidewall Fuel-Cooled
Heat Exchanger Demonstrated
Structural Durability



Combustor Operability and Performance
Demonstrated Over Mach 4 to Mach 8 Range

Freejet Test of Integrated Heavyweight Engine
Demonstrated Performance & Operability

Cleared for public release: ASC 03-2959

Ground Demonstration Engine 1 Status: Testing at GASL Completed

- Testing initiated Sep 02, completed Jun 03, 60 tests
- Mach 4.5: Performance comparable to heavyweight PTE tests
- Mach 6.5: Performance exceeded heavyweight PTE tests
- Engine fuel cooled structure in excellent condition

First Demo of Flight Weight Hydrocarbon-Fueled/Cooled Scramjet Engine!

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Ground Testing Carries Scramjet Development Only So Far

High-speed flight simulation on the ground is tough

- Limited facilities world-wide
- Even in the very best facilities compromises are made
  - Model size and structure
  - Inlet air purity … composition, T-P-M profiles, etc
- Testing at fixed Mach number … no flight transients
- Still have to deduce installed performance … for an engine-airframe that must be well integrated
- Hydrocarbon fuels and active structural cooling exacerbate the test challenges
  - Complex fuel thermodynamics and chemistry

Flight-test required to demonstrate scramjet viability

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X-51A Scramjet Engine Demonstrator (SED)

- Joint AFRL-DARPA flight demo of AFRL's hydrocarbon-fueled scramjet & waverider airframe technologies
- Uses modified ATACMS booster
- Scramjet take-over at Mach 4.5
- Cruise at Mach 6.5 to 7.0
- Four flights (FY09 1st flight)

X-51A SED Configuration

Potential Weapon Characteristics

- Tandem or side-by-side booster
- 2300 lb launch weight
- Range: 600 nm/10 min
- 300 lb payload (penetrator, smart submunitions, or explosive)

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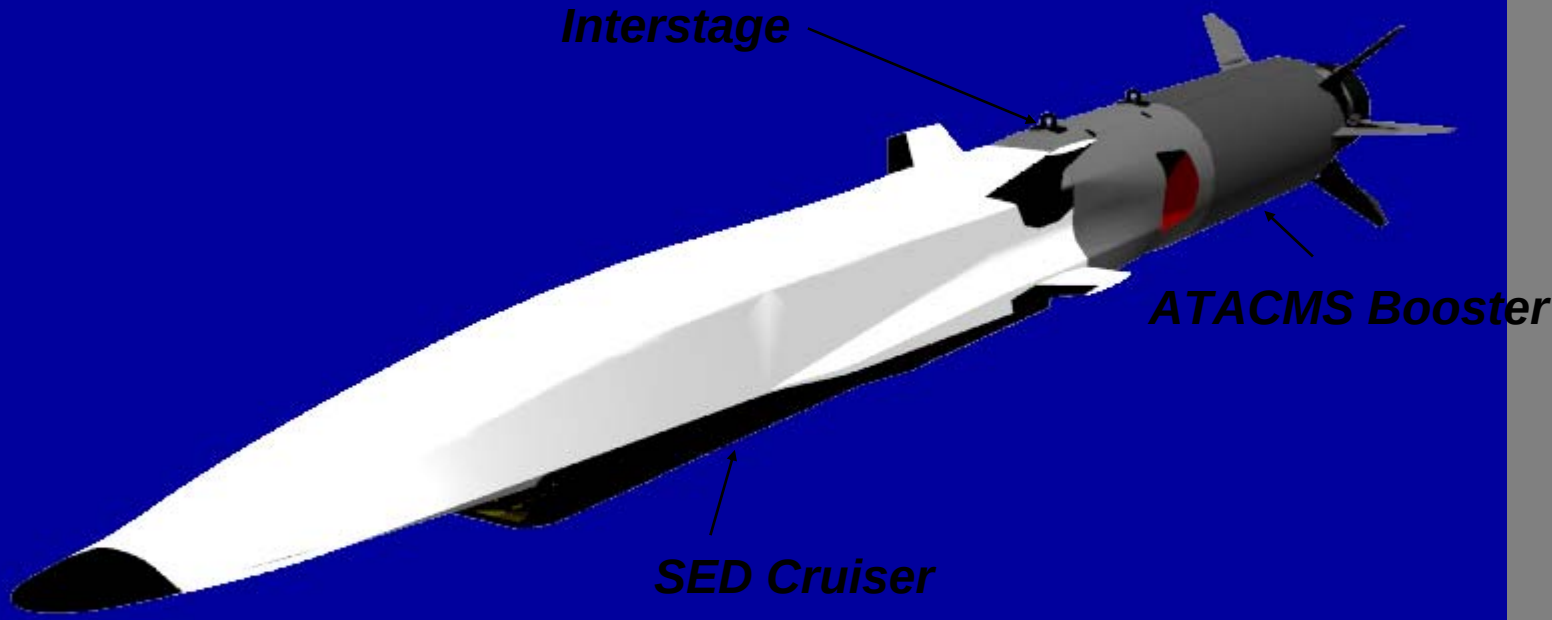
X-51A Configuration



- *Utilizes one HyTech scramjet engine derivative flowpath*
- *Composite leading edges and Boeing proprietary TPS*
- *Utilizes off-the-shelf booster technology; booster will be modified slightly to optimize air launch*

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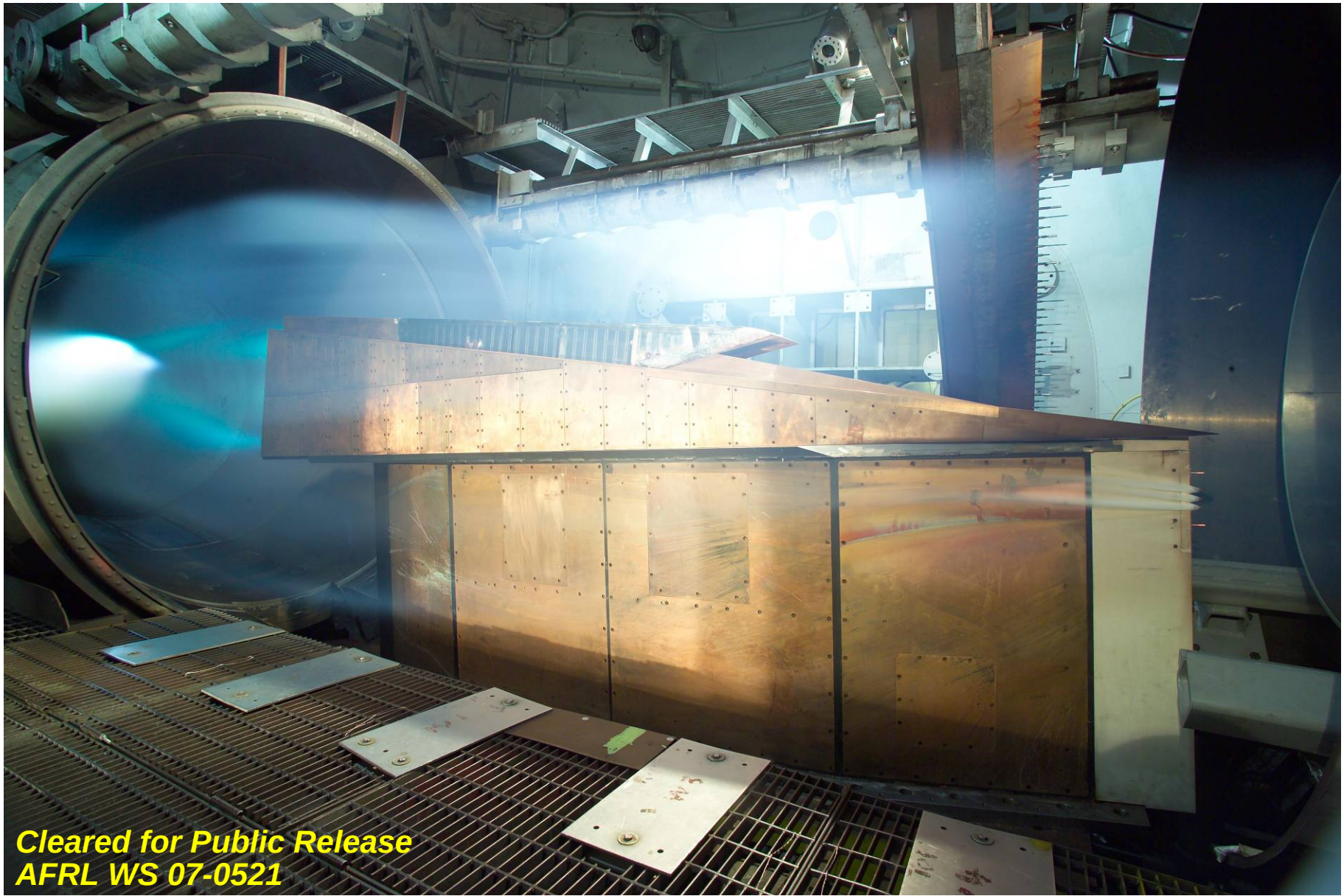
SJX61-1 Testing at LaRC



Cleared for Public Release
AFRL WS 07-0521

X-51 SED Flight Test Operations

EAFB - Flight Ramp
A/C Pre-Takeoff Events
- **SED Build Up**
- **Load Mission OFP Tape**
- **Load Encryption Keys**
- **Load SED On A/C**

Pt. Mugu Test Range
- Ingress
- Determine - In Zone
- Apply Power
- BIT/GPS Acquisition
- Intent to Launch

Launch
- Internal Power
- Release/Eject Air Vehicle
- Safe Separation
- Booster Ignition

Climb

Separation

Boost

Unpowered Descent

Impact

Return to EAFB

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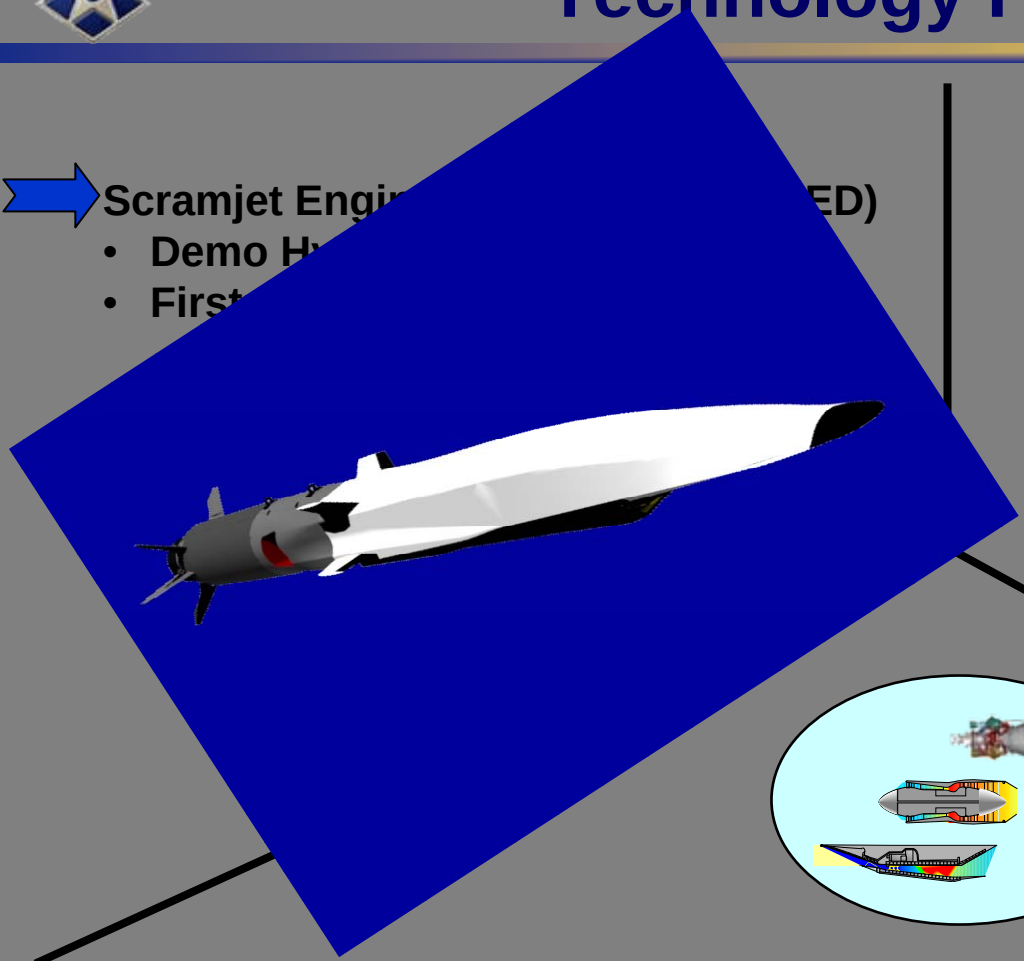
AFRL Hypersonic Propulsion Technology Programs

Scramjet Engi ED)

- **Demo H**
- **First**

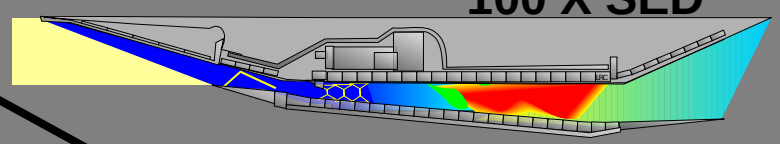


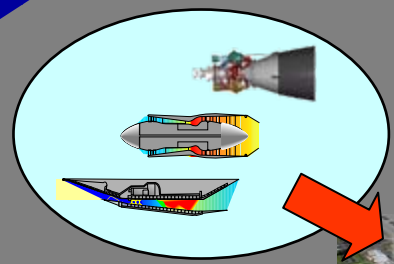
Robust Scramjet

- **10X – 100X scale**
- **Increased durability**
- **Improved operability**

10 X SED

100 X SED





Combined Cycle Engine Components

- **Merge scramjet with turbine and rocket engines for wide range of flight speeds**
- **Key to air breathing access to space**

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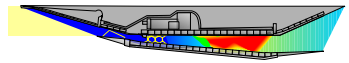
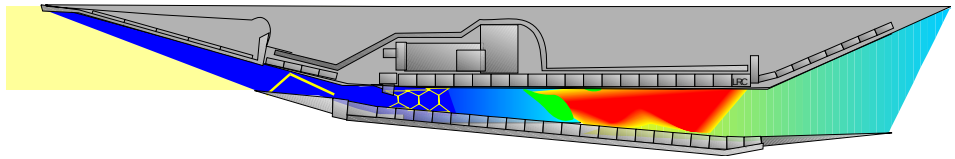
Robust Scramjet Program

- Addresses scaling issues for 10X and 100X flowpaths
  - Examines improvements to fuel penetration and mixing, as well as general combustion kinetics
- Improves overall scramjet operability
  - Reduce takeover to Mach 3.5
  - Extend upper Mach to 8 to 12
- Identifies new structural concepts to extend durability and reusability
  - 50 cycles near-term
  - 250 cycles far-term





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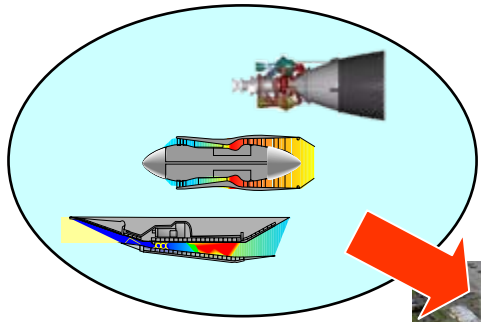
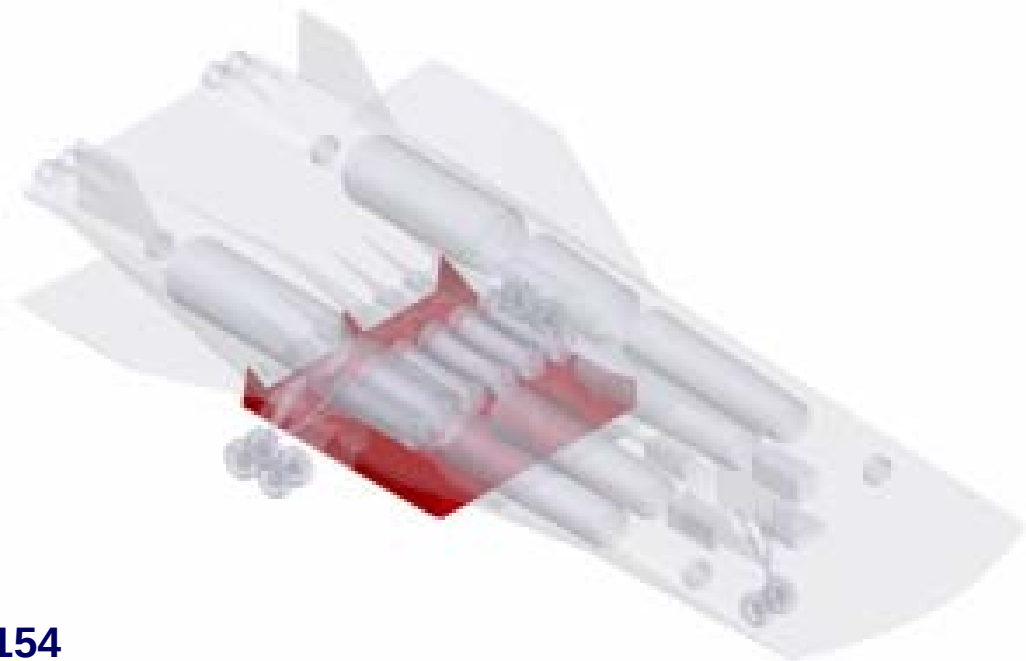
Combined-Cycle Engine Component Development

- Studies since 2002 show concept feasibility and no show stoppers
- Combines ramjet/scramjet engines with turbine and rocket engine cycles
- Rocket-Based Combined Cycle (RBCC) easiest integration
- Studies show promising results for over-under arrangements Turbine-Based Combined-Cycle (TBCC)
- Component development to begin October 2005





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Summary

- Hypersonics is a disruptive technology
  - Near term: hypersonic cruise missile could be used to defeat time critical targets
  - Far term: CCEs could enable operationally responsive spacelift with “aircraft-like” operations
- AFRL’s hypersonic propulsion technology development is on track to mature the enabling technologies

Propulsion is the Pacing Technology in Aviation

Wright Brothers Redesigned Engine Provided Enabling Power-to-Weight Ratio

Jet Engine Revolutionized the Shape and Speed of Aerospace Vehicles

High Bypass Turbofans Enabled Jumbo Jets

Scramjets Will Enable Sustained Hypersonic Flight and Routine Access to Space

Cleared for Public Release: # DOD 06-S-2154

DISRUPTIVE TECHNOLOGIES
A Combatant Command Faces the Challenge

Mel Chaloupka
Chief, Transformation & Experimentation
USPACOM J81
4 September 2007

This brief is:
UNCLASSIFIED

Overview

- **Purpose**
- **Definition**
- **Areas of interest**
- **Moving forward … currently working**
- **Staying ahead of disruption**

Purpose

- **Suggest areas in which the U.S. might leverage technology advantage**

Disruptive Technologies Definition

Technical innovations – capabilities, processes, or procedures – that overturn existing, dominant technologies and prevent users of the existing technologies from achieving intended effects. Bower & Christensen, "Disruptive Technologies: Catching the Wave," *Harvard Business Review,* Jan-Feb 95.

USPACOM Focus:

- **An external initiative, adversely impacting U.S. intended effects**
- **U.S. initiative, either favorably impacting U.S. operations or adversely impacting a potential adversary's intended effects**

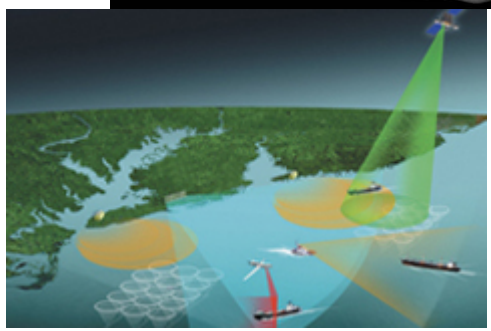
Areas of interest . . .

- **Persistent ISR/All Weather Sensors**
  - **Tactical Satellites/UAVs**
- **Communications**
  - **Minimize effects of communications/navigational losses**
  - **Agile frequency ranges**
- **Computer network defense**
  - **Individual and network intrusion detectors and identifiers**
- **Rapidly changing tactics for terrorist operations**
  - **IED detection & Non-lethal capabilities/ information operations**
- **WMD detection**
  - **Ability to detect various sources and distribution means**
- **Biometrics**
  - **Ways to provide more secure physical and computer assets**
- **Energy Alternatives**
  - **Tactical (Extended battery life)**
  - **Strategic (Alt energy sources to lessen dependence)**

Moving forward… currently working

Synergy of S&T and COCOM Experimentation

- **WMD Detection**
- **Persistent ISR**
  - **-- UAVs/Airships/Space**
  - **- Net-Centric Operations**
- **Agile and secure C2**
  - **- Comms at Speed and Depth**
  - **- Secure networks**
  - **- Multinational and Interagency Coordination/Interoperability**
- **Force Protection**
  - **- Non-lethal capabilities**
  - **- IED detection and mitigation**
- **Maritime Domain Awareness**
  - **- Find, Fix, Track, Target**
  - **- Maritime Interdiction**



Transitioning Successes

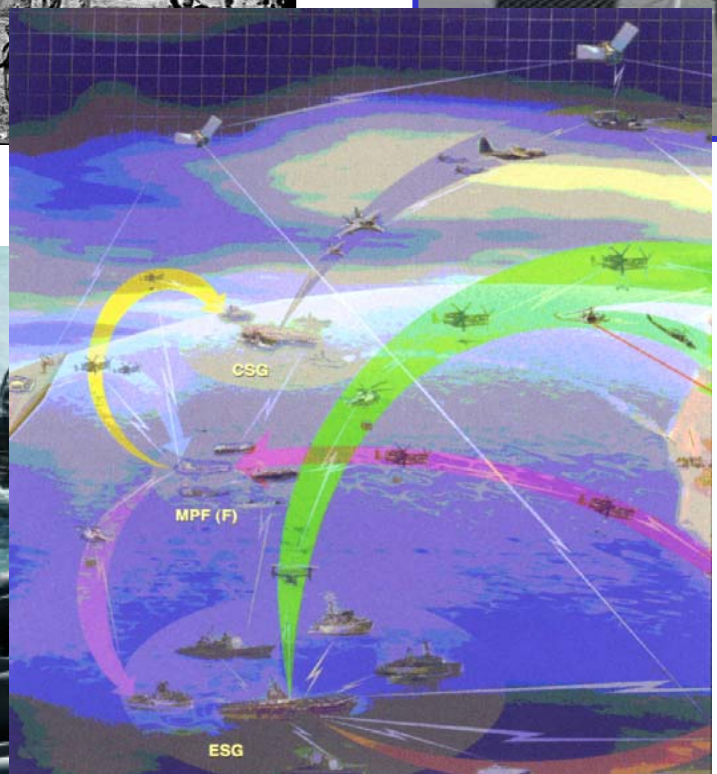
Staying ahead of disruption . . .

- **Avoiding technological surprise**
  - **Understand emerging and commercial technologies & implications**
  - **Predictive modeling (social and behavioral)**
- **Identifying technologies we rely on**
  - **Exercise & experiment on how we operate without them**
- **Without a mitigating technology, developing TTPs to address shortfalls near term**
- **Leverage modeling and simulation for wargaming, experimental testing, and discovery**
- **Develop means to rapidly insert technologies in a conflict (e.g., USPACOM S&T Cell during exercises)**
- **Align DoD acquisition system to support emerging disruptive technologies**

Disruptive Technologies Transform the Force

Forward Observer
Civil War, 1863

Forward Observer
Talisman Saber, 2007



Service
Transfo
must su
Joint
Transfo

Coalition
Interoperability
and
Commonality
are Key

Contact

Mr Mel Chaloupka

Chief, Transformation & Experimentation

USPACOM J81

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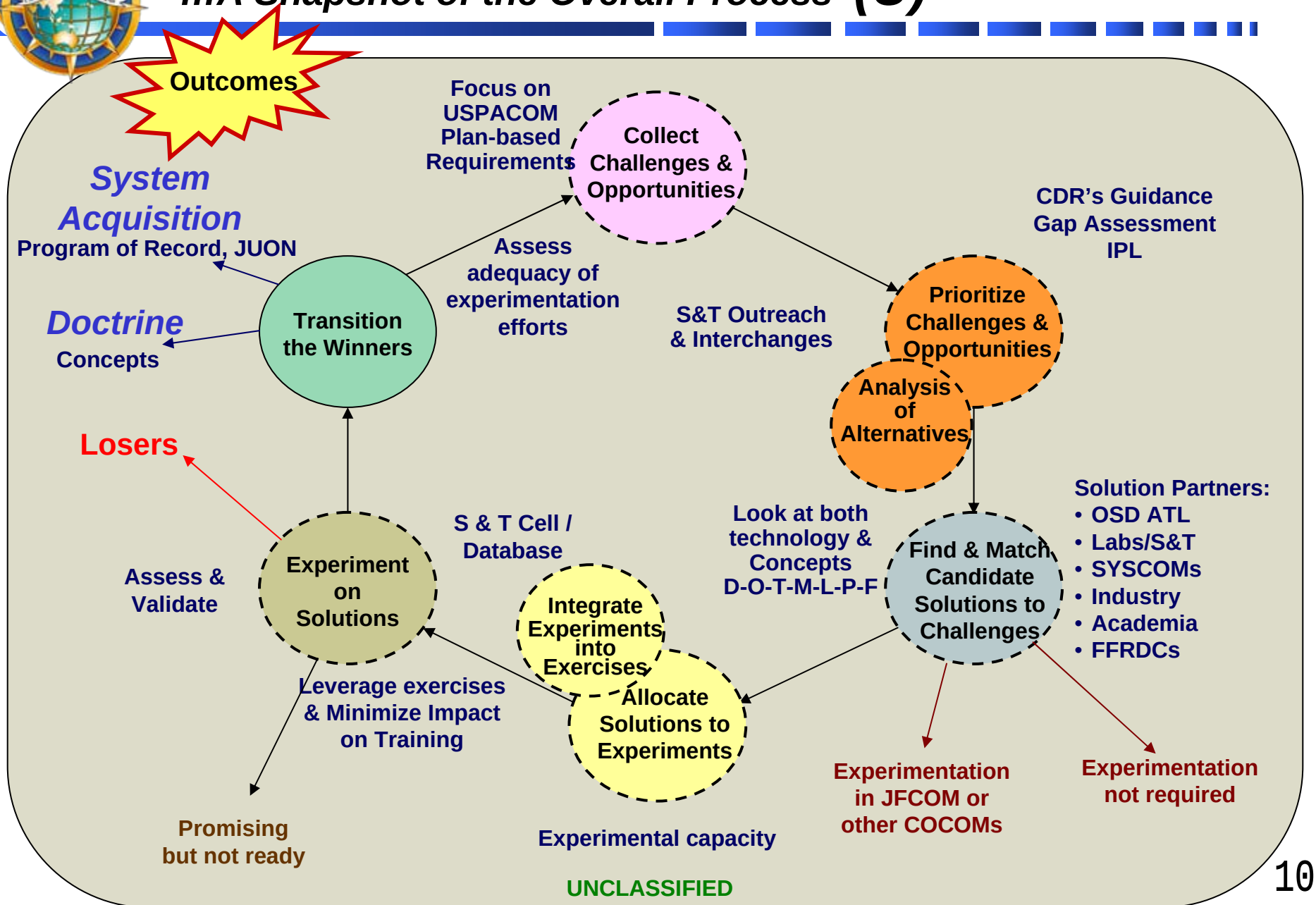
mel.chaloupka@pacom.smil.mil

As of 24 1600W August 07

How Does it Work?

…A Snapshot of the Overall Process (U)



Disruptive Technologies
The Future Role of Computing

Presented to:
National Defense Industrial Association
Hyatt Regency Capital Hill

By:
Dr. David H. Crandall
Assistant Deputy Administrator for
Research, Development and Simulation

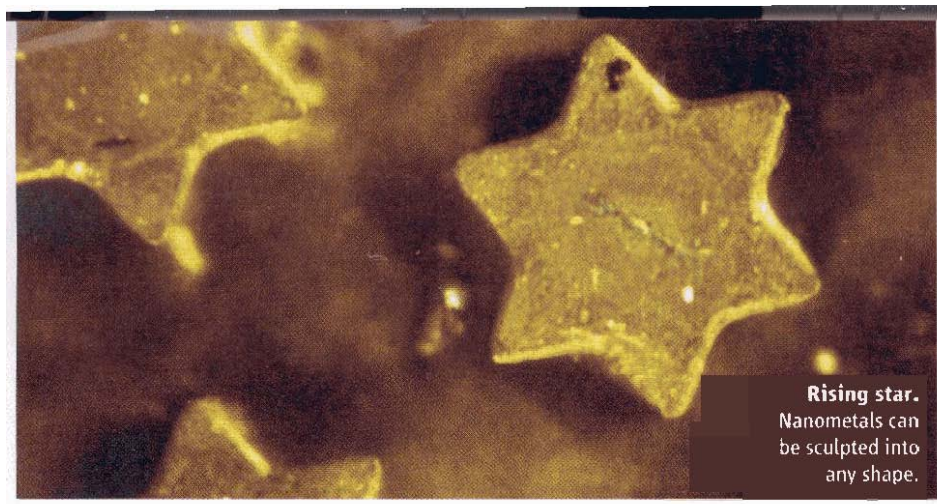
September 4, 2007
9:15 a.m.

Disruptive Technologies – the future role of computing

National Nuclear Security Administration

- Examples of disruptive technology today (2 charts)
- Impact of computing on warhead certification without testing (no charts)
- Models and computation as a future route to disruptive technology
  - Materials Fracture
  - Inertial Fusion
  - A general approach

Nanoputty



Rising star. Nanometals can be sculpted into any shape.

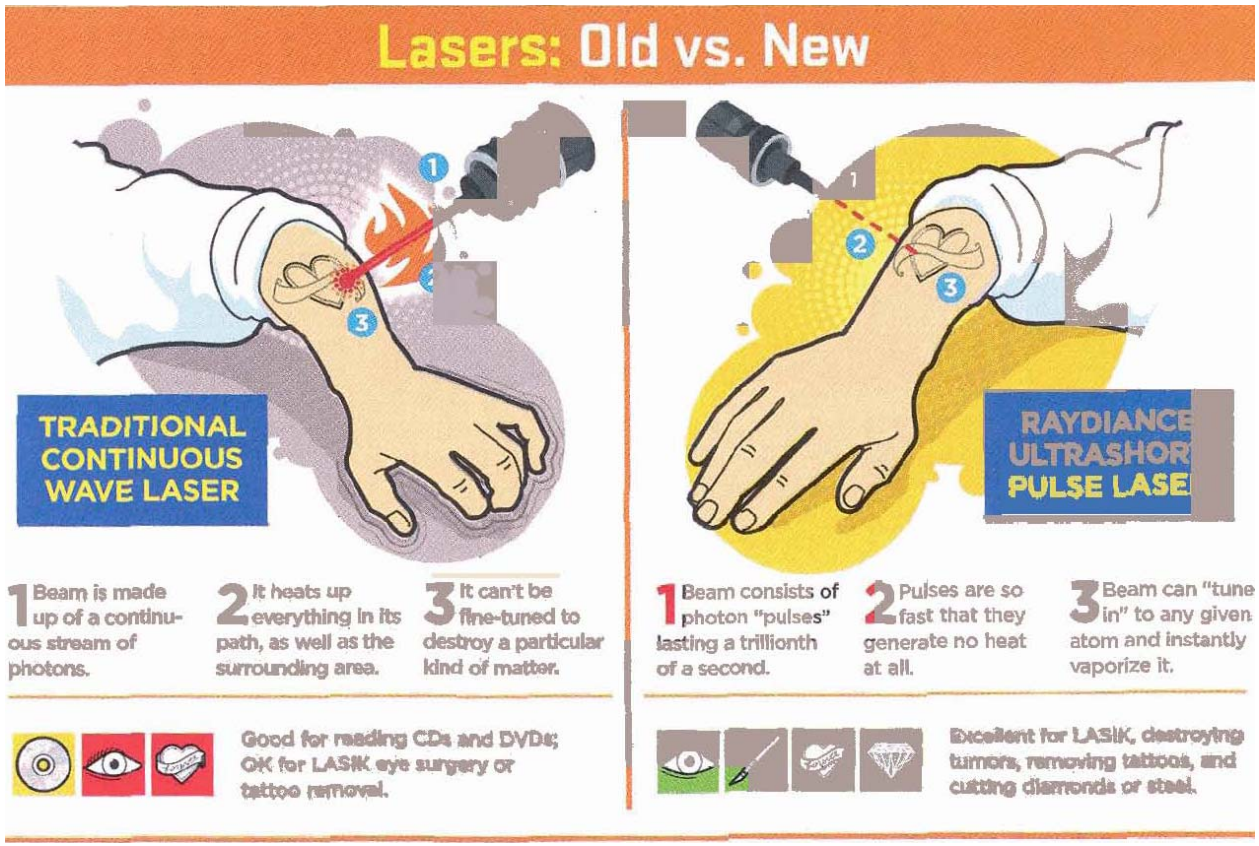
MATERIALS SCIENCE

Chemists Mold Metal Objects From Plastic 'Nanoputty'

www.sciencemag.org SCIENCE VOL 316 13 APRIL 2007

Lasers: Old vs. New

THE DISRUPTOR:
RAYDIANCE

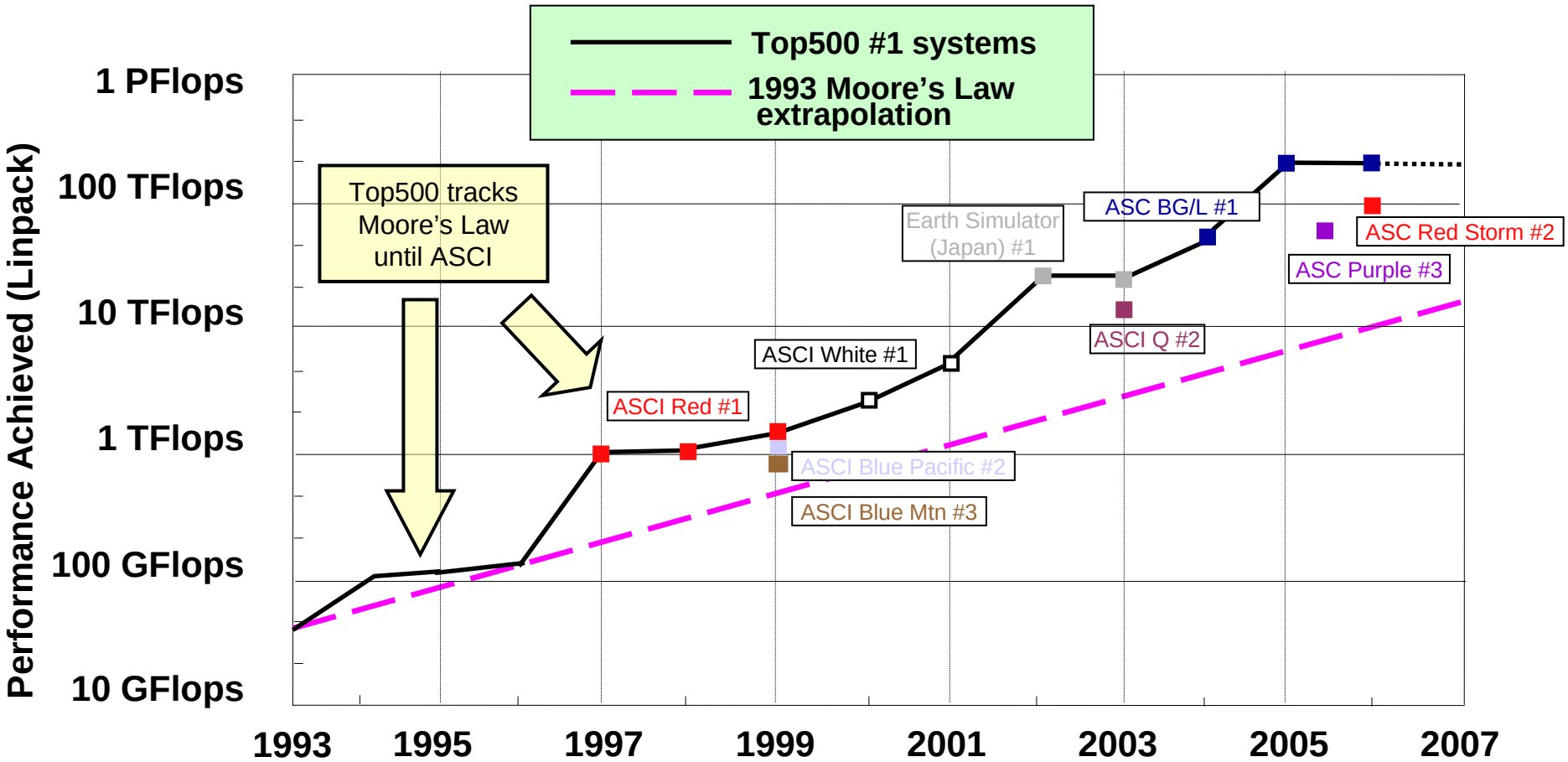


Business 2.0 September 2007

Example of NNSA Impact on Technology Worldwide

Computation

National Nuclear Security Administration



Since first ASCI platform deliverable in 1997, ASC systems have maintained a prominent position on the Top500 list.

Miniaturization

Design layout expertise, applied engineering and manufacturing technologies for product miniaturization

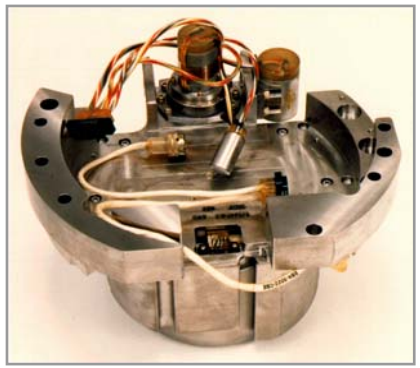
National Nuclear Security Administration

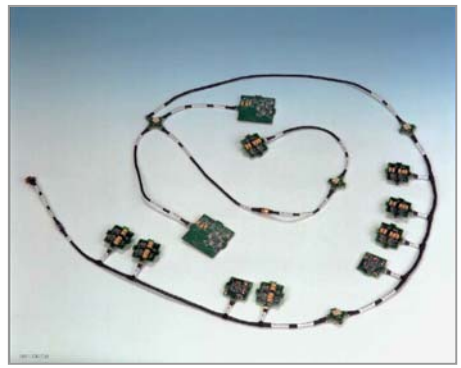
RADARS

Size

Time →

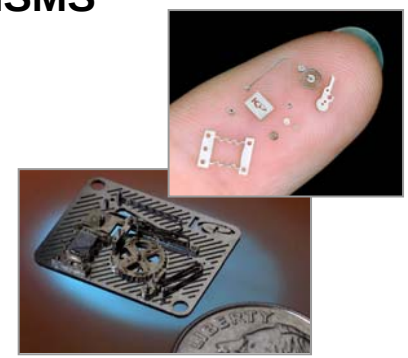
TELEMETRY





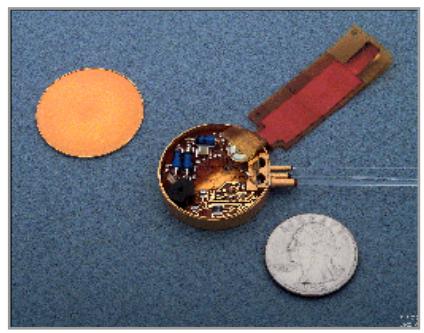
Telemetry → Distributed Telemetry

MECHANISMS



Precision Machining → Micromachines

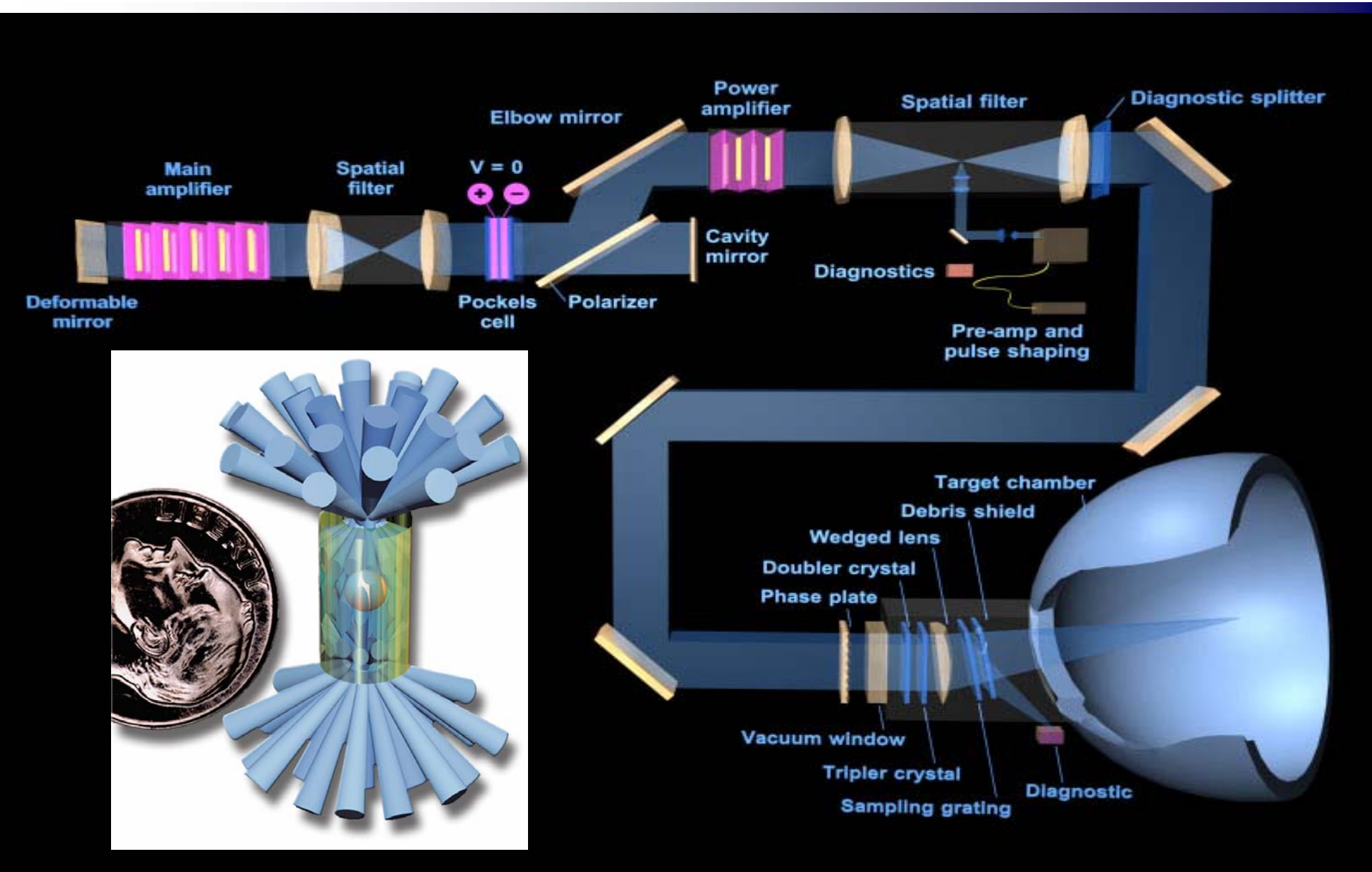
FIRESETS



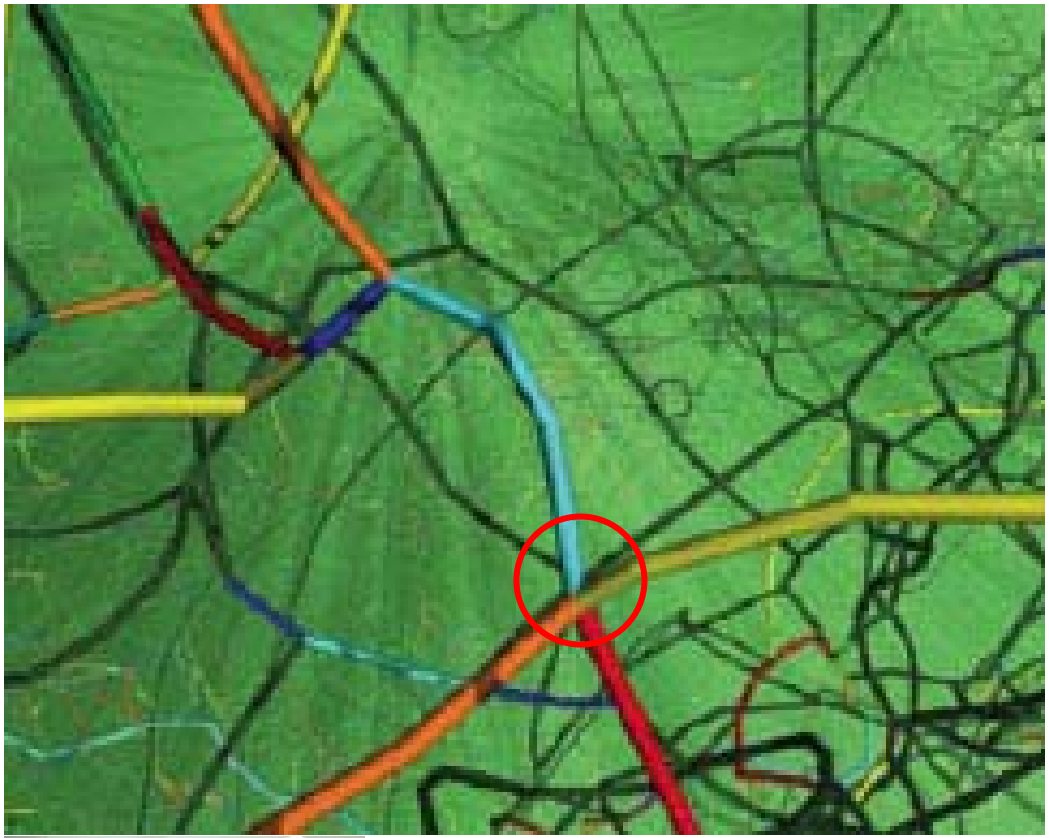
Fireset → Micro Fireset

Schematic of NIF Beam Line

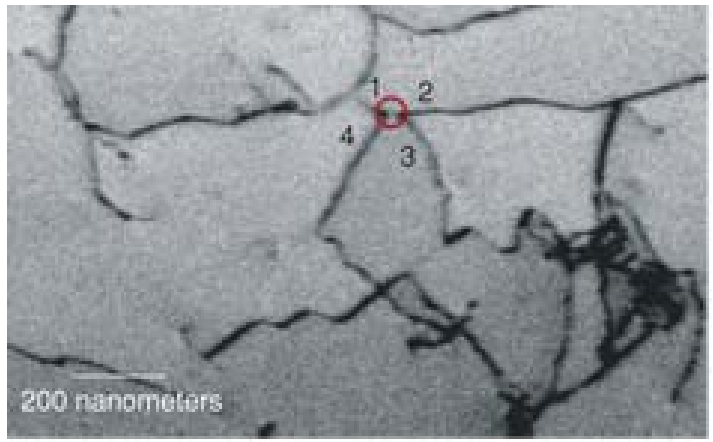
National Nuclear Security Administration



Multi-Junction discovery



mesoscale simulation of crystalline molybdenum atoms, predicting the formation of multijunctions and multinodes.



Simulations allow discoveries to be made, which then must be confirmed with experiments – simulations are disruptive!

Routes to Disruptive Technology

National Nuclear Security Administration

Traditional

Basic Exploration

↓

Lab work

↓

Discovery & proto type

↓

Products (transistor)

Future

Model

↓

Computation

↓

Selected lab work

↓

Model/Computation (discovery)

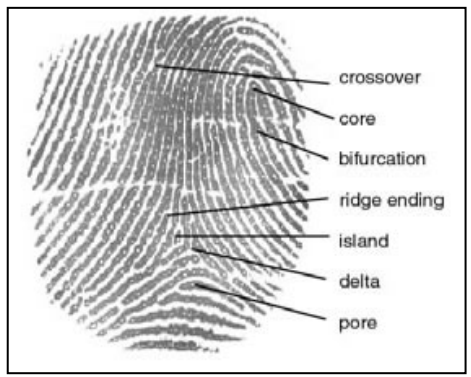
↓

Products (materials fracture)

DoD Biometrics

NDIA
Disruptive Technologies

5 Sep 2007



Mr Tom Dee
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OSD AT&L, DDR&E
thomas..dee@osd.mil (osd.smil.mil)
703-746-1385

Outline

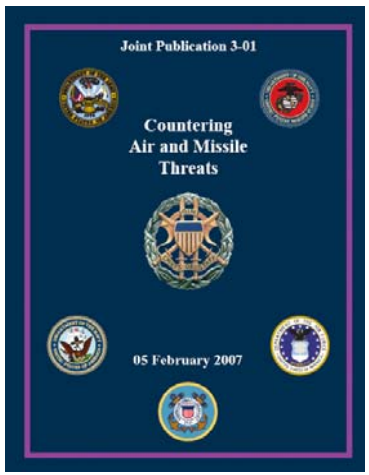
- The Problem
- Traditional Solutions
- Disruptive Technology
- DoD Biometrics

Friend? Enemy? Neutral?

Combat Identification

"Combat Identification is the process of attaining an accurate characterization of detected objects in the battle space to the extent that a high confidence, timely application of tactical options, and weapons resources can occur. Depending on the situation and the tactical decisions that must be made, this characterization will be at least, but may not be limited to, "friend," "enemy," or "neutral." Combat identification functions encompass cooperative and non-cooperative identification capabilities."

Joint Pub 3-01, 5 Feb 2007



Combat Identification

- **How to classify and identify detected objects?**

Shapes?

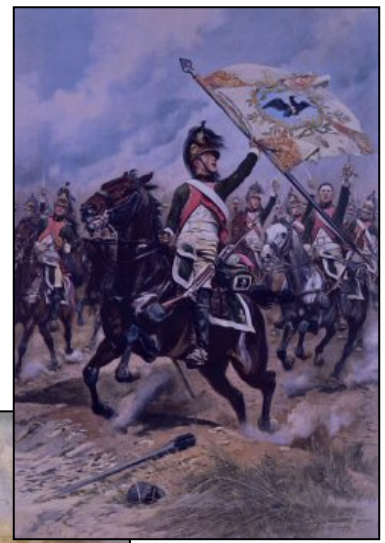
Markings?

Signatures?

Signals?

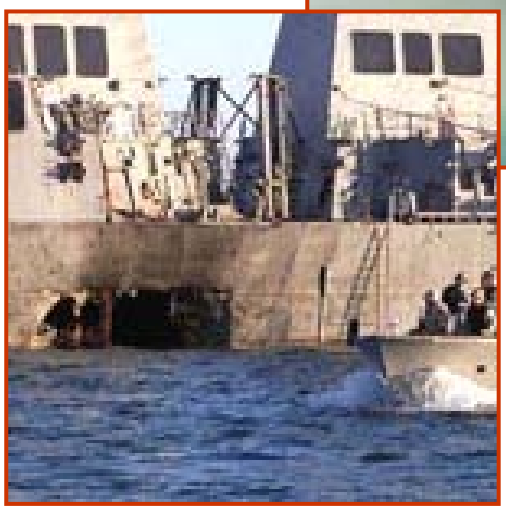
Platforms

People



What if the “object” is a non-state actor?

Enemy?



Neutral?

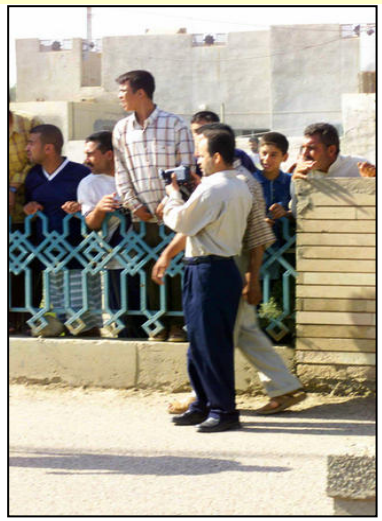
Friend?

Classification

- **Tactical decisions require:**
  - **Detection**
  - **Classification**

Airspace control integrates different airspace users and provides them with responsive and timely support.

Friend / Enemy / Neutral ?



- **But, how do you classify an anonymous individual?**
  - **Something he's wearing?**
  - **Something he's carrying?**
  - **His behavior**
  - **His identity**
    - **Who he is**
    - **Where he's been**
    - **Who's he associated with**

Post IED Blast
AR RAMADI, IRAQ Jun 04

Reuters Video photographer

And… What If You Get It Wrong

- **Consequences**
  - Tactical
  - Operational
  - Strategic

USS Cole

Friendly Fire

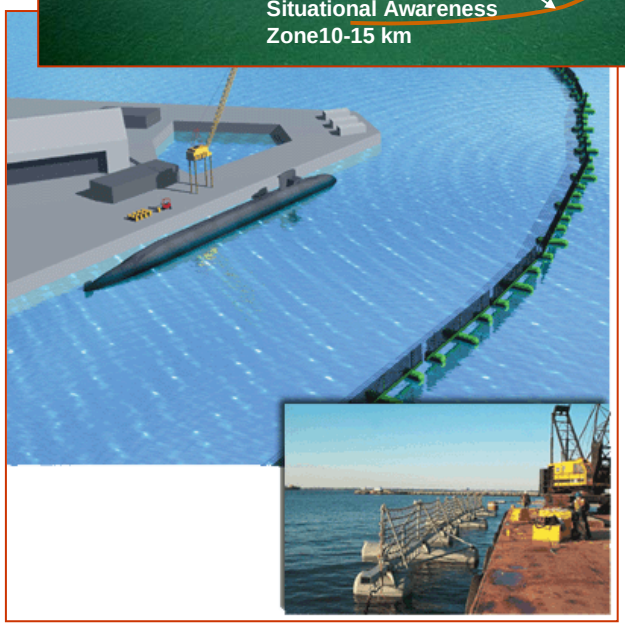
9-11

Iran Air 655

U.S. Bomb Dropped; 3 British Soldiers Die
NY Times, 25 Aug 2007

Traditional Solutions

Perimeter Systems



Deterrence

Detection technology

The Disruptive ID Technology

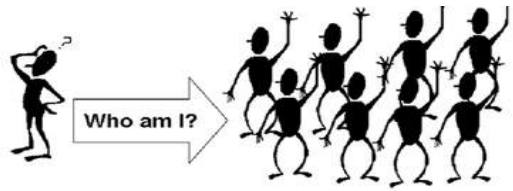
Stealth, Columbia Pictures, 2005

Terms of Reference

Biometrics – Biometrics are measurable physical characteristics or personal behavioral traits used to recognize the identity, or verify the claimed identity, of an individual.

Verification – a <u>one-to-one</u> matching process

Identification – a <u>one-to-many</u> matching process

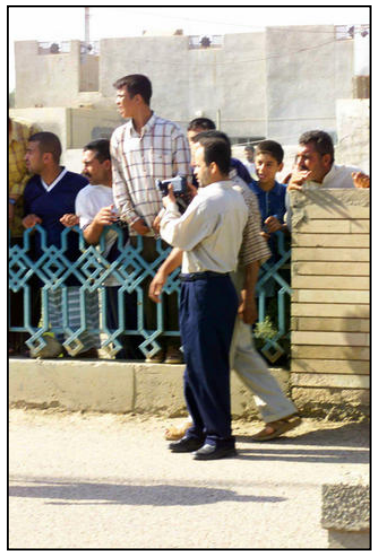


Why Biometrics in DoD?

In today's Joint Operating Environment "an anonymous enemy individual can be a tactical, operational, and even strategic threat."

- **Business Functions**
  - **Physical and logical access controls**
  - **Privilege management**
    - **Health care, benefits, finance, time and attendance, etc.**
- **Military operations**
  - **"Combat Identification"**
    - **Friend, Foe, Neutral?**
  - **Offensive Operations**
    - **Intelligence support to targeting**
  - **Force Protection**
    - **Base access**
  - **Detention Operations**
  - **Civil-Military Operations**
    - **Track target members of population.**
  - **Personnel Recovery and identification**

Friend / Enemy / Neutral ?



Post IED Blast
AR RAMADI, IRAQ Jun 04

- **Confidence level of ID?**
- **Consequences of a wrong ID?**
- **Operational situation?**
- **ROE?**

Reuters Video photographer

DoD Use of Biometrics

COLLECTION

1

- ENROLLED IN BAT ON 18 SEP 05, SUSPECTED SMALL ARMS FIRE

- LATENT PRINTS RECOVERED FROM IED MATERIALS

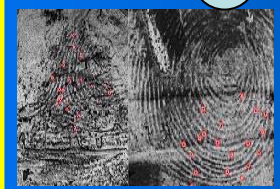
2

MATCHING & STORAGE

3,7

DOD ABIS
CLARKSBURG WV

6



25-JUL-07 Additional latent prints from same materials searched in ABIS

Enrolled in BAT on 9 JUL 07 due to capture as a result of Tier 1 alert in HIIDE

INTEL EXPLOITATION

4

NGIC PRODUCES BIAR
LATENT MATCH NOTIFICATION
12 NOV 06 & 14 DEC 06

ACTIONS

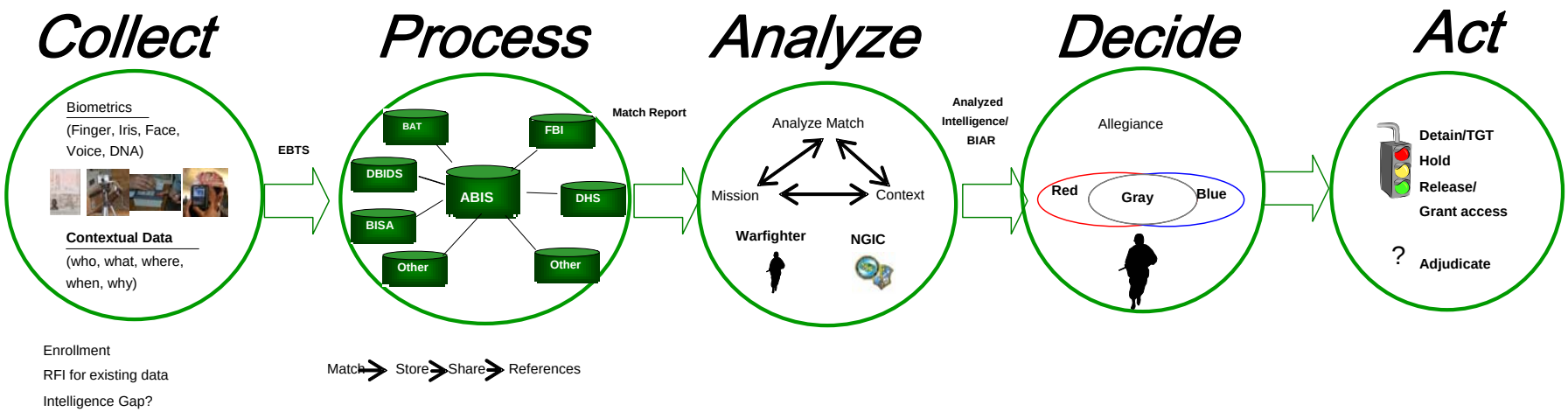
PLACED ON BIOMETRICS WATCHLIST, TIER 1 (DETAIN IF ENCOUNTERED)

29 MAY 07 RECORD FLAGGED IN ABIS AND ALERTED IN BAT

5

****CAPTURED 26 JUN 07****
during Screening via HIIDE

Supporting Requirements



- **Sensors to collect**
- **Databases to store**
  - **Data to match**
    - **Biometric forensics**
- **Applications to process**
- **Communications to share**
- **Analysis tools for decision support**

Biometrically Enabled Systems In Theater

Source	Description	Biometric Type
Biometrics Automated Toolset (BAT)	Enemy combatants, detainees, locally employed personnel (LEP), misc. fingerprinted by the U.S. military; used for intel functions, LEP processing, detention mgt	Various Flat or Rolled Fingerprint, Photo, & Iris
Biometric Identification System for Access (BISA)	Base Access System where biometrics are collected from persons requiring access to U.S. installations in Iraqi; issues biometrically-enabled badge as credential	Ten Rolled Fingerprint, Photo, & Iris
Multi-Purpose Access Card (MPAC)	Iraqi applying for a position of trust or privilege with Iraqi Gov't; some stations are being use for criminal processing	Ten Rolled Fingerprint, Photo, Iris, & Voice
Expanded Maritime Interception Operation (eMIO)	Deployed on Navy patrols performing interception and boarding operations on the high seas	Ten Flat or Rolled Fingerprint, Photo, & Iris
Special Operations Command (SOCOM) Jump Kits	Deployed with SOF troops on tactical missions.	Various Flat or Rolled Fingerprint, Photo, & Iris
Detainee Reporting Systems (DRS)	Detainee Management, collecting biometrics from all detainees held for more than 14 days and assigned an ISN number; Red Cross-compliant	Ten Rolled Fingerprint & Photo
Defense Biometric Identification System (DBIDS)	Base access system; collects biometrics from all personnel accessing US bases, including soldiers, government employees, civilians, contractors, day workers, etc.	Ten Rolled Fingerprint, Photo, & Iris
Hand-held Interagency Identity Detection Equipment (HIIDE)	Tactical operations by OGA in Iraq, 10th Mtn Div in Afghanistan; also used in detention facilities	Flat Fingerprint, Photo, & Iris

DoD Biometric Strategy

FY 07				FY 08				FY 09				FY 10			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4

Optimize What We Have

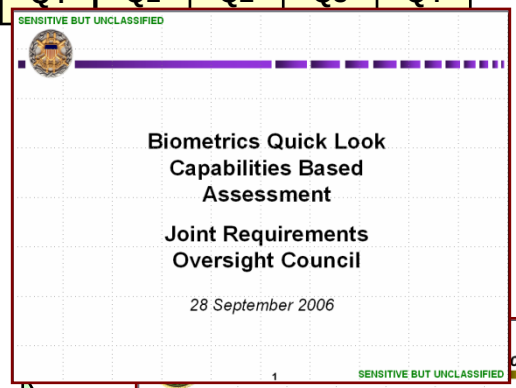
- Support and sustain legacy systems
- Increase capacity

Improve the Existing Architecture

- Implement "Enterprise JUONS"
- Down-Select "family of systems"
- Field and Sustain "family of systems"

Build What We Need

- Full CBA
- JCIDS
- PR09 Wedge
- POM 10 Build
- System Spiral Program of record
- Biometrics S&T Plan


SENSITIVE BUT UNCLASSIFIED

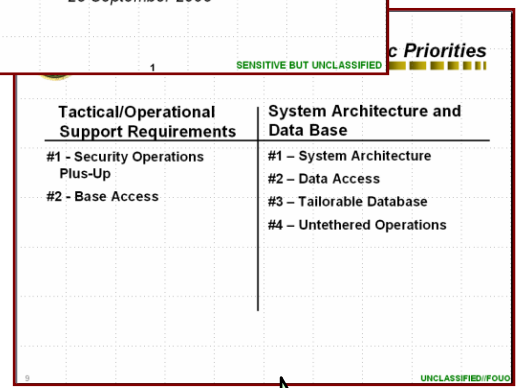
Biometrics Quick Look
Capabilities Based
Assessment

Joint Requirements
Oversight Council

28 September 2006

1

SENSITIVE BUT UNCLASSIFIED


c Priorities

Tactical/Operational Support Requirements	System Architecture and Data Base
#1 - Security Operations Plus-Up	#1 – System Architecture
#2 - Base Access	#2 – Data Access
	#3 – Tailorable Database
	#4 – Untethered Operations

UNCLASSIFIED//FOUO

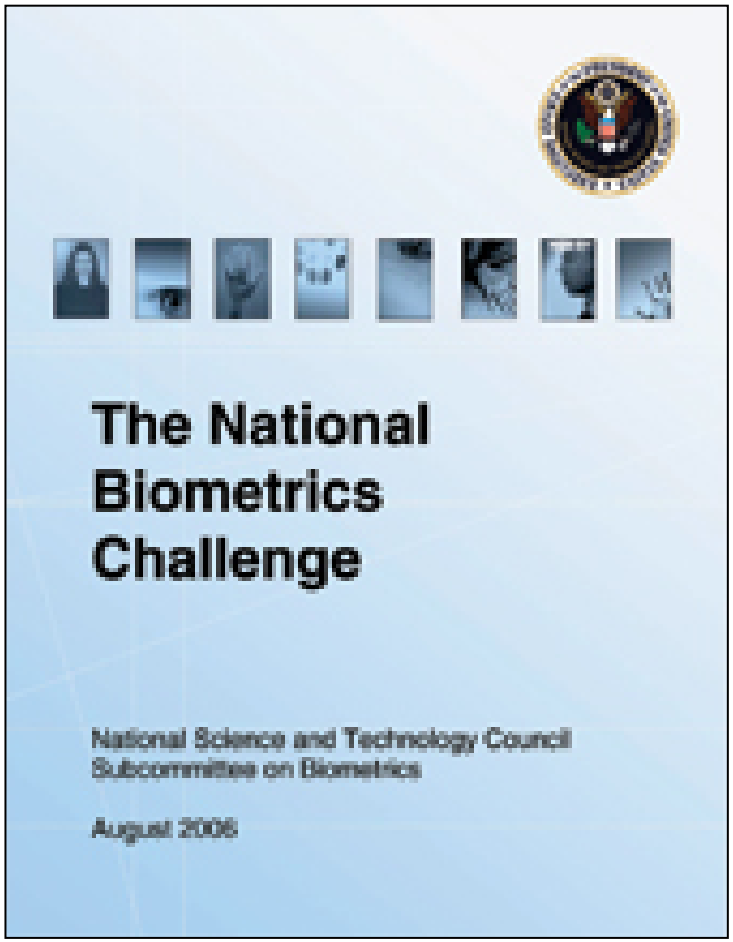
Support immediate needs while building for the future

DOD Roles and Responsibilities

- DDR&E is Principle Staff Assistant
- Army is Executive Agent
- EXCOM established as final arbitration forum and executive level collaborative forum
- Army established a joint governance structure subordinate to EXCOM
  - Full transparency of component biometrics programs
- Services retain Title 10 responsibilities

Promote unity of effort to deliver desired outcomes

Technology Challenges



www.biometrics.gov

- Improve Collection Devices
  - Biometrics Sensors
- Develop More Efficient and Effective large Scale operational Capabilities
  - Biometrics Systems
- Establish Standards for Plug and Play Performance
  - Systems interoperability
- Informed Debate on Why, How, and When Biometrics Should be Used
  - Biometrics Communications and Privacy

Challenge

- **Biometrics is only a sub-set of Global Identity Management**
  - **Holistic program must support:**
    - **Combat applications & Business Functions & Intelligence source**
    - **Red Force & Blue Force & Neutrals**
    - **U.S. Persons & Non-U.S. persons**
    - **Verification & identification**
    - **Voluntary & involuntary subjects**
    - **Multi-service & Defense Agencies & Inter-agency & International**
    - **Biometrics & Credentials & Contextual data & Forensics**
    - **Privacy Data & Public Perceptions**

Goals

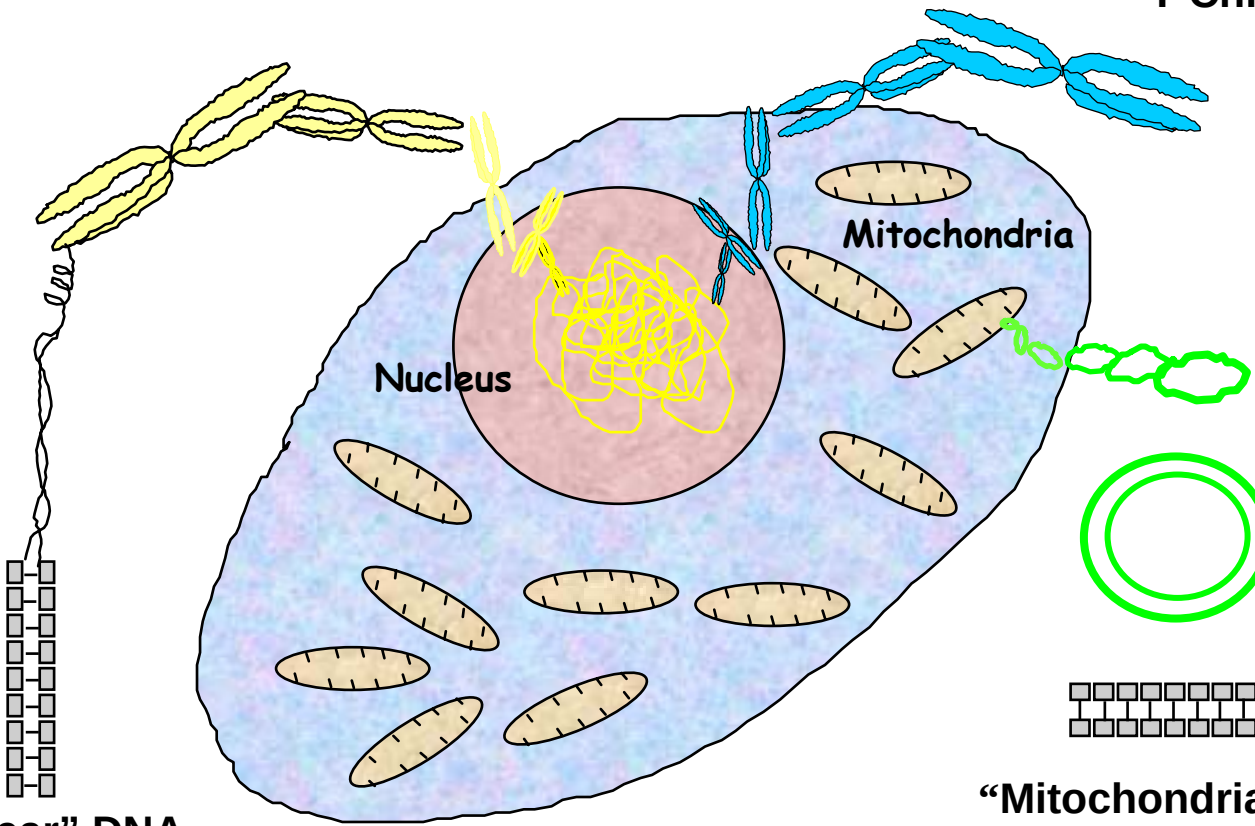
- 100% accuracy in identification and verification
- Interoperable biometrics systems within DoD & with Other Government Agencies
- Reduce workload and manpower associated with collection, storage, matching, analysis, & action
- Dramatically reduce latency in moving biometrics data and accelerating decisions
  - Hours … to minutes … to seconds (it was days & weeks)

Synchronized, Integrated, Coordinated Program

Discussion

Human Genome

as the subject of forensic analysis



“Y Chromosomal” DNA
(yDNA)
Y STRs

“Nuclear” DNA
(nucDNA)
Autosomal STRs

“Mitochondrial” DNA
(mtDNA)
Direct Sequencing or Base Composition

9/7/2007

Integrated Automated Fingerprint Identification System (IAFIS)

The five key IAFIS services are:

1. Ten-print Based Fingerprint Identification Services
   - Criminal submissions, responses within 2 hours
   - Civil submissions, responses within 24 hours
   - Supports DoD ABIS
2. Latent Fingerprint Services (at Quantico, VA)
3. Subject Search and Criminal History Services
4. Document and Imaging Services
5. Remote Ten-print and Latent Fingerprint Search Services

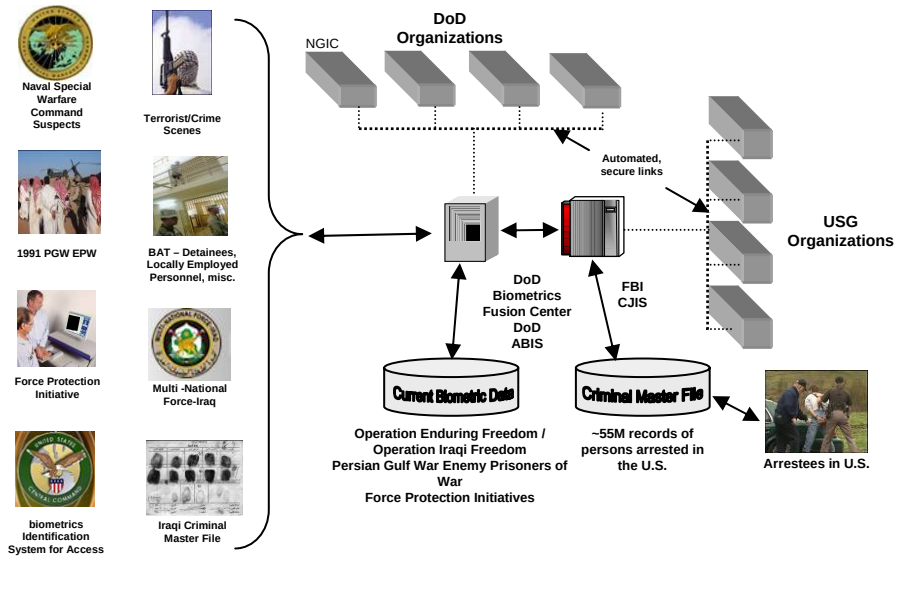
Owned by the FBI, IAFIS is the US National Fingerprint and Criminal History System

- Located at the Criminal Justice Information Services (CJIS) Division, Clarksburg, WV
- Maintains the world's largest biometrics database currently holding about 66 million records
- Has been in operation since July 1999
- Model for the DoD Automated Biometric Identification System (ABIS)

Automated Biometric Identification System (ABIS)

ABIS Background:

- Operational since July 2004
- Modeled after highly successful FBI system, Integrated Automated Fingerprint Identification System (IAFIS)
- Central repository for DoD biometric data
- Provides capability for searching, storing and matching biometrics data
- Building multi-modal searching/matching capability (NGEA)
- Located in Clarksburg, WV



ABIS has made matches to:

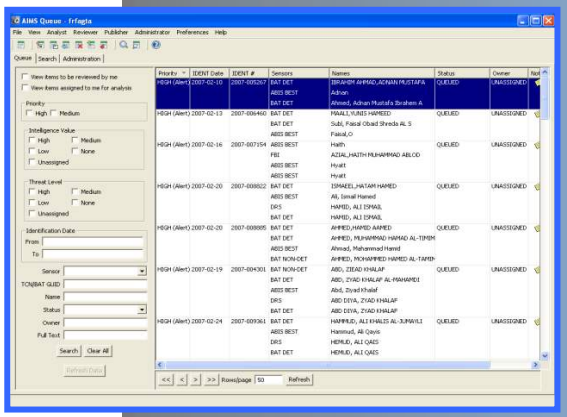
- Known and suspected terrorists
- Bomb makers
- Passport forgers
- Individuals with US criminal convictions
- Former Iraqi criminals (Hussein regime)

ABIS Operations Tasks:

- Operate and maintain the ABIS repository
- Provide 24x7 biometrics matching services
- Share biometrics data with approved agencies
- Provide latent match capabilities

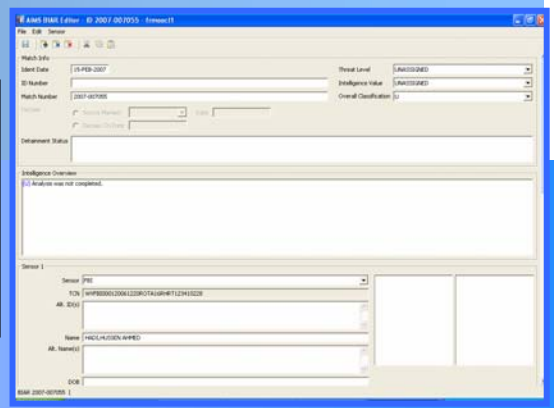
Automated Identity Management System (AIMS)

Analyst Workflow



- Automated triage and Prioritization
- Focus on most significant Matches
- ~ 4% of matches go in queue

Production Tool



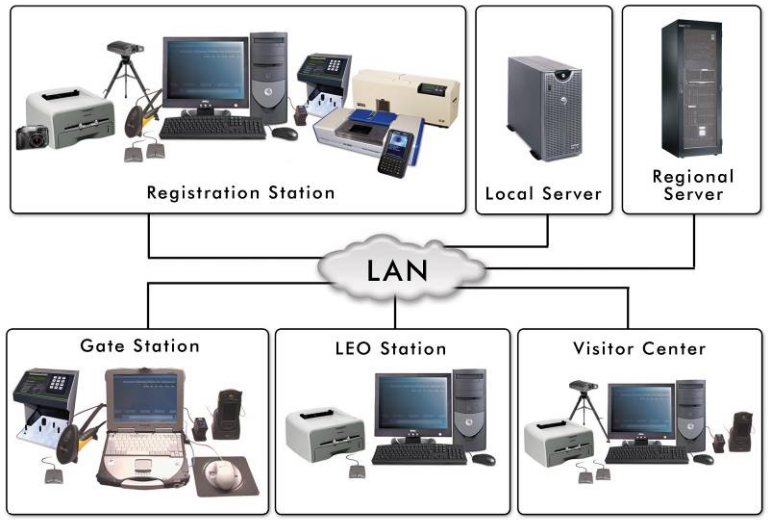
- Consistent BIAR format
- Portion Markings
- Standardized classifications
- Posting to the WEB

WEB Application

- Searchable database that contains both BIARs and BMRs
- Soundex function
- Full Text search capability

Defense Biometrics Identification System (DBIDS)

System:



Future Status:

- Afghanistan – 10 Tier 1 sites long lead time items orders sent to GSA
- Navy Europe fielding to start July 2007 – 6 sites
- Navy CENTCOM (the island of Bahrain) fielding to begin August 2007
- Air Force CENTCOM – 6 sites to begin July 2007
- Japan – 2 sites in progress
- Guam – 3 sites planned
- Representatives from all services state they want their physical access systems in CONUS to be based on/interact with DBIDS

Data Footprint:

- Currently, DBIDS installed:
  - 300 Gates
  - 135 Installations (including USAREUR, SWA, USFK, and CONUS)
  - 1.4M registrants
- DBIDS is the installation access control solution USFK and USAREUR-wide
- Attempted Accesses to DBIDS fielded Military Installations – Over 200 Million
- Accesses Denied – 1.5 Million

Levels of Commitment:

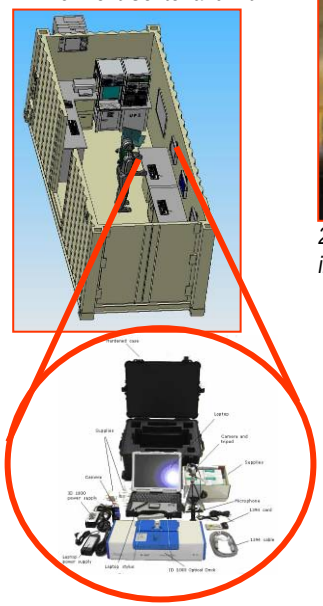
- Navy has signed MOU and has $ to field DBIDS Navy-wide
- CENTCOM has signed up for DBIDS at various sites in the AOR and will fund
- USAREUR and USFK are long-standing customers
- Representatives from all services state they want their physical access systems in CONUS to be based on/interact with DBIDS
- DoD 5200.08R and 1000.25 both name DBIDS

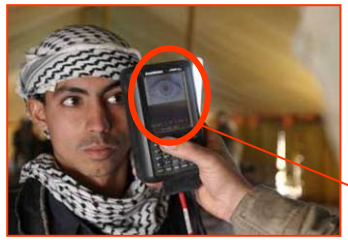
Prediction:

- By end of calendar year 2007 DBIDS will be fielded at 330 Gates at 150 Installations, including USAREUR, SWA, USFK, USPACOM, and CONUS

Biometric Identification System for Access - BISA

1. *Enrollment Center and Kit*





2. *Iris-Scan and creation of digital image*

3. *Fingerprint Scan and creation of digital image*

4. *Digital biometric data loaded onto 'smart-card' BISA badge, with other contextual data.*

5. *Biometric data on badge verified ('one-to-one' match) by electronic readers at ECP.*

Operational Concept

- Collect biometric data on all local- and third-country nationals (LN/TCN) accessing US bases in Iraq.
- Screens applicants against ABIS/IAFIS; If vetted then produces & issues access credential based on unique (person's) fingerprint & photo. Digitally verify biometric at each entry to assure identity.
- Electronic storage of biometric characteristics on 'smart-card' biometric template provides tamper-proof, forge-proof base-access credential, which also includes privilege (DFAC etc) eligibility and other commonly-required data. At verification (at ECP), electronically stored data is compared to individual data by all-electronic means; one-to-one match performed between digital image vs actual fingerprint of holder.
- Designed for turn-key deployment & operation in communications-austere and otherwise unfavorable (eg climate, dust, etc) environments.

National Detainee Reporting Center (NDRC) Detainee Reporting System (DRS)

- **Function**: Provide total accountability and reporting of all biographic and biometric data for persons detained in association with the GWOT
- **Scope**:
  - DRS allows for real time data sharing with deployed systems
  - Independent satellite communication packages enable rapid transmittal of detainee information
- **Capabilities**:
  - DRS (v5.0) is web based
  - Issues Geneva Convention required Internment Serial Numbers
  - Collects and submits biometric fingerprints and photos with biographic information including medical and property files on all detainees
  - Contains an 'In Camp' management system and a 'Do Not Release' detainer option ensuring accuracy and preventing HVD releases

27

Biometrics Automated Toolset (BAT)

BAT Enrollment Station

Optional Equipment:

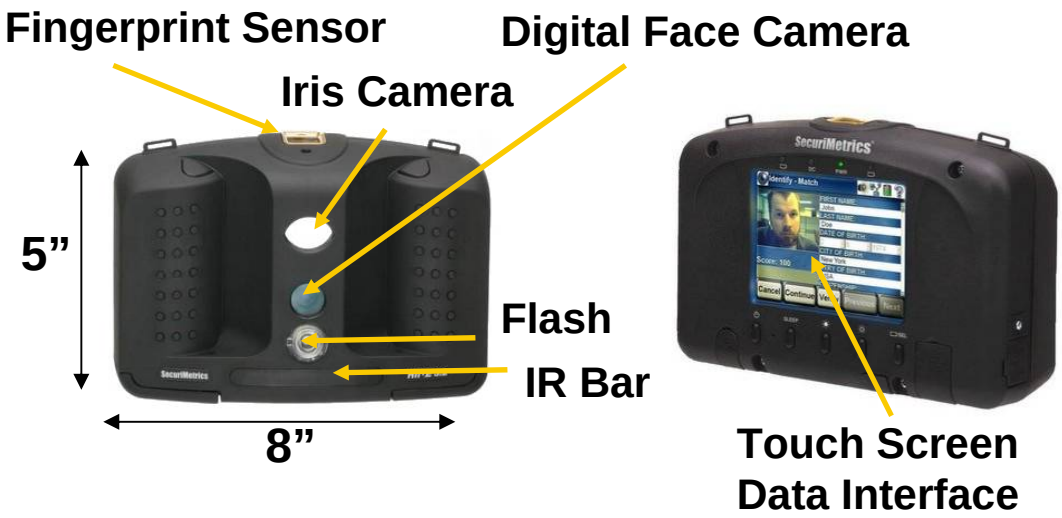
- **500GB Hard Drive**

- **Badge Printer**

- **Bar Code Scanner**

- **Function:** BAT collects fingerprints, iris scans, facial photos and biographical information of persons of interest into a searchable data base.
- **Scope:** Over 2,000 systems deployed; 560,000+ biometrics enrollments
- **Mission Threads**: Tactical Operations, Force Protection, Detainee Operations, Population Control, Base Access, IED Forensics Operations, Special Operations, and Local Hire Screening / Intelligence

Handheld Interagency Identity Detection Equipment (HIIDE)



HIIDE Characteristics:

- **Lightweight (2lbs, 3 oz)**
- **Multimodal collection and matching device**
- **Interoperable with BAT for biometrics data exchange back to DoD biometrics Data Repository**

- **Function:** HIIDE collects and matches fingerprints, iris images, facial photos and biographical contextual data of Persons of Interest against an internal database.

- **Scope:** Major HIIDE fieldings since Oct 06: 900 OIF, 450 OEF, 250 USMC, 89 ISAF, and 45 SOF; planned total fielding of 6,664 devices

- **Mission Threads:** Tactical Operations, Force Protection, Detainee Operations, Access Control, Special Operations, and Intelligence Operations

Special Operations Identity Dominance (SOID) – Biometric Identification Kits

COMPONENTS

- Organic CF-18 Laptop
- Live Scan Management System (software)
- CrossMatch MV-5 Wand-style Print Reader
- Organic Team Comms Equipment

FUNDING INFORMATION

- Procurement (934 kits at $2K each): $1.9M
- O&M: $846K
- Total, FY 08-13: $2.7M

BOIP

75th Ranger Rgt:	80 (RGT = 14, BN = 21, CO = 18, PLT = 27)
USASFC:	651 (GRP = 7, BN = 56, ODB = 84 ODA = 504)
USACAPOC:	84 (BN = 4, CAT-A = 80)
USAJFKSWCS:	119 (1 system / student)

BACKGROUND

- ARSOF have unfunded requirement to capture, store, manipulate, transmit, & query against REDFOR and GRAYFOR biometric signatures in support of national strategic objectives and the GWOT.

- Identification kits are used for hold/release info in a tactical environment

- # 14 on USASOC Commander's Priority List

Special Operations Identity Dominance (SOID) – Biometric Enrollment Kits

COMPONENTS

- Organic CF-18 Laptop
- Live Scan Management System (software)
- CrossMatch ID442 Scanner (10-print)
- Canon G-6 Digital Camera (f/ facial recognition)
- Iris Imager
- Organic Comms Equipment

FUNDING INFORMATION

- Procurement (714 kits at $10K each): $7.2M
- O&M: $3.2M
- Total, FY 08-13: $10.4M

75th Ranger Rgt: 16 (RGT = 7, CO = 9)

USASFC: 651 (GRP = 7, BN = 56, ODB = 84, ODA = 504)

USACAPOC: 20 (BN = 4, CO = 16)

USAJFKSWCS: 27 (5 students / system)

BACKGROUND

- ARSOF have an unfunded requirement to capture, store, manipulate, transmit, & query against REDFOR and GRAYFOR biometric signatures in support of national strategic objectives and the GWOT.

- Enrollment kits are for full enrollments in less austere environments

- # 15 on USASOC Commander's Priority List

Navy MIO Collection Systems

Operational Concept

The fundamental purpose of the Identity Dominance System (IDS) is to provide the capability to positively enroll, identify, and verify the identity of personnel. This capability is expected to play a key role in the Global War on Terrorism (GWOT) and the full range of military operations. The Tactical Biometrics Collection and Matching System (TBCMS) will be fielded using the IDS spiral one requirements as a quick reaction response to a CENTCOM JUONS. The BFC provides Subject Matter Experts to the Navy in support of IDS

Technical Approach & Milestones

- Approved at eR3B – Nov06
- Staffed in Joint Staffing Process; modified CDD due to Joint Staff – 2 Mar 07
- Significant modifications made
- Back to Phase 1 staffing 18Jun07
- BAWG – Aug07
- FCB – Sep07
- MS B – Jan 08
- MS C – Oct 08
- IOC – Dec 08

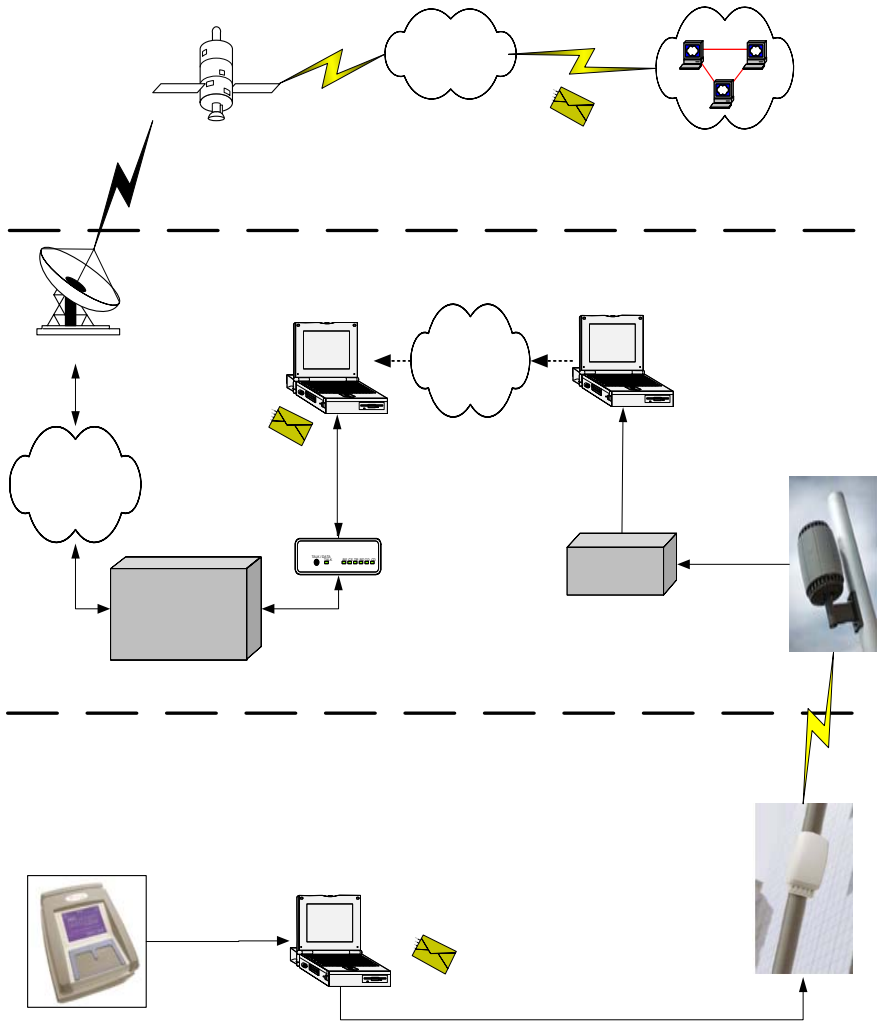
Challenges

- Responsibility for adjudication of matches currently resides with the commanding officer of the vessel dispatching the VBSS team (ONI will receive match response)
- System for passing data between boarded vessel and host vessel in development
- Funding for TBCMS follow on systems/IDS not yet secured

Expanded Maritime Interception Operations (EMIO)

Equipment Description:

- Pelican 1600 Case
- CMT ID442R
  - 8.8Lbs
  - Sealed Aluminum
  - FBI Certified
  - 500DPI Optical
  - Slaps and Rolls
- BB2590/5590 Battery
- Panasonic CF-18F
- Panasonic IRIS
- Olympus D595 5.1 MPX Digital Camera
- Capable of 10 prints – rolls/slaps
- <18 Watts power requirement
- 12 VDC Battery with converter



Biometrics S&T

- **Develop a DoD Science and Technology (S&T) Road-map**
  - **Synchronized with interagency**
  - **Transition goals to acquisition**

- **Accelerate longer-range advanced technologies**

- **Potential Opportunities:**
  - **Iris-at-a-Distance**
  - **Facial Recognition**
  - **Non-Obtrusive Biometrics**
  - **Rapid Fingerprint Capture**
  - **Enhanced Latent Fingerprint Detection**
  - **Natural Forensics for Backtracking Terrorists**
  - **Biometrics Operational Exchange**
  - **Multimodal Biometrics Fusion**
  - **Standards Development & Prototype Deployments**
  - **Improved Data Storage and Exchange**
    - **Wireless systems, data architectures, data standards, system form factors to permit expeditionary operations**

Training and Mission Rehearsal's Contribution to Defeating Disruptive Technologies

FRANK C. DIGIOVANNI,
Deputy Director, Military Training and Ranges
Office, Deputy Under Secretary of Defense, Readiness
Comm: (703) 693-4973

Overview

- **Defense Science Board Task Force "*Training Superiority & Training Surprise*"**
- **Asymmetric Warfare and Training to Adaptability**
- **Emerging Technologies and Training Capability**
- **Summary**

Training Superiority & Training Surprise

- **2001 Defense Science Board Task Force Report**

  “The superb performance of our military in the 1990s was not just the result of technological superiority but equally of TRAINING SUPERIORITY”

  “Training superiority is ours to lose and for others to gain”

Training Superiority & Training Surprise

- **Key Thoughts**
  - **The first training revolution was the standup by the Services of large force, “full scrimmage” training venues**
  - **Training must become an integral part of the acquisition of hardware or we will fail to realize the full potential of our superior technology**
  - **Future weapons technology appears to require more training, not less**
  - **Most training R&D today is ad hoc, local and small scale**

Training Superiority & Training Surprise

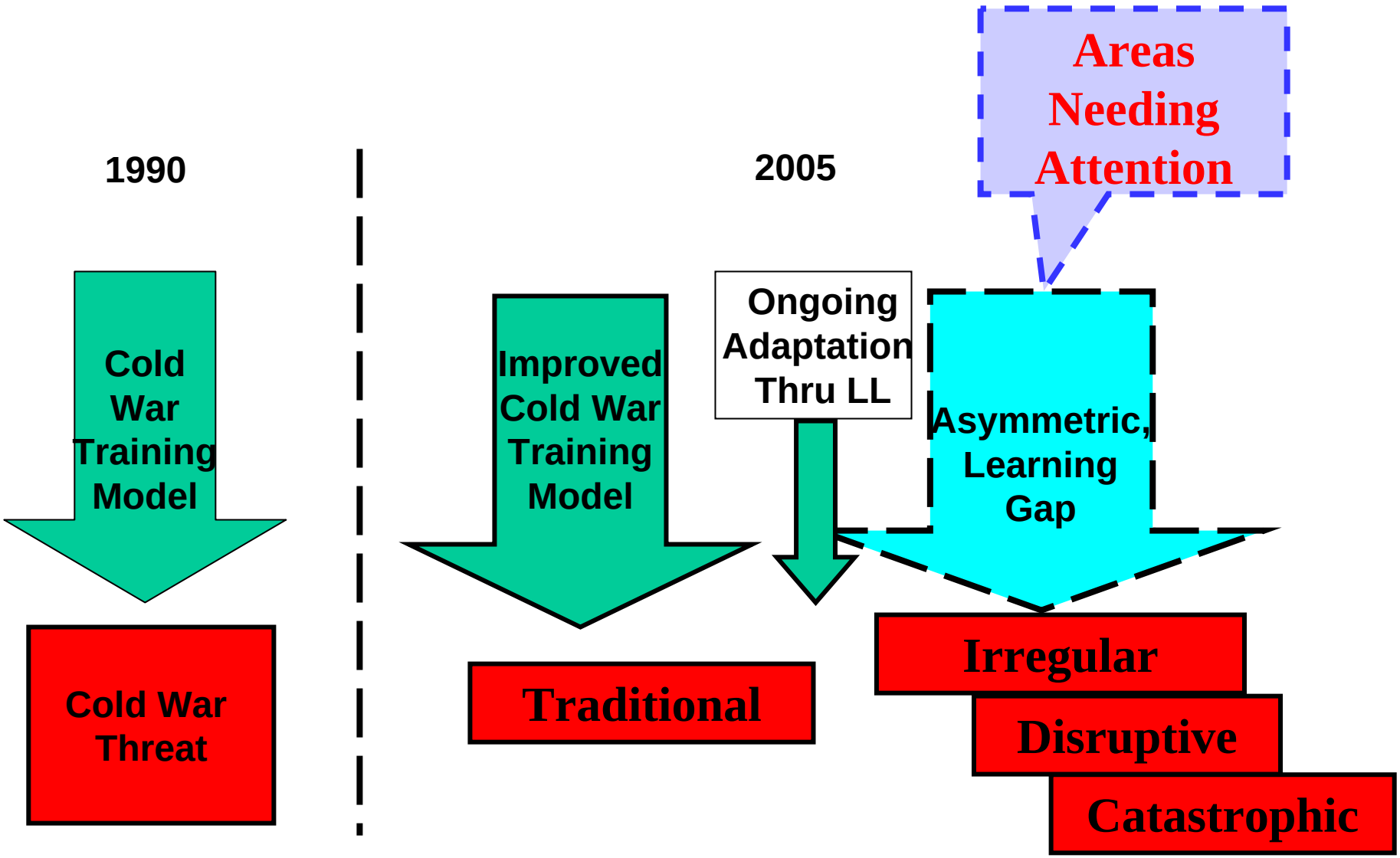
- **Warfighting success is as dependent upon the proficiency of people as it is upon hardware with which they fight**

- **If training is to supply people who can fight under new paradigms. . .it cannot be done in the old way, based upon the existing training system**

Asymmetric Warfare and Training to Adaptability

- **IDA Study "Learning to Adapt to Asymmetric Threats"**
- **Asymmetric threats in the 21st Century are largely unpredictable**
- **Given this unpredictability. . .the key skill that needs to be trained to is adaptability**
- **DoD needs to revise its training paradigm to improve its ability to adapt to new threats**

Asymmetric Warfare and Training to Adaptability



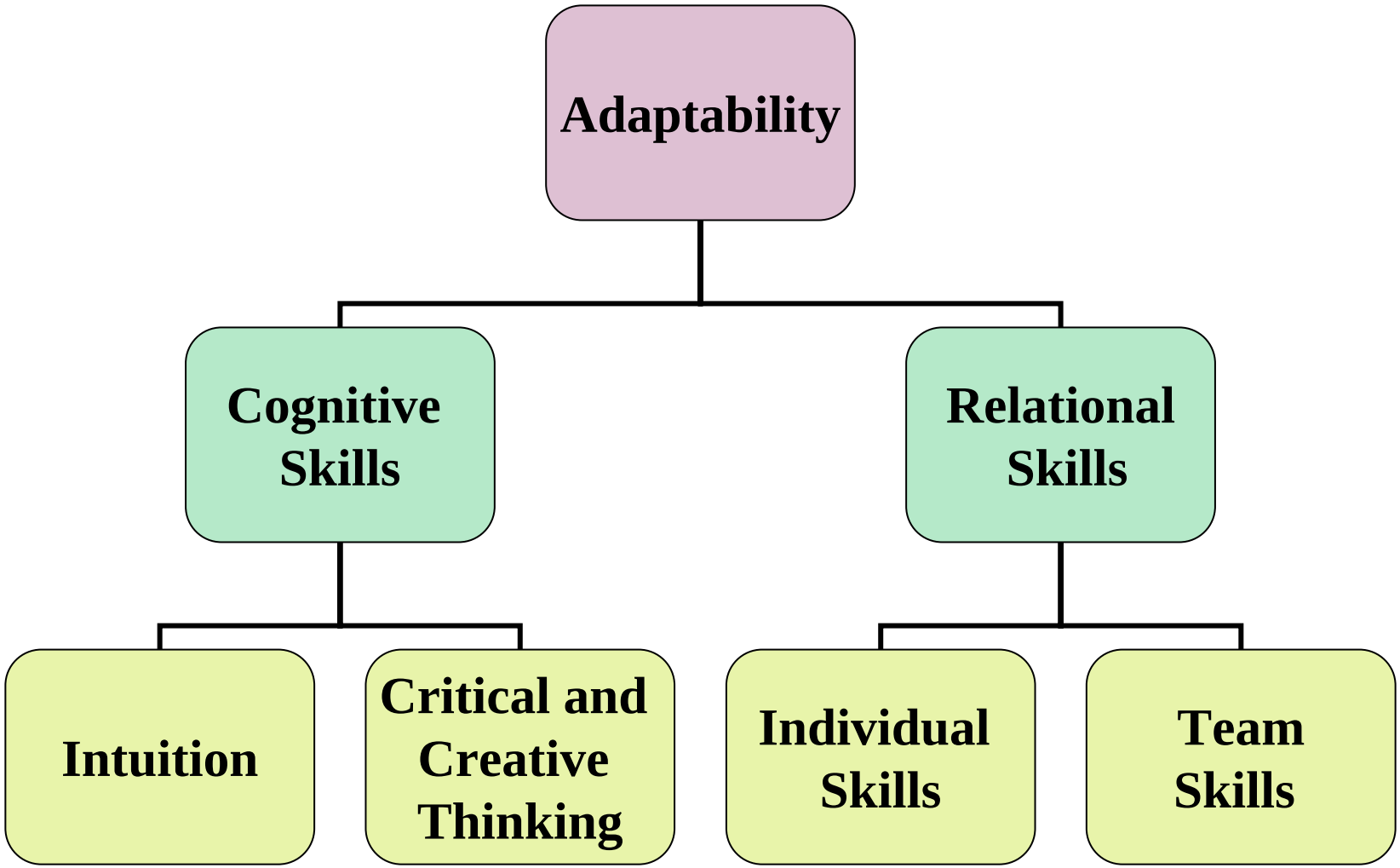
Asymmetric Warfare and Training to Adaptability
Basic Findings

- **DOD learning environment must prepare individuals, units, and staffs to adapt quickly to unpredictable missions and tasks**

- **Current training and education tools are necessary but not sufficient**

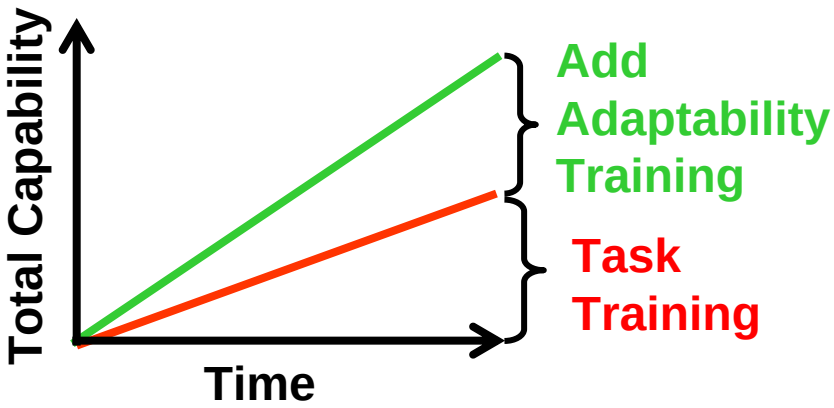
- **DoD needs to develop new adaptability learning tools**

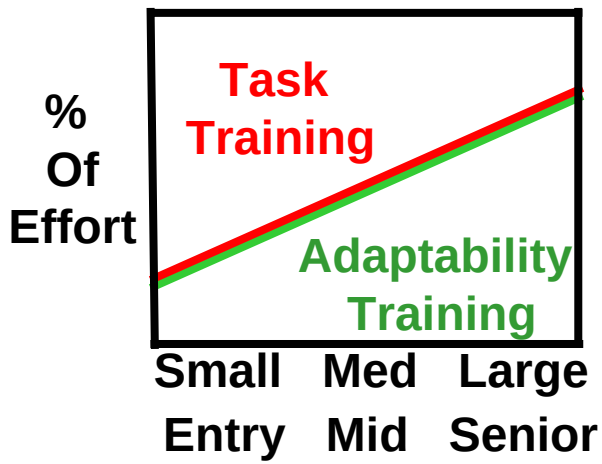
Components of Adaptability



Adaptability Learning Goals

- **Create adaptable individuals and units/organizations more capable of operating in the new era of asymmetric threats**
  - **Create the cognitive and relational skills essential to enhanced adaptability**
- **Develop adaptability learning opportunities for individuals, units/organizations**
- **Integrate adaptability training into existing learning system**





Asymmetric Warfare and Training to Adaptability

- **IDA recommendations include:**
  - **Expand upon Army's Battle Command Knowledge System**
  - **Expand use of decision making exercises to develop adaptability-related skills**
  - **Develop a robust Red Teaming structure with both online and mobile training teams**
  - **Leverage online capabilities to provide self-development programs**
  - **Conduct an experiment or demonstration program to investigate the potential for adaptability learning efforts**

Emerging Technologies & Training Capability

- **New visualization tools are needed**
  - **Computer network attack and defense**
  - **PYSOPS, Civil Affairs and Nation Building**
  - **Understanding Counter Insurgency catalysts**
  - **Non-kinetic and kinetic skills interface/transition**
- **Disruptive and Asymmetric threat analytical forecasting**
- **Teaching empathy, language and culture**
- **Training capabilities must target both the "digital immigrant" and "digital native"**

Emerging Technologies & Training Capability

- **Emerging capabilities**
  - **DARWARS AMBUSH**
  - **Civil Effects Leadership Training System**
  - **“Immersive Infantry Trainer”**
  - **Second Life™ and other Massively Multiplayer online gaming opportunities**
  - **“Peacemaker: The Game”**

Summary

- **If training is to supply people who can fight under new paradigms. . .it cannot be done in the old way, based upon the existing training system**

- **<u>Bottom Line</u>: The key to defeating disruptive and asymmetric adversaries. . .is to leverage the richness of our human capital. . .trained with the best capabilities our technology can provide**

Questions

WEL COME
TO
KHYBER AGENCY
KEEP TO THE LEFT
ATTENTION
ENTRY OF FOREIGNERS
IS PROHIBITED
BEYOND THIS POINT
TIR

Turning Lists into Capabilities

Rich Engel
Maj Gen USAF (Ret.)
Deputy NIO for Science and Technology
National Intelligence Council

Overview

- The Challenge
- Bottom Line Up Front
- Definitions
- Process Initiatives
- Lists
  - CIA 2015
  - RAND 2020
  - STIC Emerging Technology Landscape
  - SRIC-BI Emerging Disruptive Civil Technologies
  - DNIO/ST
- Examples
- Lists to Capabilities

The Challenge

IC Perspective

Why is it Crucial To Focus Intelligence > 15+

Effectiveness of threat mitigation	Very Effective	Effective if lucky on intelligence	Ineffective/ expensive
Risk of technical surprise	Low to medium	High	Very High
Effectiveness of intelligence collections tools	Good for R&D direction	Low because development concealed and hard to collect against	Good for *deployed* system
Maturity of technology	Now to 5 years basic R&D, published work	5-15 years IOT&E, SAP, D&D, little to no OSINT	15 + Emerges as deploying system

Conclusion: Stay on the left side of the bathtub

The Challenge

Defense Science Board Perspective

"With so much technology in the world markets, the DoD has yet to organize and staff accordingly. The DoD does not know what it does not know and to date has yet to construct solutions or processes to overcome this important barrier. There are no systemic and enterprise-wide mechanisms to determine how global technologies can be used to enhance military capabilities or how these technologies can be used against the United States by potential adversaries."

DSB 2006 Summer Study
21st Century Strategic Technology Vectors
Volume III, p 12

The Challenge: Pace of Technology

"Moore's Law" → **Computing doubles every 18 months**

"Fiber Law" → **Communication capacity doubles every 9 months**

"Disk Law" → **Storage doubles every 12 months**

Defense Acquisition Pace

F-22	**Milestone I:**	**Oct 86**	**IOC:**	**Dec 05***
Comanche	**Milestone I:**	**Jun 89**	**IOC:**	**Sep 09**

*** Computers at IOC are 512 X faster, hold 65,000 X bits of information than they did at MS I**

Technology growth is non-linear…
Acquisition path has been linear

Bottom Line Up Front

- **Ho: Capability is derived from**
  - **Knowledge**
  - **Imagination**
  - **Resources**
  - **Time**

The greatest challenge is with "imagination." What process can be used to apply imagination to the generated knowledge (lists)? What organization is responsible for imagination? How does "the system" deal with organizational threatening imagination?

Definitions

NIC National Intelligence Priorities Framework

Emerging and/or Potentially Disruptive Technologies:

Discovery, development or exploitation of advanced technologies or combinations of advance technologies by foreign states or non-state actors that could threaten U.S. military forces or national security interests. The foreign technology base of adversaries and competitor nations. Science and technology plans, policies, programs, and facilities that could lead to emerging or disruptive technologies. Globalized trends in research in civilian advanced technologies. Development and/or application of technologies that could lead to asymmetric warfare threats to U.S. forces or critical U.S. infrastructure. Special focus on integration of information technology, biotechnology, materials science, and/or nanotechnology.

Definition of Disruptive Technology
The Textbook Definition

- **Coined by Christensen* to describe a new, lower-performance (but cheaper) new product that can be improved more rapidly, so that performance outpaces the product it is replacing**

- **Key concepts:**
  - **Greater performance than previous product**
  - **Replaces (drives) old product out of market**

**** "The Innovator's Dilemma", 1997***

Disruptive Technology
The Non-Textbook Definition

- **Lower cost and lower initial performance does not matter**
- **What matters is rapid evolution from old, stable technology to new, dominating technology**
- **A technology surprise that gives a competitor an advantage**
  - **Business - Technology that overturns market**
  - **Military - Technology that causes a fundamental change in force structure, basing, and capability balance**
- **Disruptive Technologies can be intended or unintended - but both represent change**
- **Disruptive Technologies may arise from systems or enabling technology**

Definitions

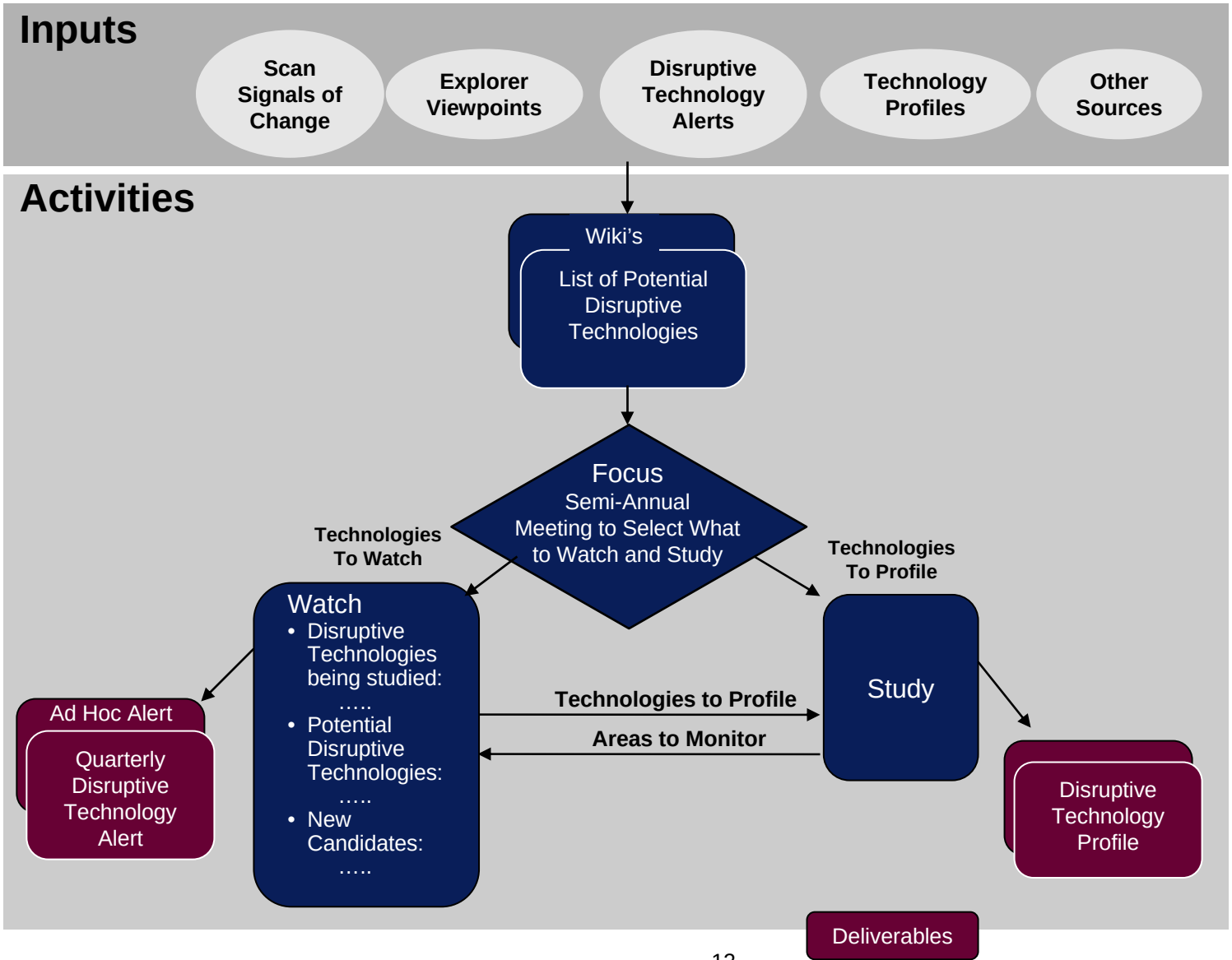
NIO/ST Perspective

Those emerging technologies and integration capabilities identified as most significant to advance or degrade US security broadly defined. Must cross the "major" threshold of interest – if not satisfactorily resolved would result in a noticeable but temporary degradation of US geopolitical, economic, military power or social cohesion.

Process Initiatives

- NIO/ST tasking to the Scientific and Technical Intelligence Committee
  - STIC Serves as NIPF Manager
- NIO/ST contract efforts with SRIC-BI and Institute for the Future
  - Targeted at Civil Technologies
- DIA Partnership with the National Academies
- DoD Service Intelligence Centers
  - Targeted at Military Technologies
- CIA Initiatives
  - Organizational and Partnerships with Businesses
- NSA – Institute for Analysis

Overall Process for Identifying and Monitoring Disruptive Technologies

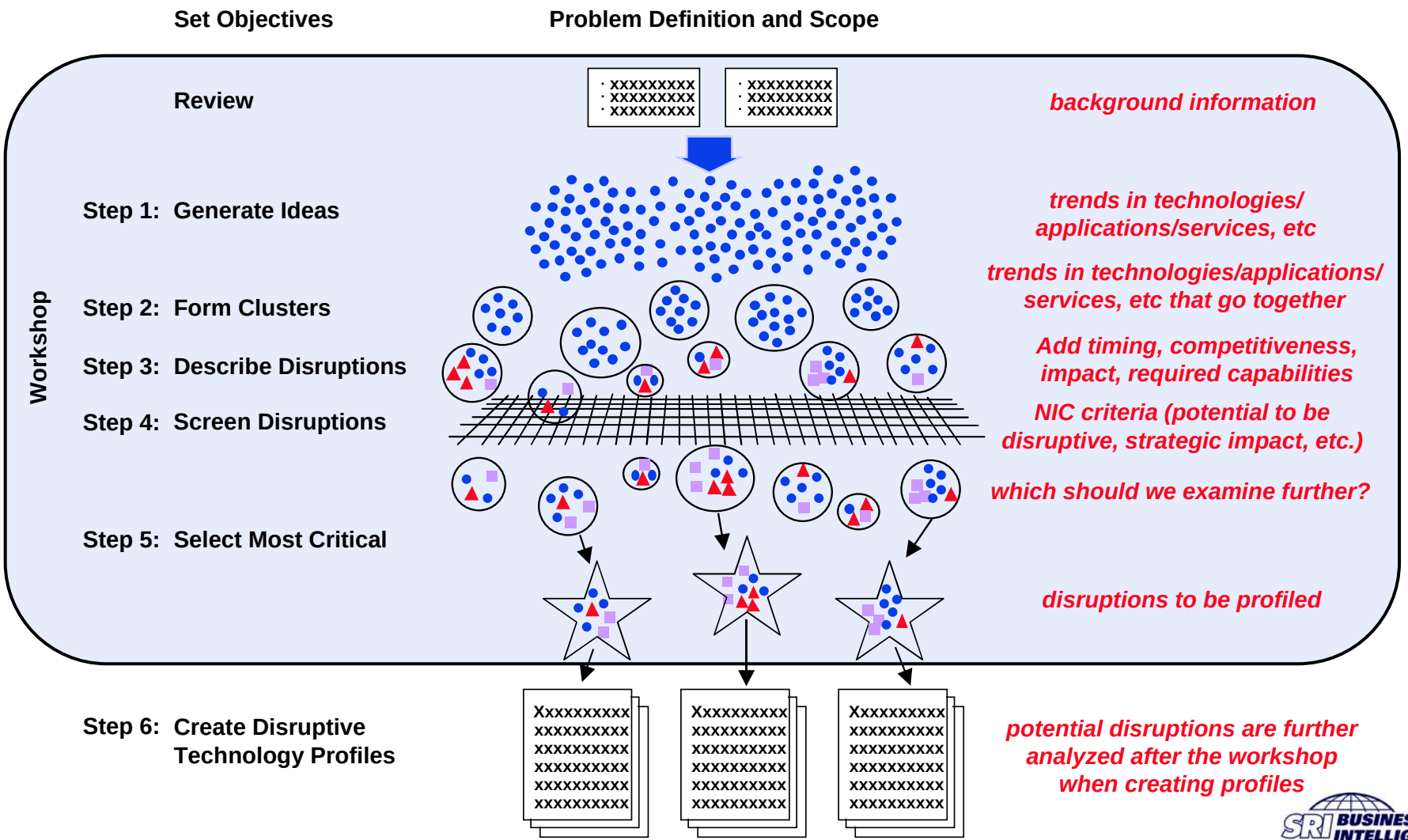


NIC and SRIC-BI:

- **Identified two potentially disruptive technologies to watch and study based on current SRIC-BI Explorer coverage**
- **Developed templates for the disruptive technology profile for the quarterly alerts to update changes in technologies being watched and studied**
- **Prepared a profile on human embryonic stem cells (HESC)**
- **Prepared two quarterly alerts on HESC (profiled technology) and ocean energy (watch technology)**

SRI CONSULTING BUSINESS INTELLIGENCE
An SRI International Business Partner

Task 3: Disruptive Technology Workshop—Example Process Flow

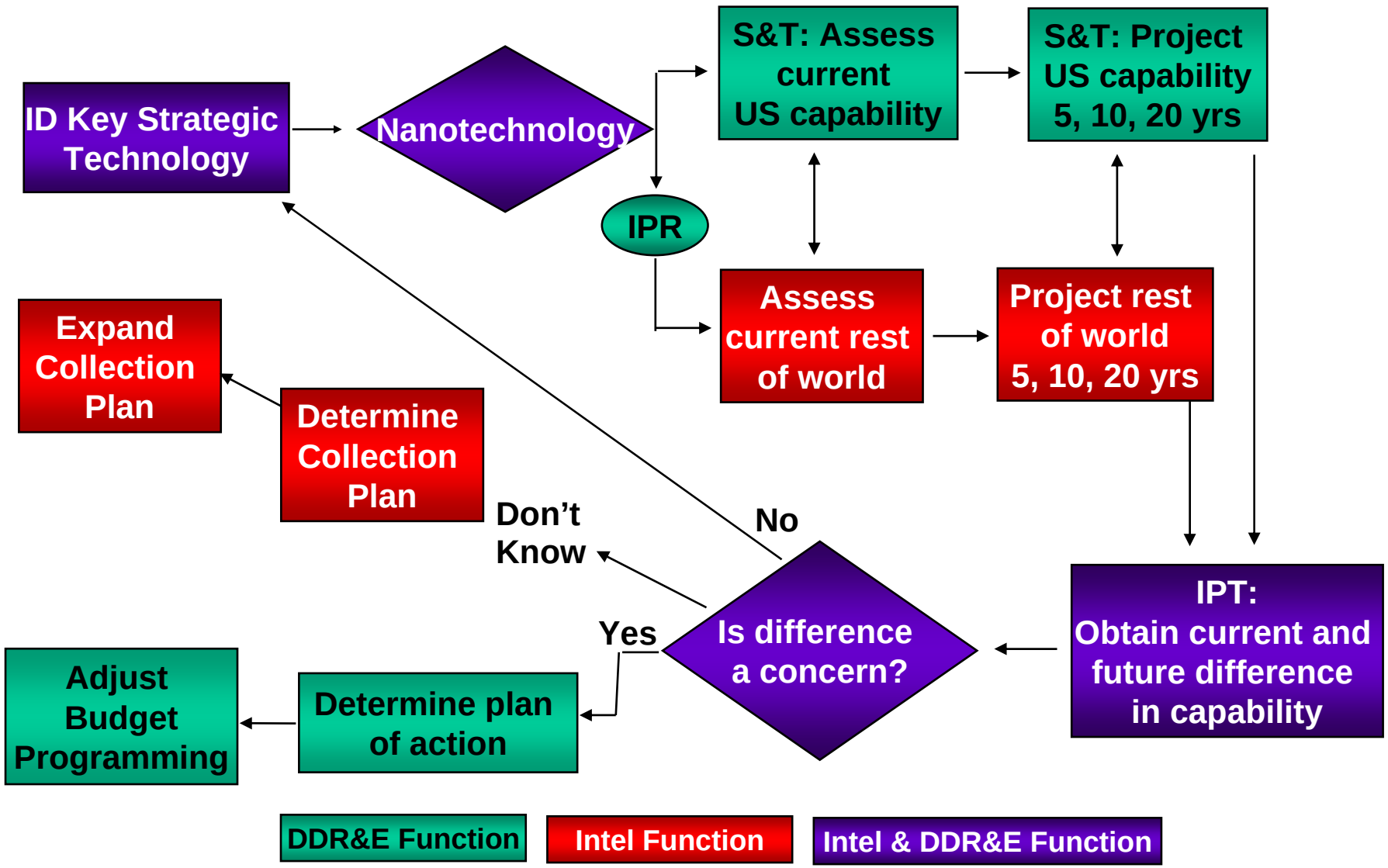


Process Initiatives

But in the end, by and large, the processes give you lists.

What do you do with the lists?

Integration Process
Notional Example



Lists

CIA/OTI/SAG

Global Technology Scenarios Through 2015: America's Game to Lose

Views From a Panel of Experts (OTI IA 2001-083, November 2001)

Tier 1 – High Impact

- Gene Therapy
- Wireless Communications
- Image Understanding (Automatic Target Recognition)
- Cloned or Tailored Organisms
- MicroElectricalMechanical Systems (MEMS)
- Nanotechnology

Tier II – Enablers

- Optical Communications
- Regenerative Medicine
- Efficient Software Development
- Sensor Webs
- Advanced Materials

Lists

RAND 2020

The Global Technology Revolution 2020
RAND National Security Research Division (2006)

Implementation and Technology Feasibility:

Hybrid Vehicles
Rapid Bioassays
Rural Wireless Communications
Targeted Drug Delivers
Ubiquitous Information Access
Ubiquitous RFID tagging
Improved Diagnostic and Surgical Methods
Quantum Cryptography

Lists

STIC Emerging Technology Landscape

- **Remote, Accelerated, Instant Learning**
- **Personalized (smart) Bioeffects and Bioweapons**
- **Tagging, Tracking & Locating Devices, Systems, Capabilities**
- **Cheap, Clean, Distributed Energy Sources and Energy Harvesting**
- **Understanding and modeling the brain**

Lists

SRIC-BI 2025 Disruptive Civil Technologies

- **Clean Coal**
- **Biofuels and bio-based Chemicals**
- **Biomedical Breakout**
  - **Healthspan and Lifespan Extension**
- **Energy Storage Materials**
- **The Internet of Things**
- **Personal Robots**

DRAFT

Lists

NIO/ST Civil Technology List

- **Advanced Energy Techniques (inexpensive solar energy systems, hybrid automobiles—particularly "series" hybrids)**
- **Advanced Information Process and Management Capabilities (widely available telephone and Internet connectivity—both wired and wireless, ubiquitous radio frequency identification (RFID) tagging of commercial products and individuals; pervasive sensors, wearable computers, quantum cryptography)**
- **Advanced Medical Techniques (rapid bioassays, targeted drug delivery therapies, tissue engineering, improved diagnostic and surgical methods)**
- **Technologies to facilitate human sustainability and quality of life (genetically modified (GM) crops, filters and catalysts, autonomous housing, green manufacturing processes)**

Examples

What to do with a list?

- **Turn it into a scenario**
- **Craft a credible path from today to:**
  - **Where we want to go, or**
  - **What we might face**
- **“Plausible” vs “Probable”**
  - **Driving forces**
  - **Technology maturation**
  - **Programmatics (dollars, commitment, resources, events)**
  - **Supporting Infrastructure**
  - **Cultural acceptance**

Examples

Scenario 1 – Energy Markets Collapse

- **Two technology breakthroughs occur in the near term (w/i ten years)**
  - **Energy Storage greatly improves**
  - **Bio-Fuels**
- **Bio Fuels allow the use of existing infrastructure – particularly diesel/jet fuel**
  - **Energy storage takes 85% of personal automobile travel off of petroleum fuel and onto the electrical grid**
  - **Long Haul Truck, Train, and Aviation migrate to biofuels**
  - **With government incentives, automobile infrastructure begins a radical transformation that takes 10 years to compete**
- **Petroleum based Energy Markets for transportation collapse**
  - **Regulation/social concern for environment preclude a return to petroleum fuel for transportation**

Examples

NIC *Scenario II – Touch Labor Markets Collapse*

- **Two enabling technologies and market drivers create an unforeseen opportunity**
  - **Aging populations begin a wide spread use of "proxy-bots"**
  - **Next generation internet allows for real-time control of remote devices with video/tactical/audio feedback**
- **Touch labor goes on the net**
  - **Begins with service economy (security, cleaning, cooking)**
  - **Migrates to manufacturing**
    - **24/7 facilities begin operation with the "labor" coming from sources all over the world**
- **Marginal cost of labor plummets and local labor markets collapse**

Examples

Scenario III – Demographics go Non-Linear

- **Biomedical breakthroughs transition medicine from "treating the disease" to "preventing human system degradation"**
  - **Widespread use of sensor to track body functions and provide very early indications of trouble**
  - **"Wal-Mart" Physicals (cheap, ubiquitous, high resolution)**
  - **Preventative medication targeted at food**
- **In developed countries, human productivity and lifespan significantly increase**
- **Governments and societies struggle with existing "retirement" and "social insurance" systems based on outdated demographics**

Lists to Capabilities

Is this a profound idea or fortune telling?

Lists to Capabilities

Who provides the imagination?

- **Intelligence Community**
- **Think Tanks / Science Boards**
- **Users**
- **Academics**
- **Developers**
- **Contractors**
- **Futurists**
- **Politicians**
- **Fortune Tellers**

The Proverbial Integrated Product Team –
aka, “all of the above”

Lists to Capabilities

Defense Science Board

"To summarize, a number of different types of execution agents, each with distinct core competences and cultures and governed by different rules sets and incentives, are required to meet conflicting demands: top-down versus bottom up, long development time versus quick response time, requirements-driven versus innovation-driven, DoD-specific technologies versus commercial technologies, and planned-for threat versus newly emerged threat."

DSB 2006 Summer Study
21st Century Strategic Technology Vectors
Volume III, p 18

Lists to Capabilities

Some Suggestions

- **This is a multi-discipline problem**
  - **Technical skills/knowledge**
  - **Programmatic sensitivity**
  - **Operational utility**
- **Scenario approach provides value added**
  - **Discipline**
  - **Can we really get there from here**
    - **Are the individual steps plausible**

Intelligence Community Willing to Help!

Questions?

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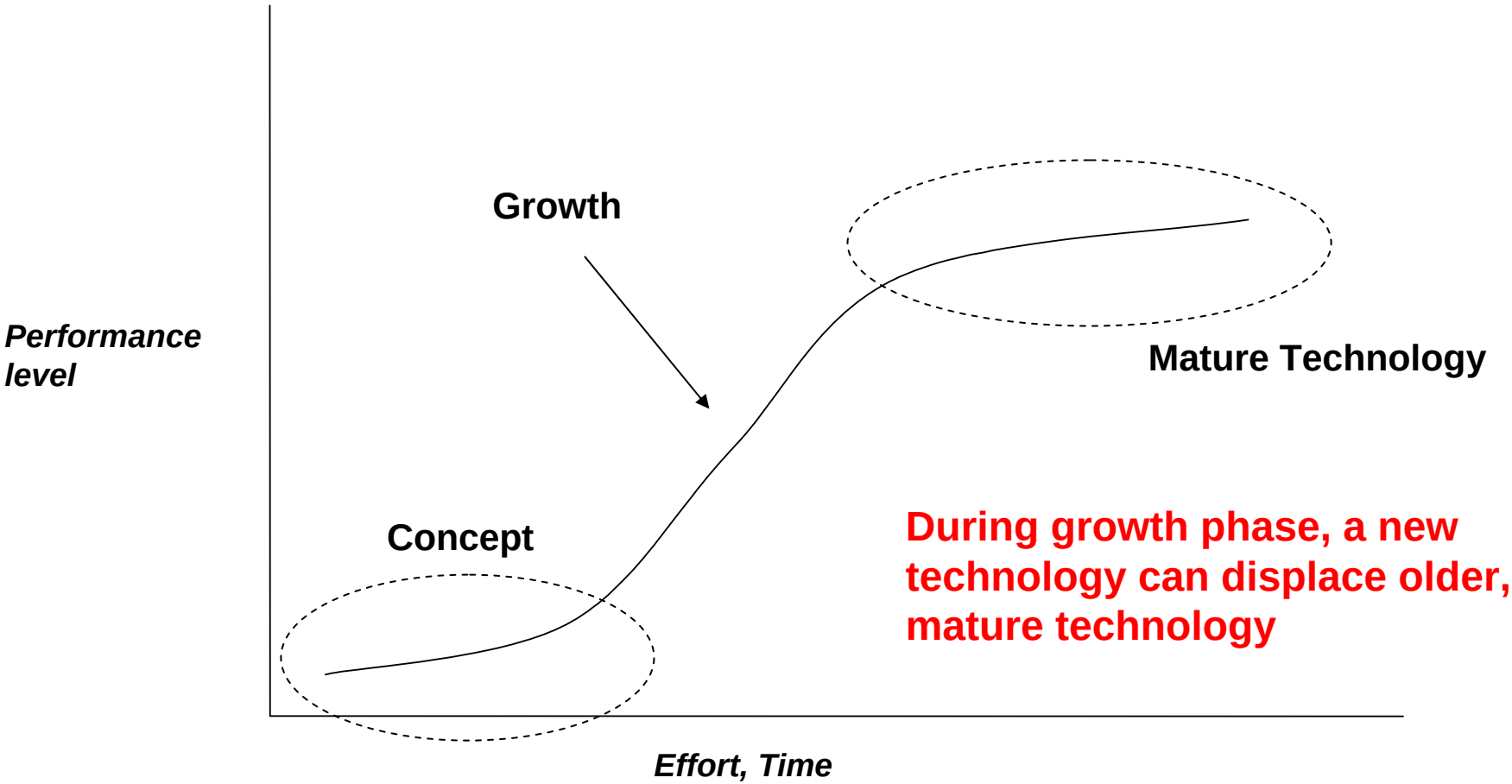
A Final Concept
Technology S-Curve

Most Technology maturation follows S-curve:

Initial Discovery, "Product-ization", then Incremental Improvement



During growth phase, a new technology can displace older, mature technology

Changing Security Environment
- Four Challenges -

Irregular

- Unconventional methods adopted by non-state and state actors to counter stronger state opponents.
- (e.g., terrorism, insurgency, civil war, and emerging concepts)

Catastrophic

- Acquisition, possession, and use of WMD or methods producing WMD-like effects against vulnerable, high-profile targets by terrorists and rogue states.
- (e.g., homeland missile attack, proliferation from a state to a non-state actor, devastating WMD attack on ally)

Traditional

- Military capabilities and military forces in long-established, well-known forms of military competition and conflict.
- (e.g., conventional air, sea, land forces, and nuclear forces of established nuclear powers)

Disruptive

- International competitors developing and possessing breakthrough technological capabilities intended to supplant U.S. advantages in particular operational domains.
- (e.g., sensors, information, bio or cyber war, ultra miniaturization, space, directed-energy, etc)

Higher

Lower

VULNERABILITY

Lower

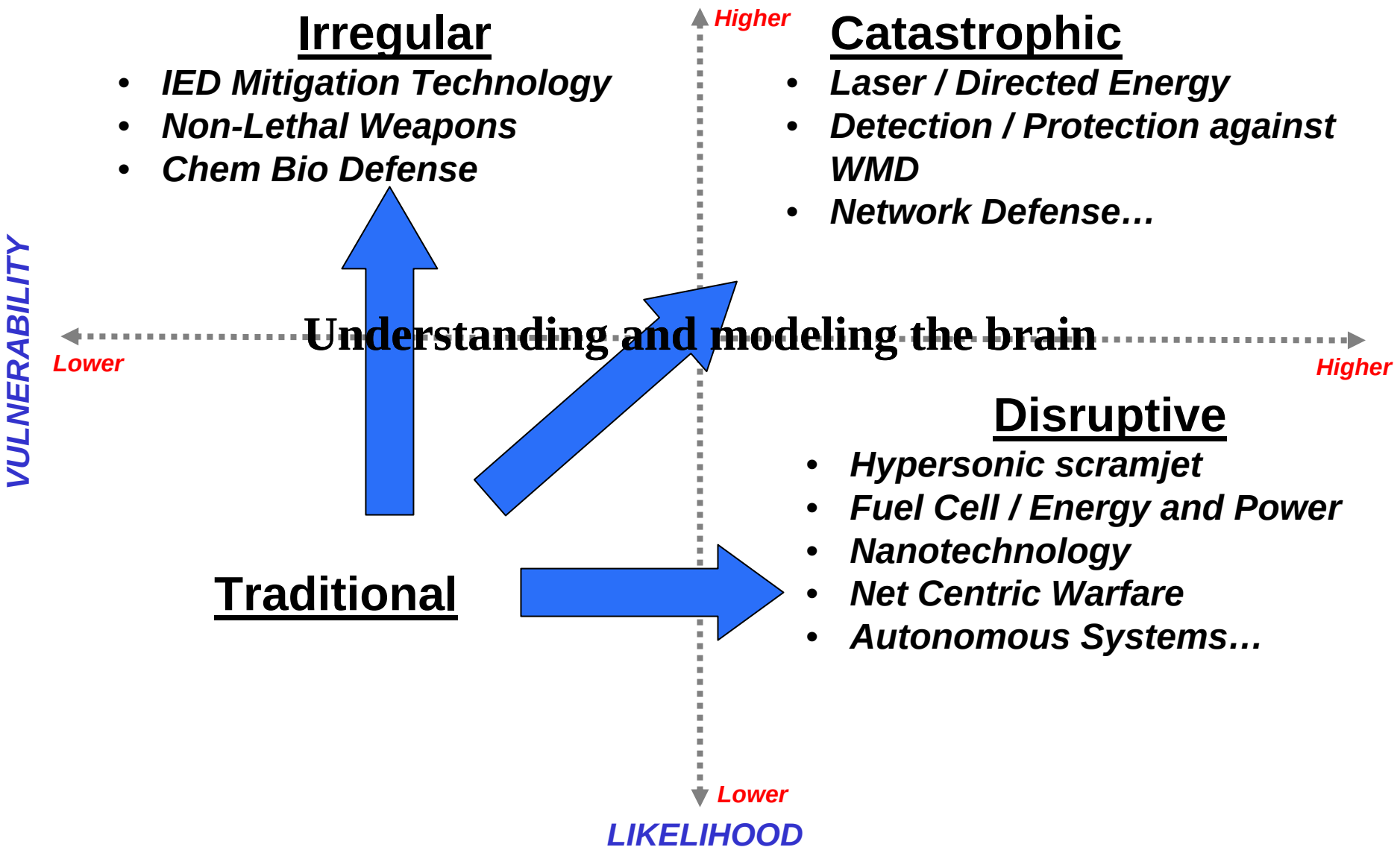
Higher

LIKELIHOOD

Uncertainty is the defining characteristic of today's strategic environment

Shift to "Transformational Technologies"

Investment Priority Changes from PBR05 to PBR06



UNCLASSIFIED

Disruptive Technologies Conference

Evolving Joint Needs & Desired Joint Military Capabilities

September 4-5, 2007

UNCLASSIFIED

***Moderator:* Mike Knollmann**

ADUSD (Joint & Coalition Operations Support)

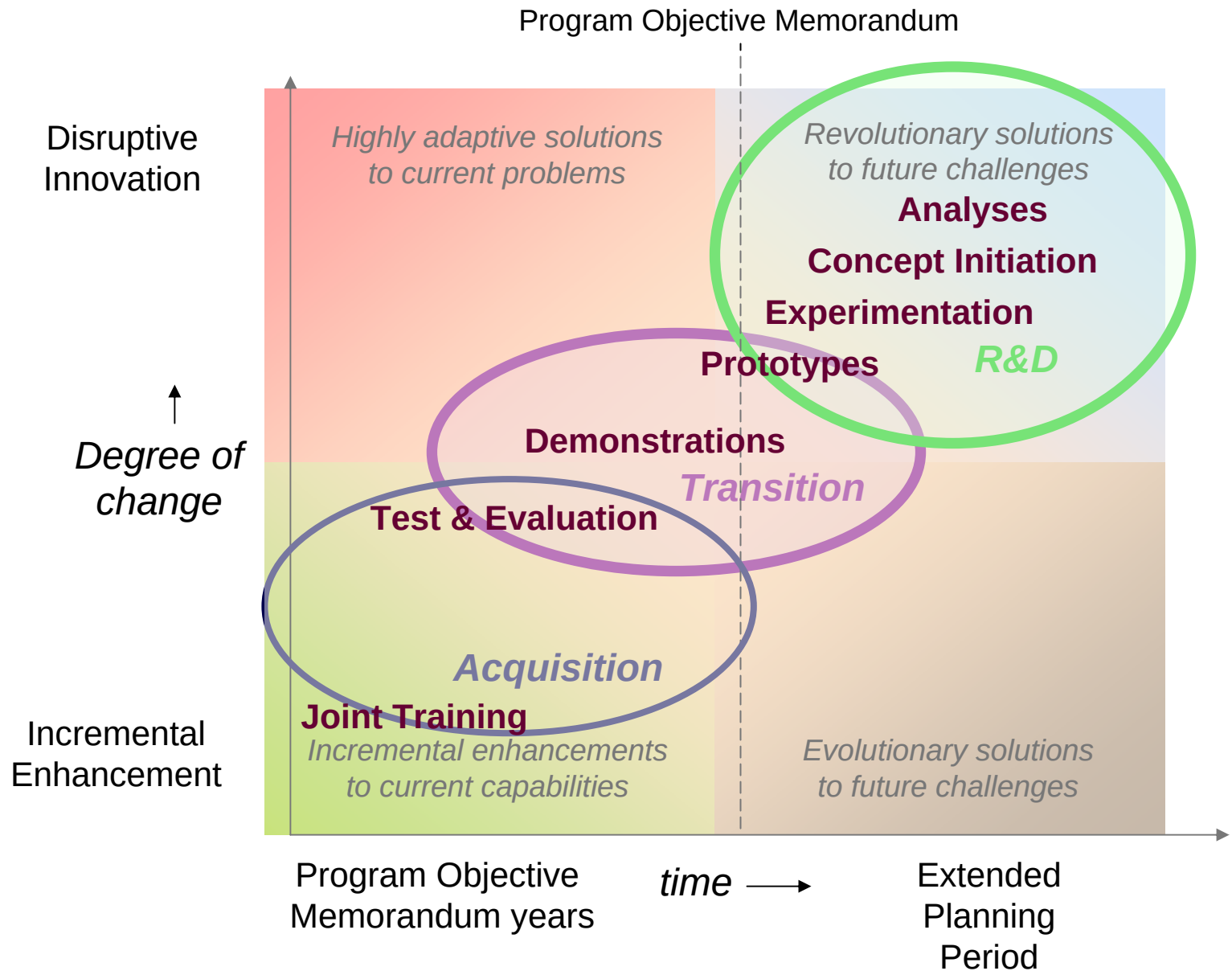
Defense Research & Engineering

mike.knollmann@osd.mil

(703) 693-0462

Capability Transition Environment

Defense Research & Engineering



Joint Capability Areas

Defense Research & Engineering

No implied prioritization

Force Application	Movement & Maneuver Joint Fires Territorial Control	Surface Warfare Undersea Warfare Maritime Warfare Littoral Expeditionary Operations
Command & Control	Command Leadership Command Structures Cdr Intent, Guidance	Operational Planning Govt Interagency Integration Mission Partner Leverage
Net Centric	Information Transport Network Management Information Assurance	Enterprise Services Applications Knowledge Management
Battlespace Awareness	Information Transport Network Management Information Assurance	Enterprise Services Applications Knowledge Management
Protection	Conventional Weapon Protection Personnel Recovery WMD Threat Protection	Terrorist Threat Protection Exploitation Threat Protection
Logistics	Joint Deployment/Distribution Agile Sustainment Operational Engineering	Joint Health Protection Joint Tehater Logistics Log Information Fusion
Influence	Public Affairs Ops Planning Public Information Community Relations	Military Diplomacy Security Cooperation Presence
Force Support	Man Equip Organize	Skills Development Global Posture Global Force Management
Corporate Mgt & Support		

Development Model for Acquisition Solutions

Defense Research & Engineering

Transition to Procurement & Sustainment

- Joint Training

Readiness & Suitability Confirmation

- Test & Evaluation
- Military assessment of utility

Functional Validation; Tailored Form/Fit/Function

- DOTMLPF construct development and confirmation
- Demonstration

Technical Concept Design & Development

- Prototyping

Alternatives Development & Assessment

- Experimentation
- Red Teaming Analysis

Conceptualization

- Needs identification/lessons learned/assessment
- Tech push exploitation

Technology-Based Capability Transition Programs

Defense Research & Engineering

6.1 | 6.2 | 6.3 — Science & Technology

6.4 | 6.5 | 6.7 — Research & Engineering

Proc | O&M

TRL 1 | TRL 2 | TRL 3 | TRL 4 | TRL 5 | TRL 6 | TRL 7 | TRL 8 | TRL 9

A — Technology Development

B — System Development & Demonstration

C — Production & Deployment

Operations & Support

Initial Product/ Process Capability

Product/Process Development

Product/Process Insertion

Product/Process Improvement & Sustainment

Service S&T, DTRA and DARPA Programs

JRAC / Svc Rapid Acquisition Programs

SBIR Phase I

SBIR Phase II

SBIR Phase III

CWID (US)

JWP

CWP

CoCom Initiative Fund

COCOM /Joint/Coalition focused – Demo 1-4 yrs

ACTDs/JCTDs

USSOCOM R&D and Acquisition

USJFCOM : JE/JI&I/JSIC (with Limited Acquisition Authority)

JT&E

6-12 mos fielding

QRSP Quick Reaction Fund/ RRF – RRTO / JIEDDO

Acquisition "On" Ramp – Test to Procure Tech Refresh

Defense Acquisition Challenge

Service, SOCOM Nominated Test to procure

Foreign Comparative Testing

Congressionally Directed – DOD Lab Tech Push

Tech Transition Initiative

Independent Research & Development *(Contractor Funding)*

JFIIT/JSIC

Tech Transfer

Manufacturing Technology

Title III of the Defense Production Act

Needs to Solutions: Integrated but Separate Processes & Roles

Needs Process

1. Develop & specify needs
2. Review & comment on budget-based programming and acquisition solutions
3. Allocate resources to joint/combatant commanders

Needs Roles

CJCS/JCS
CoComs
Joint Staff
Military Staffs
CoCom/Component Cdr Staffs

Acquisition Solutions Process

1. Consult with needs authorities in development of acqusition solutions
2. Acquire material solutions based on validated needs and budget-based programming
3. Deliver resources (acquisition products) for allocation to joint/combatant commanders

Solution Roles

USD (AT&L)/DAE
Service Secretaries/SAEs
OSD (AT&L) Staff
Service Secretariat Staffs
Systems/Materiel Commands
Military Agencies

PPBES:Program – Budget Process

CoCom Options: Needs Translation Into Capabilities

Component Commander Advocacy (With Parent Service/Agency)

- *Needs must align with core Service/Agency military capabilities*
- *Normally, constrained to PPBES solutions/out-year solutions*

Integrated Priority List (IPL) Submission/Senior Warfighter Fora (SWarF)

- *If long-standing, can be opening input to Service/Agency POM process*
- *Basis for Service program review & adjustment after Service POM closes*
- *Some execution year relief; often yield out-year solutions*

Capability Transition Program Participation

- *Relatively rapid response (0 to 3 years); well dapted for serving joint needs*
- *Limited funding, limited capability residuals*
- *Potential on-ramp for spiral technology improvement or program initiation*
- *Bridges capability gap until PPBES delivers sustained solution*

U.S. Combatant Command Representatives

Defense Research & Engineering

Mr. Doug Richardson, US Special Operations Command

Mr. Mel Chaloupka, US Pacific Command

Mr. Shawn Spencer, US Strategic Command

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Disruptive Technologies Conference

Evolving Joint Needs & Desired Joint Military Capabilities

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Characterization of Acquisition Processes

Defense Research & Engineering / Advanced Systems & Concepts

JRAC

- ✓ Urgent, mission critical
- ✓ 120 days or less initial materiel or logistics solution

Delivers within 2 years

Agile/"Limited" Acquisition Process

Delivers between 1 and 3 years

- ✓ Attuned to CoCom timelines
- ✓ Well adapted for integrating joint solutions
- ✓ Rapid, responsive, flexible program
- ✓ Decentralized execution
- ✓ Transformation engine; innovation enabler
- ✓ Small, non-traditional business "on-ramp"
- ✓ "Try before you buy" cost control mechanism
- ✓ Spiral improvement generator; risk mitigation

Deliberate Acquisition Process

Delivers between 4 and 11 years

- ✓ Optimized for delivery of complex systems
- ✓ Methodical oversight and synchronization
- ✓ Includes sustainment resources
- ✓ Well adapted to individual Service cultures
- ✓ Scalable for large-scale military solutions

Military Capability Transition Programs

Defense Research & Engineering

Transition to Procurement & Sustainment

- Joint Training

Readiness & Suitability Confirmation

- Test & Evaluation

Foreign Comparative Testing
Defense Acquisition Challenge

- Military assessment of utility

Functional Validation; Tailored Form/Fit/Function

- DOTMLPF construct development and confirmation

ACTDs ***JCTDs***

- Demonstration

Technical Concept Design & Development

JI&I ***JFIIT*** ***JSIC***

- Prototyping

Alternatives Development & Assessment

Joint Experimentation

- Experimentation

JWP

- Red Teaming Analysis

Conceptualization

JAWP

- Needs identification/lessons learned/assessment
- Tech push exploitation

Weaponizing the Spectrum

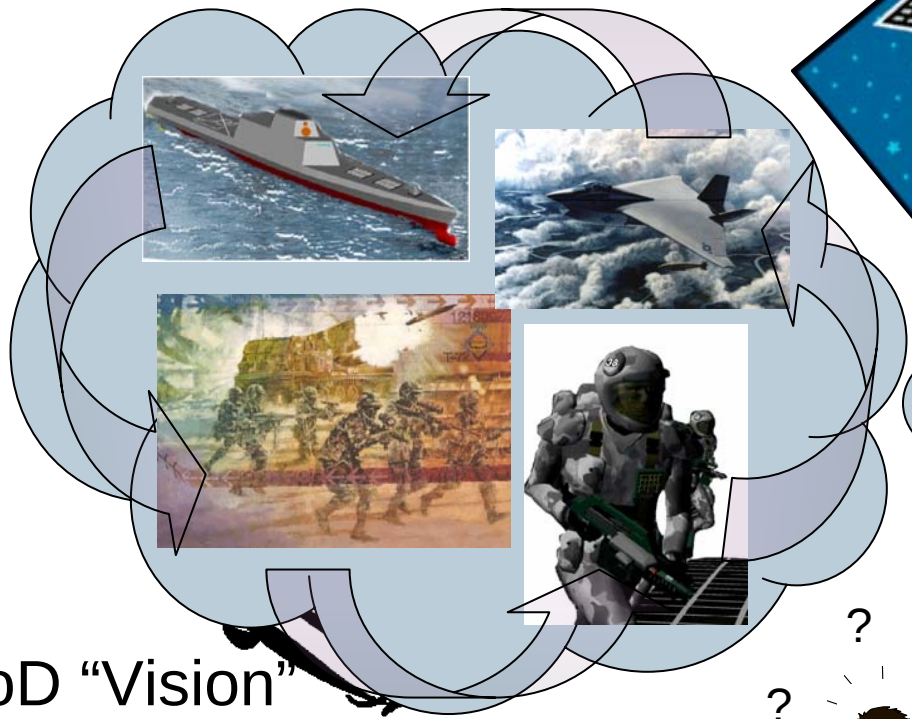
Presentation at the NDIA Disruptive Technologies Conference
4 September 2007
by

Kalle R. Kontson
Alion Science and Technology

Phone: 240-646-3620
Email: kkontson@alionscience.com

ALION
SCIENCE AND TECHNOLOGY

Moving to Net-centric Operations?



DoD "Vision"

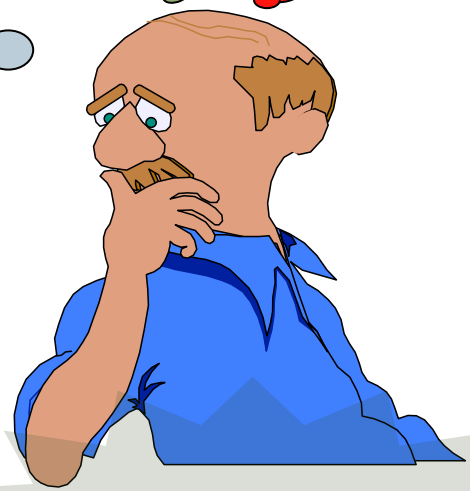
Slow pace of acquisition

vs

Warfighter's tempo for improvisation

Response

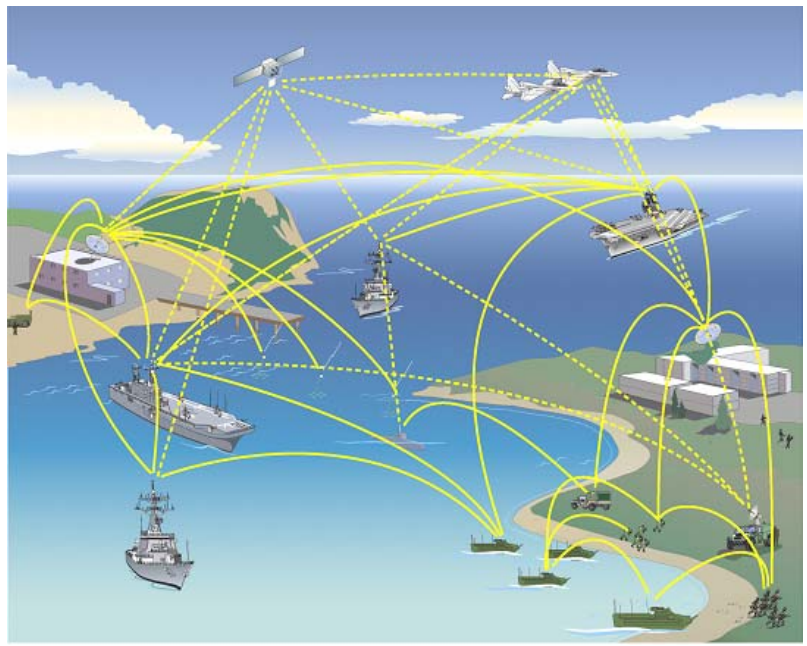
An Improvising Adversary



Opportunity to Transform… or just make a bigger version of what we've got?

Two Parts to Achieve Leap-forward Net-centric Operations Capability

- Distributed, Opportunistic C4ISR Devices and Systems-of Systems
  - Assured communications through redundancy, agility, adaptability, spectrum and bandwidth reuse
  - Net-centric sensing, C3
  - Flat, mesh-like architecture
  - Multifunction C4ISR…
  - Integrated, distributed situational awareness; to the edge
- Next Generation NETOPS and Battle Command at the "Edge"
  - Auto net formation & management - minimize user burden
  - Every PoP is both a source, and a consumer of information
  - Collaborative sensing, comms, fusion and C2… at the local level
  - Multifunctional, distributed behaviors; smart radios and smart protocols

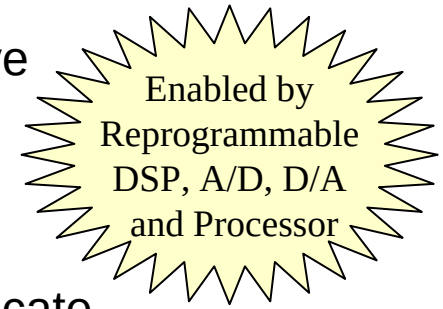


OUR C4ISR SoS MUST BE FLEXIBLE AND RELIABLE AT THE CORE, AND *"IMPROVISABLE"* AT THE EDGE!

Disruptive C4ISR Devices and Systems

Opportunistic Multifunctional Spectrum Access Devices

- Integrated Packages of “Detectors/Transducers” and “Emitters” for Integrated, Multifunction Capability to Provide Comms, Sensing, Targeting, EW, Deception; all Driven by a Common DSP and Computational System
  - Advantages: Weight, Size, Modular Upgrade, Adaptive Flexibility/Survivability



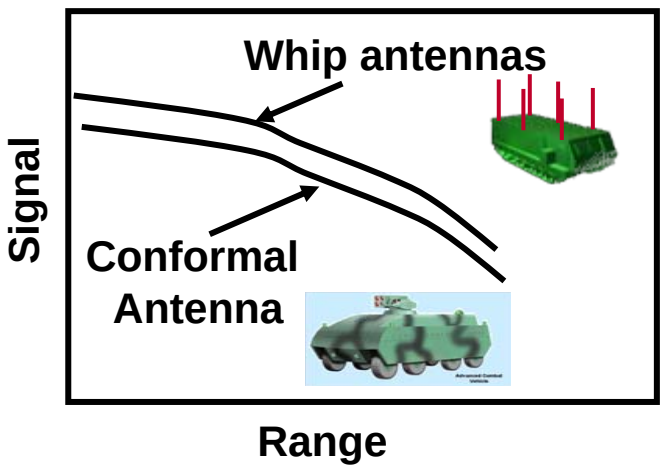
- Operating Principles:
  - Any and All Passive Devices Can Sense or Communicate
  - Any and All Active Devices Can Probe, Communicate or Jam
  - All Devices are Addressable Through Common Air-interface Protocols that Operate in Any Part of the Device’s Range
- Key Technologies: Software Defined Devices; Advanced DSP; Common, Addressable Air-interface Protocols
- Some DARPA Initiatives Illustrate Disruptive Technology Trends
  - WNaN, XG, Wolfpack, Mobile MIMO, etc.

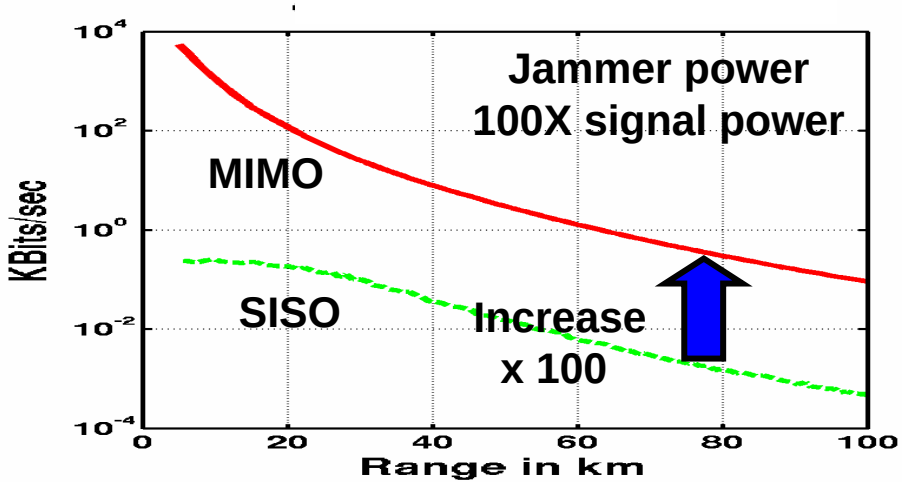
Functional Power: C4ISR & EW Agility/Redundancy

- Multifunction platforms: Soldiers, manned vehicles, UAVs, UGVs, hand-placed, expendables
  - Common addressable interface to net
  - Reprogrammable DSP-driven functionality
  - Compliance with opportunistic C4ISR design architecture
- Operating principle: Every platform (including the soldier) serves as a communications device, navigation system, relay/router/mobile cell-site, sensor, or EW/spoofing system using any or all detectors and emitters as needs dictate and opportunity allows
- Resource allocation managed by software agents integrated with Battle Command functionality

Disruptive Technology Device Example: Distributed Adaptive Antenna Element Arrays and MIMO

- Two key technologies:
  - Compact, conformal, affordable, broadband antennas > TRL 6
  - Diversity Processing - distributed elements, separately processed
- Technology focus on MIMO and "diversity processing"
  - Offers 10 to 100-fold increases in data capacity
  - 2 to 3 fold range increases; 20 dB or more AJ margin
  - Significant gains in spectrum efficiency
- MIMO being deployed in commercial wireless operations

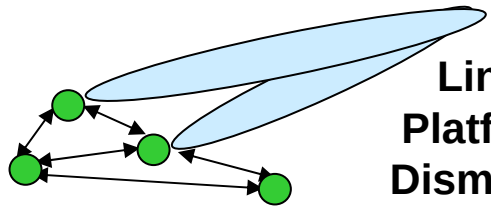




Disruptive Technology: Antenna Opportunities & Issues

- Vast improvements in performance, capacity
  - Net-centric aperture capability: antenna arrays adaptively configured by addressing elements on single platform, or separate platforms

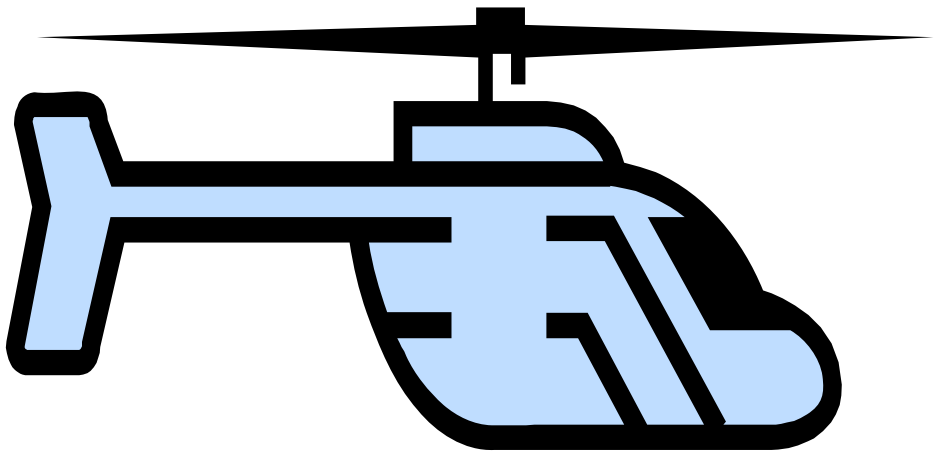
Single Platform



Linked Platforms, Dismounts, or UGS

- Eliminates need for certain “dedicated” sensor platforms
- Improved connectivity to dismounts and UGS
- Invest in future: “Design in” element arrays in platforms
  - Leverage future enhancements in DSP and waveforms (“MIMO inside”)
  - Allows growth to multi-function, multi-mode systems
  - Impact on platform; integral antenna elements … its part of the skin/armor
  - Revolutionary, new capability in tactical C4ISR
  - Requires integral set of protocols (radio, router, antenna control)
  - Common, integrated control for Comms, CID, Intel, EW, Sensors
    - Multi-function protocols and development tools – new technology area?

Disruptive Technology Device Example: : Sensor/Comms UAV Systems

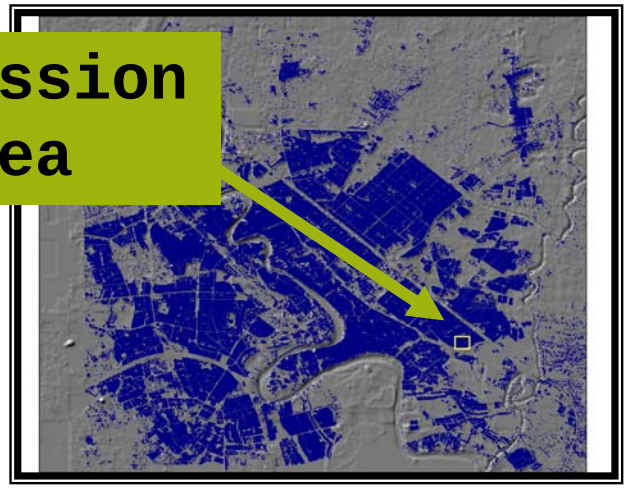


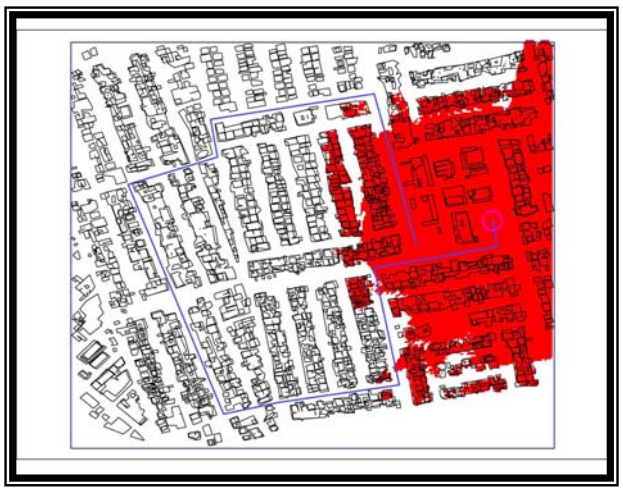
Multifunction Sensor/Comms UAV functions

- RF MANET mesh-net node
- Sensor

Issue: Where do we put it, when do we put it there, and what do we ask it to do?

Tactical RF Planner: Simple to Use; Simple to Understand; Complex Inside





Soldier's Handheld Screen Views

Disruptive NETOPS and Battle Command at the “Edge”

Net-Centric Ops Battle Command Technology

Provide Net-centric Operations RF managment components and dynamic spectrum access software/algorithms to "weaponize the spectrum" and be capable of exploiting critical NETOPS components through Battle Command software.

Manipulate the Spectrum Resource as a Weapon to Gain Advantage

C4ISR Resources Integral to Battle Command

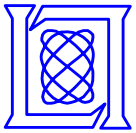
- Multifunction C4ISR on every platform should become an integral part of the Battle Command ensemble
  - Creates a multifaceted “Sixth Sense” for Commander SA
  - Provides Commander additional dimensions in Battle Command
    - Multiple source fusion capability on every platform
      - “Am I seeing the same thing as I am hearing, and what do the other vehicles see and hear?”
    - Expanded response options
      - “Do I shoot, or jam, or spoof, …. or go quiet and evade?”
      - “Should I communicate by radio and give away my position, or can I communicate by IR, or laser, or acoustics?”
- Common Battle Command interface to all asset management:
  - Forces, weapons, logistics ***and*** communications, sensors, EW, NAVAIDS, info banks

Advantages

- Provides a structured approach for leveraging our technology to gain significant advantage
  - We are leaders in DSP, SDR and Info Management Technologies
- Provides a vision and theme to rally the transformation of C4ISR
  - Equivalent in scope and ambition to the quest for smart weapons and stealth technology

Summary

- Multifunctional Devices and Systems Combined with Advanced Battle Command Software Capabilities Provide Opportunity to Exert Opportunistic Control Over the Spectrum…. *We Can Weaponize Spectrum Access*



DoD Research Challenges for the Next Decade

4 September 2007

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Chief Technology Officer
MIT Lincoln Laboratory

Victor Zue

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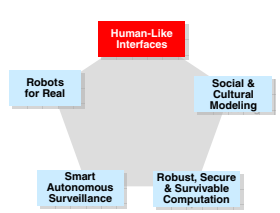
Director, MIT Computer Science
Artificial Intelligence Laboratory

Key Technology Enablers for the Evolving Threat Space

Preparing human terrain	• Social/cultural dynamics modeling • Automated language processing • Rapid training/learning methods/aids
Ubiquitous observation	• Day/night all-weather wide area surveillance • Close-in sensor and tagging systems • Soldiers-as-sensors
Contextual exploitation	• Mega-scale data management • Situation dependent info extraction • Human/system collaboration
Scalable effects delivery	• Consequence-modeled decision making • Information ops • Time critical fires • WMD mitigation

From Defense Science Board 21ST Century Strategic Technology Vectors Study

Computer: Yesterday and Today



CSAIL

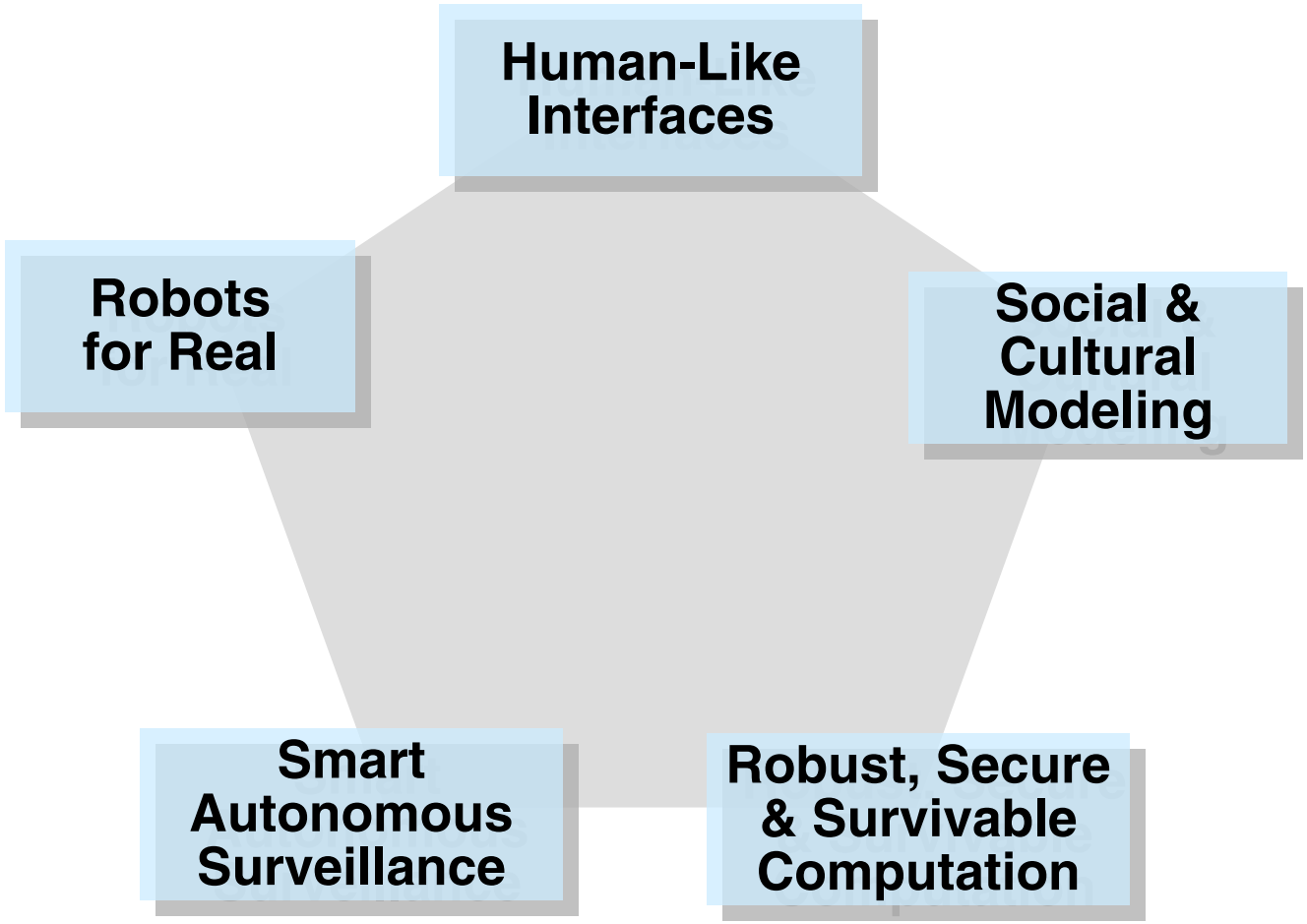
- Computation of static functions in a static environment, with well-understood specification
- Computation is its main goal
- Single agent
- Batch processing of text and homogeneous data
- Stand-alone applications
- Binary notion of correctness

- Adaptive systems operating in environments that are dynamic and uncertain
- Communication, sensing, and control just as important
- Multiple agents that may be cooperative, neutral, adversarial
- Stream processing of massive, heterogeneous data
- Interaction with humans is key
- Trade off multiple criteria

Today's World

Ubiquitous communication, cheap computation, overwhelming data, and scarce human resource

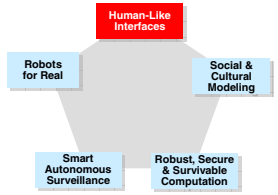
Technology Research Challenges



Environment

- High tempo
- Enormous data loads
- Civilian clutter
- Deep hide threats
- Wicked problems
- Unstructured environments
- Cultural interaction
- High consequence

Challenge 1: *Human-like Interfaces*



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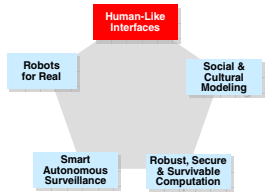
- **Interacting with computation should be as natural as interacting with people.**

- **Human-like interfaces need to be:**
  - modality-opportunistic
  - modality-agnostic
  - non-distracting
  - symmetrically-multimodal
  - mixed-initiative
  - multi-lingual

Human-like Interfaces
Today, Tomorrow, and Beyond



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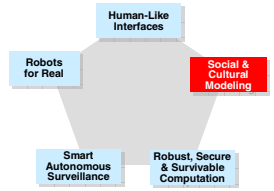
Today	3-5 years	5-10 years
individual modalities	selected combinations	multimodal interaction
controlled environments	noisy environments	uncontrolled environments
pre-specified language	learn new vocabulary interactively	learn new vocabulary by example
pre-specified multimodal interactions	opportunistic use of multimodal interaction	adapting opportunistically to modalities available
understand structured language	***understand conversation***	***non-distracting interaction with a teammate***

Challenge 2: *Operate in Foreign Cultures and Coalitions*



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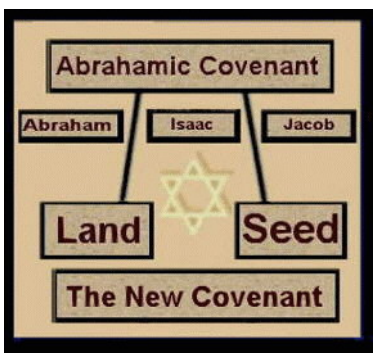
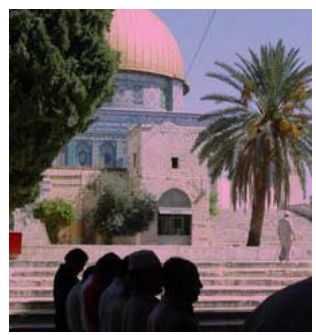
- … current and future military operations will require enhanced capability to understand social and cultural "terrains" as well as various dimensions of human behavior.
- Developing broader linguistic capability and cultural understanding is critical.
- The DoD has gaps in software tools and decision aids that will allow U.S. commanders to better understand different cultures.
- The Department must dramatically increase the number of personnel proficient in key languages such as Arabic, Farsi and Chinese. Source: 2006 QDR



The Binding of Isaac
The Covenant

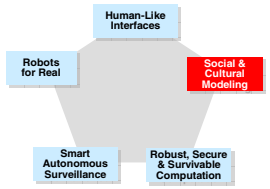
Jews Praying at
The Wailing Wall



Muslims Praying at the
Dome of the Rock

The Ascension of
Muhammad

Key Research Elements



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Cultural data

Electronic media

Story understanding & Indexing

Models Of culture

Culture sensitive analogical information retrieval

Match-making Information push Argument structure capture

Analysts Workbench

Immersive Language & culture training system

Recovering topical structure

Core natural language processing

Universal speech understanding

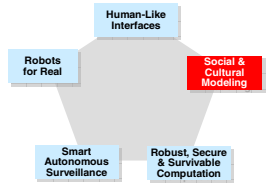
Spoken queries in mixed languages

Spoken dialog based training

Emotions & motivations
Sub-cultures
Preferences, value systems
Individual decision making
Allegiance and desertion

Immersive
Human like interfaces

Social & Cultural Operations
Today, Tomorrow, and Beyond



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Today

Limited ability to understand natural language

Retrieval based on keywords - low precision

Significant gaps in tools for modeling culture

Phraselator

Drill exercises

3-5 years

Robust natural language understanding of topic structure

Retrieval based on semantics - high precision

Models of key stories of culture

Two way translation

Activity translation

5-10 years

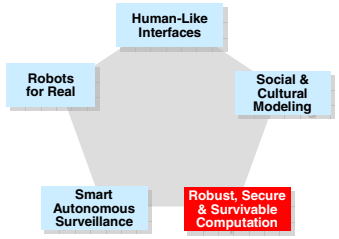
Robust understanding of causal structures

Continuously evolving models of culture, values, motivations, preferences

Full dialogue

Immersive, story and dialogue based interactions

Challenge 3: Make Net-Centric Systems Secure and Survivable



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"Combat information capability" is a **critical defense weapon system.**

- Commercial information technology architecture presents **critical information assurance challenges**.
- … The system and its capabilities will always be under attack and, as a result, will be **operated in degraded or compromised mode.**
- There is ample evidence that U.S. adversaries have recognized this potential vulnerability and are now aggressively developing doctrine, tactics and technology to **attack this soft underbelly**.

Software glitches leave Navy Smart Ship dead in the water

In 1995, the U.S. Navy, on advice Naval Research Advisory Committee (NRAC), started a program to research labor and manpower saving ideas. The results of this program, deemed the Smart Ship, are being tested aboard the USS Yorktown. The Navy quickly deemed the program a success in reducing manpower, maintenance and costs. In September of 1997, however, the Yorktown's propulsion system failed. The ship had to be towed to a Naval base at

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White House Spy Probe Shows Computer Vulnerabilities
Digital Tools Exist to Spot Leaks, Corporate Spies, But May Not Have Been Used

Oct. 6, 2005

abc NEWS

The proliferation of computers and network technology has made it a lot easier to create and share vital information. Sometimes, too easy.

Leandro Aragoncillo, a former White House staff member, was arrested last month for allegedly using his top secret security clearance to download

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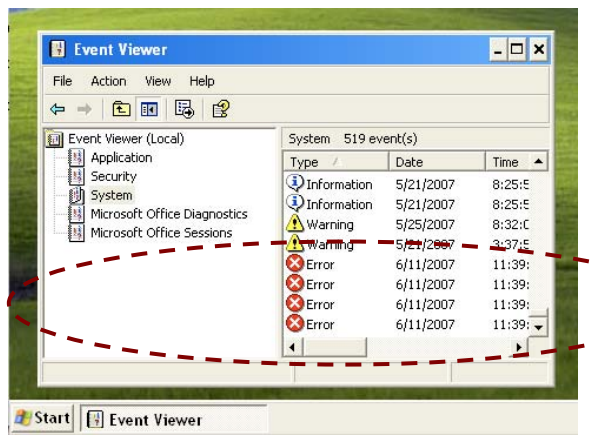
Talk Back
+ Tell us what you think
+ Add new facts
+ Talk straight to the newsm
+ Comment

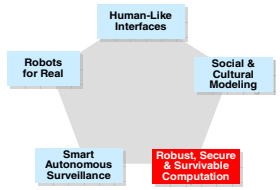
Sandia Red Team hacks all computer defenses

ALBUQUERQUE, N.M. — Over the past two years, a group at Sandia National Laboratories known informally as the Red Team has, at customer invitation, either successfully invaded or devised successful mock attacks on 35 out of 35 information systems at various sites, along with their associated security technologies

Comin' at you — Sandia's



Why Is This Hard?



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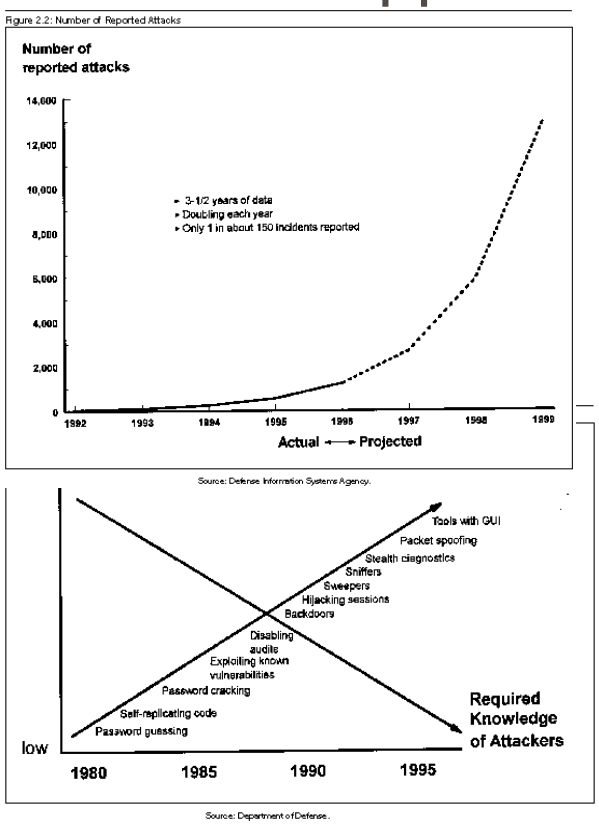
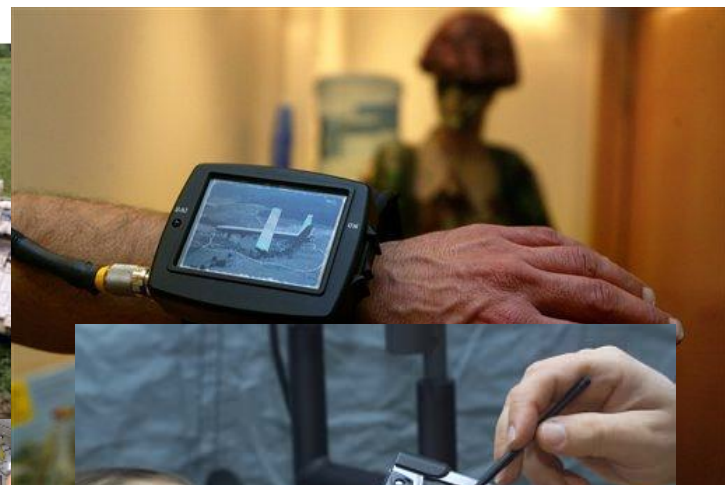
Harsh Environments

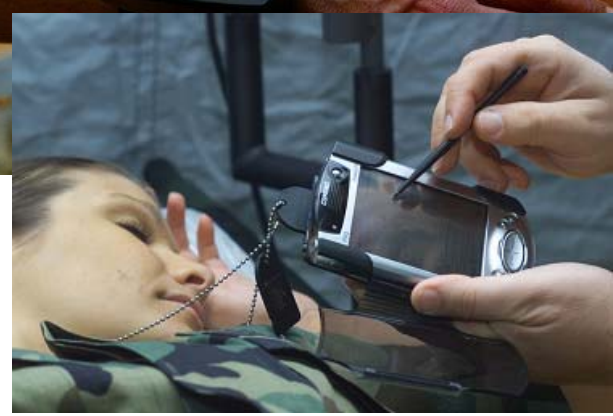
Capable and dedicated opponents



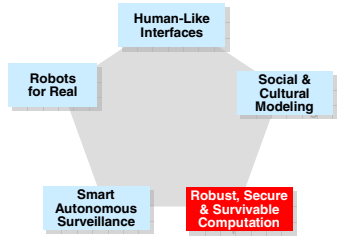
Mobile and distributed components

Heterogeneous systems





Key Research Elements



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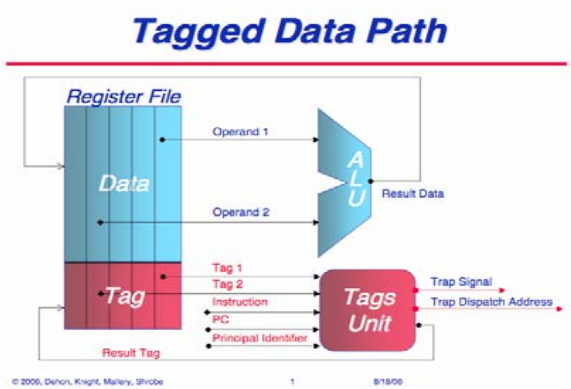
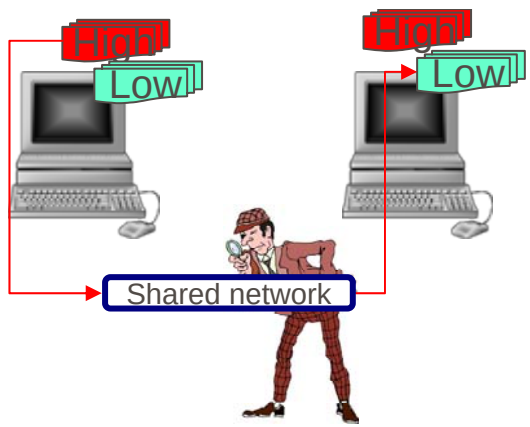
1. A highly secure and sustainable computer architecture
2. Model-based self checking and self-healing frameworks
3. Information flow control
4. New algorithms for dynamic distributed systems
5. High performance embedded networked security monitor
6. Abstractions and compilation for emerging multi-cores
7. End-to-end certification of critical infrastructural systems

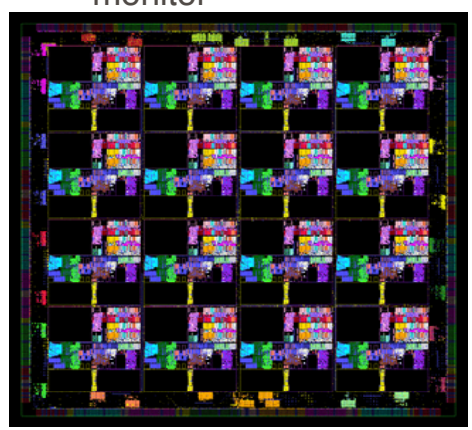
Secure and sustainable computing
Using hardware enforced integrity



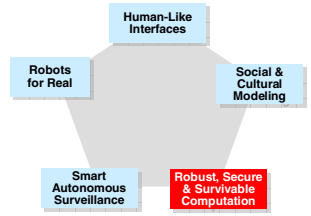
Model based self-checking &
information flow control



High performance
network security
monitor



Secure and Survivable Systems Today, Tomorrow, and Beyond



CSAIL

Today

All COTS systems are vulnerable

Isolated components, serious problems with dynamic distributed systems

No ability to assess overall exposure, low confidence that deployed systems have worked correctly

3-5 years

Modest survivability provided by hand-crafted solutions at single level

Data tagged with provenance and credibility; accountable flow of information.

Reasonable confidence that systems have worked correctly

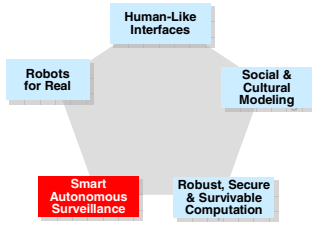
5-10 years

Systematic survivability, defense in depth

Auditable assurance cases, formal methods and self-checking software and hardware together

High confidence that failures and security attacks have not and will not occur

Challenge 4: Smart Autonomous Surveillance (SAS)



CSAIL

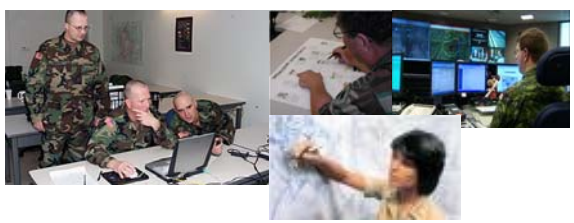
Mexico City

NGA's High-Resolution Terrain Information (HRTI) Test Range

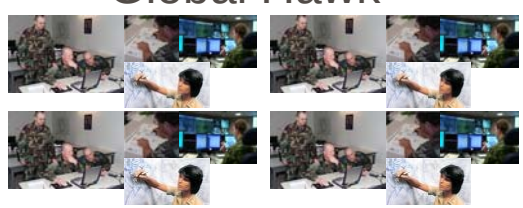
Predator

Global Hawk

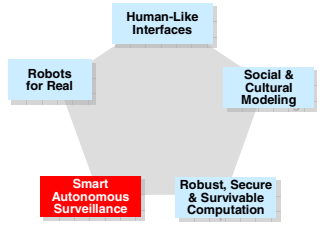
Avg. 6 people needed to interpret data from 1 Predator



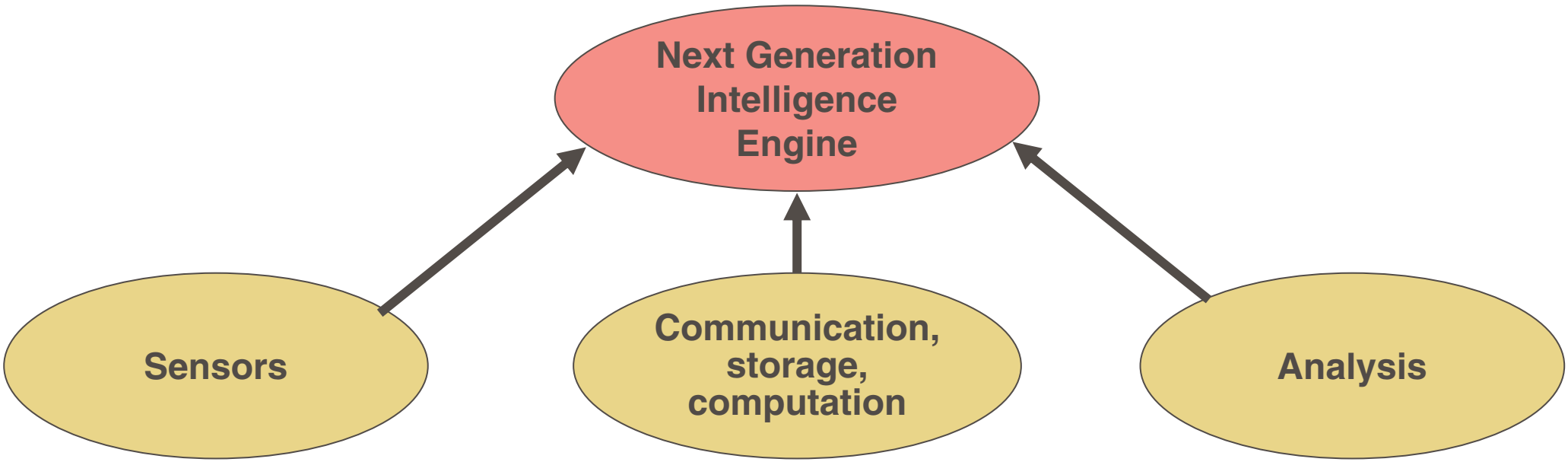
Avg. 24 people needed to interpret data from 1 Global Hawk



Smart Autonomous Surveillance: from Forensic to Prediction Tools



CSAIL

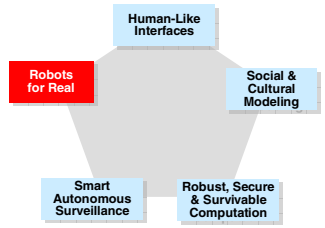


- Computational cameras
- Coded aperture sensors
- Queuing sensors

- Power and content-aware networking.
- Fusion across modality, time, place, and source

- Change detection
- anomaly alerts
- contextual analysis, integration with historical data,
- prediction

Challenge 5: Robotics for Real



CSAIL

- **Military "robots" today lack autonomy**
  - Currently, many soldiers operate one robot
  - Want few soldiers working with a *team* of *agile* robots, to achieve *force multiplication* even in *harsh* environments
  - Put fewer soldiers in harm's way

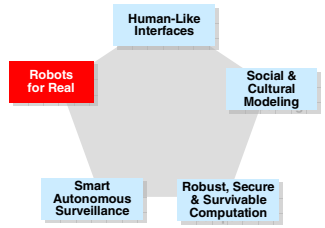
RQ1-Predator GCS

- **Better robots for monitoring**
  - *Enable* soldiers w/ persistent and pervasive ISR, including from hard to reach places (e.g., inside buildings/caves/bunker networks)

Supply-chain task

- **Better robots for logistics**
  - *Replace* soldiers in the supply chain with capable autonomous robots and vehicles

Key Research Elements



CSAIL

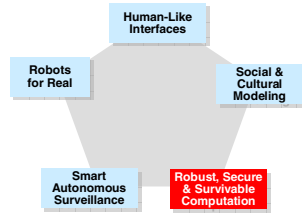
Logistics:
- Packing
- Loading
- Transportation

Monitoring:
- Surveillance
- Patrol
- Observation

Perception and Awareness	Planning and Reasoning	Manipulation and Control	Communication and Coordination
Vision	Uncertainty	Grasping	Teaming
Speech	Dynamic world	Rolling, legged, flying mobility	Coordinated motion
Gesture	Scale		
Localization	Prediction		
Surround awareness			

← Enabling Technical Areas →

Robotics
Today, Tomorrow, and Beyond



CSAIL

Today

Tele-operated, unmanned vehicles used effectively by special forces

Supply chain implemented by human pilots/drivers and loaders/unloaders

Humans interact with robots through joystick interfaces

3-5 years

FCS vehicles in common use, but still require teams of trained personnel

Robotic ground vehicles perform routine supply runs in friendly areas

Humans interact with robots using restricted speech and gesture commands

5-10 years

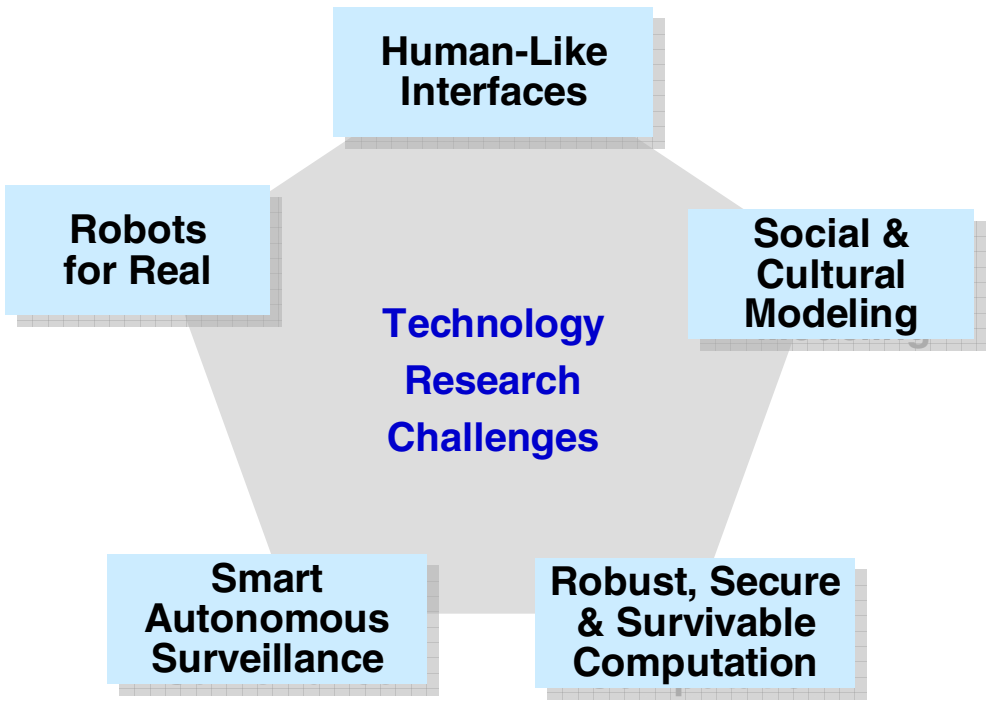
Autonomous vehicles require minimal supervision, and outperform the best human pilots

Robotic supply chain improves efficiency and surge response, greatly reducing the danger to humans

Humans interact with robots as partners and capable team-mates

Summary

- We are in a much more challenging threat environment
- Success will depend on operating;
  - in high tempo unstructured environments
  - against asymmetric adversaries in deep civilian hide
- A new set of research challenges are before us:



NAVAL RESEARCH ADVISORY COMMITTEE

Science and Technology for Naval Warfare, 2015--2020

Mark Lister
Chairman, NRAC

NDIA Disruptive Technologies Conference
September 4, 2007

Excerpted from the Final Briefing

Outline

Terms of Reference
Panel Membership
Briefings & Discussions

Global S&T Trends
Military Implications
U.S. Navy-Marine Corps in 2020
Threats to U.S. Forces

Mission+Threats+Technologies Matrix
Counter-Threat Technologies Investments
Mission-Enabling Technologies Investments
Overarching Issues Requirements

Conclusion
Recommendations

Global S&T Trends/1

- Continued asymmetric opposition to U.S. interests
  - Non-state actors
  - Nation states
  - Military actions
  - Against U.S. critical infrastructure
  - Against U.S. civilian population
- Continued dilution of U.S. S&T base
  - Foreign students outnumber Americans in advanced engineering and science curricula
  - Technical education losing to business, arts
  - Government laboratory positions less attractive
  - Foreign investment in technical education accelerating

Global S&T Trends/2

- Globalization eroding U.S. technical dominance
- Impending oil availability crisis
  - U.S. dependence on Middle East oil
  - Near-term Chinese demand for oil
  - Mid-term EU, Indian demand for oil
  - Changing situation in Venezuela
- Increasing U.S. dependence on foreign technology
- Worldwide access to advanced technology through foreign and U.S. sales and espionage
- Technological surprise is **probable!**

Military Implications of the World of 2020 for S&T /1

This study makes no attempt to define the future or to draw possible scenarios for what the world will look like in 2015-2020. However, certain trends are obvious:

- Nuclear, chemical, bio weapons continue to proliferate
- Terrorism continues
- Increasing violence and political influence by non-state actors
- Proliferation of primitive (but effective) as well as modern weapons/systems
  - Improvised explosive devices
  - Man-portable air-defense missiles
  - Sea mines
  - Surface-to-surface missiles

Military Implications of the World of 2020 for S&T/2

- Growing foreign economic power and changing politics
  - Rapidly changing demographics
  - Major emphasis on advanced S&T education
  - Advanced weapon development and sales
- Development of significant regional military powers
  - Blue water navies: China, India
  - Regional navies: Iran

Navy-Marine Corps Missions in 2020

Many missions are similar to the Cold War era

BUT with significantly different emphasis

- ↑ Provide seaborne missile defense
- ↑ Provide seaborne support for operations against terrorism (including homeland defense)
- ↑ Protect U.S.-Allied maritime areas of interest (inc. SLOCs)
- ↑ Project military power (presence/rescue/peacekeeping/ strike/assault)
- → Threaten military forces of potential enemies (especially their WMD capabilities)
- ↓ Deter nuclear attacks (Trident SSBNs)

Threats Impacting Navy-Marine Corps Missions/1

- Increased availability of long-range weapons against naval-maritime formations
  - Ballistic missiles with terminal guidance
  - High-speed, sea-skimming cruise missiles
  - EM Guns
- Proliferation of nuclear, chemical, biological weapons
- Proliferation of inexpensive delivery systems and weapons, including
  - Air (UAVs, mini-UAVs)
  - Surface (USVs)
  - Underwater (UUVs, mines, mini-submarines, SDVs)
  - Land mines, IEDs, and other low-tech systems
  - MANPADS, laser devices, and other high-tech systems

Threats Impacting Navy-Marine Corps Missions/2

- Proliferation of advanced submarine technologies *and concepts of operation*
  - Propulsion
  - Sensors
  - Stealth
  - Weapons
- Proliferation of capabilities for sophisticated information warfare
- Increase in vulnerabilities of U.S. logistics
  - Pipeline
  - Overseas procurement of goods and services

Threats Impacting Navy-Marine Corps Missions/3

- Near-continuous surveillance of U.S. land and sea forces by opposing military and commercial satellites, “cheap” UAVs, and other means
- “Network centricity” creates vulnerabilities for U.S. forces
  - Interruption/jamming
  - Effective EMCON impossible
  - Information overload
  - Over-dependence on reachback
- Loss of low-observable effectiveness
- Reliance on GPS makes it a major target

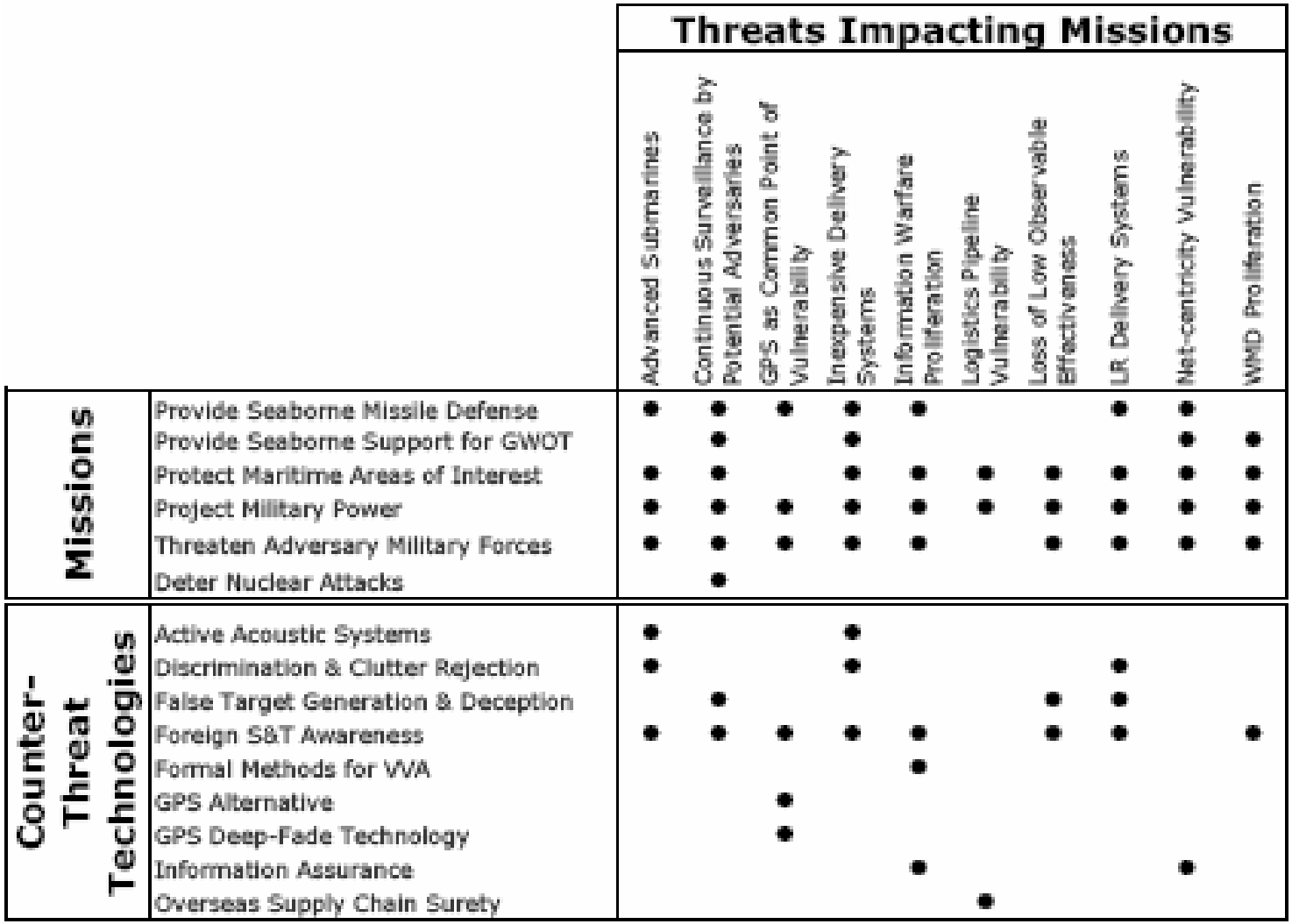
Technology Traceability to Navy Marine-Corps Missions

Missions
Provide Seaborne Missile Defense
Provide Seaborne Support for GWOT
Protect Maritime Areas of Interest
Project Military Power
Threaten Adversary Military Forces
Deter Nuclear Attacks

Technology Traceability to Missions Indexed by Threats

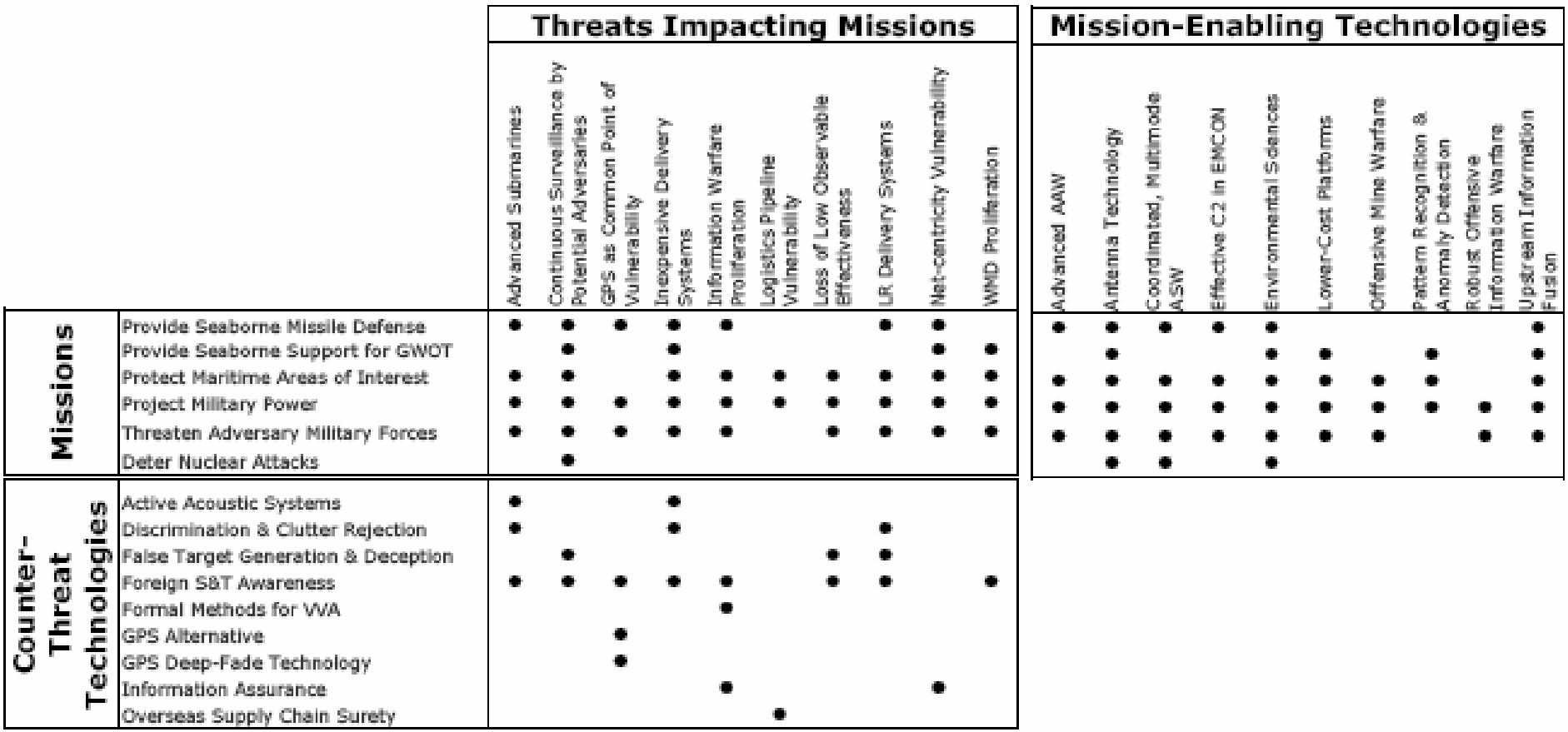
Missions		Threats Impacting Missions									
		Advanced Submarines	Continuous Surveillance by Potential Adversaries	GPS as Common Point of Vulnerability	Inexpensive Delivery Systems	Information Warfare Proliferation	Logistics Pipeline Vulnerability	Loss of Low Observable Effectiveness	LR Delivery Systems	Net-centricity Vulnerability	WMD Proliferation
	Provide Seaborne Missile Defense	●	●	●	●	●			●	●	
	Provide Seaborne Support for GWOT		●		●					●	●
	Protect Maritime Areas of Interest	●	●		●	●	●	●	●	●	●
	Project Military Power	●	●	●	●	●	●	●	●	●	●
	Threaten Adversary Military Forces	●	●	●	●	●		●	●	●	●
	Deter Nuclear Attacks		●								

Technology Traceability to Counter-Threat Technologies

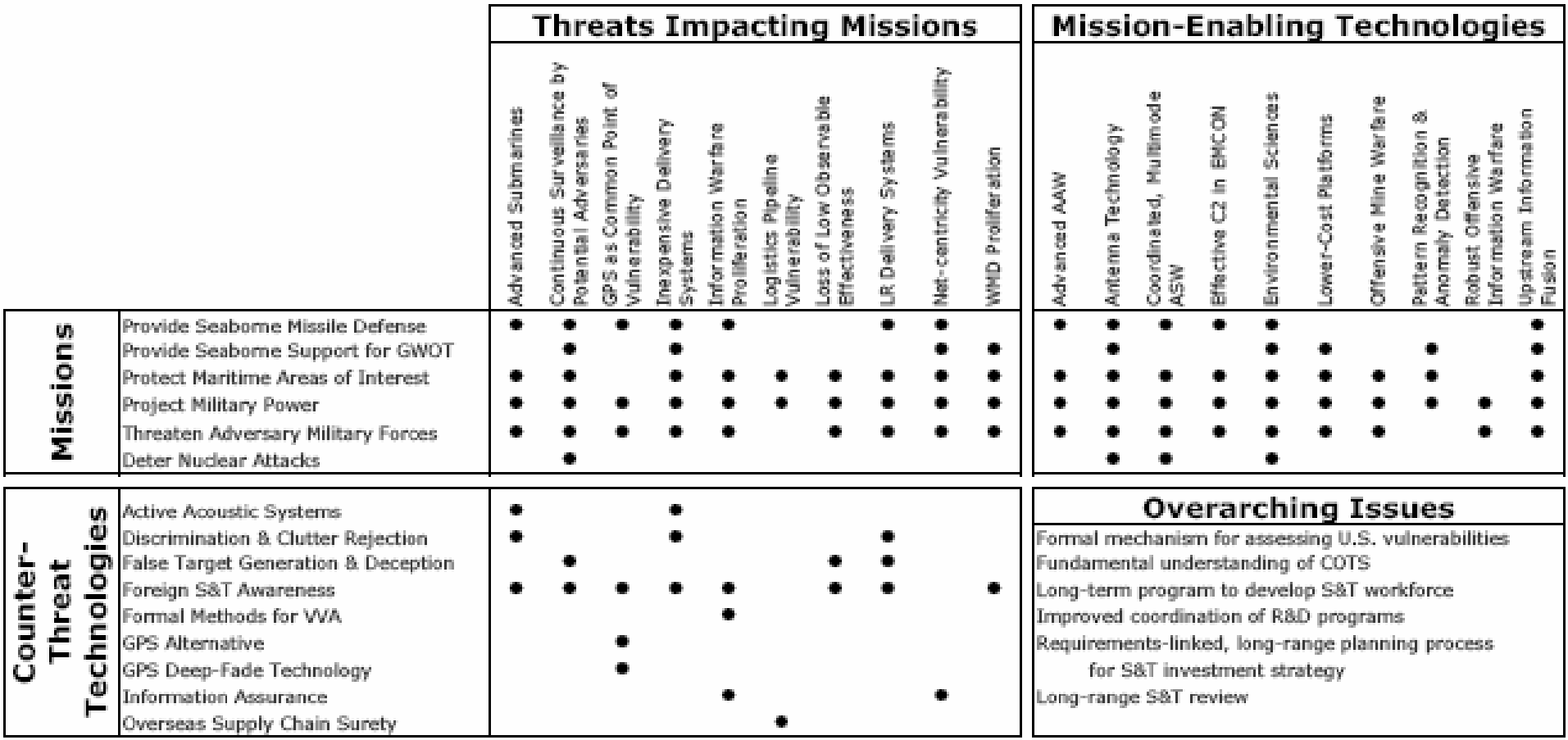


		Threats Impacting Missions										
		Advanced Submarines	Continuous Surveillance by Potential Adversaries	GPS as Common Point of Vulnerability	Inexpensive Delivery Systems	Information Warfare Proliferation	Logistics Pipeline Vulnerability	Loss of Low Observable Effectiveness	LR Delivery Systems	Net-centricity Vulnerability	WMD Proliferation
Missions	Provide Seaborne Missile Defense	●	●	●	●	●			●	●	
	Provide Seaborne Support for GWOT		●		●					●	●
	Protect Maritime Areas of Interest	●	●		●	●	●	●	●	●	●
	Project Military Power	●	●	●	●	●	●	●	●	●	●
	Threaten Adversary Military Forces	●	●	●	●	●		●	●	●	●
	Deter Nuclear Attacks		●								
Counter-Threat Technologies	Active Acoustic Systems	●			●						
	Discrimination & Clutter Rejection	●			●				●		
	False Target Generation & Deception		●					●	●		
	Foreign S&T Awareness	●	●	●	●	●		●	●		●
	Formal Methods for VVA					●					
	GPS Alternative			●							
	GPS Deep-Fade Technology			●							
	Information Assurance					●				●	
	Overseas Supply Chain Surety						●				

Technology Traceability to Mission-Enabling Technologies



Technology Traceability to Missions and Threats



Findings/1
Counter-Threat Technologies Investments

- Tactical/Operational
  - Active acoustic systems
  - Discrimination and clutter rejection
  - False target generation for deception
  - GPS deep-fade technology
  - GPS alternative
- Logistics
  - Security for overseas supply chain
- Capabilities/Systems Development
  - Foreign S&T awareness
  - Formal, automated methods for Verification, Validation, and Accreditation
  - Information assurance

Findings/2
Mission-Enabling Technologies Investments

- Tactical/Operational
  - Advanced AAW
  - Coordinated, multimode ASW
  - Effective C^2 in EMCON
  - Offensive mine warfare
  - Pattern recognition and anomaly detection
  - Robust offensive information warfare
  - Upstream information fusion
- Capabilities/Systems development
  - Antenna technology
  - Environmental sciences (specific areas)
  - Low-cost platforms technologies

Findings/3
Overarching Issues Requirements

- Formal mechanism for assessing U.S. vulnerabilities
- Fundamental understanding of COTS
  - Business models
  - Technology drivers
  - Standards
  - Internal structure, functionality, vulnerabilities
- Long-term program to develop S&T workforce
- Improved coordination of R&D programs
- Requirements-linked, long-range planning process for S&T investment strategy
- NRAC long-range S&T review should be a continuing responsibility

Conclusion/1

The **bottom line** is that

While the Navy has a productive S&T program today….

The rapidly changing threat and the rate of world technological development demands change in the Navy-Marine Corps investment strategy for S&T over the next 15 years to insure that the naval services can continue to effectively carry out their missions.

Conclusion/2

Failure to change the investment strategy for Navy-Marine Corps S&T will make technological surprise on the battlefield **likely**…and success in executing naval missions will be **problematic.**

Recommendations

- **Develop Long-Term S&T Planning Process**
- **Develop Long-Term S&T Workforce Plan**
- **Accelerate Lower-Cost Platform Technologies**
- **Assess and Mitigate Long-Term COTS Vulnerabilities**

“Disruptive Application” Observations

- Christensen: Disruptive Technology to Disruptive Innovation
- Time to migrate to “Disruptive Applications”
  - Not necessarily based on Disruptive Technology
  - Inexpensive, easily accessible, unanticipated asymmetric capabilities
- Know thy enemy
  - Today’s and tomorrow’s
  - Culturally, mentally, emotionally, technologically
- We have a Disruptive Technologies Office…do we need a Disruptive Applications Office?
  - Proactive vs. reactive

Emerging Sensors and Electron Devices for Army Applications

John M. Pellegrino, PhD
Director, Sensors and Electron Devices

National Defense Industrial Association
Disruptive Technologies Conference

4-5 September, 2007

RDECOM

ARL

Approved for Public Release Distribution Unlimited

POWER
ELECTRONICS
SENSORS

Persistent ISR

“The ability of the future force to establish an “unblinking eye” over the battlespace through persistent surveillance will be key to conducting effective joint operations”

- Quadrennial Defense Review Report
(February 6, 2006)

POWER
ELECTRONICS
SENSORS

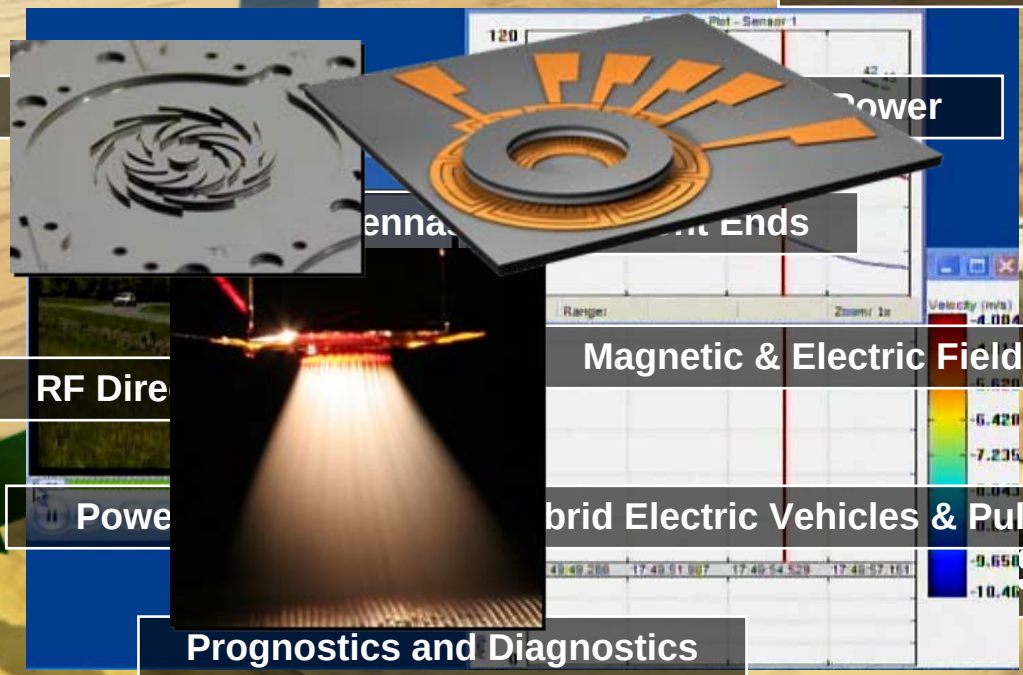
Enabling Electronics

Photonic Devices

Nanoelectronics and MEMS

Flexible Displays

Advanced Concepts



Magnetic & Electric Field Sensing

Prognostics and Diagnostics

Lasers / Sources

Magnetic & Electric Field Sensing

Challenges: The Stage

Urban

Riverine

Borders/Perimeters

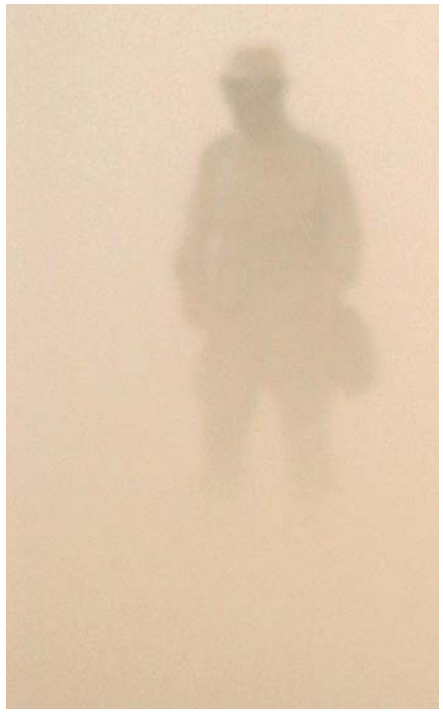
Caves

Jungles/Canopy

Challenges: The Environment

Urban / Cave Warfare Requires Sensors for Detecting the Enemy

Riverine – Limited Access Environment



Excessive Heat, Humidity, and Dust in the Environment

Non Line of Sight in Urban Environments

Jungle Canopy – degraded mobility, aerial surveillance, and communications

Emerging Solutions

Family of UGS

Persistent ISR to OIF

Microsystems

Persistent Threat Detection System to OIF

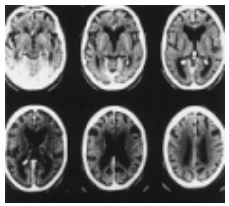
Wearable Sensors

Unmanned Equipment for Scouting and Detection

A Look into the Future - Basic Research… The Next Generation of Disruptive Technologies

Decade of the 1970's

Structural Imaging



1971 – First Practical X-ray Computed Tomography Image

Artificial Intelligence

1970-Shakey the robot

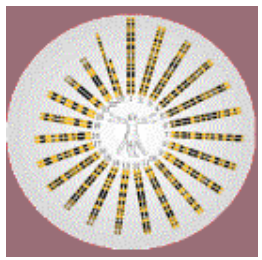
Microprocessors

1971 – First 4 Bit Microprocessor in Production

Supercomputing

1975 – Cray I Supercomputer

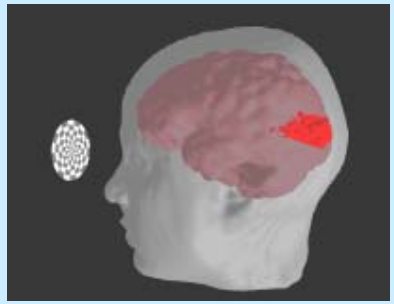
Genetic Engineering



Arcade Games

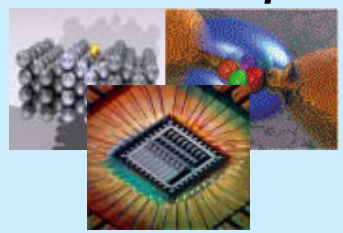
Today for 2020 and beyond…

Functional Brain Imaging

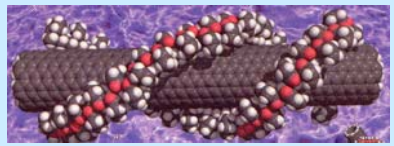


Robotics

Quantum Computing

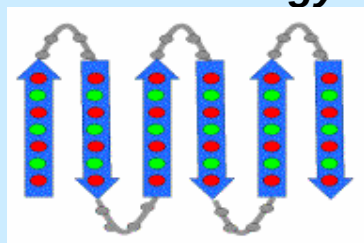


Nanotechnology



Immersive Environments

Biotechnology

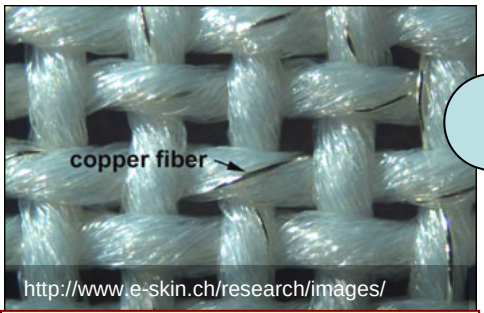


From March, 2006 presentation by Dr. John Parmentola, Army Director for Research and Laboratory Management

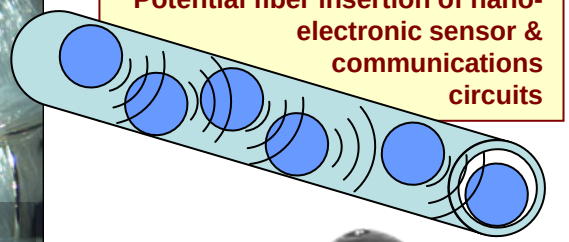
Nanoelectronics: Devices & Sensors

GOAL: **Multifunctional 3-D nanodevice architectures for electronic textiles and networked microsystems for remote sensing applications**

OBJECTIVE: **Fundamental research on integrated nanoelectronic devices**



Current Technology for E-textiles



Potential fiber insertion of nano-electronic sensor & communications circuits

Nanoelectronic sensor & communications devices for networked microsystems

Fundamental nanoelectronic device research for future soldier requirements.

ARL's *in-house* nanoelectronics basic research capability:

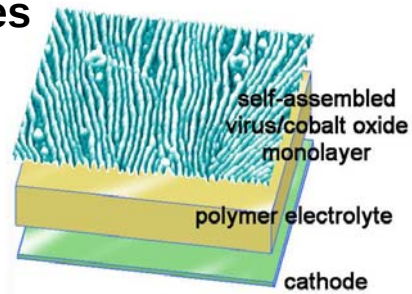
- Discrete nanodevice fabrication:
  - Thermal CVD SW-CNT growth
  - Directed nanoscale assembly
  - Nanoscale manipulation
  - 3-D nanoscale architectures
  - Microfluidic channels
- Nanoelectronic device testing:
  - Micro- to nanoscale probing
  - DC to 110 GHz
  - 4.5-475 K
  - fA sensitivity
  - Controlled ambient environments

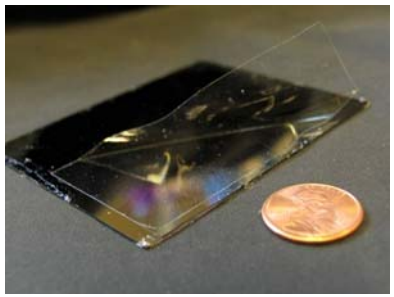
Research focus:

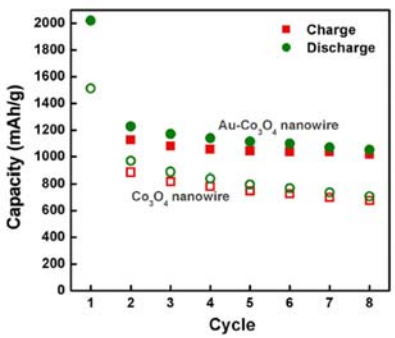
- Amperometric sensors
- Ultra-high frequency (GHz-THz) communications & sensor devices
- Nanoscale thermal management
- Ensemble effects in nanoelectronic devices

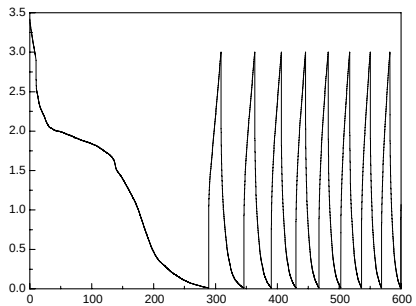
Biologically directed assembly of flexible batteries:

- Use genetically modified viruses to control assembly of cobalt oxide anode
- Polymer electrolyte
- Standard cathodes (metal rod or sheet shown)







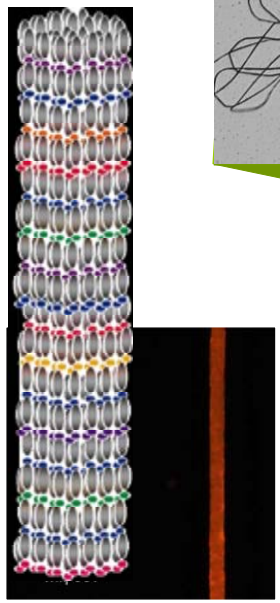


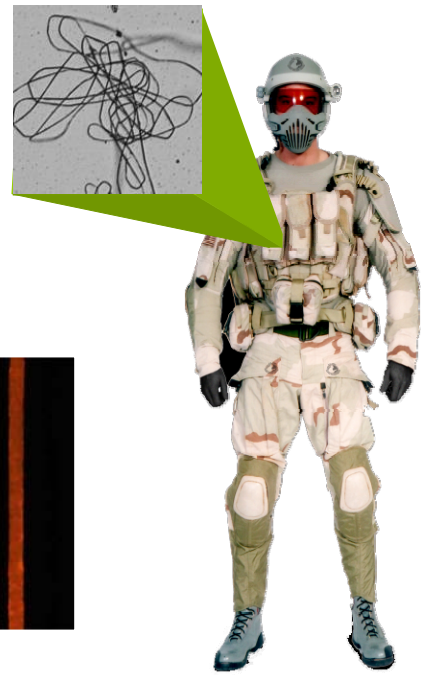
Higher Capacity, Faster Reaction Rates

Prof. Angie Belcher, MIT

Virus fibers for use in multi-functional textiles:

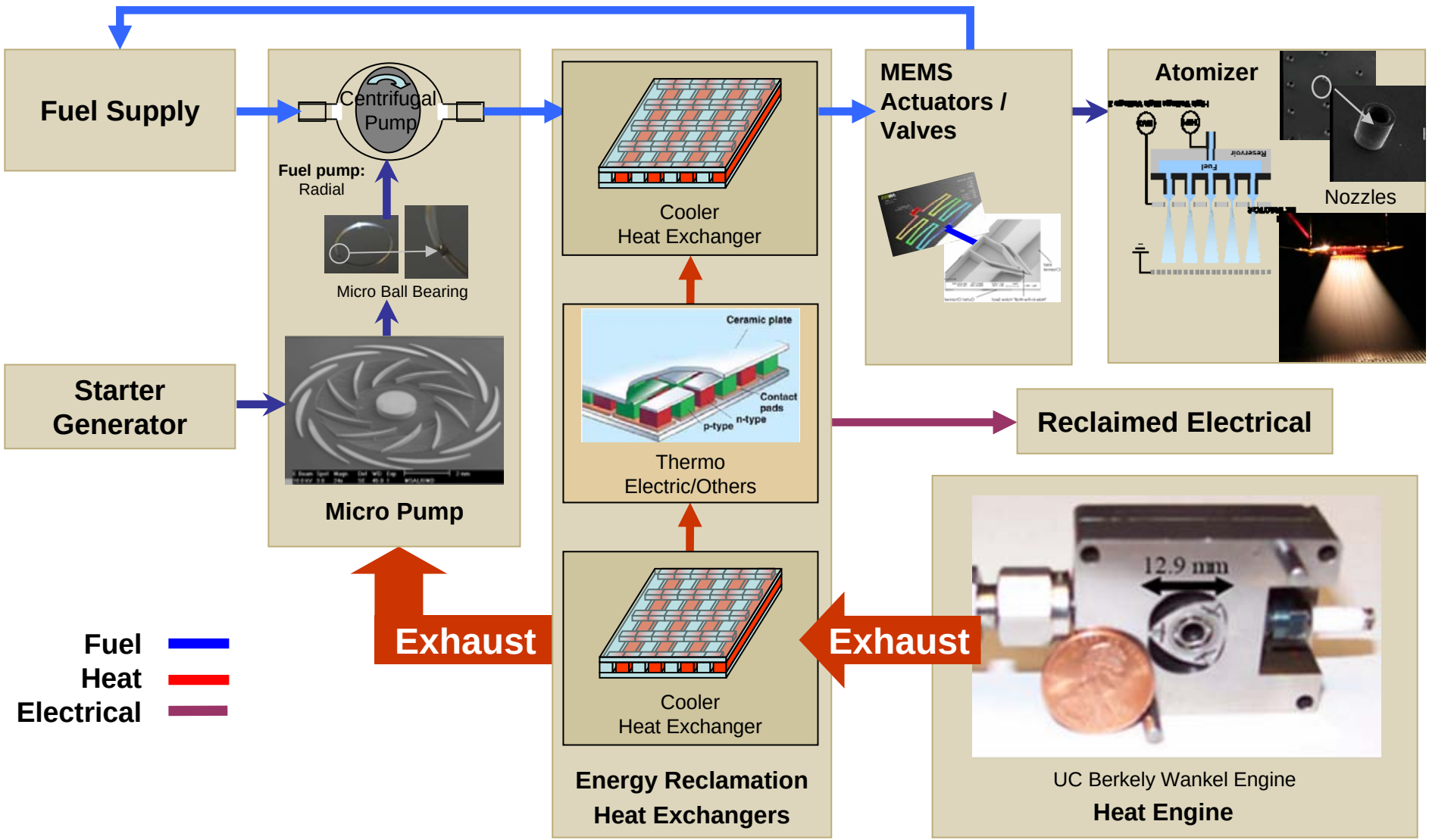
- Virus-assembled barcodes
- Electro-spun virus fibers for sensor & electronics applications



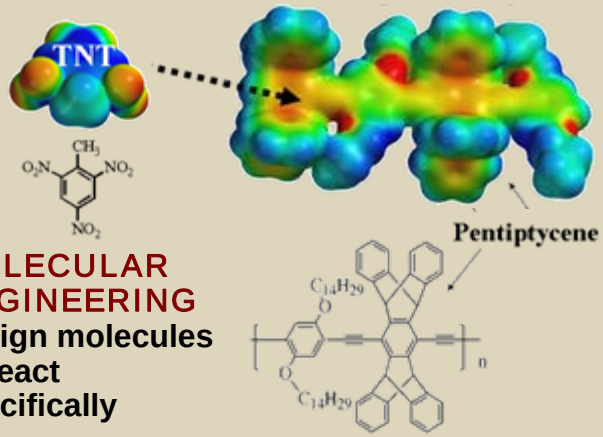


Prof. Angie Belcher, MIT
Dr. Charlene Mello, NSRDEC

MEMS for Power & Energy



Chem-Bio Detection and Defense

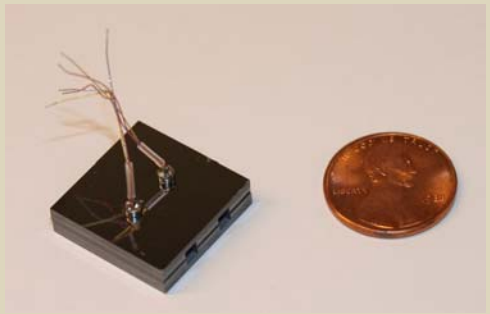


MOLECULAR ENGINEERING
design molecules to react specifically

TNT Detected

SCIENCE
Amplifying Fluorescing Polymer (AFP) developed by MIT ISN Prof. Swager glows green, but quenches when TNT is present.

MEMS Photo Acoustic Sensor



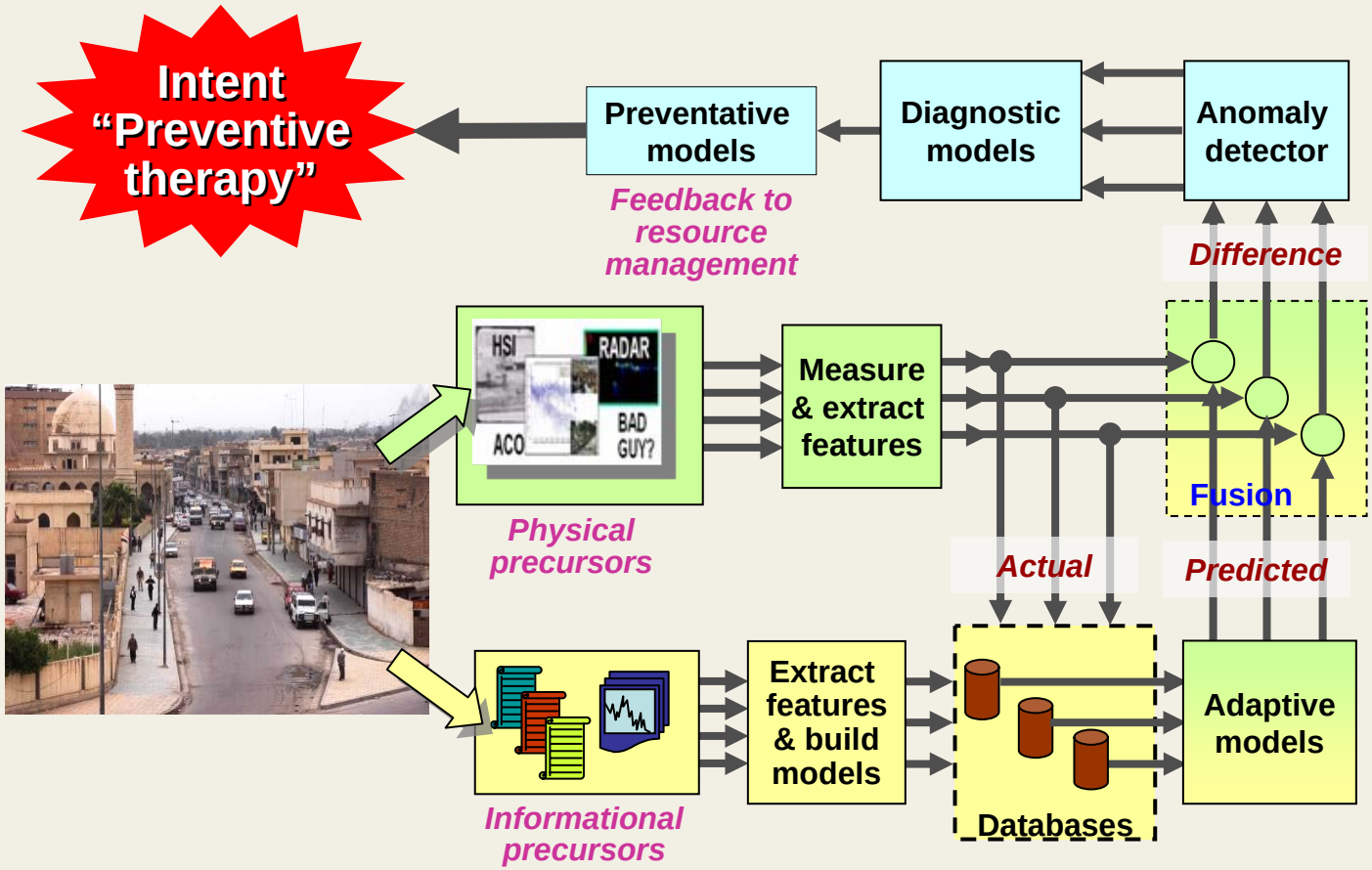
Science Making a Difference for Soldiers: FIDO Explosives Detector

DETECTION OPPORTUNITY
Hidden explosives give off traces of chemicals, which may be detected.

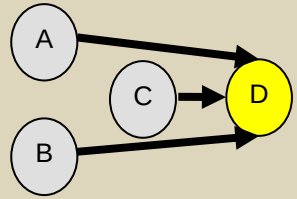
FIDO Units in Iraq for Evaluation (2005) – Integrated on robot and handheld

Integration of Chemical / Biological Sensing with Electronics.

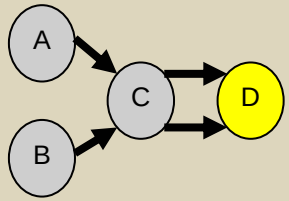
Networked Fusion & Understanding



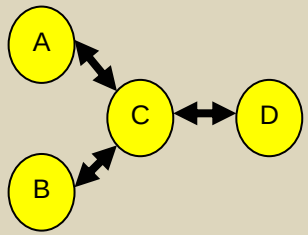
Data Flow Architecture



Centralized



Distributed



Decentralized

Characteristics:

- Scalable
- Adaptive
- Expandable
- Modular

Challenges:

- Network Architecture
- Robust Fusion Engines
- Autonomous Management
- Up-to-date

Shaping the Vision: Operational Scenarios

Autonomous networked ensembles of multifunctional microsystems for enhanced battlefield situational awareness for the Soldier

Scenario #1: small unit building search

Autonomous navigation in benign indoor environment with human mission control

Scenario #2: small unit cave search or demolished building

Autonomous navigation in complex environment with human mission control

Scenario #3: small unit perimeter defense

Autonomous navigation in complex environment with autonomous mission control

RDECOM

ARL

Electronics, Power, and Microsystems

Critical Components for Emerging Army Applications

We can make a **difference** to them

US Special Operations Command

Successes / Lessons Learned: Adapting Technology to Enhance the Warfighter

Mr. Doug Richardson
SOAL-T WSO
4 September 2007

The overall classification of this briefing is:
UNCLASSIFIED

20 1987 2007
Proven • Vigilant • Prepared
in the past today for the future

USSOCOM Roles

- **Supported Combatant Commander (COCOM)**
- **Supporting COCOM**
- **Military Department (MILDEP)-Like:**
  - **Budget & Programming Authority (MFP-11: Science &Technology, Research and Development, Procurement, Operations & Maintenance, Military Construction)**
  - **Acquisition Authority, Head Contracting Activity (SOFARS), Chief Information Officer, Chief Financial Officer, Investigations and Audits**
- **Service-Like:**
  - **Organize, Train, Equip**
  - **Requirements**
  - **Operational Testing**
  - **Operational Logistics**

USSOCOM Acquisition Mission

Provide Rapid and Focused Acquisition, Technology, and Logistics Support to SOF Warfighters

Recent News Excerpts

- **Weekly Standard, 3 Sep 07, Operation Phantom Strike**
  - **“Disruption is a way to seize and maintain the initiative”**
  - **“Disruptive attacks keep the enemy off-balance”**
  - **“Being able to distinguish between insurgent and civilians is the key to victory”**
- **U.S. News and World Report, 3 Sep 07, Planning and Training for the Post-Surge**
  - **“Greater role for U.S. military advisor”**
  - **“The preparation for transition teams has seen substantial change”**

Science & Technology (S&T) is Supporting the Surge and Post Surge Periods -- Now

Commander USSOCOM
- Vision -

- **"The SOF Warrior: A Disruptive Force in a Complex Environment"**
- **"These Continuously Evolving Capability Increases Will Allow SOF to Not Only Conduct Find and Fix Operations Globally, But Also to Disrupt or Even Disintegrate the Terrorist Organizations"**

VADM Olson, 2004, Disruptive Technology Briefing
– then Deputy Commander, USSOCOM

Disruptive Warriors, Conventional and SOF,
Are Using S&T Derived Capabilities -- Now

Challenge

- **If You Have Applicable Technologies That Can Influence the Surge – Move Them Now**
- **Otherwise: Analyze, Plan, and Begin S&T That Will Support the Post Surge Environment**

Choosing an Efficient Path for Moving S&T to Fielded Capability Is a Key Enabler – *Lessons Learned*

C-MNS and Urgent Deployment Acquisition (UDA) Processes

- **CMNS**:
  - Submitted by Operational Forces
  - Endorsed by TSOC & Appropriate USSOCOM Component
  - Headquarters Rapid Response Team Assesses CMNS for Validation & Develops Plan of Action for DCDR Approval
- **UDA**:
  - Upon CMNS Approval, Immediate Initiation of UDA Program
  - Expedited Acquisition Procedures Apply
  - Objective is to Field Capability Within 180 days

Note: The OSD Joint Urgent Operational Need Statement (JUONS) – Joint Rapid Reaction Cell (JRAC) Process Was Modeled on this USSOCOM Process

Example: Urgent Deployment Acquisitions

Laser Targeting Devices

Leaflet Delivery System

Standoff Detectors

CMNS Requirement	IOC
Laser Targeting Devices	7 days
Remote Camera Controller	11 days
All Terrain Vehicles	5 wks
Coalition Video Teleconferencing	4 wks
Standoff Explosive Detection System	10 wks
Man-Portable Decontamination (Cbt Eval)	9 wks
Small Un-piloted Aerial Vehicles	14 wks
Leaflet Delivery System	14 wks
Remote Observation Post	18 wks
Personnel Tracking System	21 wks

UAV Pointer

Man Portable Decontamination

Coalition VTC

SOAL-T

Organizational and Cultural Barriers to S&T

- S&T Community has Difficulty Projecting and Meeting Dates for Availability of Technology in a Form Useful to the Acquisition Community
- Acquisition Community is Reluctant to Build a Program Schedule Around Uncertain Technology Availability
- The Comptroller Community Routinely Penalizes Both the S&T and Acquisition Communities for Failure to Meet Dates, and Typically Uses S&T Budgets as Bill Payer for Operational Funding Shortfalls
- Requirements and Operational Community: Unfounded Expectations, “Irrational Exuberance”, and Rapid Disenchantment

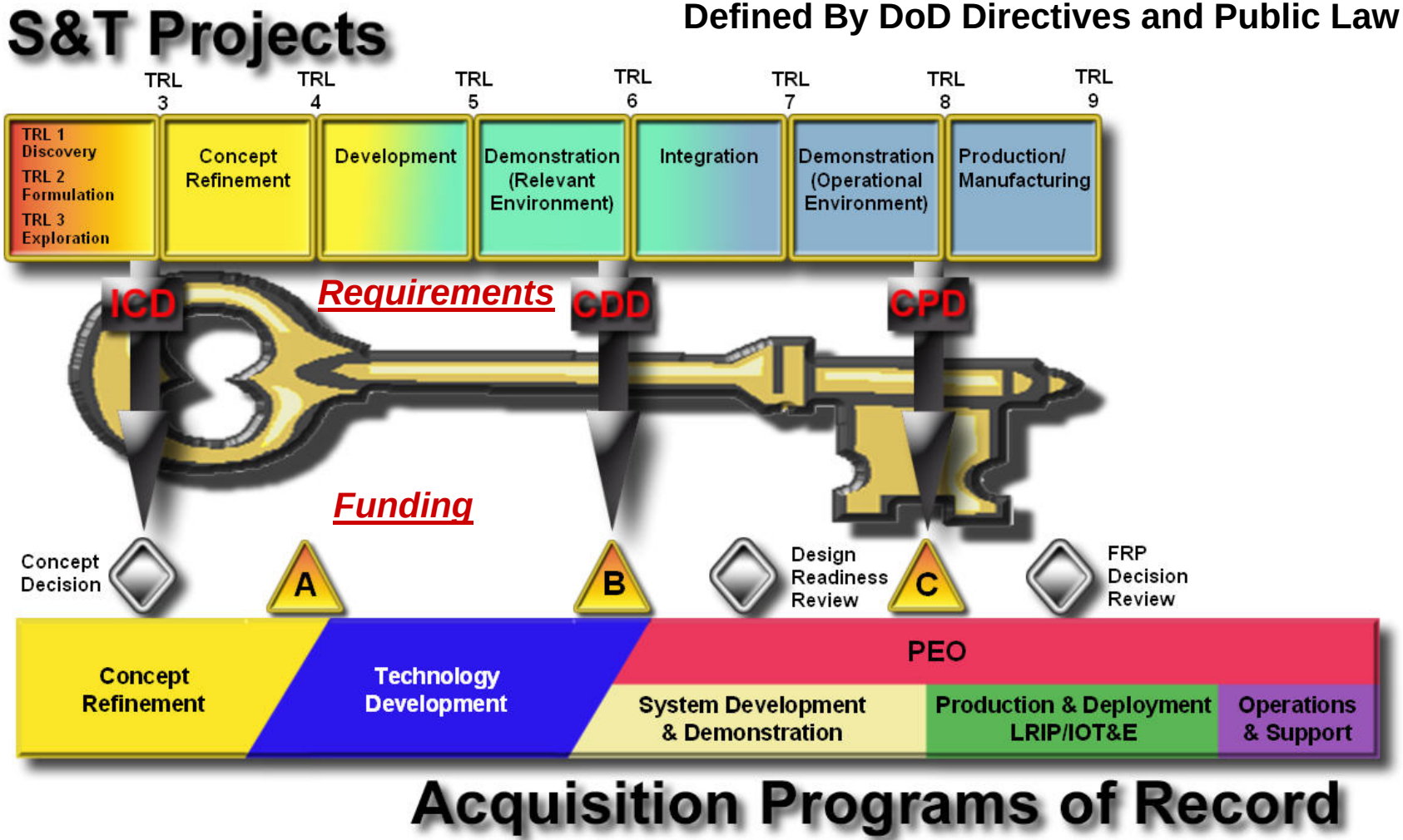
Extracts from USSOCOM Acquisition Executive Discussion on Technology Transition

Adjusting the Way Ahead

- **Program Executive Offices (PEOs)/Program Managers (PMs) Maintain Portfolio Plans that Identify Technology Needs and/or Insertion Points**
- **Technology Insertion Funding is Planned with the PEO/PM Program Budget**
- **Conduct Effective Institutionalized Outreach Between PEOs/PMs and S&T Community – S&T becomes Part of the Team**
- **PEOs/PMs are Chartered to Provide Solutions to Operator Requirements – They are the Key Link Between Technology and the Operator**

Technology Transition Challenge – Move S&T Closer to the PEO/PM

Defined By DoD Directives and Public Law



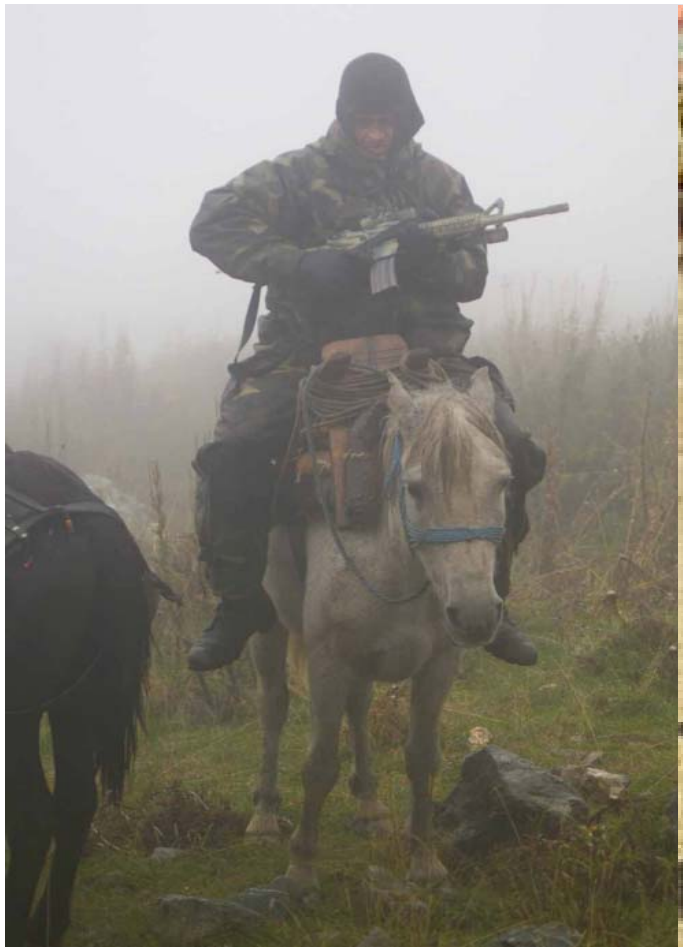
ICD: Initial Capabilities Document; **CDD**: Capability Development Document; **CPD**: Capability Production Document

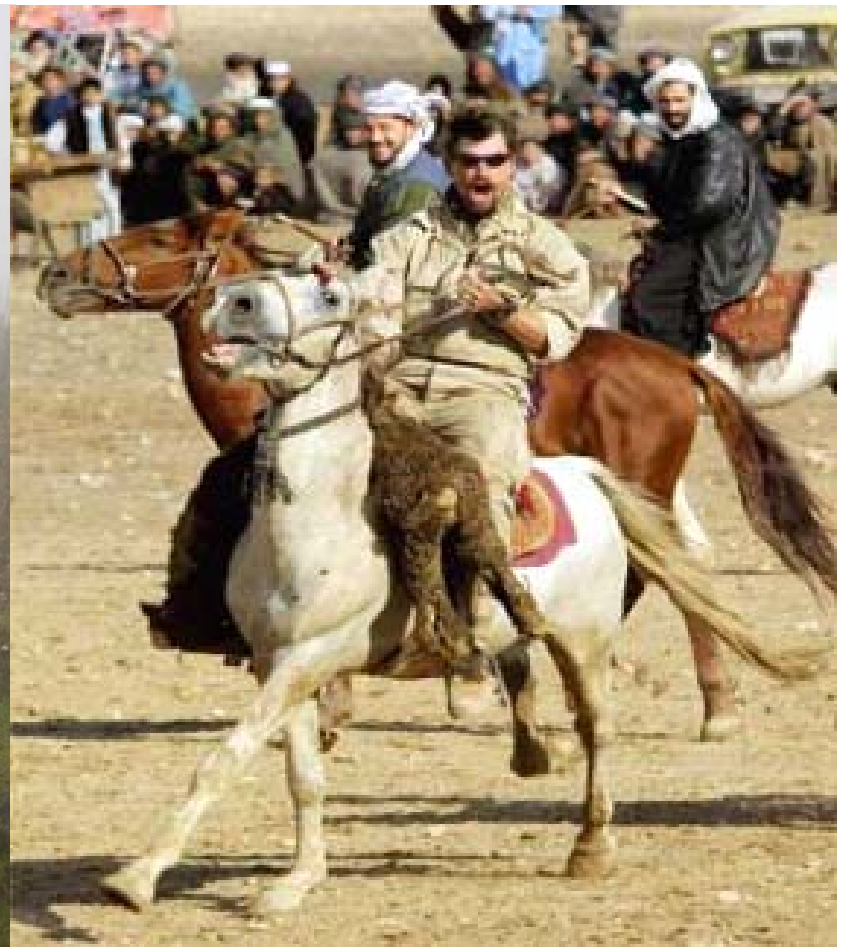
SOAL-T

Accelerating New Capabilities Forward

- **Ensure that the Relevant PEO/PM is Aware of the Technology Opportunity**
  - **Title 10 Authority, Appropriate Orders, Releases, and Requests**
  - **Different Processes for Government and Private Sectors**
- **When Mining for Requirements, Keep PEO/PM, Requirements and Programming Communities in the Loop.**
- **Partner When Possible to Develop a More Complete Technology "System"**
- **Mutual Respect and Cooperation**

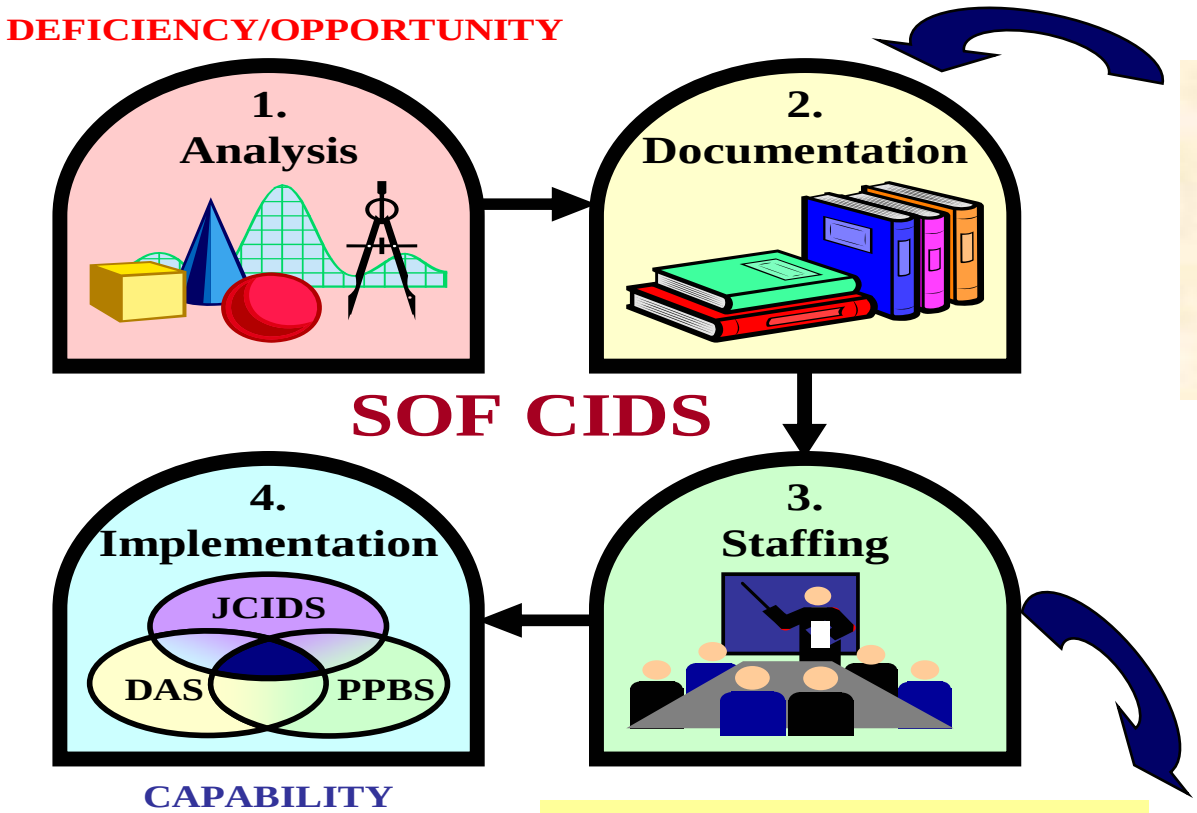
Questions?





SOF CIDS Process

Four Phases of the SOF Capabilities Integration and Development System



Initial Capabilities Document (ICD)

Capability Development Document (CDD)

Capability Production Document (CPD)

Special Operations Command Requirements Evaluation Board

SOAL-T

Combat Mission Needs Statement (C-MNS)

- Rapid Validation, Approval, and Fielding of Critical (Mission Failure or Loss of Life) New or Existing SOF Materiel Capability
- Not an Unfunded Requirement Process (Separate UFR or Supplemental Process Exists)
- Not a Means to Circumvent or Accelerate the Normal Special Operations Command Requirements Review Board (SOCREB) Approval and Strategic Planning Process (SPP) Resourcing Processes

Approving a C-MNS Mandates an Offset (Must Pay Bill)

C-MNS Criteria

System	Metric	Criteria
JCIDS	Critical Capability Need	▪ Urgent and Compelling New or Existing Materiel Need Identified During Preparation for or Active SOF Combat/Contingency Operations That Must Satisfy at Least One of Two Criteria: – Satisfy Critical Shortfall on the Overall Success of the Mission (Mission Failure) – Mission Critical Combat Survivability Deficiency (Loss Of Life)
DAS	Capability Solution	▪ Expeditious Acquisition of New or Existing Material to Meet Critical SOF Combat Needs. Normally Fielded Within 180 Days of C-MNS Approval – Solution Sustainable Through Duration of Combat or Contingency Operation – Equipment No Longer Maintained or Sustained After Operation Unless Capability Document Approved IAW USSOCOM Directive 71-4
PPBE	Capability Resourcing	▪ Resources Made Available to Finance Capability Solution

Congress Established "Combat Mission Requirements" P-1 Line Item in FY06 Appropriations Bill

- USSOCOM Submits a Funded C-MNS Report Quarterly
  - Appropriated $21 million in FY 2006
  - Appropriated $22 million in FY 2007
- FY 2008 President's Budget request contains $20 million for C-MNS

Policies and Procedures

- **Statutes**
  - 10 USC Sec 167 (HQ USSOCOM Acquisition and Budget Authority)
  - 10 USC Sec 2430 (Major Defense Acquisition Programs)
  - 10 USC Chap 137 (Head of Agency)
  - 10 USC Chap 87 (Defense Acquisition Workforce and Overarching Acquisition)
- **OMB/DOD/OCJCS**
  - OMB Circular A-109 (Major System Acquisitions)
  - DOD 5000 Series (Defense Acquisition System)
  - Defense Acquisition Guidebook
  - CJCSI 3170.01 (Joint Capabilities Integration & Development System)
  - DOD Financial Management Regulation (FMR)
- **Federal Acquisition Regulation (FAR), DOD FAR Supplement and HQ USSOCOM FAR Supplement**
- **HQ USSOCOM**
  - D70-1 (Acquisition Management Policy)
  - D71-4 (SOF Capabilities Integration and Development System)
  - D71-5 (OT&E)
  - R700-1 (Equipment Management)
  - D700-7 (Reducing SOF Total Ownership Costs)

Same Overarching Statues and Policies Which Are Used Throughout DoD

Naval Innovation and Disruptive Technology

Lawrence Schuette
Office of Naval Research
Director of Innovation
5 September 2007
larry.schuette@navy.mil

INNOVATIVE NAVAL PROTOTYPES
Disruptive Innovations

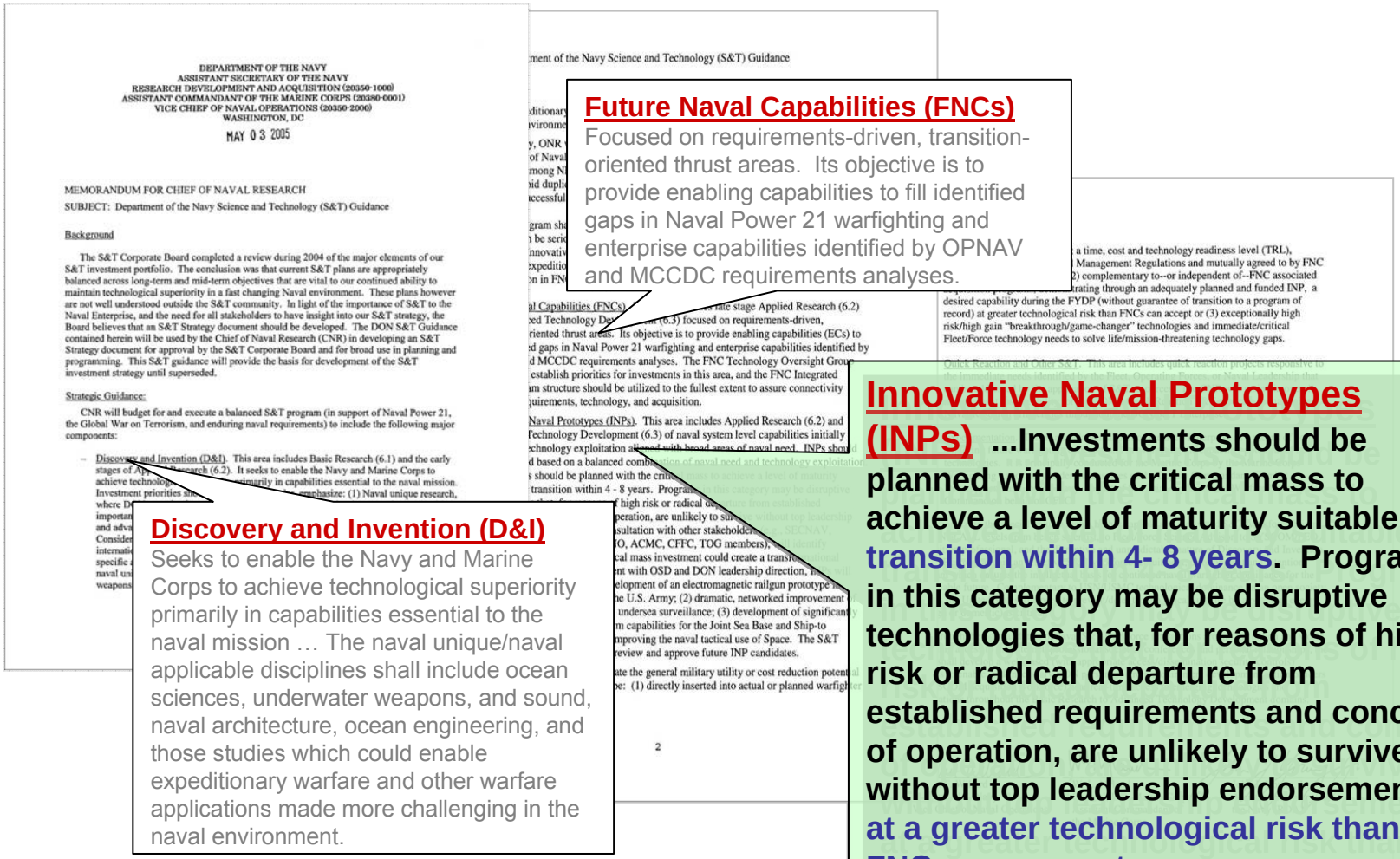
Distribution Statement A – Approved for Public Release

Overview

- "This Conference seeks to exploit the unique and often contrasting nature of commercial industry and military sponsored science and technology efforts.
- Many of the rapidly evolving disruptive technologies will most likely be developed by agile commercial marketplace attributes.
- Larger and longer to develop disruptive technologies will probably be championed by the DoD for application as pure national security capabilities.
- The Conference seeks to exploit the hybrid situation. Specifically the identification and adaptation of technology products that result in a high end military capability."

This talk will explain the range of Navy S&T Innovative Technology Programs.

DoN S&T Guidance



DEPARTMENT OF THE NAVY
ASSISTANT SECRETARY OF THE NAVY
RESEARCH DEVELOPMENT AND ACQUISITION (20350-1000)
ASSISTANT COMMANDANT OF THE MARINE CORPS (20380-0001)
VICE CHIEF OF NAVAL OPERATIONS (20350-2000)
WASHINGTON, DC

MAY 03 2005

MEMORANDUM FOR CHIEF OF NAVAL RESEARCH

SUBJECT: Department of the Navy Science and Technology (S&T) Guidance

Background

The S&T Corporate Board completed a review during 2004 of the major elements of our S&T investment portfolio. The conclusion was that current S&T plans are appropriately balanced across long-term and mid-term objectives that are vital to our continued ability to maintain technological superiority in a fast changing Naval environment. These plans however are not well understood outside the S&T community. In light of the importance of S&T to the Naval Enterprise, and the need for all stakeholders to have insight into our S&T strategy, the Board believes that an S&T Strategy document should be developed. The DON S&T Guidance contained herein will be used by the Chief of Naval Research (CNR) in developing an S&T Strategy document for approval by the S&T Corporate Board and for broad use in planning and programming. This S&T guidance will provide the basis for development of the S&T investment strategy until superseded.

Strategic Guidance:

CNR will budget for and execute a balanced S&T program (in support of Naval Power 21, the Global War on Terrorism, and enduring naval requirements) to include the following major components:

– Discovery and Invention (D&I). This area includes Basic Research (6.1) and the early stages of Applied Research (6.2). It seeks to enable the Navy and Marine Corps to achieve technological ... primarily in capabilities essential to the naval mission. Investment priorities ... emphasize: (1) Naval unique research, where D... important... and adva... Consider... internati... specific ... naval un... weapons

...ment of the Navy Science and Technology (S&T) Guidance

...ditionary ...vironme... ...y, ONR ... ...of Naval ...mong N... ...oid dupli... ...ccessful... ...gram sha... ...be seric... ...innovativ... ...expeditio... ...on in FN...

...al Capabilities (FNCs) ...late stage Applied Research (6.2) ...ed Technology Dev... ...(6.3) focused on requirements-driven, ...riented thrust areas. Its objective is to provide enabling capabilities (ECs) to ...d gaps in Naval Power 21 warfighting and enterprise capabilities identified by ...d MCCDC requirements analyses. The FNC Technology Oversight Grou... ...establish priorities for investments in this area, and the FNC Integrated ...m structure should be utilized to the fullest extent to assure connectivity ...quirements, technology, and acquisition.

Naval Prototypes (INPs). This area includes Applied Research (6.2) and Technology Development (6.3) of naval system level capabilities initially ...chnology exploitation ... ...d based on a balanced ... ...s should be planned with the ... ...transition within 4 - 8 years. Progra... ...f high risk or radical d... ...peration, are unlikely to su... ...sultation with other stakeholder... ...O, ACMC, CFFC, TOG members); ...cal mass investment could create a transi... ...nt with OSD and DON leadership direction, ...elopment of an electromagnetic railgun prototype ... ...he U.S. Army; (2) dramatic, networked improvement ... undersea surveillance; (3) development of significant ...m capabilities for the Joint Sea Base and Ship-to ...mproving the naval tactical use of Space. The S&T ...review and approve future INP candidates.

...ate the general military utility or cost reduction potent... ...e: (1) directly inserted into actual or planned warfigh...

2

...a time, cost and technology readiness level (TRL), ... Management Regulations and mutually agreed to by FNC ...2) complementary to--or independent of--FNC associated ...trating through an adequately planned and funded INP, a desired capability during the FYDP (without guarantee of transition to a program of record) at greater technological risk than FNCs can accept or (3) exceptionally high risk/high gain "breakthrough/game-changer" technologies and immediate/critical Fleet/Force technology needs to solve life/mission-threatening technology gaps.

Quick Reaction and Other S&T. This area includes quick reaction projects responsive to ...

Future Naval Capabilities (FNCs)

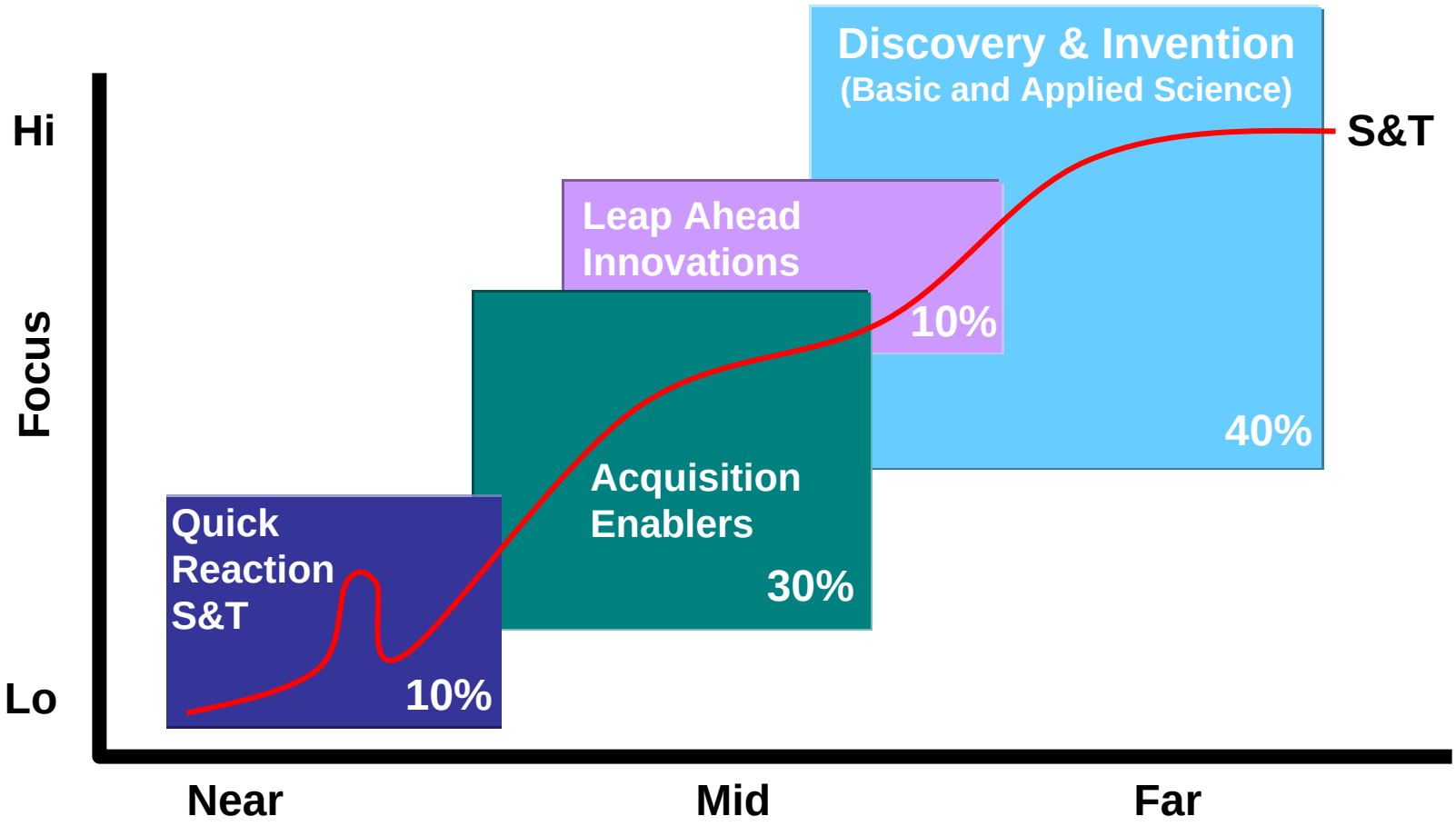
Focused on requirements-driven, transition-oriented thrust areas. Its objective is to provide enabling capabilities to fill identified gaps in Naval Power 21 warfighting and enterprise capabilities identified by OPNAV and MCCDC requirements analyses.

Discovery and Invention (D&I)

Seeks to enable the Navy and Marine Corps to achieve technological superiority primarily in capabilities essential to the naval mission … The naval unique/naval applicable disciplines shall include ocean sciences, underwater weapons, and sound, naval architecture, ocean engineering, and those studies which could enable expeditionary warfare and other warfare applications made more challenging in the naval environment.

Innovative Naval Prototypes (INPs) **...Investments should be planned with the critical mass to achieve a level of maturity suitable for transition within 4- 8 years. Programs in this category may be disruptive technologies that, for reasons of high risk or radical departure from established requirements and concepts of operation, are unlikely to survive without top leadership endorsement ... at a greater technological risk than FNCs can accept ...**

ONR S&T Portfolio Balance

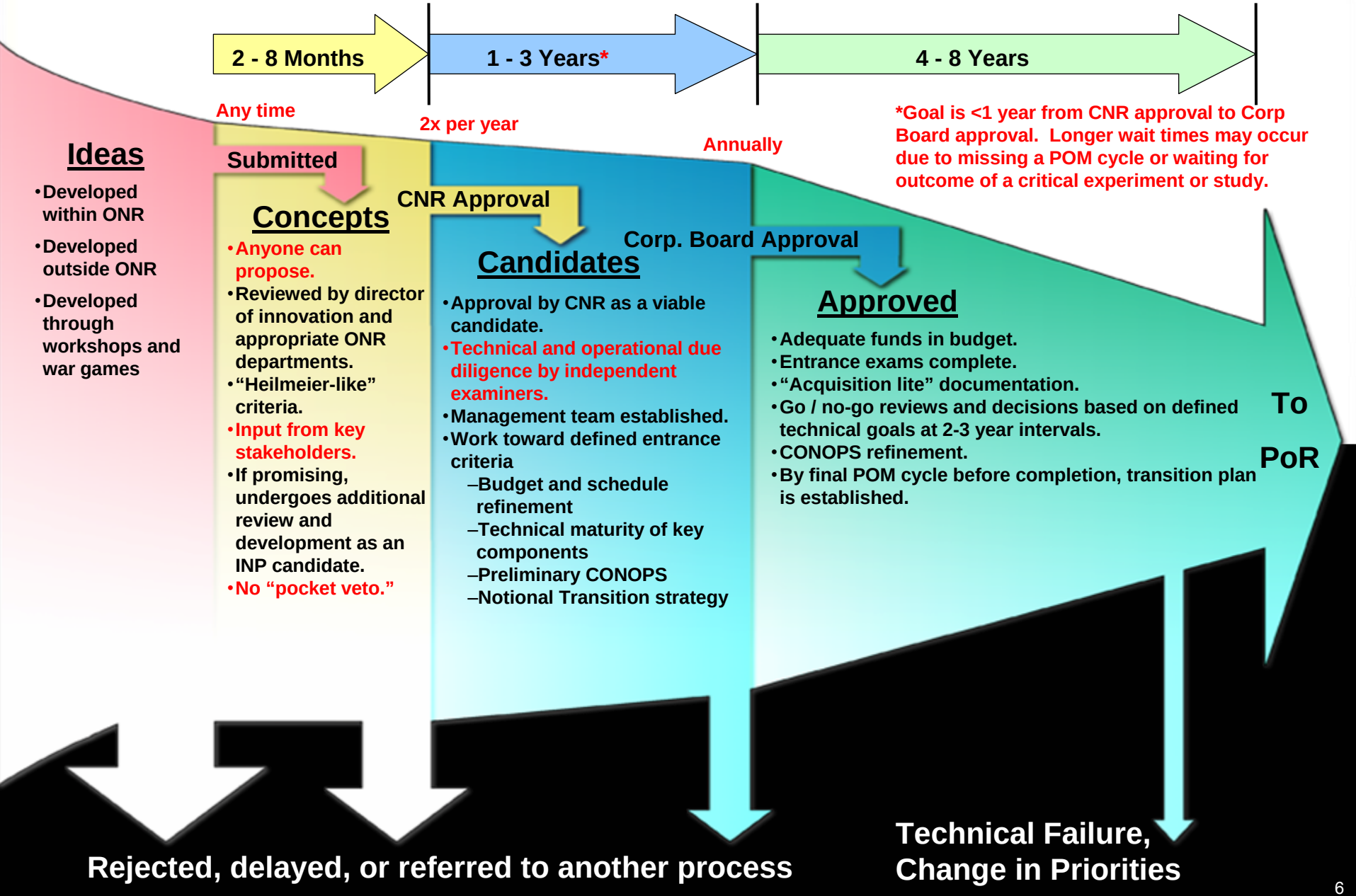


Navy S&T has a long-term focus but is responsive to near - term Naval needs

INPs Compared to Other ONR Programs

	Discovery and Invention	Future Naval Capability	Direct Fleet Support / Quick Reaction	Innovative Naval Prototype
% of Portfolio	>40	>30	~10	~10
Focus	Expanding frontiers of knowledge in areas of naval interest	Transitioning mature S&T to acquisition program of record	Solving emergent fleet / force needs	Demonstrating Leap-ahead technology
Motivation	General Naval needs and opportunities	OPNAV-identified capability gap	Fleet-identified need	Significant military advantage
Example	Ocean Acoustics	38 MW water jet for JHSV	IED Jammer	Electromagnetic Railgun
Type of Innovation	Disruptive or sustaining.	**Sustaining -** makes an existing capability better	Disruptive or sustaining.	**Disruptive -** makes an existing capability obsolete
Time frame	continuing	3-5 years	1-2 years	4-8 years
Typical TRL entry point	TRL-0	TRL-3	TRL-4 to TRL-5	TRL-2 to TRL-3
Typical TRL end point	TRL-3 to TRL-4	TRL-6	TRL-7	TRL-6
Technical Difficulty	High	Medium	Medium	High
Operational Integration Complexity	N/A	Usually straightforward	Medium	High
Approval Level to start a program	ONR Department	Technology Oversight Group (3-Star)	ONR Corporate	DON Corporate Board (4-Star)

Going From Idea to INP



Business Rules

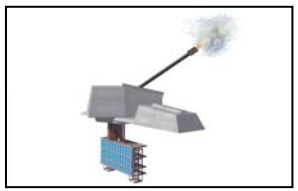
- ***Preserve*** **competition as long as possible within budget, time, and milestone constraints of INP**
- **Ensure open architecture enables continued competition in acquisition and life cycle phases**
- **Provide incentive to contractors where possible**
- **Reduce system and platform costs**
- **Reduce system and platform life cycle costs**
  - Ensure open architecture facilitates future technology insertion and innovation
  - Reduced manning
- **Ensure innovation by enabling participation by small and start-up businesses**

INP Program Snapshot

$991M
Planned / Proposed
FY08-13

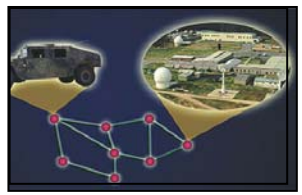
- Guidance
  - Innovative and game-changing.
  - High risk, high payoff.
  - Useable prototype available at completion.
  - Deputy PMs from Acquisition PEOs to facilitate transition.

Current INPs



EMRG

SBE



TACSAT

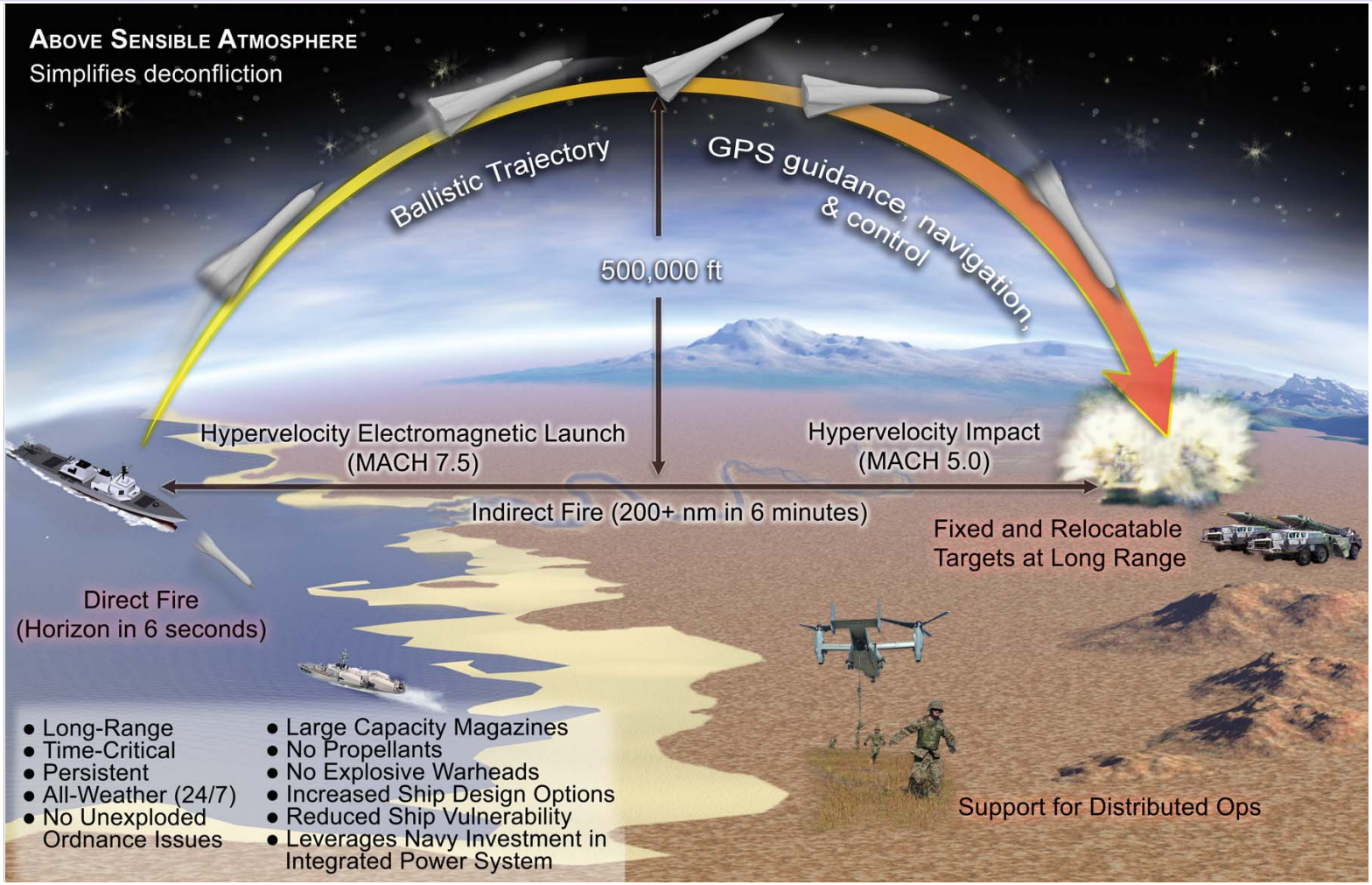
PLUS

FY-10 INPs

FEL

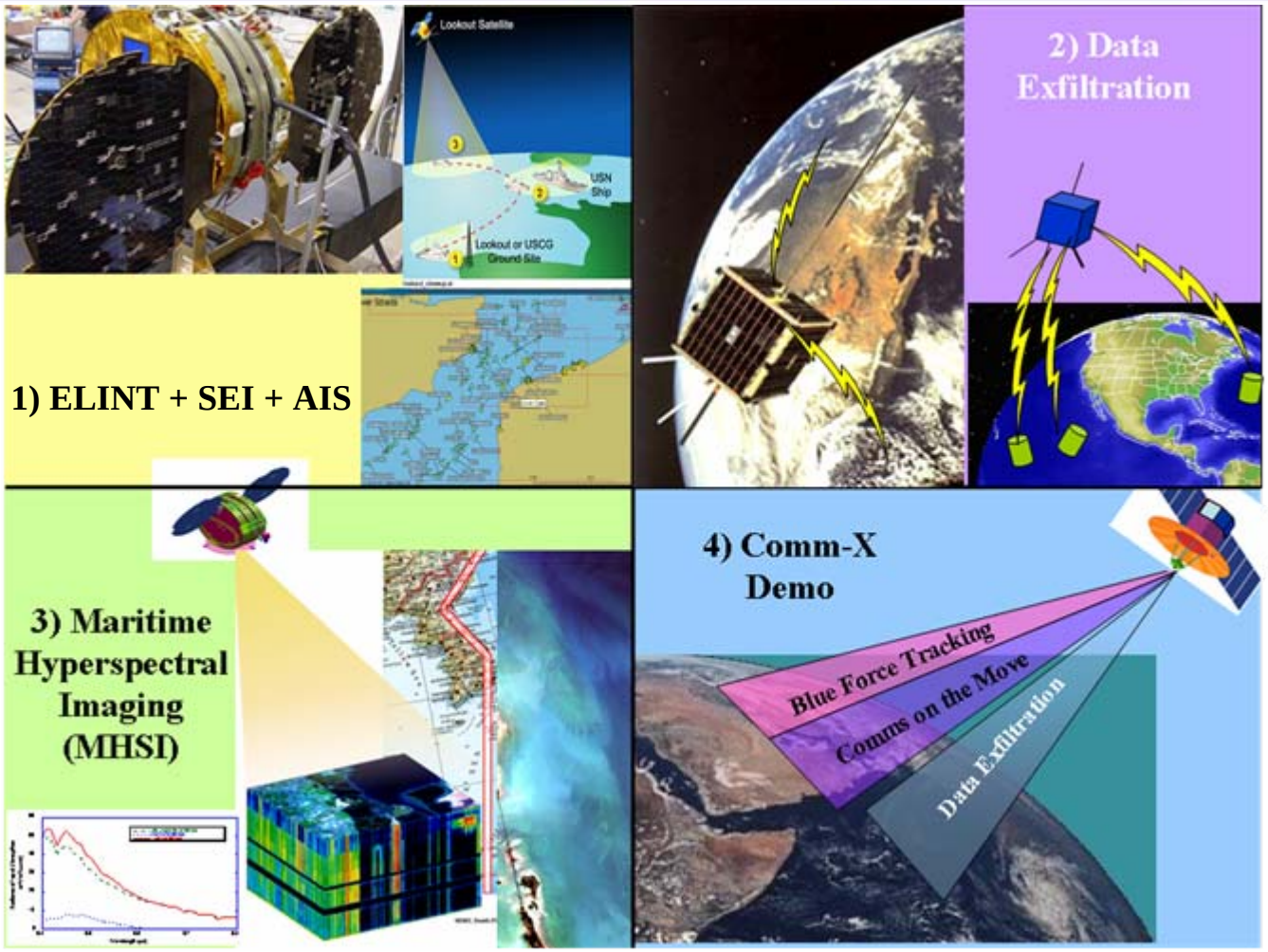
INT TOPSIDE

EM Railgun INP



EMRG	Relationship to Strategic Plan	"Leap Ahead" Characteristics
	Power Projection − Future Naval Fires	•2 orders of magnitude increase in surface combatant lethality against land targets. •Replace propellants and energetics with electric power and kinetic energy

Tactical Satellite (TACSAT) INP



TACSAT	Relationship to Strategic Plan	"Leap Ahead" Characteristics
	•Maritime Domain Awareness − Vessel tracking •Information, Analysis, and Communications	•Low cost and responsive access to space. •Control and tasking by tactical users. •Advanced sensors and comms

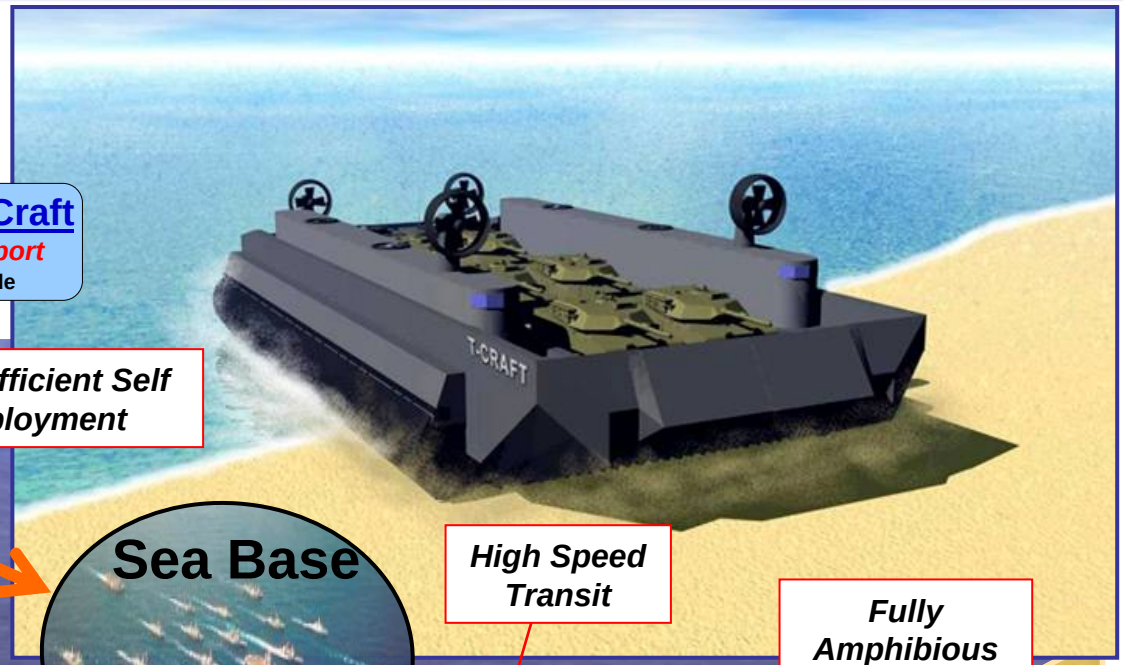
Seabase Enablers INP

T-Craft

Multi-Mode Vehicle Delivery Craft

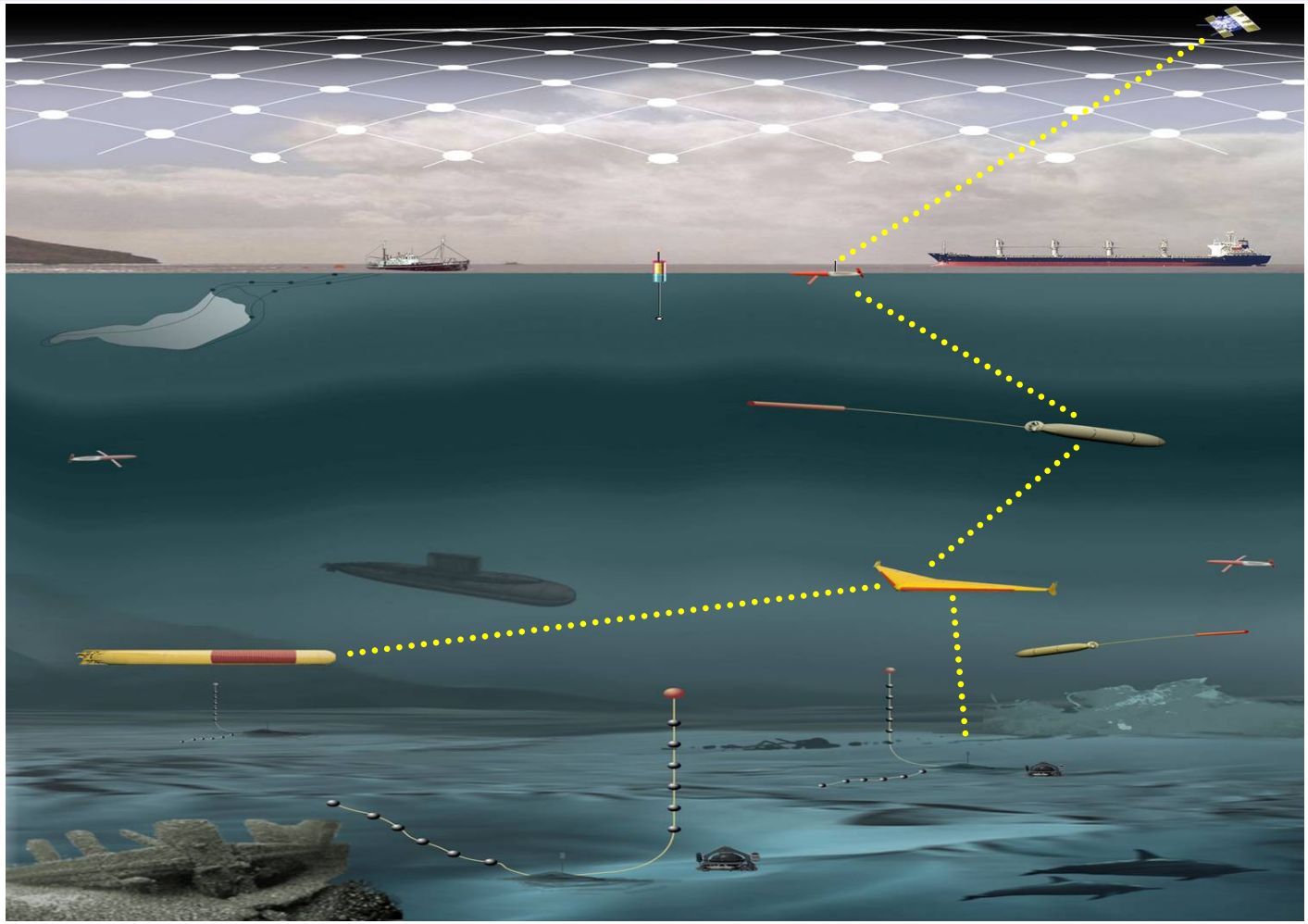
T-Craft: High Speed Beach-able Transport

40kt in SS-4 with beaching & amphibious mode



SBE	Relationship to Strategic Plan	"Leap Ahead" Characteristics
	Fleet and Force Sustainment – Advanced Sea Platforms	Radical new approach to amphibious delivery. Combines JHSV and JMAC-like characteristics in one vehicle.

Persistent Littoral Underwater Surveillance (PLUS) INP

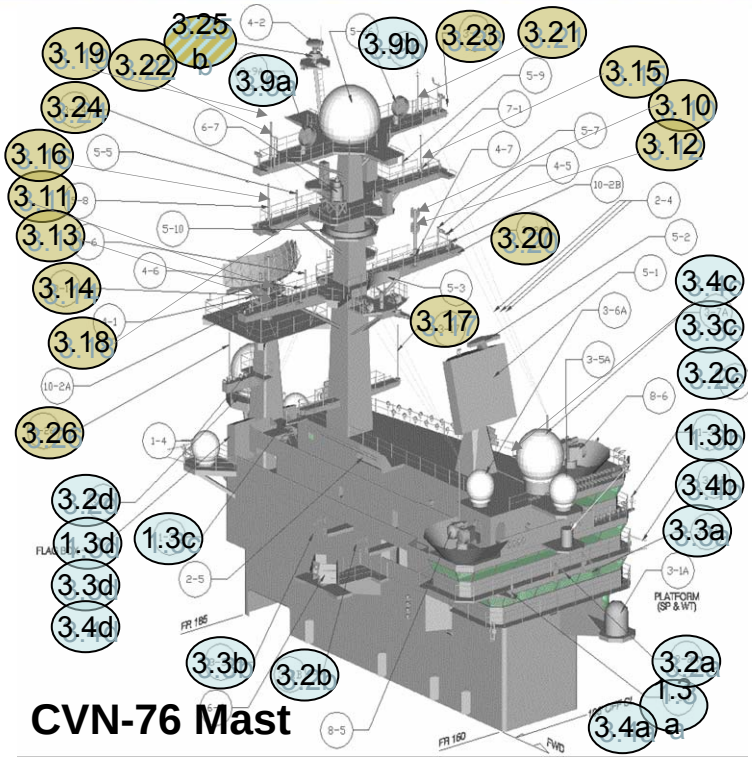


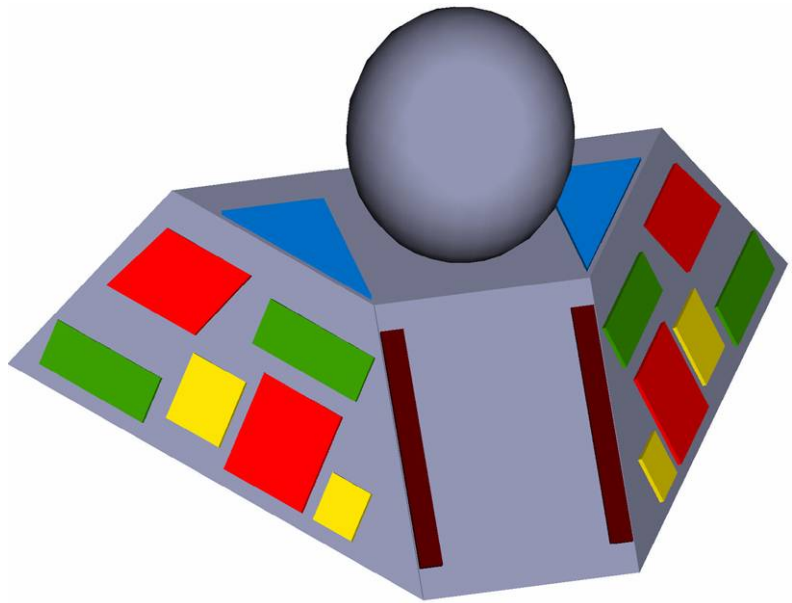
PLUS	Relationship to Strategic Plan	"Leap Ahead" Characteristics
	Assured Access and Hold at Risk − ASW, distributed surveillance	•Find quiet diesel subs without putting high value platforms at risk •High end ASW capability embedded in distributed network of low-cost autonomous mobile nodes.

FY-10 INP – Free Electron Laser

FEL	Relationship to Strategic Plan	"Leap Ahead" Characteristics
	Survivability and Self Defense − Speed of light engagement	•Speed of light weapon trumps speed and maneuverability of threat weapons. •Replace propellants and energetics with directed energy. •Deep magazine.

FY-10 INP – Integrated Topside





46 to 51 antennas		4 panels , 20 meters ^{2}
	NEW	
> 3500 pounds (Ant. Only)		< 1800 pounds

Integrated Topside	Relationship to Strategic Plan	"Leap Ahead" Characteristics
	• Affordability, Maintainability, and Reliability • Information, Analysis, and Communications	•Dominate the EM Spectrum •Multi-function apertures break down barriers between comms, EW, and sensing.

INPs in the Pipeline

	Technology at Appropriate Level	Programmatics Defined	Game Changer	Outreach / Due Dilligence
Air Connector for Distributed Ops	Y	N	Y	N
Compact Directed Energy System for Air Platforms	N	N	Y	N
Free Electron Laser	Y	Y	Y	Y
High bandwidth comms with submerged submarines and UUVs	N	N	Y	N
Integrated Topside	Y	Y	Y	Y
Persistent Air Platform	Y	N	Y	N
Radically Augmented Human Performance	N	N	Y	N
Submarine Advanced Propulsion	Y	N	Y	N
Supercavitating Weapon	Y	N	Y	N
Super Endurance Aircraft Propulsion	N	N	Y	N
UV Sentry System	Y	N	Y	N
WMD Standoff Detection	N	N	Y	N

. . . Your Ideas for new INPs?

Questions?
Ideas?

larry.schuette@navy.mil

Distribution Statement A – Approved for Public Release

United States Strategic Command

Mr. Shawn Spencer

Chief, Future Capabilities Division

4 September 2007

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Overall Briefing Classification

Purpose

To provide a general overview of USSTRATCOM warfighter needs, the Command mission and where it is going, and examples of the S&T efforts to support this

USSTRATCOM Mission

"Provide the nation with global deterrence capabilities and synchronized DoD effects to combat adversary weapons of mass destruction worldwide. Enable decisive global kinetic and non-kinetic combat effects through the application and advocacy of integrated ISR, space and global strike operations, information operations, integrated missile defense and robust command and control."

Provide Global Capabilities to Geographic COCOMS

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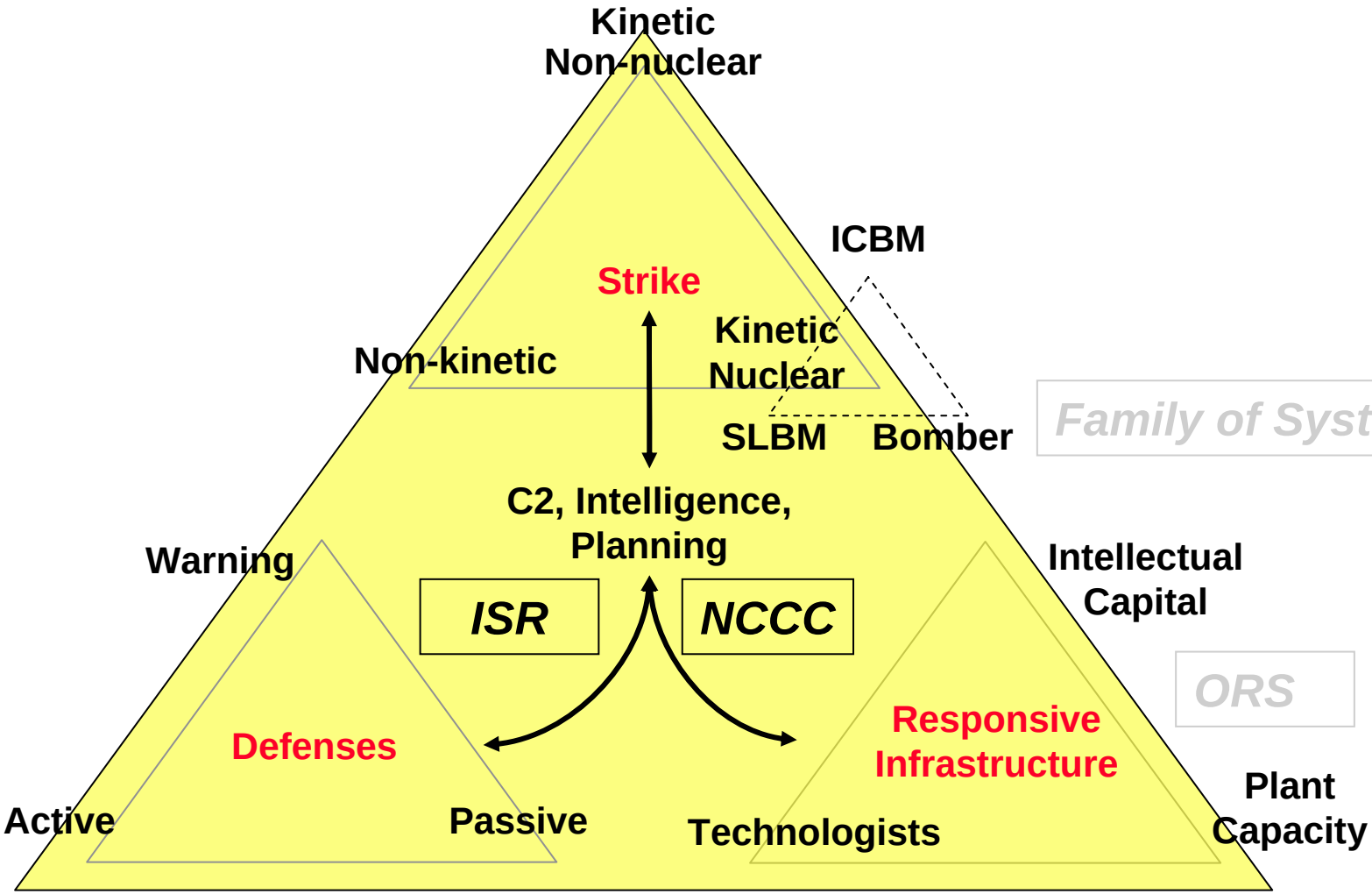
CDR USSTRATCOM Highest Priority

"My highest priority is to accelerate our transformation to a net-centric force. Virtually every current DoD mission would benefit from a net-centric approach and all of our future major mission capabilities are being designed and built on the promise of net-centricity. The Department can increase the pace of delivering the fundamentals (e.g., governance, data standards, system engineering, and architecture) necessary to enable ubiquitous, secure, and trusted information access. We require a Service Oriented Architecture, a data strategy, and a secure transport network unrestricted by bandwidth or application to achieve the advantages of a net-centric approach"

Maneuver within the enemy's decision cycle

(Source: SecDef Rumsfeld Snowflake on COCOM Priorities, Feb 2006)

C2, Intelligence and Planning



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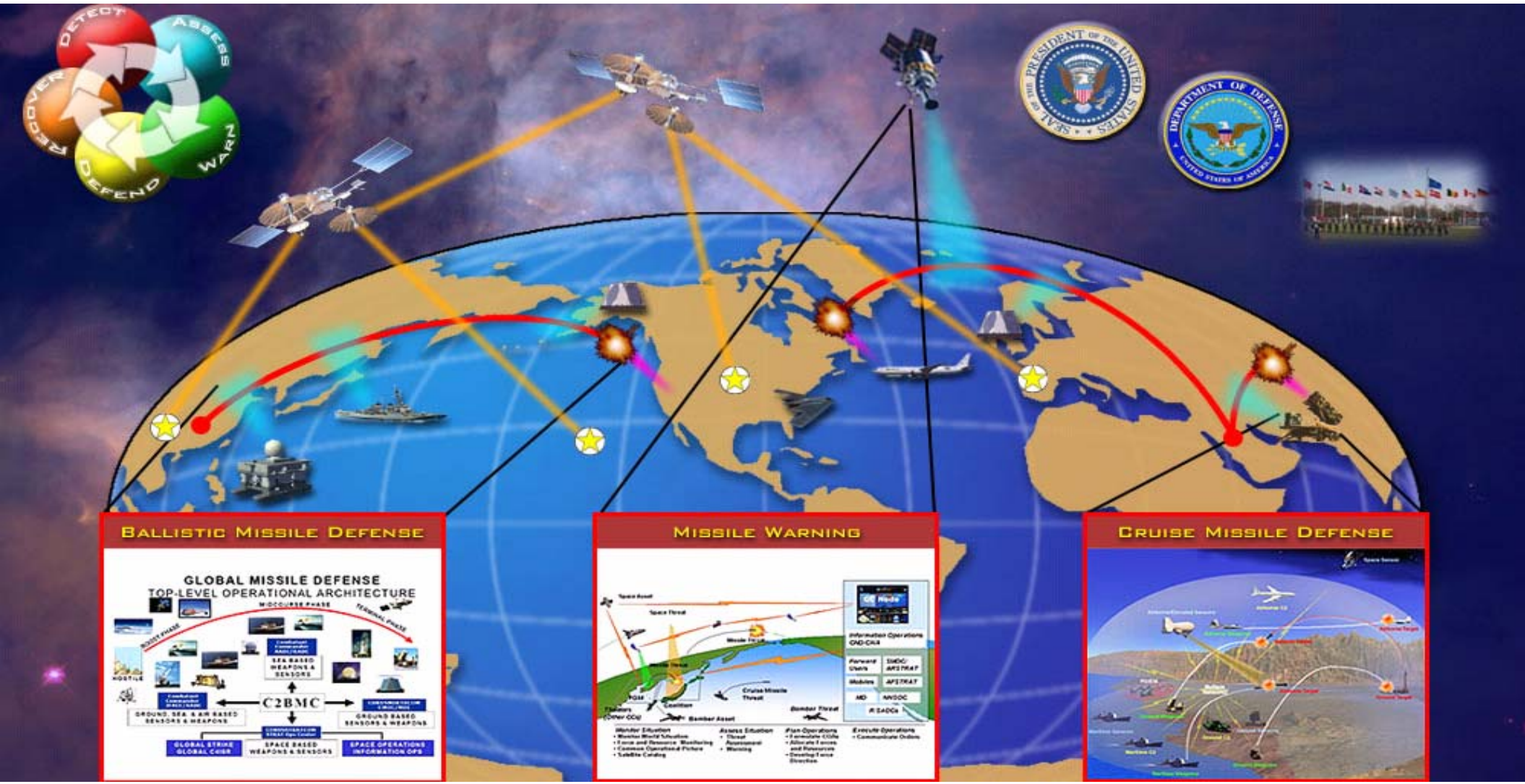
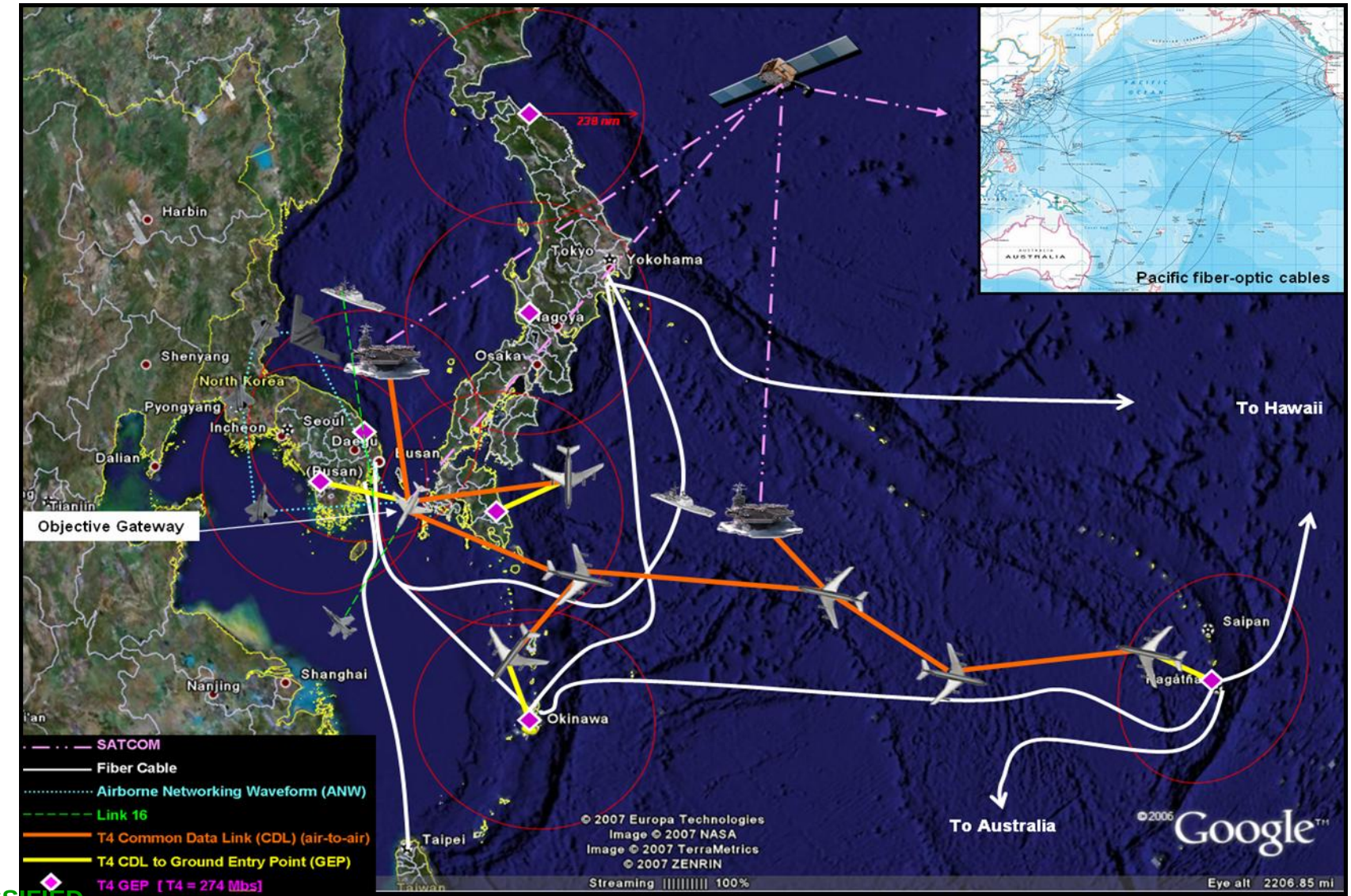
Integrated Missile Defense

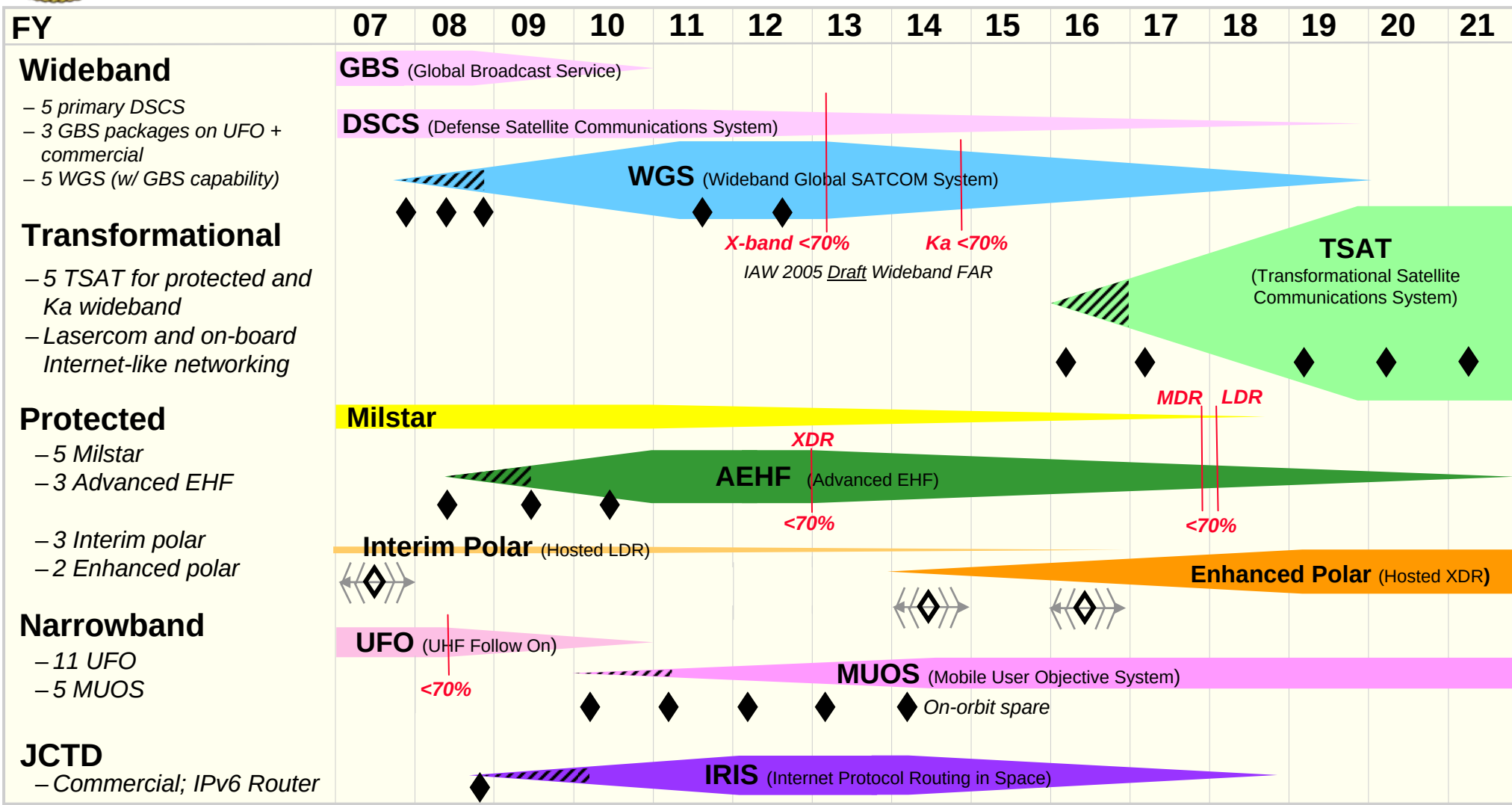


Communications Pathways



MILSATCOM Overview
System of Systems Schedule

As of: 23 May 07



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Pre-Operational

Launch

Available

Constellation functional availability data taken from respective AFSPC Functional Availability *Reports (FAR).*

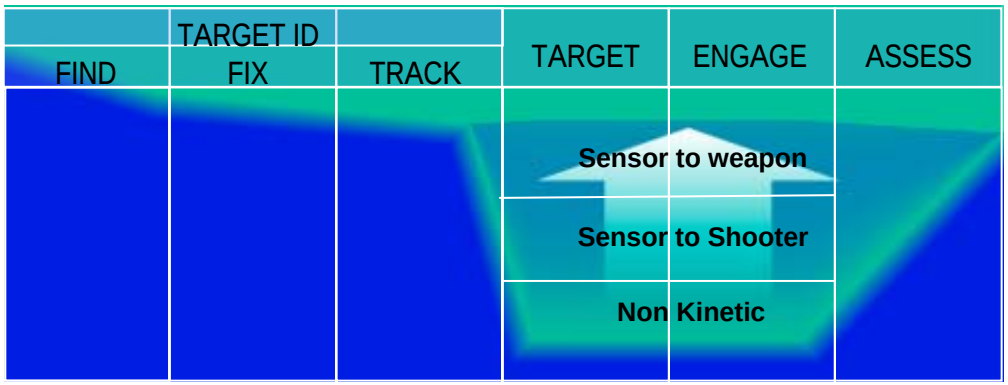
Bar thickness ~ indicates relative capacity (within, but not between, the 4 categories)

XESSA – Data to the Net

Add Intelligence Capabilities

Add Platforms and Sensors

Pull Across Kill Chain



Expand Missions

Constructing a Capabilities-Based Network Roadmap

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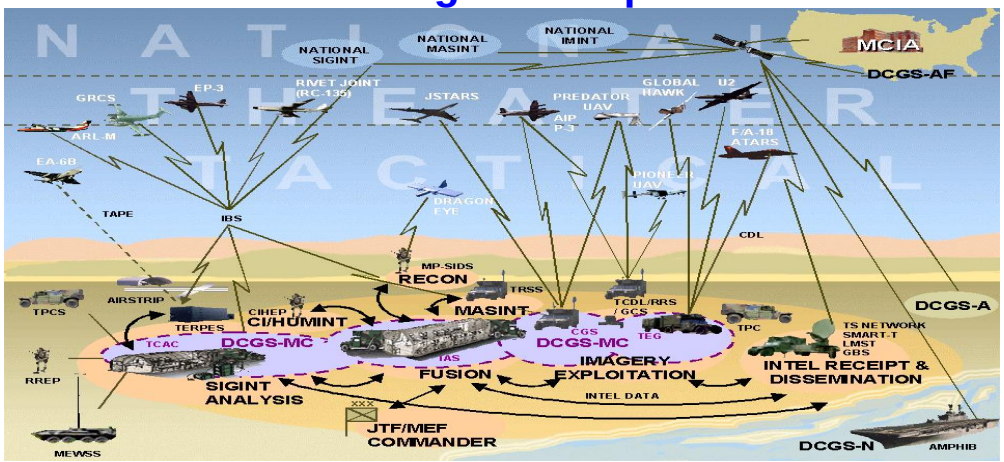
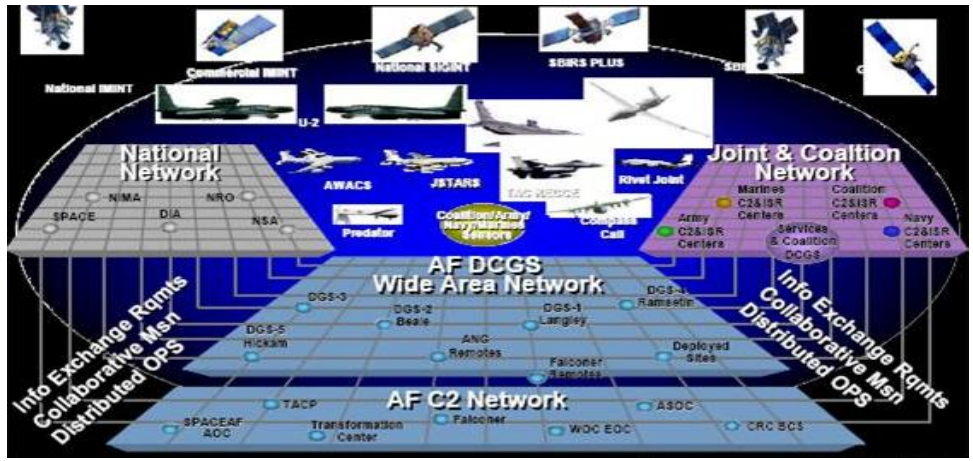
DCGS Development Strategy

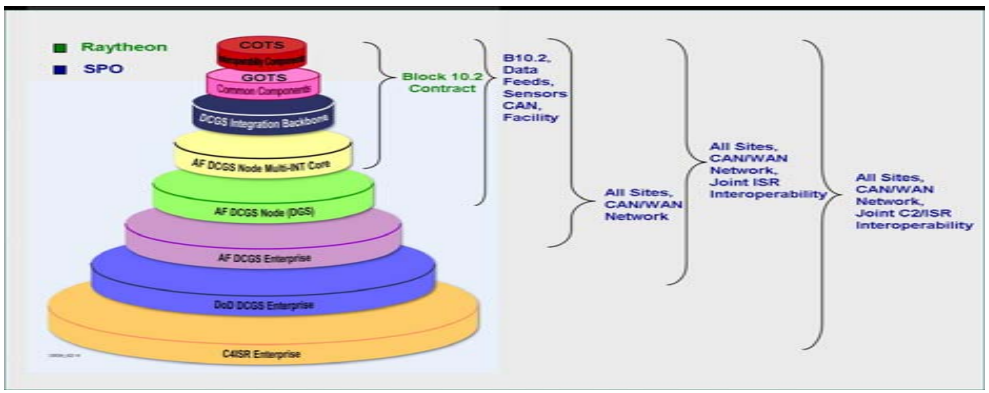
Tactical Intelligence Capabilities



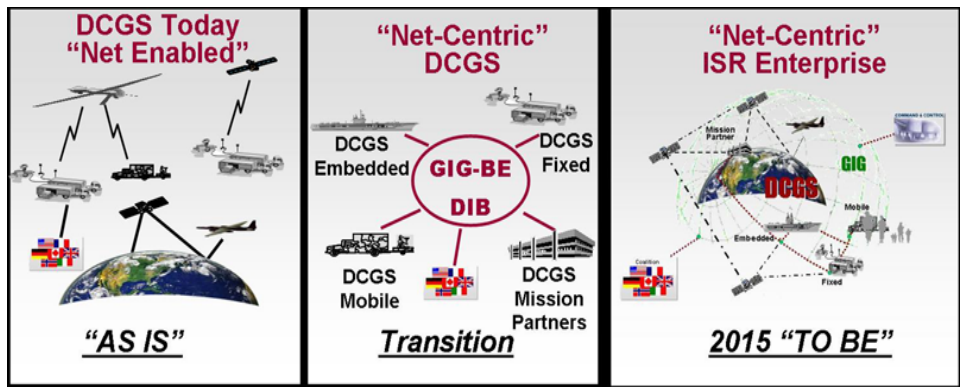
Platforms and Sensors



TPED Advancements



Moving to Net-Centric



Moving Towards a Net-Centric Tactical ISR Enterprise

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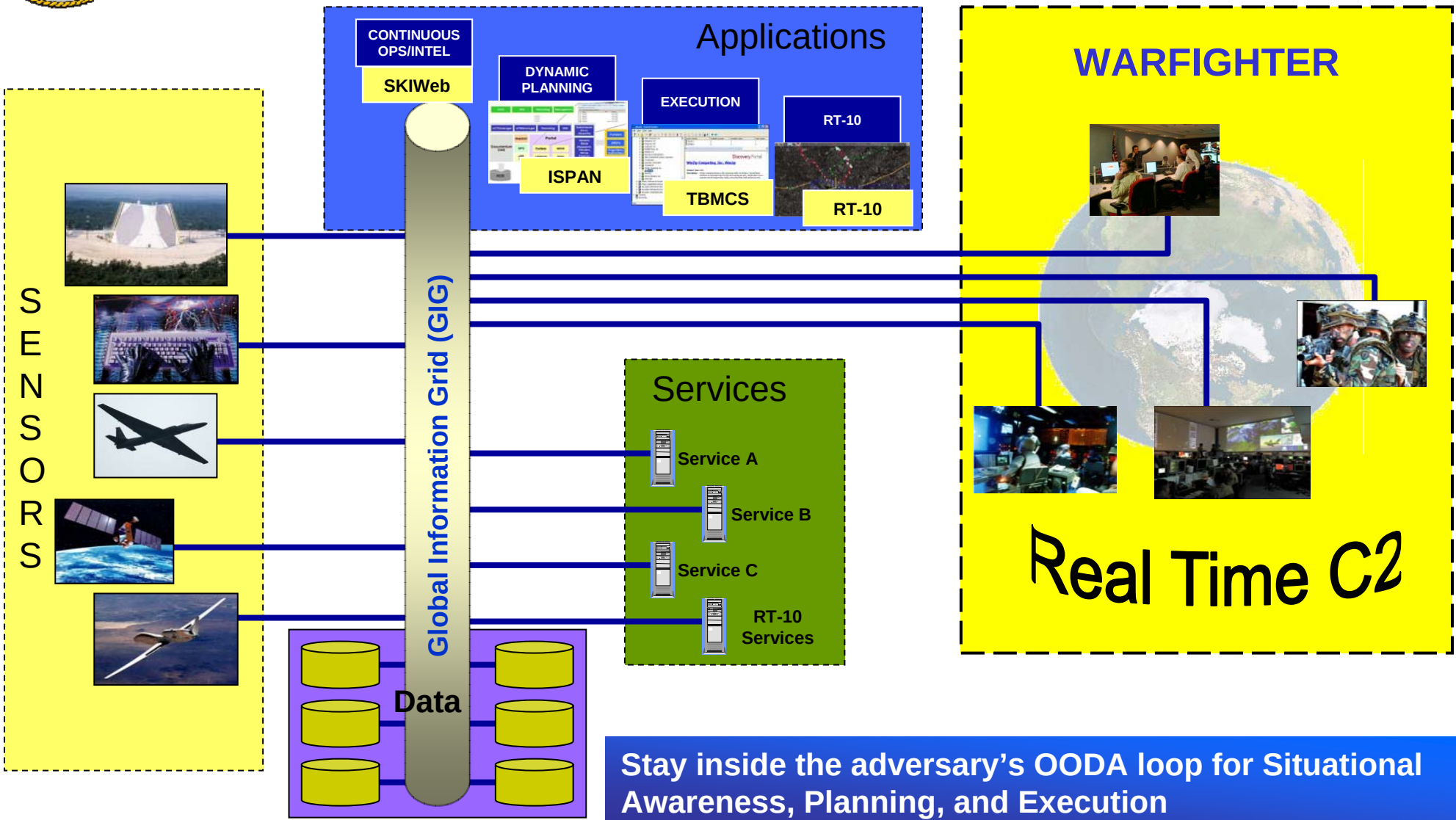
C2 Vision



Stay inside the adversary's OODA loop for Situational Awareness, Planning, and Execution

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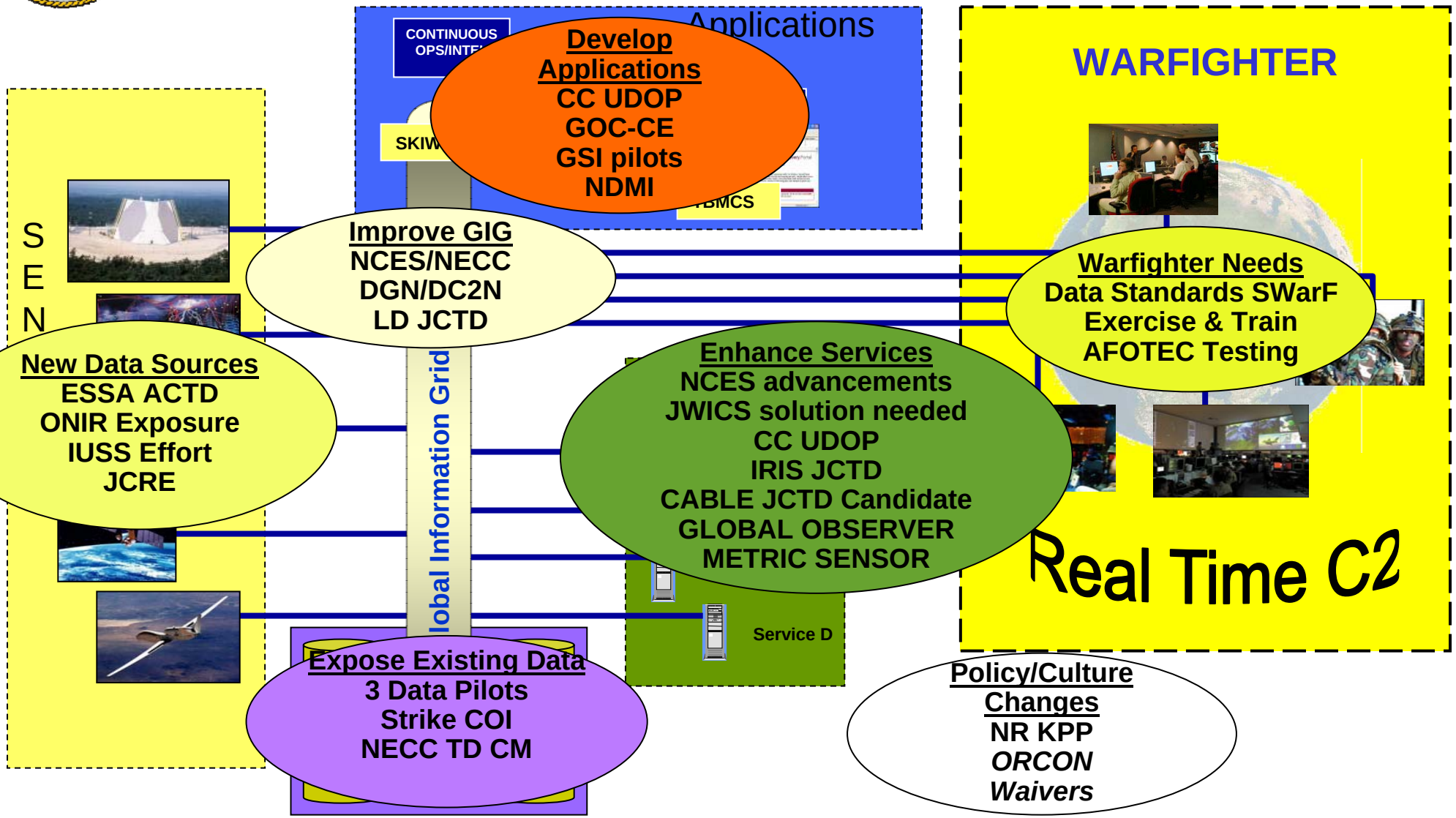
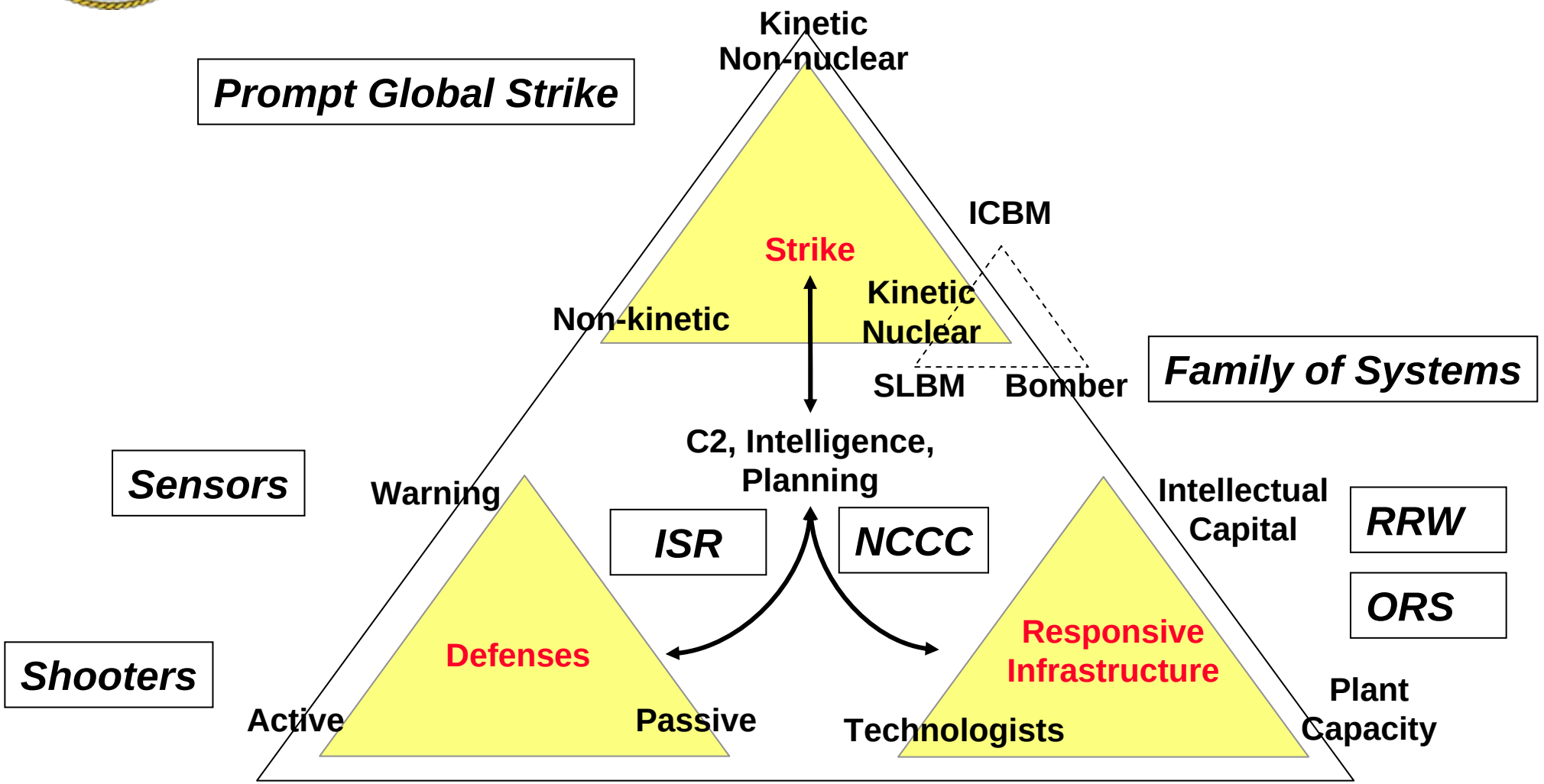
Aligning Efforts to Provide Information to the Warfighters



Data sharing vulnerable to classification practices and standards compliance

USSTRATCOM Triad



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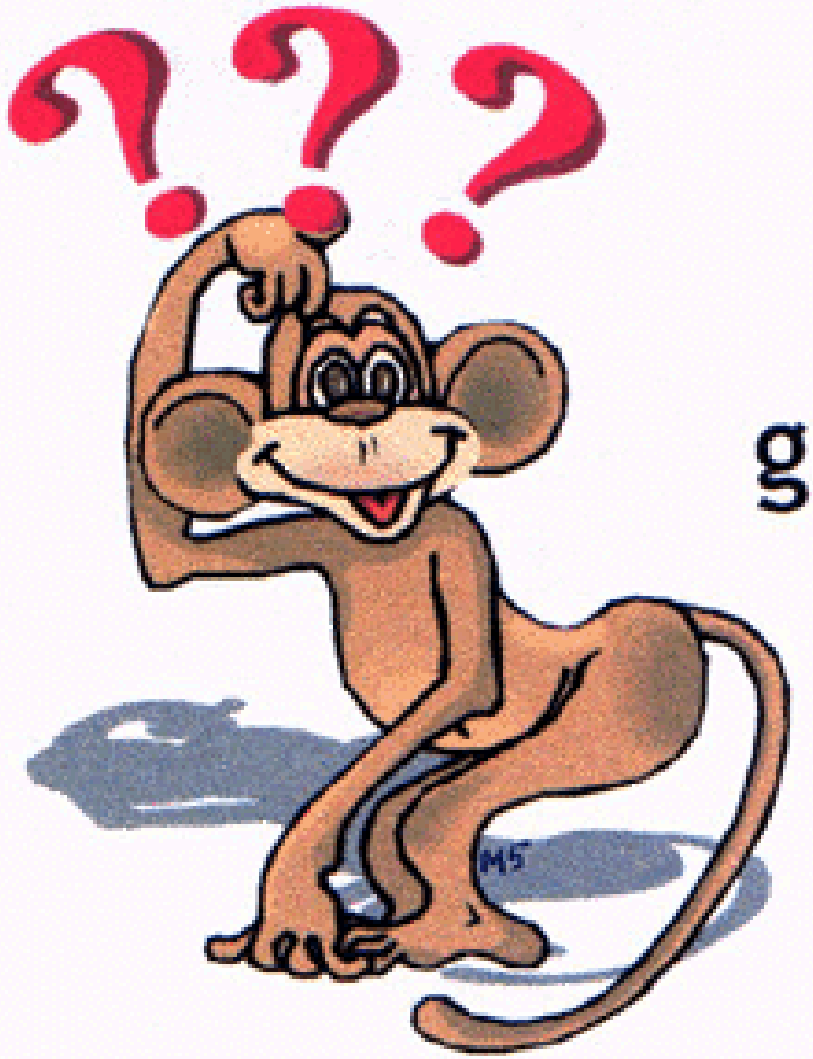

Questions
are
guaranteed in
life;
Answers
aren't.

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National Defense Industrial Association Disruptive Technology Conference

"Self-Powered Autonomous Next Generation Chem-Bio Sensors"

Richard L. Waters
Principle Investigator
4 September, 2007

H. Jazo, M. Fralick, M. Ceruti, R. Patel, S. Rubin

SSC San Diego … on Point and at the Center of C4ISR

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Problem Statement → Solution

Problem Statement:

Potential for Chemical / Biological warfare grows with each passing day as terrorist groups / rogue states gain access to, or develop the ability to fabricate life threatening agents.

DoD Need:

Develop small, inexpensive, highly accurate sensors to detect these life threatening agents. If possible, sensors should be small enough and cheap enough to distribute as needed at potential threat areas, e.g. ports, borders, reconnaissance missions, etc.

Solution:

Develop, prototype and demonstrate CB sensor with warning and reporting capabilities for fixed or handheld wireless nodes using self-powering energy scavenging techniques.

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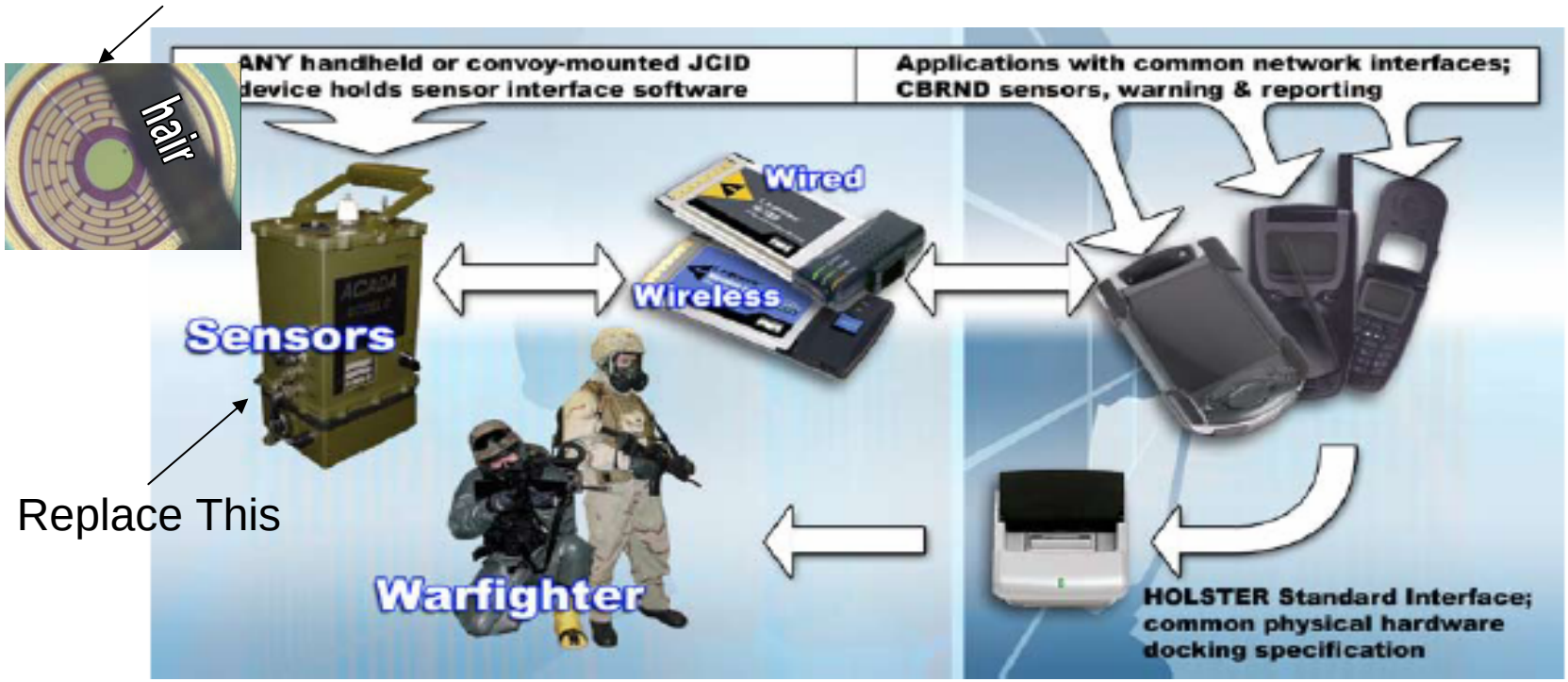
Big Picture

Energy Harvesting – SSC-SD prototyped and patented technology for creating usable energy from vibrational sources using electromagnetic transduction.



Replace This

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Existing CBRN Sensors

1. Too large
2. Too expensive (particularly for distributed arrays)
3. Consume too much power
4. Require user intervention by a trained technician (not applicable for autonomous operation)
5. Subject to false positives due to technology limitation + single point detection (i.e. lack of multiple sensor redundancy).
6. For positive identification samples must be sent to laboratory for GC/MS or optical spectral analysis.

Examples of Commercially Available, Portable Sensors

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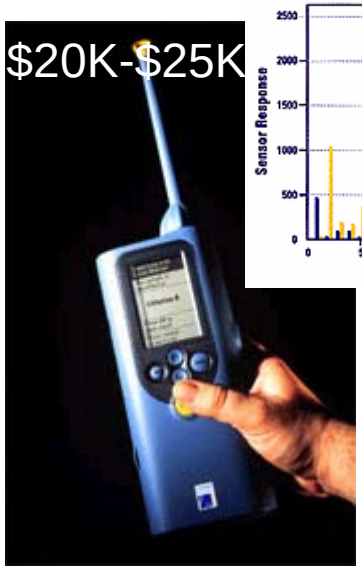
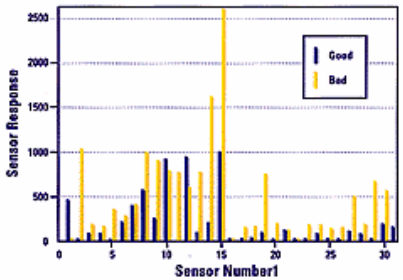
$20K-$25K

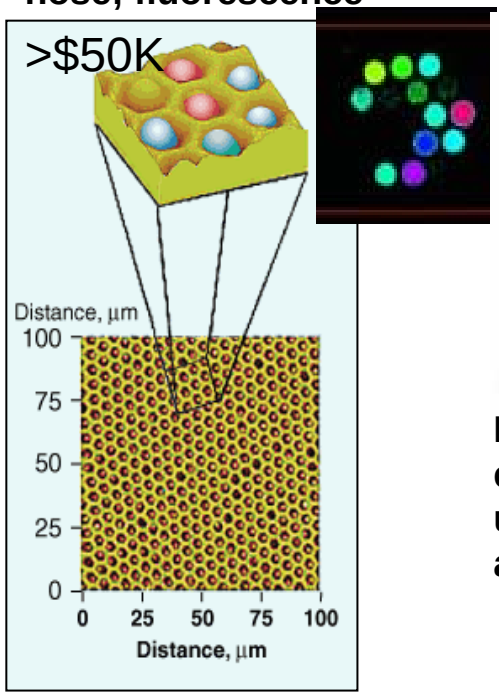




Cyranose 320: An electronic nose using chemiresistor sensors

Illumina: artificial nose; fluorescence

>$50K

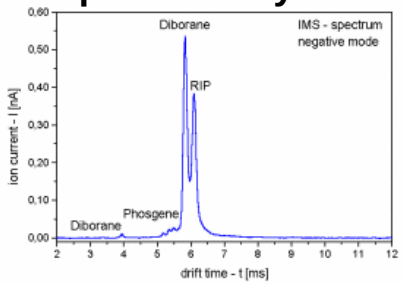


>$5K

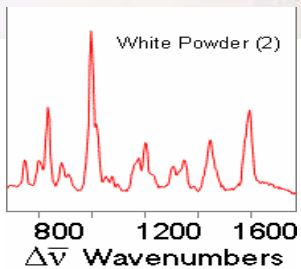
HAZMATCAD: electronic nose using SAWs and ECs

>$10K

CAM: ion mobility spectrometry



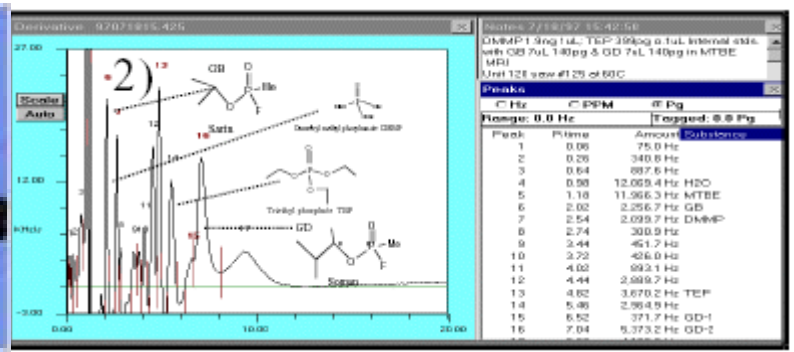
$16K



Inspector Raman

ZNOSE 4200: GC/SAW

$21K-$26K



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Sensor Technologies that have been Explored for Use in Disposable CB Sensors

- SAW devices
- CHEMFETs
- Microcantilevers
- Chemoresistors

These sensors use a coating to attract the analyte of interest. In order to detect and positively identify a target, that coating needs to exhibit great selectivity for the target analyte. These devices have no other way of differentiating the target analyte from an interferent.

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Approach

Reduce CB sensor size

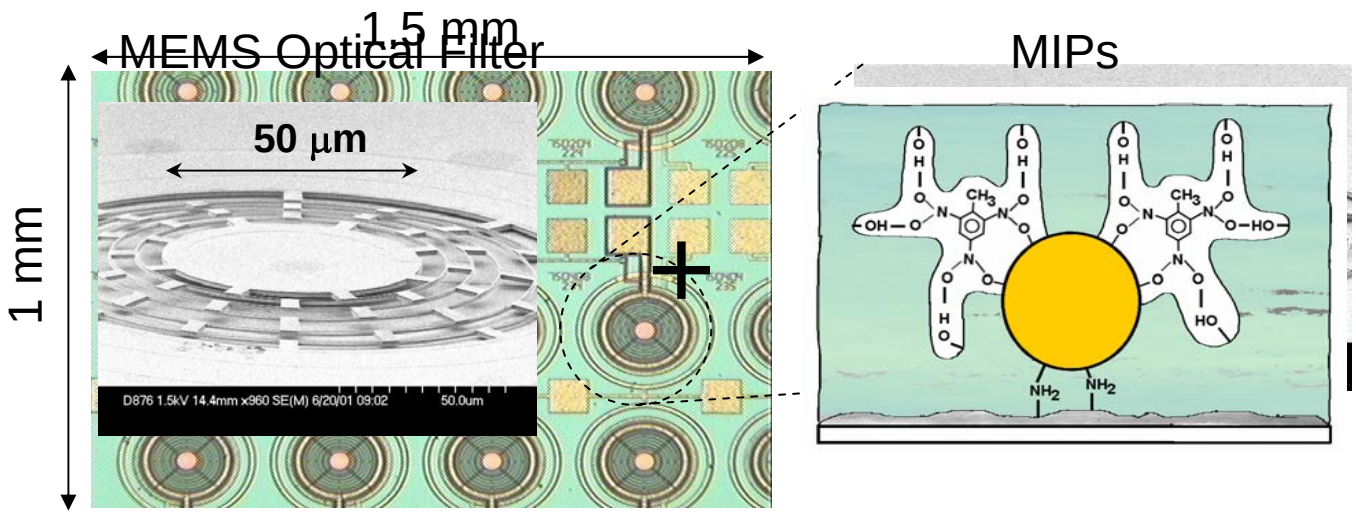
1. Develop micro tunable spectrometer arrays (Reduce an expensive state-of-the-art laboratory system to an inexpensive and small autonomous device which requires little to no user intervention.)

    a) Surface Enhanced Raman Spectroscopy (SERS) – Laboratory experiments have shown single molecule detection using SERS.

- Couple with SERS active Molecularly Imprinted Polymers (MIPS)

    b) Absorption Spectroscopy

    c) Fluorescence Spectroscopy



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Approach

Utilize Energy Scavenging Techniques for self-powering remote nodes

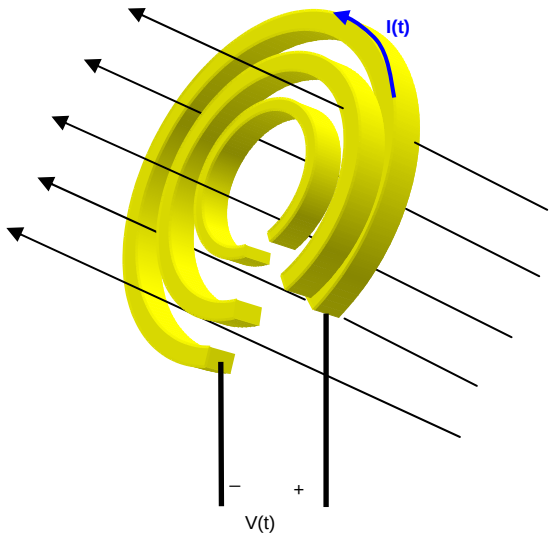
1. Develop vibrational energy harvesting device based on electro-magnetics.
2. Couple energy harvesting device to existing wireless sensor nodes.
3. Integrate other energy harvesting technologies to platform .

$$\oint_\ell E \cdot d\ell = -\frac{d}{dt}\int_S B \cdot ds = -\frac{d\psi_m}{dt}$$

$$\vec{B} = B + B_0 \cos(\omega t)$$

$$\frac{d}{dt}\int_S B \cdot ds = \frac{d}{dt} A(B + B_0 \cos(\omega t))$$

$$V = N(2\pi f B_0 A) = N(2\pi^2 r^2 f B_0)$$



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Advantages of Concept

- **Three optical techniques in one device:**
  - **SERS Analysis**
  - Fluorescence Detection
  - Change in Absorption
- **Sensitive** (single molecule detection has been reported for SERS)
- **Specific** (Binding + optical detection greatly reduces false positives)
- **Easily expandable / adjustable to meet emerging threat conditions**
- **Capable of detecting CW, BW & TICs** (multiple agents can be detected in a parallel fashion)
- **Can either be used to detect a single agent or arrayed for simultaneous detection of multiple agents**
- **Low-power** (Each sensor < 10 mW)
- **Compact** (<1 in^3 – includes light source, sensor, comms, and battery).
- **Low-cost** (sensor fabrication utilizes batch fabrication of existing IC infrastructure). $50-$100.
- **Anticipate small temperature / humidity sensitivity**

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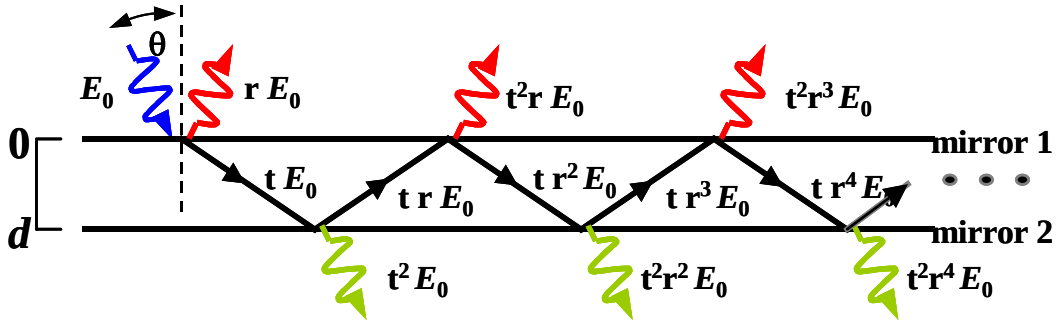
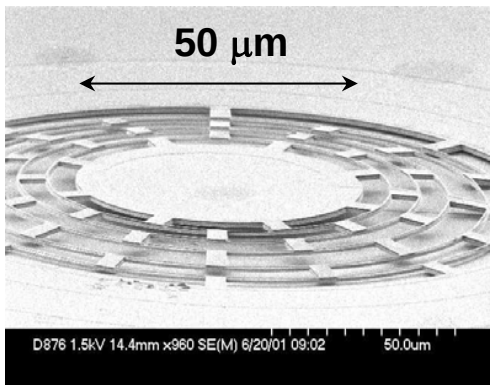
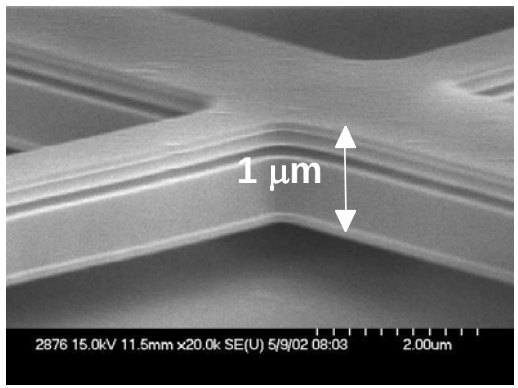
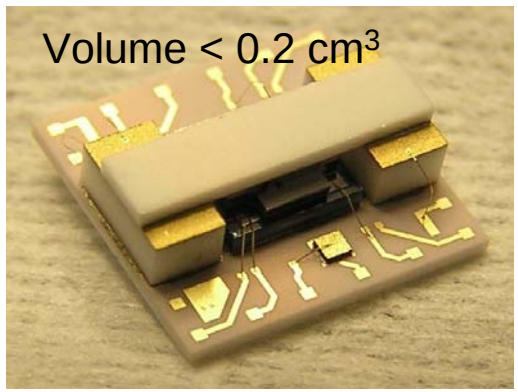
Fabry-Perot Etalon / Interferometer



Fabry-Perot Interferometer is comprised of two optically flat parallel mirrors where one of the two mirrors is allowed to move thereby adjusting the spacing between the mirrors. If the spacing is a integral multiple of half wavelengths, a resonance occurs with a corresponding peak in transmission.







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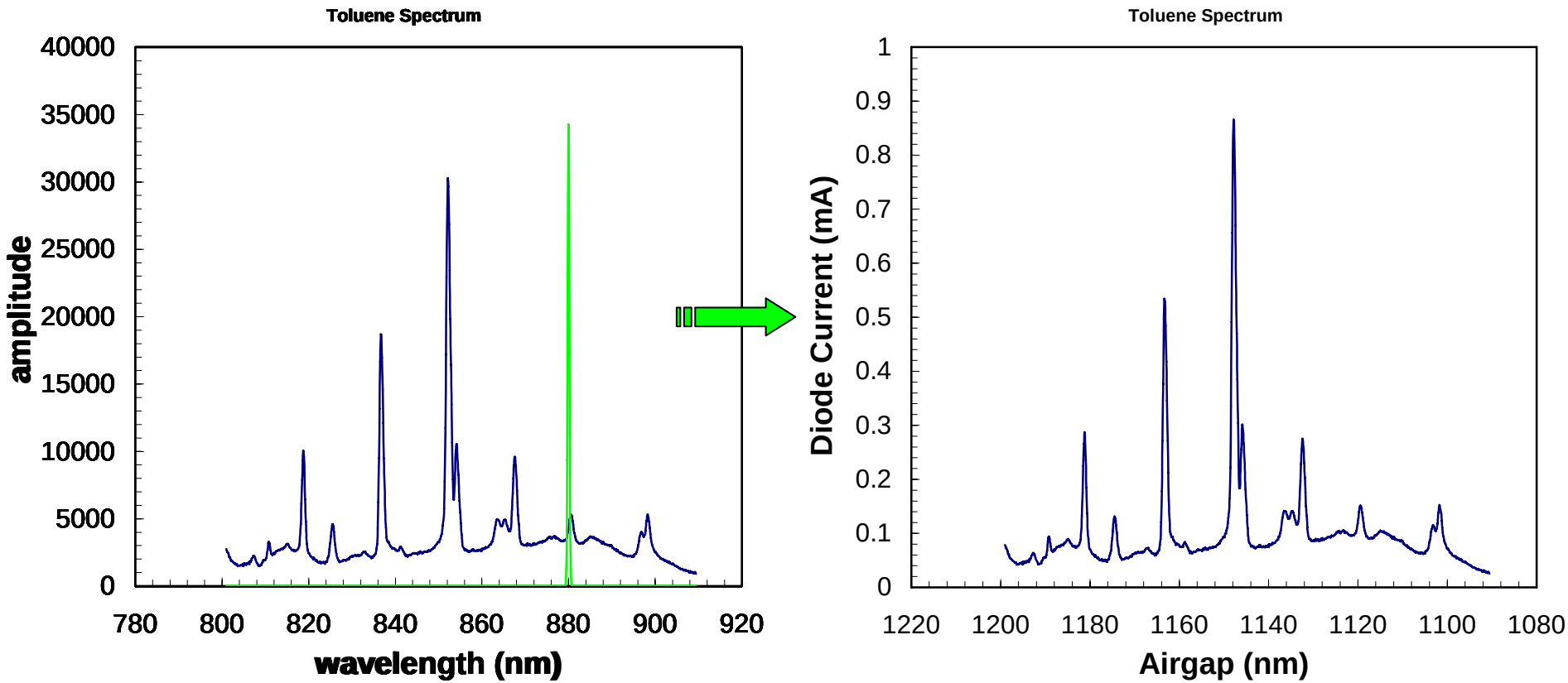
Spectrometer: Ideal Operation



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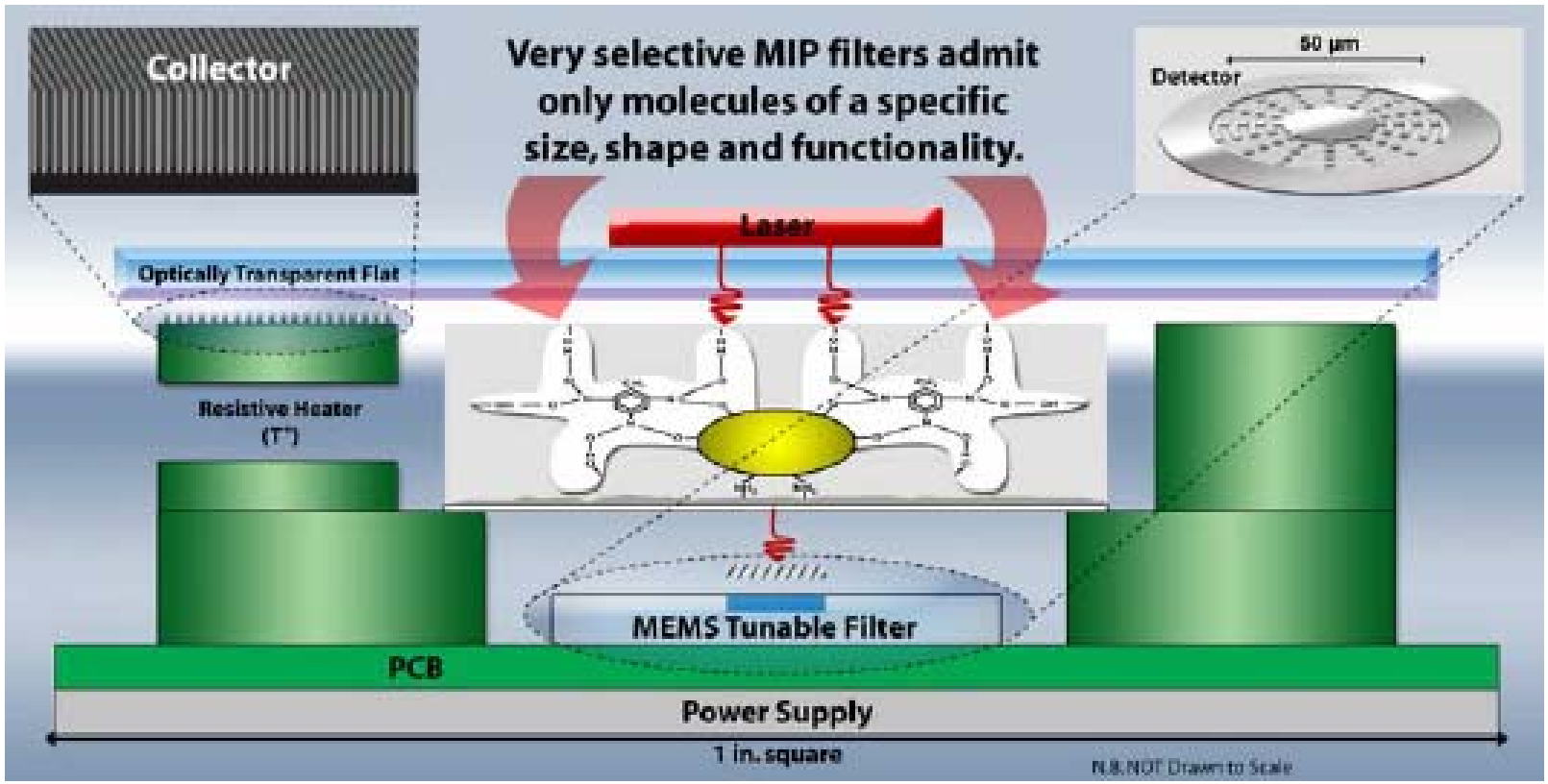
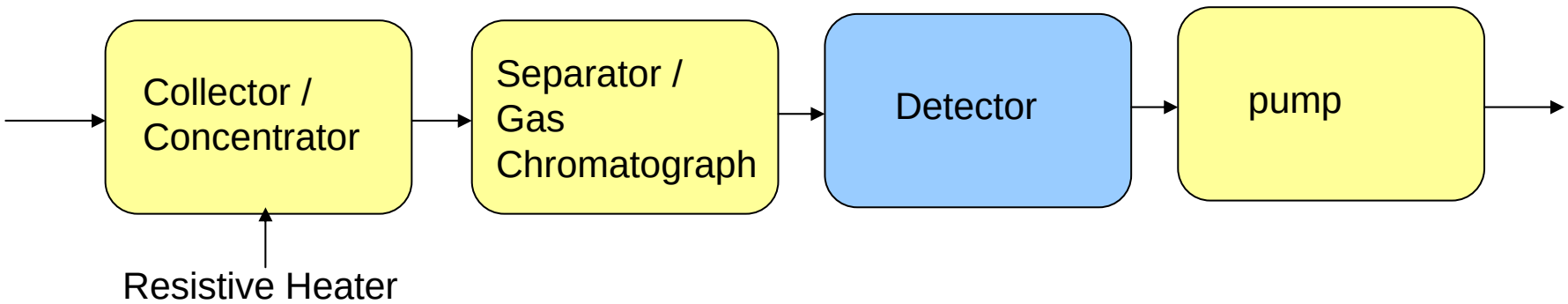
System Description





ENERGY HARVESTING

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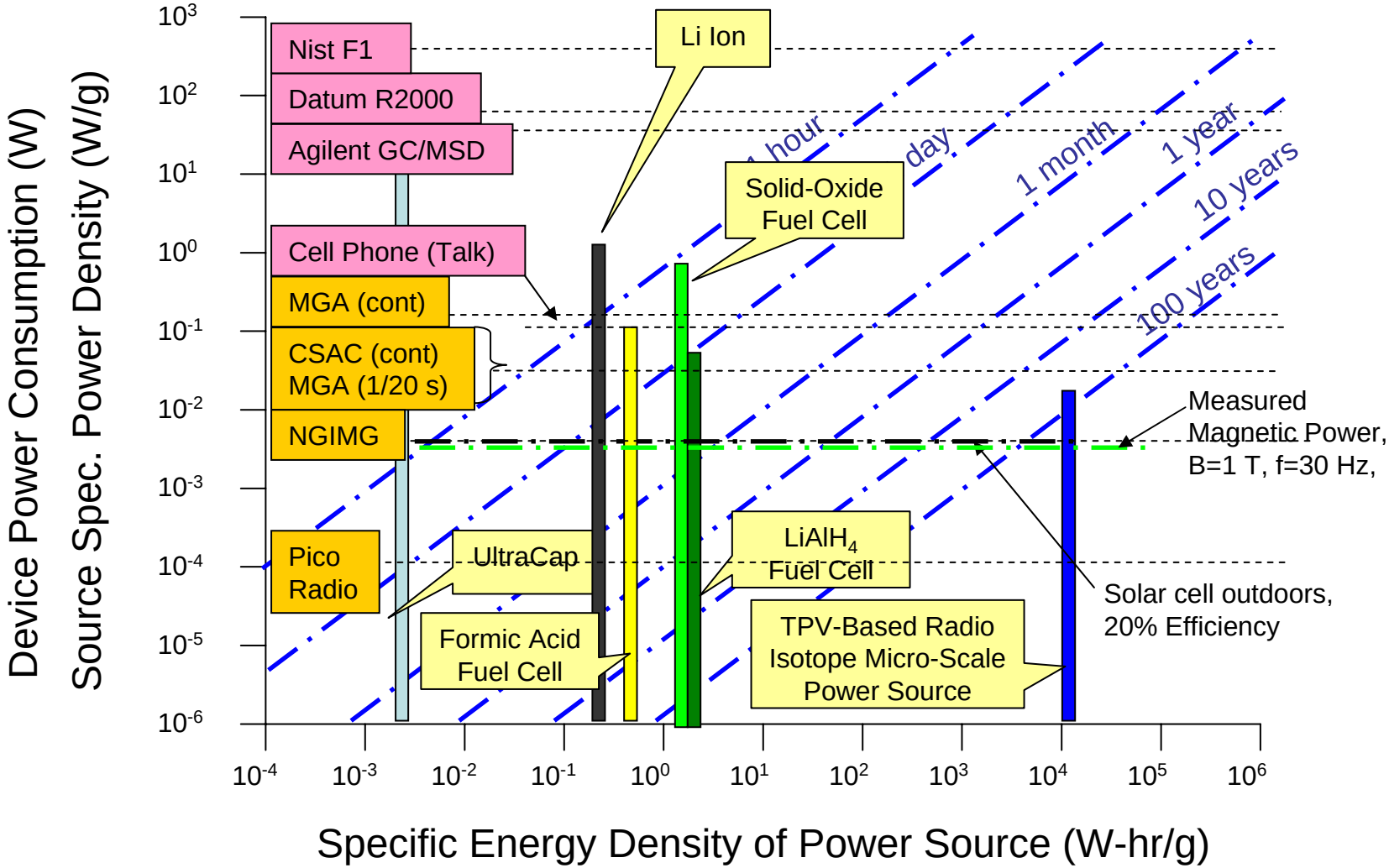
Power Consumption vs. Longevity



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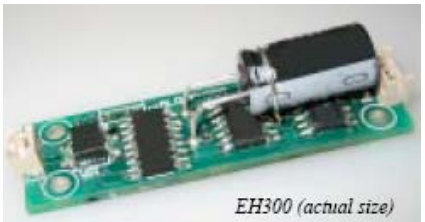
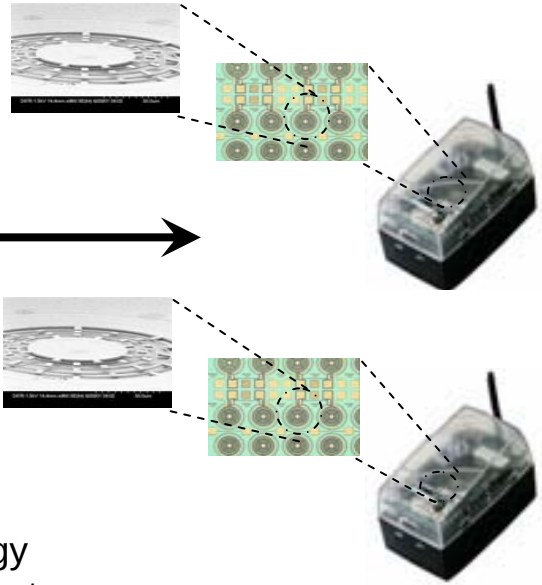
Energy Harvesting Demonstration Vehicle

Energy Harvesting Module

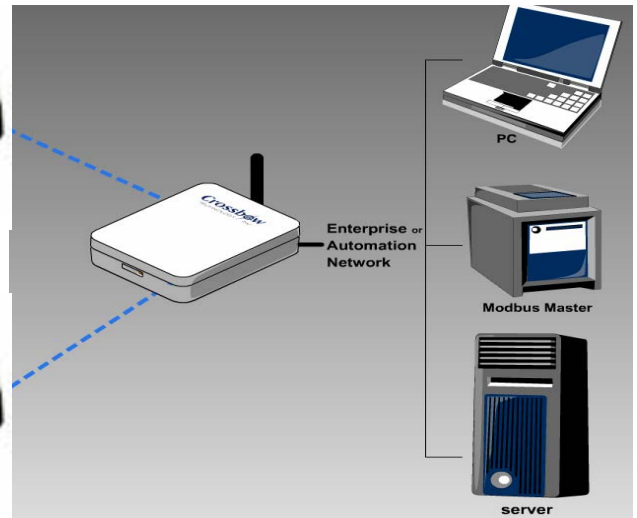


Energy Harvester

VIBRATIONS



Crossbow environmental wireless sensor network



	Process	Current Draw @ 3V	Units
Mica2™	Transmit	27†	ma
	Receive	10††	mA
	(Sleep Mode)	<1	µA
	Processing	8	mA
	(Sleep Mode)	<15	µA
MTS400 Sensor Module	Temperature & Humidity	0.1	mA
	Light Intensity	10	mA
	Barometer	1	mA
	2-axis Accelerometer	<0.6	mA

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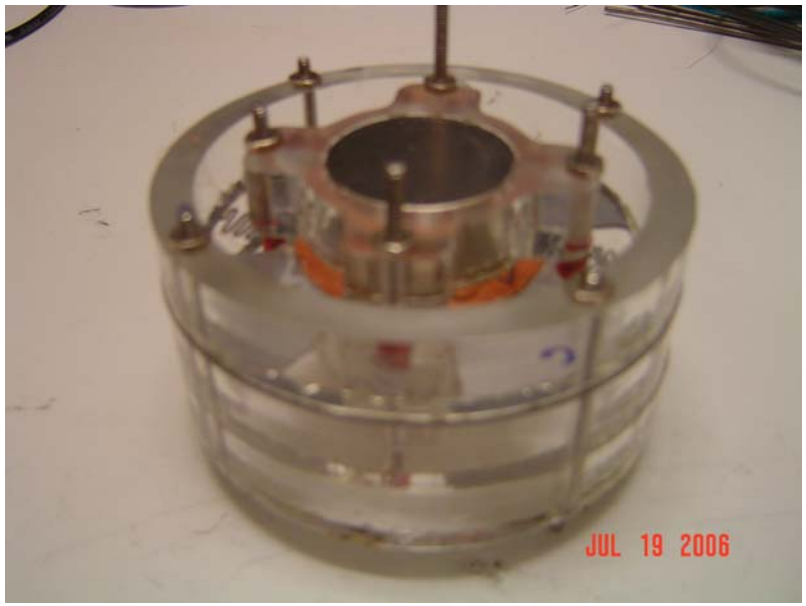
Energy Harvesting Prototypes

1st Generation: 3.85 mW/cc/g

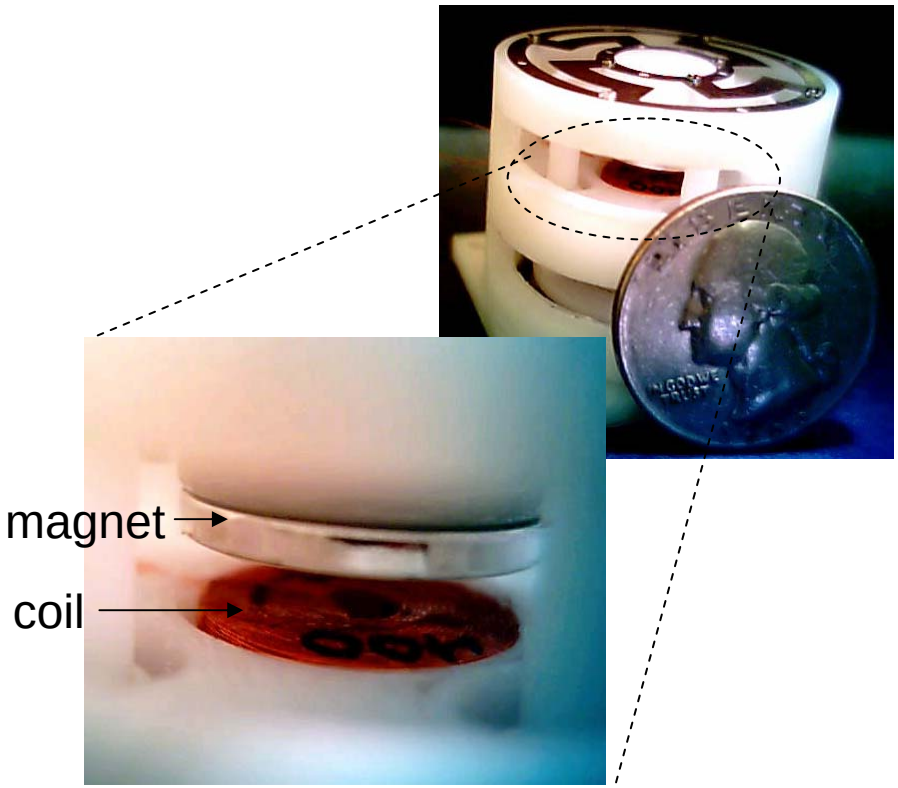


Hockey puck size

Resonant Frequency ~30Hz

Maximum acceleration ~120 mg

2nd Generation: 9.9 mW/cc/g



Volume ~19 cm^3

Resonant Frequency ~90Hz

Maximum acceleration ~1 g

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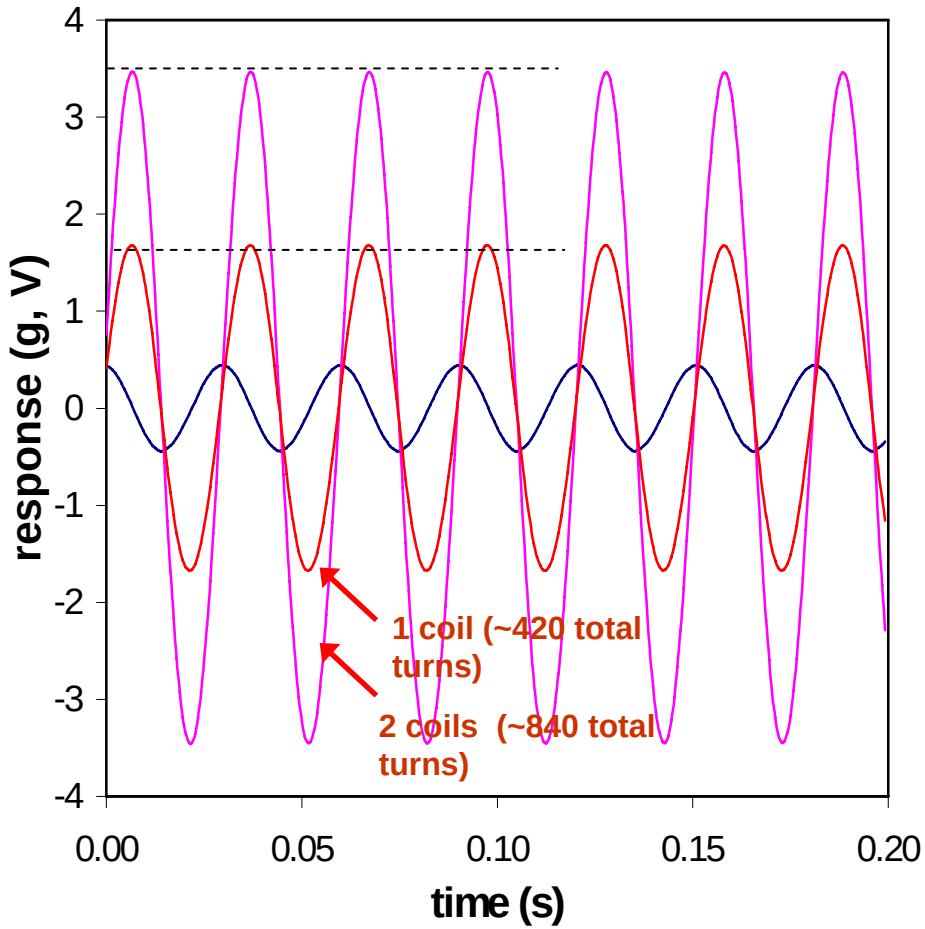
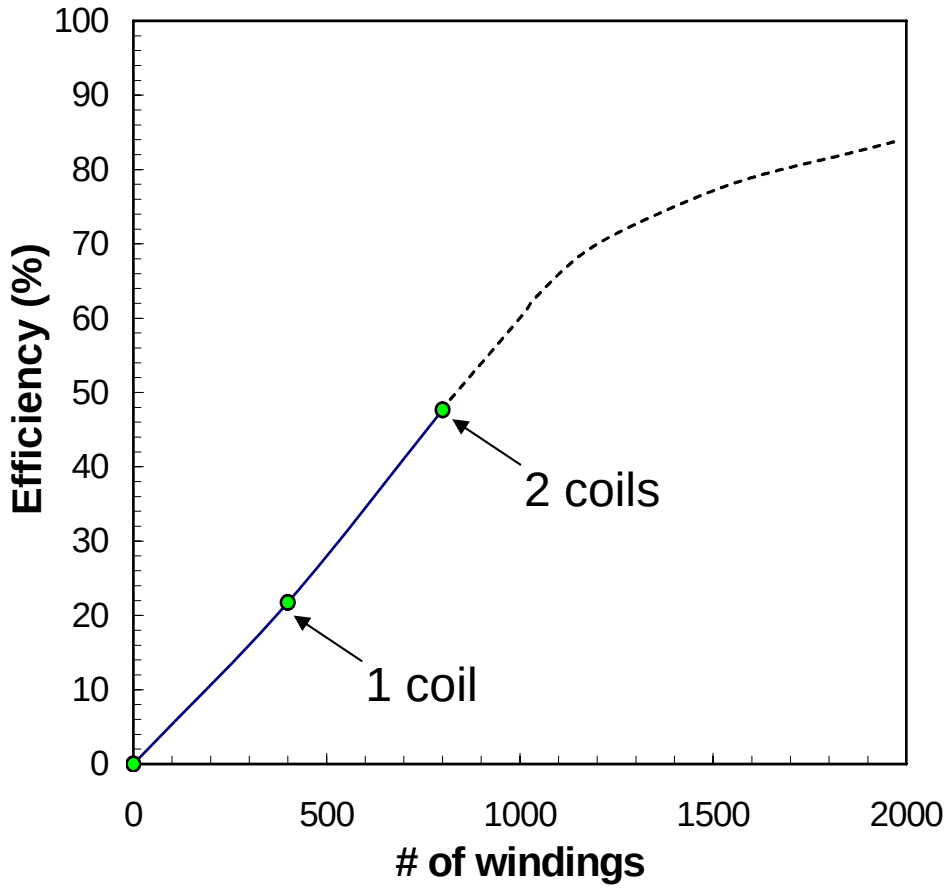
FY07 Experimental Results @35 Hz

Voltage doubles when # windings doubles

- We have not saturated
- We can still extract more energy with better coil design / smaller wire diameter.

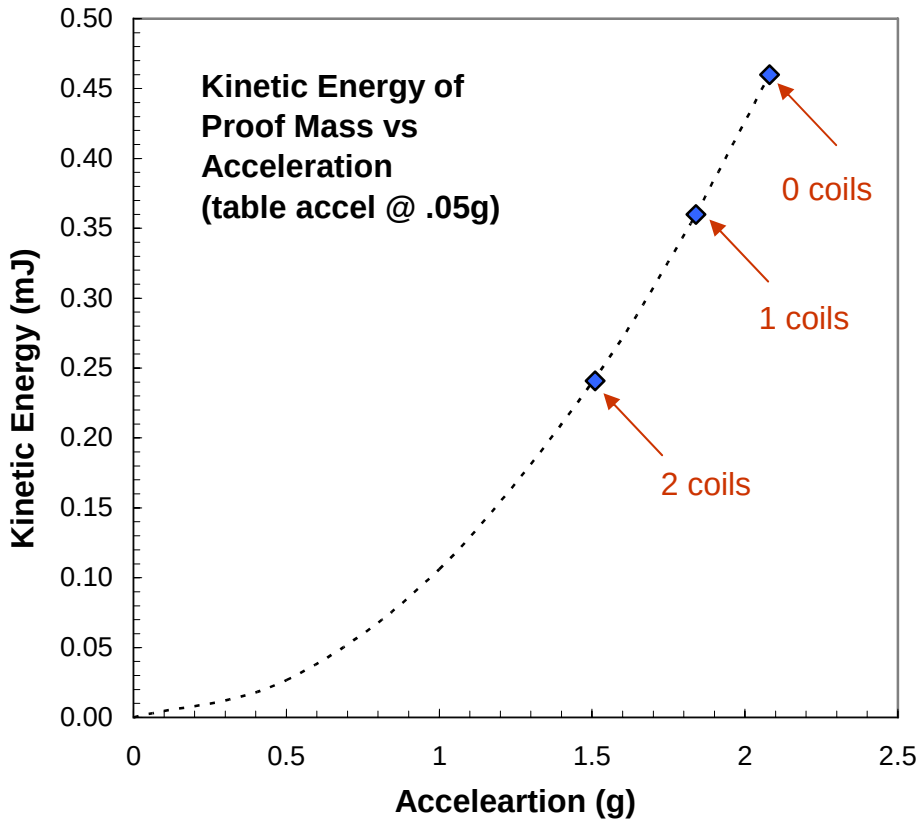




FY07 Experimental Results

As coils / windings increase, electrical dampening increases and kinetic energy of the vibrating mass decreases.

Therefore, there is an optimum # of coils / windings to maximize energy extraction



- Kinetic energy of proof mass dampened by opposing B field
- Can calculate efficiency
  - $\frac{KE(\text{no coils}) - KE(1\text{coil})}{KE(\text{no coils})} \times 100$

  KE eff ~ 22% per coil

Rectified Power efficiency

- $\frac{P(1\text{ coil})}{KE(\text{no coils})*f} \times 100$

Power eff ~ 21.5%

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Vibration Data (Results Summary)

Test Condition	Avg Output Power (μW)
Car Off	0.43
Car Idling	19.2
Freeway	639 – 1352
Paved Surface Road	331-511
Dirt Road	290 – 662
Walking	18 – 47
Vibration Table @ 30Hz, 0.035g (peak power)	13500

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Summary

- SSC-SD is developing
  - Micro arrayable spectrometers to replace large, expensive, user intensive laboratory grade analysis equipment.
    - Sensors will be low-cost, expandable to meet emerging threat conditions, accurate, and consume less than 10 mW.
    - Will utilize JWARN, JCID and HOLSTER in its final implementation
  - Energy Harvesting Modules based on vibrational energy with power densities of >9mW/cm^3/g.
    - As demonstration vehicle we will power Crossbow wireless sensor nodes.

Backup

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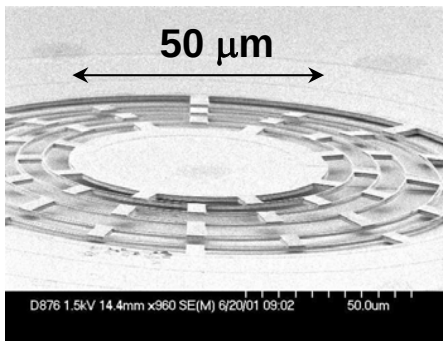
Our Concept

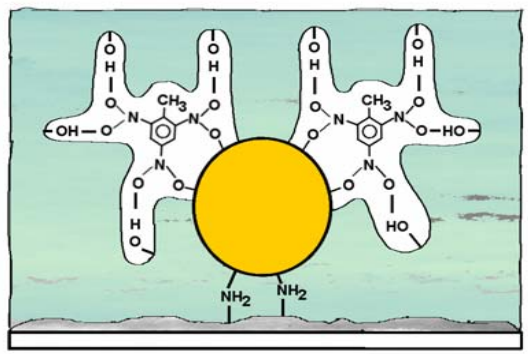
Combine demonstrated MEMS tunable optical filters with Molecularly Imprinted Polymers (MIPs) for Surface Enhanced Raman Spectroscopy (SERS).

MEMS Optical Filter



+

MIPs



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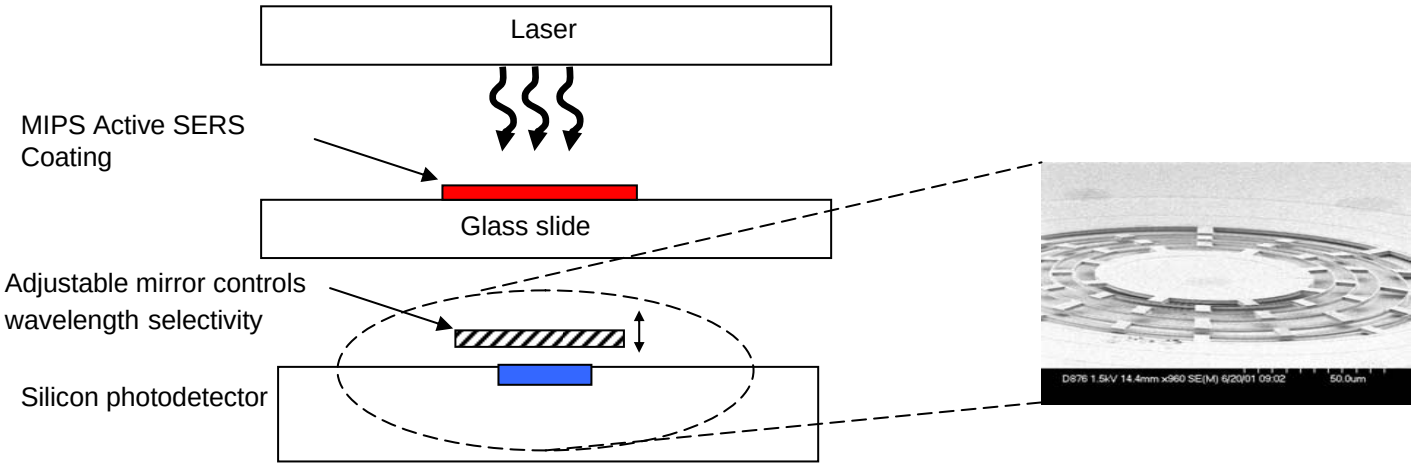
Operational Concept (How it Works)

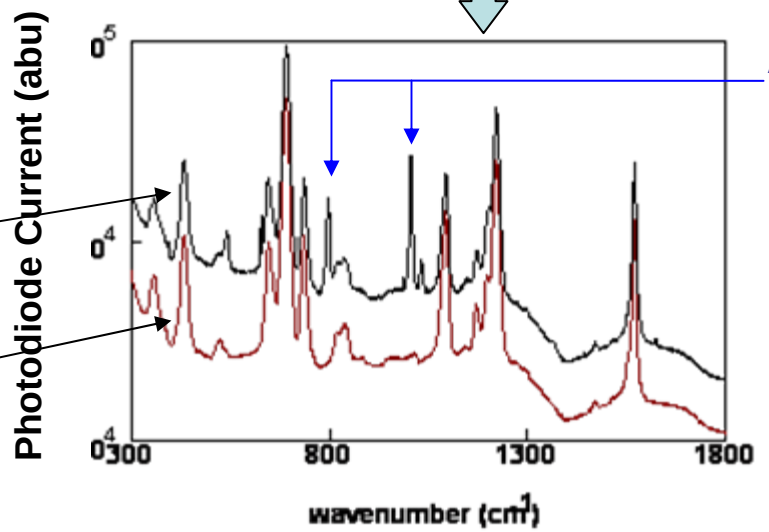
Depiction of proposed assembly for testing. Assembly includes FPI sensor, glass slide with coating and halogen or broad spectrum LED light source.



Expected Output of Photodiode:

Top spectrum *is coating reacting with Toluene (TIC)*

Bottom spectrum *is unreacted Coating*



Additional peaks positively identify presence of Toluene (TIC)

Binding + optical detection greatly reduces false positives

Proportional to Distance between mirrors

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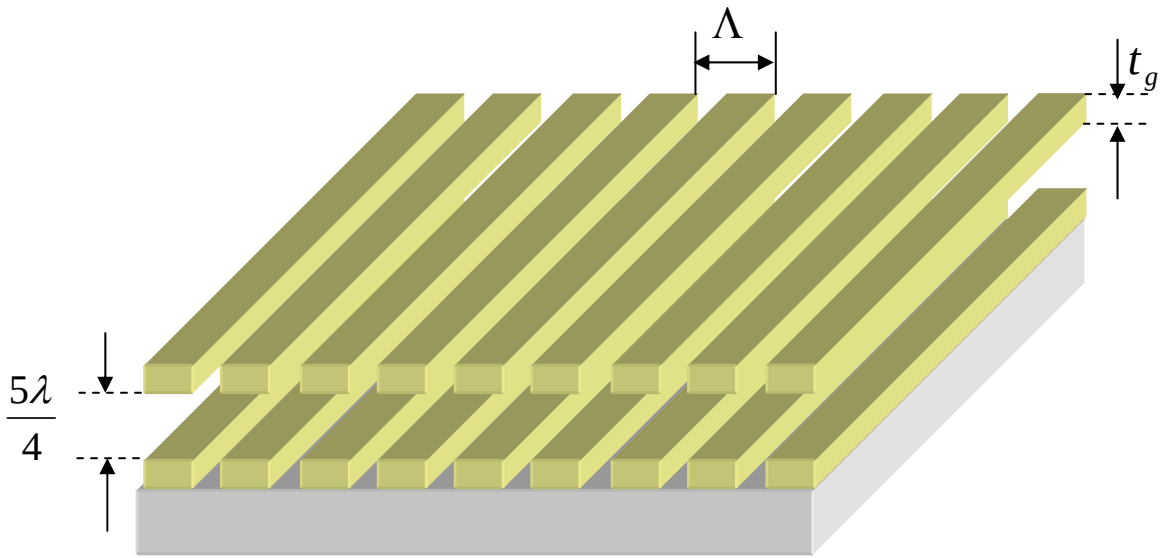
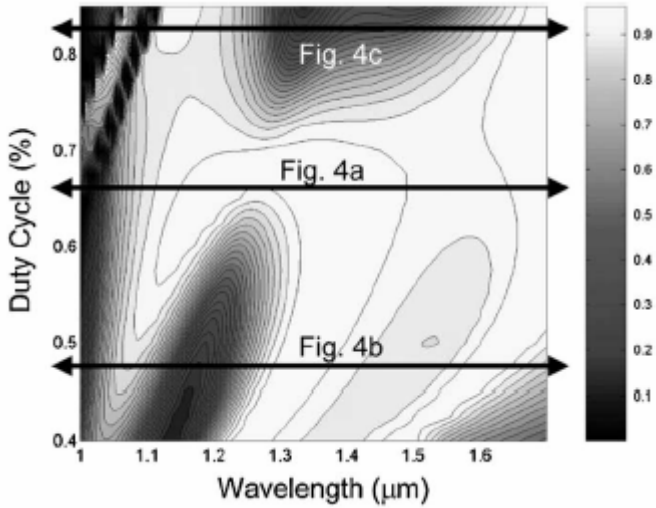
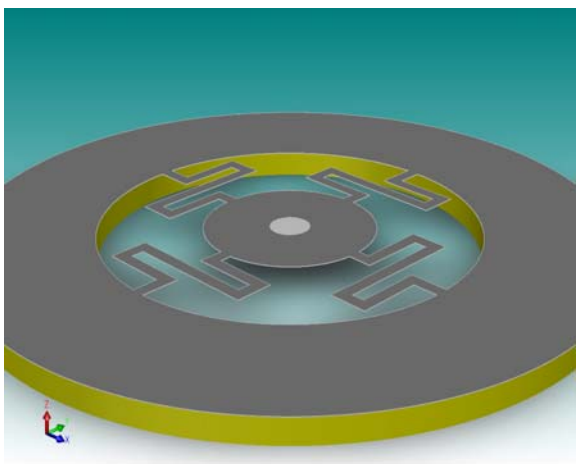
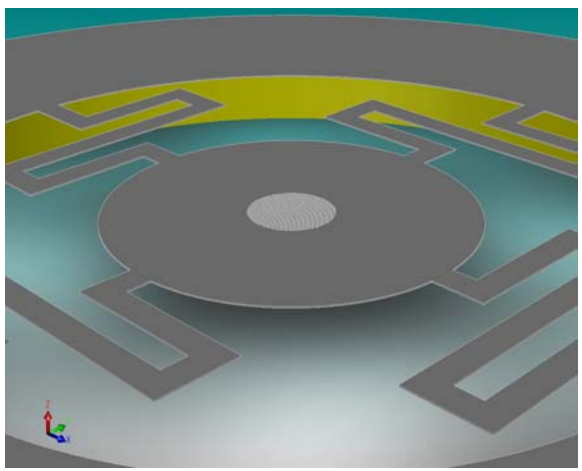
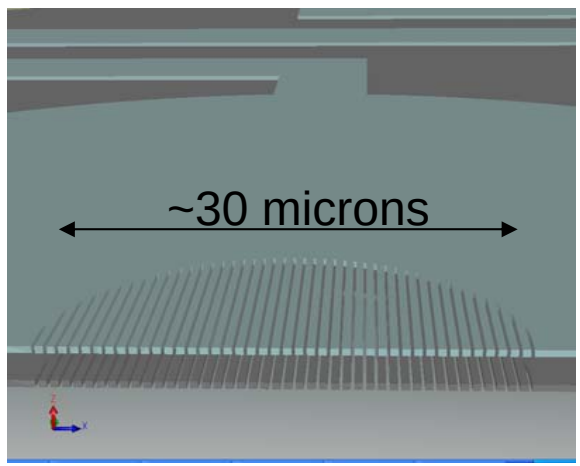
High-Contrast sub-wavelength Grating (HCG) Mirror











SPAWAR Systems Center San Diego

Background: Common Vibration Sources

VIBRATION SOURCE	PEAK ACCELERATION (m/s^2)	FREQUENCY (Hz)
BASE OF 3-AXIS MACHINE TOOL	10	70
KITCHEN BLENDER CASING	6.4	121
CLOTHES DRYER	3.5	121
DOOR FRAME JUST AS DOOR CLOSES	3	125
SMALL MICROWAVE OVEN	2.25	121
HVAC VENTS IN OFFICE BUILDING	0.2 – 1.5	60
WOODEN DECK WITH FOOT TRAFFIC	1.3	385
BREADMAKER	1.03	121
EXTERNAL WINDOWS (2 FT. X 3 FT) NEXT TO A BUSY STREET	0.7	100
NOTEBOOK COMPUTER WHILE CD IS BEING READ	0.6	75
WASHING MACHINE	0.5	109
SECOND STORY FLOOR OF A WOOD FRAME OFFICE BUILDING	0.2	100
REFRIGERATOR	0.1	240

NDIA Disruptive Technologies Conference

WASHINGTON, DC
04 Sep 2007

Joseph W. Dyer
President,
Tom White
Director, Programs
Government & Industrial Division

jdyer@irobot.com

Forward Looking Statements

- Certain statements made in this presentation that are not based on historical information are forward-looking statements which are made pursuant to the safe harbor provisions of the Private Securities Litigation Reform Act of 1995.

- These statements are neither promises nor guarantees, but are subject to a variety of risks and uncertainties, many of which are beyond our control, which could cause actual results to differ materially from those contemplated in these forward-looking statements.

- Existing and prospective investors are cautioned not to place undue reliance on these forward-looking statements, which speak only as of the date hereof. iRobot Corporation undertakes no obligation to update or revise the information contained in this presentation, whether as a result of new information, future events or circumstances or otherwise.

- For additional disclosure regarding these and other risks faced by iRobot Corporation, see the disclosure contained in our public filings with the Securities and Exchange Commission.

Disruptive Technologies Timeline

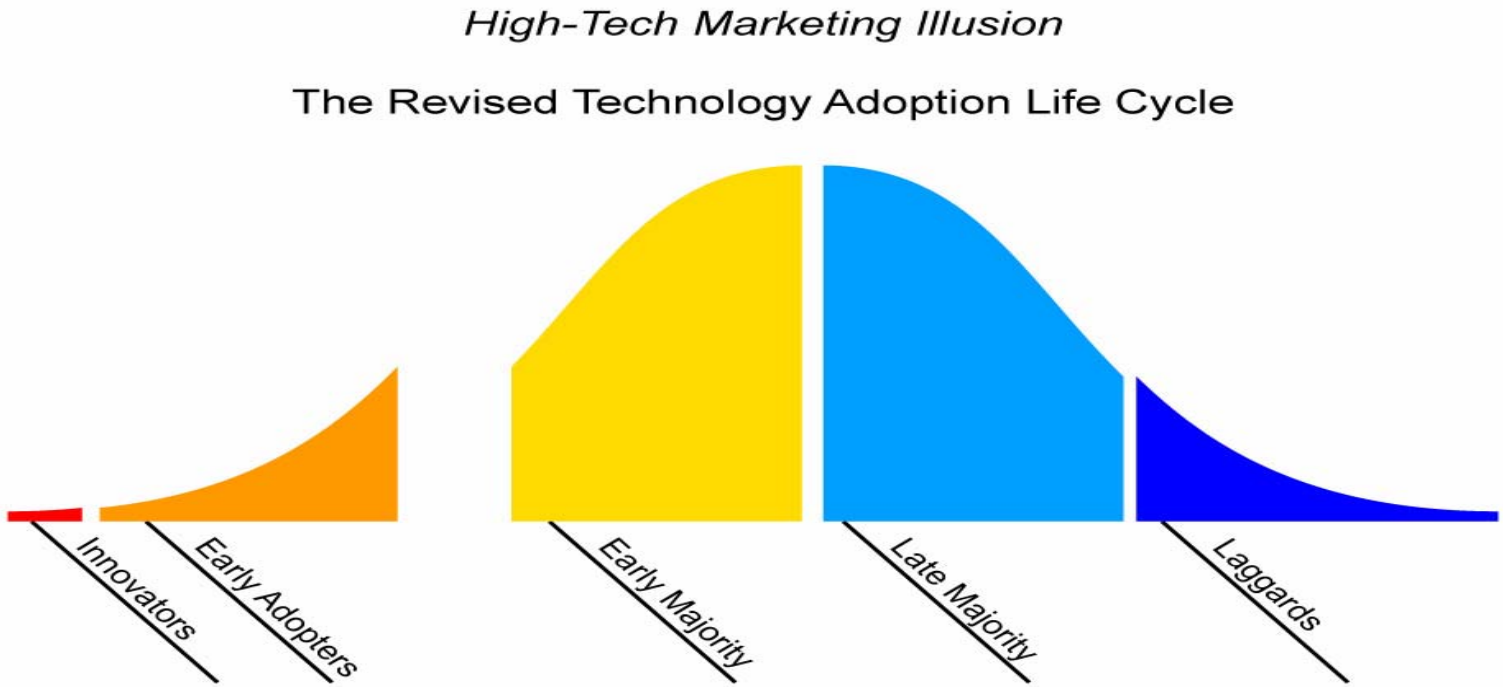
Massive disturbances occur with the introduction of disruptive technology. Life before and after a disruptive technology is fundamentally different.

Disruptive Technologies Timeline

Fire

60000BC

CROSSING THE CHASM



"Crossing the Chasm" by G. Moore, Harper Business Essentials

PackBot #129

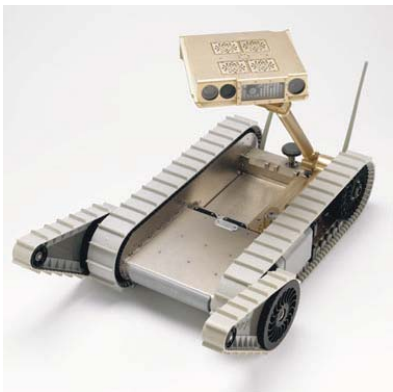
Killed In Action
Iraq

What We Do

PackBot w/ Recon kit, Afghanistan, 2003

PackBot w/EOD kit, Iraq, 2006

PackBot w/Recon kit



PackBot w/Advanced Recon kit

PackBot w/EOD kit

iRobot SUGV for FCS Exp. 1.1, WSMR 2007

iRobot Warrior X700

Roomba®
VACUUMING ROBOT

- **Introduced in 2002**
- **2 million units sold**
- **1% market penetration**

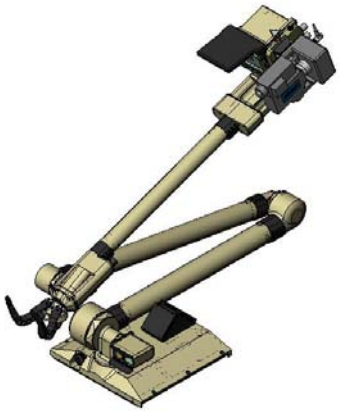
Air Assault Expeditionary Force (AAEF) Experiment, Ft. Benning, GA 09 Dec 2005

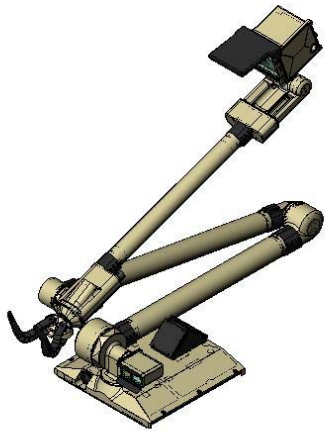
- **Scene: 09 Dec 2005 -- The experimental force commander and five of his team (from team leader to trooper) at Q&A session chaired by Gen William S. Wallace (new TRADOC 4 star)**
  - **First question: "Captain, of all the new technologies and capabilities you've used during this AAEF experiment, which one single piece would you deploy today?"**
  - **Answer: "Sir, the Packbot (Explorer.)"**

PackBot: Digital Modular Architecture

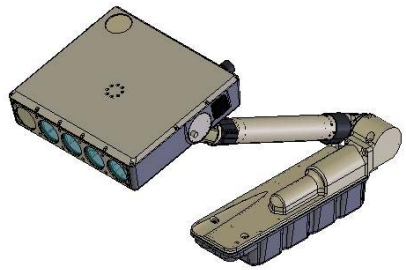
EOD: Explosive Ordnance Disposal

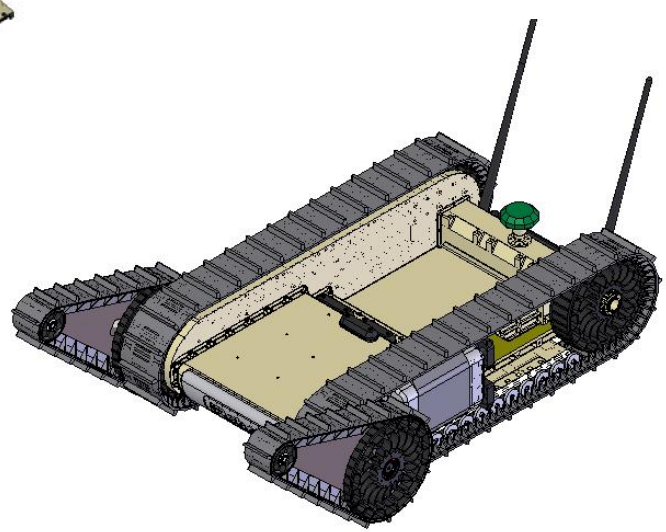
FIDO: Explosives sniffer



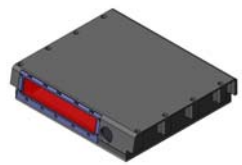


Explorer: Recon & Surveillance





Scout: Recon & Surveillance



PackBot: Modular Chassis

Digital Architecture & Systems Integration

Nomadics FIDO + iRobot PackBot

iRobot

SAFETY FROM STANDOFF: PackBot carries the sensor to the vehicles, so Soldiers aren't exposed.

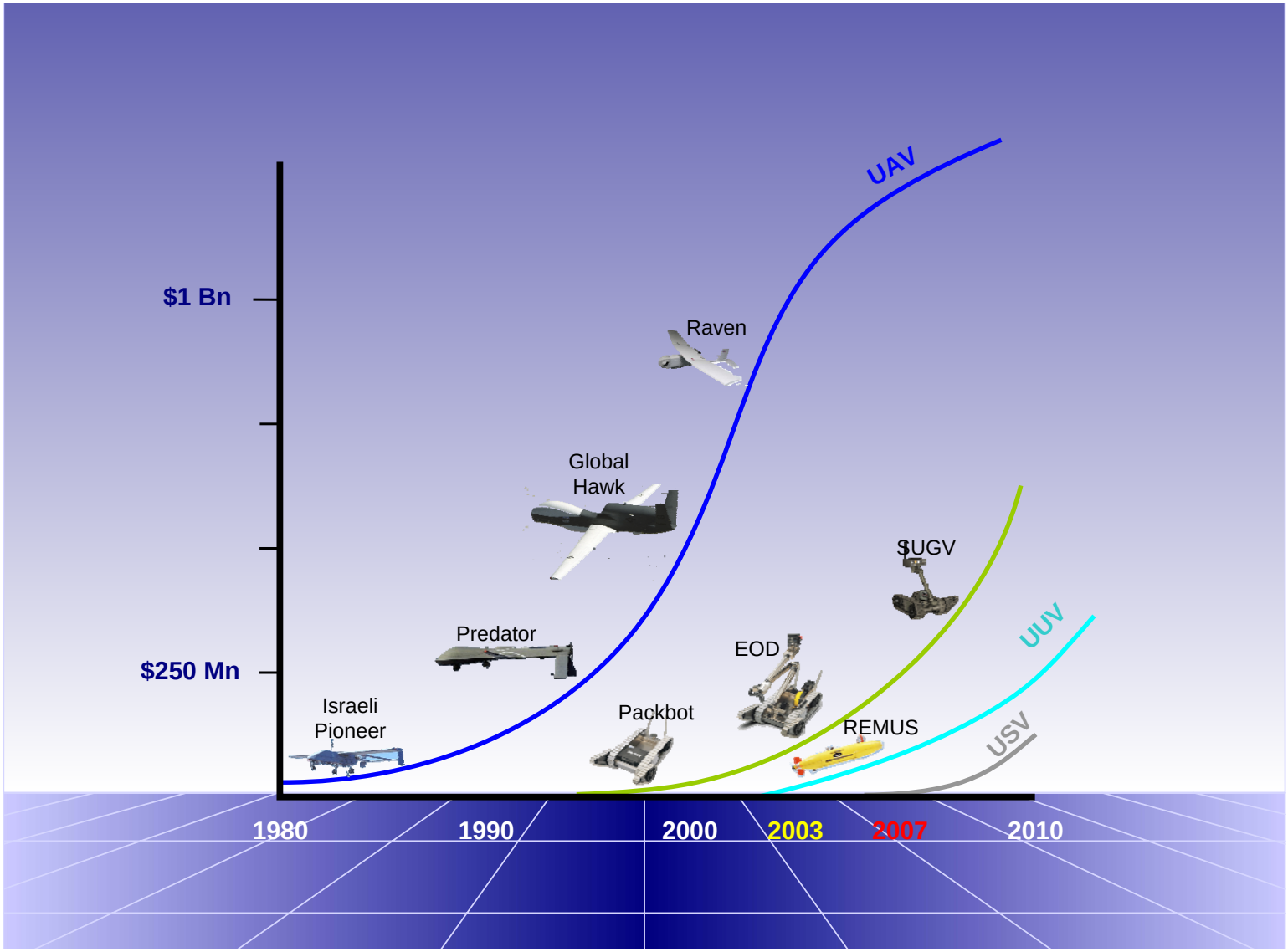
Fido™

Explosives Detector

THE DETECTION OPPORTUNITY: Explosives leave invisible traces of vapors which FIDO can sniff and detect.

"FIDO was able to detect explosives 80 feet away. This allowed separation of the Soldiers and dog from the bomb, thus saving lives. . . ."

Market Maturation of Unmanned Military Vehicles



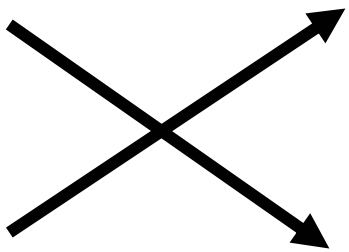
Computers 1978 = Robots 2001

- Locked away from public
  - too dangerous for computers
- Used inside large companies
- Operational use in military
- First few “home” computers
  - in the form of games
- Computer hacking clubs
- How-to-build-your-own books
- Undergraduate majors appearing
- First mass market “serious” home computer attempts

- Locked away from public
  - too dangerous for people
- Used in manufacturing plants
- Operational use in military
- First few “home” robots
  - in the form of toys
- Robot hacking clubs
- How-to-build-your-own books
- Undergraduate majors appearing
- First mass market “serious” home robot attempts

Military Engagement – The World is a More Dangerous Place

- High tempo military operations and a dramatically lower tolerance for causalities and POW's.
- U.S. volunteer force resources are being stretched



Need for Operations

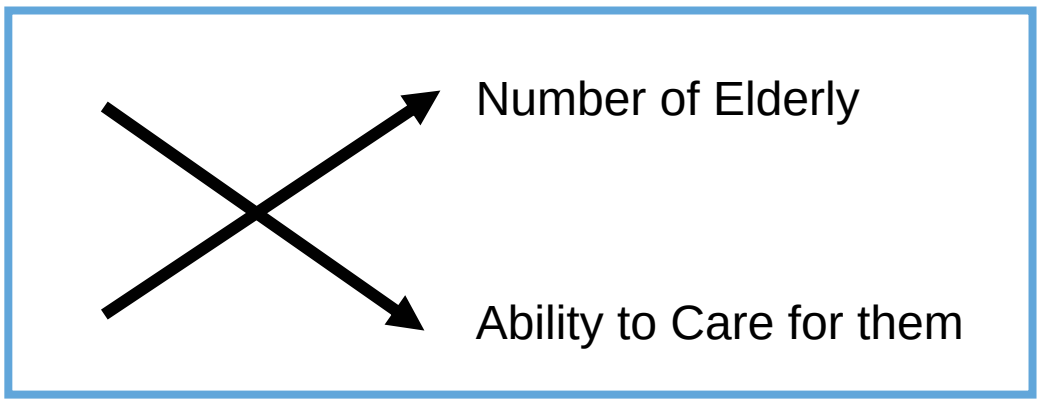
Ability to support them

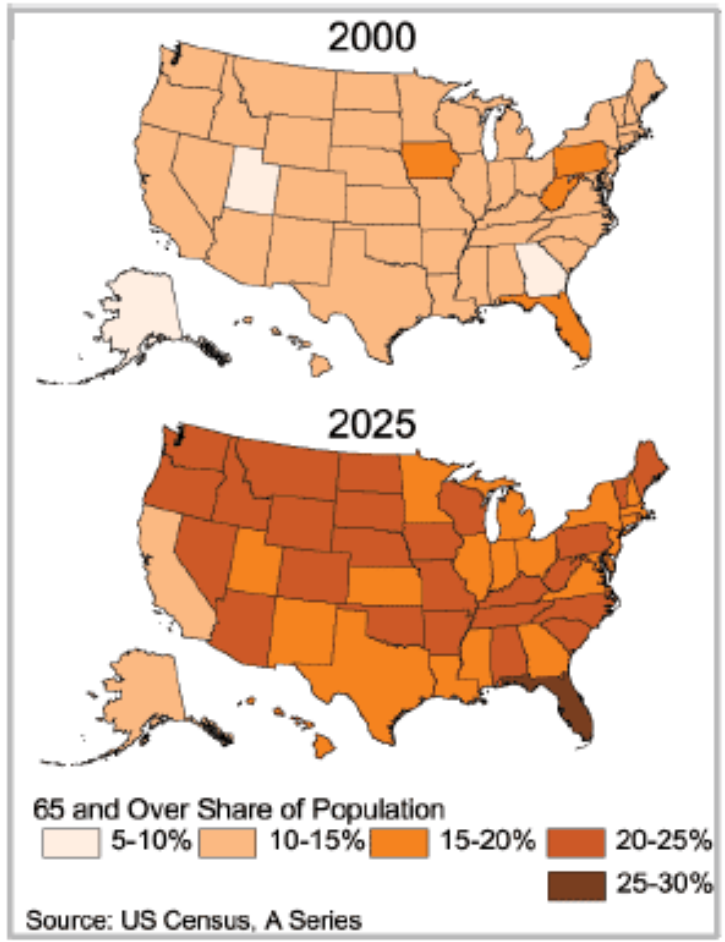
We have over 350,000 SOLDIERS overseas in 120 countries

- **The US cannot afford to spend our way out of this problem using current technology and doctrine**

Long Term Driver

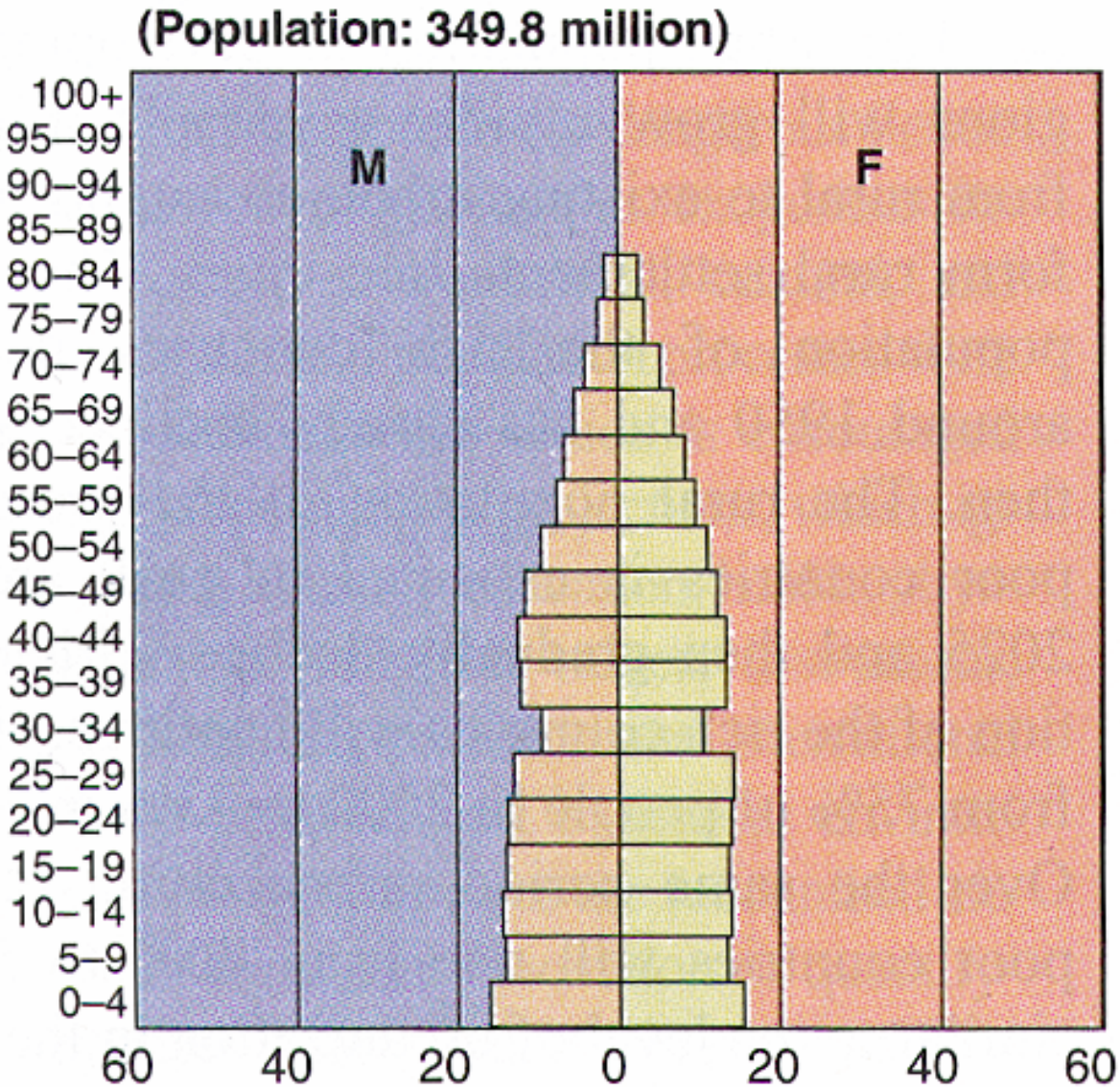
- Our current ability to care for the elderly is barely adequate and in decline
- A massive increase in the number of elderly people is imminent



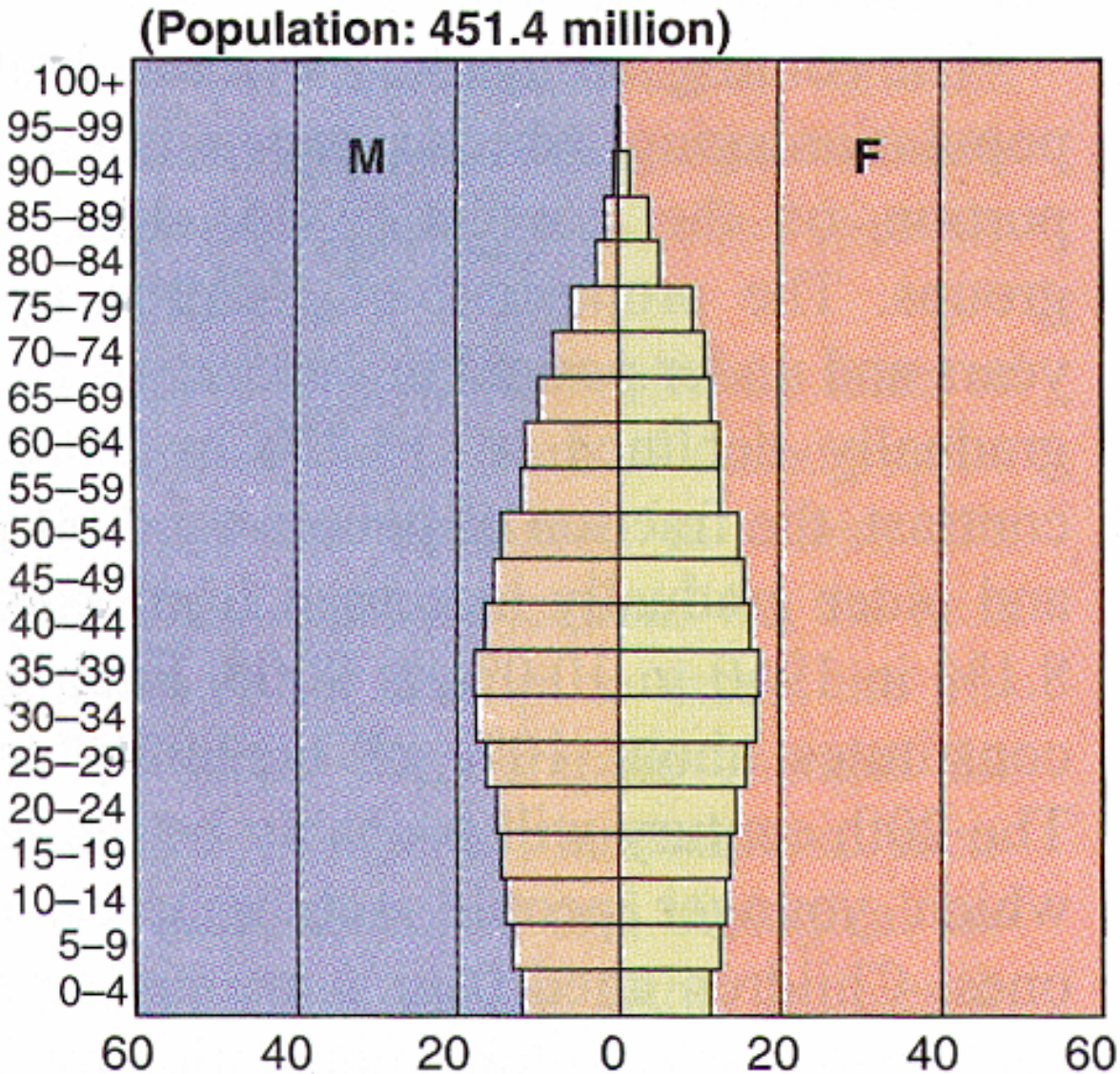


- **We cannot simply spend our way to a solution.**

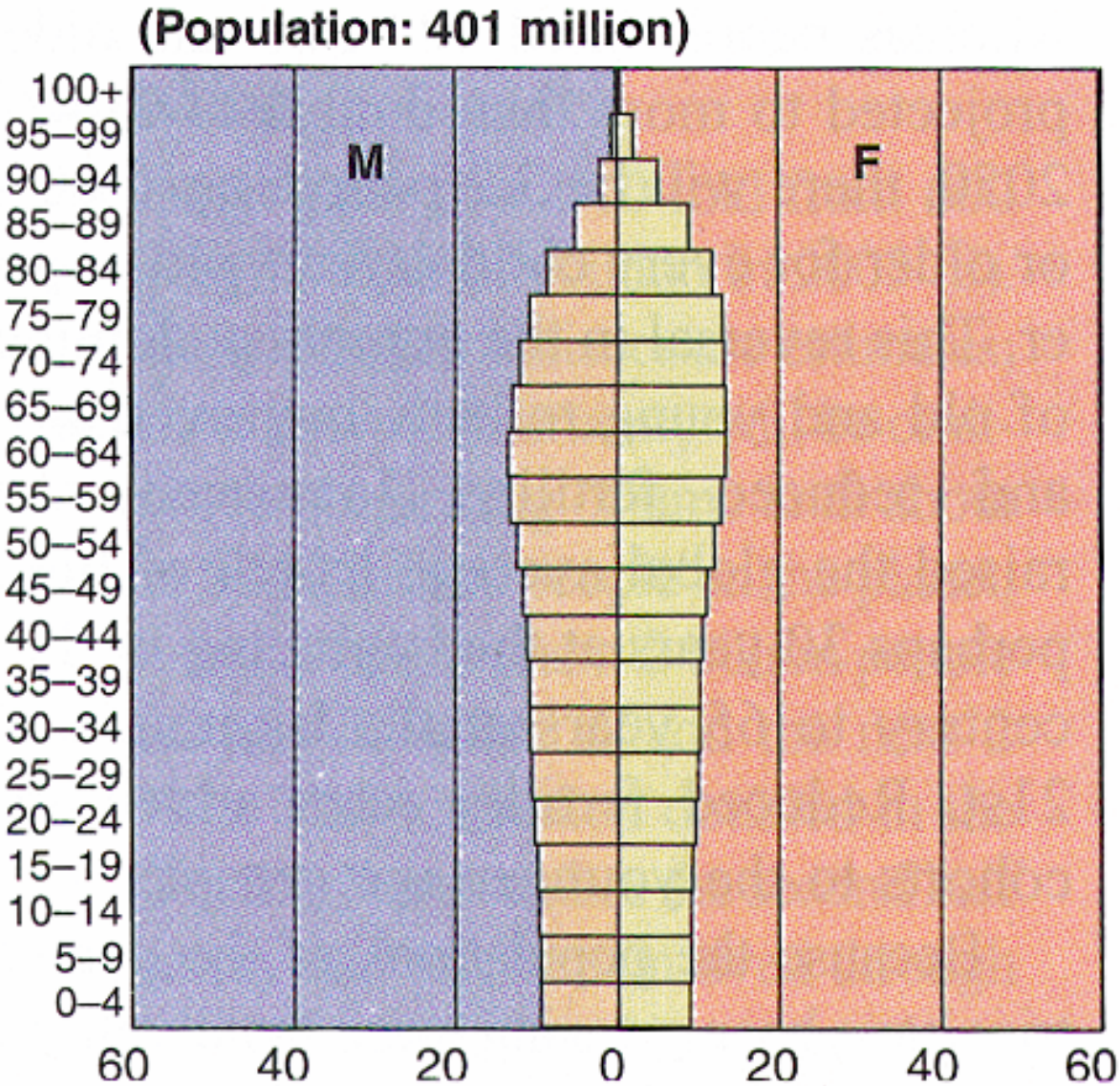
Europe - 1950


(Population: 349.8 million)
100+
95–99
90–94
85–89
80–84
75–79
70–74
65–69
60–64
55–59
50–54
45–49
40–44
35–39
30–34
25–29
20–24
15–19
10–14
5–9
0–4
M
F
60
40
20
0
20
40
60

Europe - 2000


(Population: 451.4 million)
100+
95–99
90–94
85–89
80–84
75–79
70–74
65–69
60–64
55–59
50–54
45–49
40–44
35–39
30–34
25–29
20–24
15–19
10–14
5–9
0–4
M
F
60
40
20
0
20
40
60

Europe - 2050


(Population: 401 million)
100+
95–99
90–94
85–89
80–84
75–79
70–74
65–69
60–64
55–59
50–54
45–49
40–44
35–39
30–34
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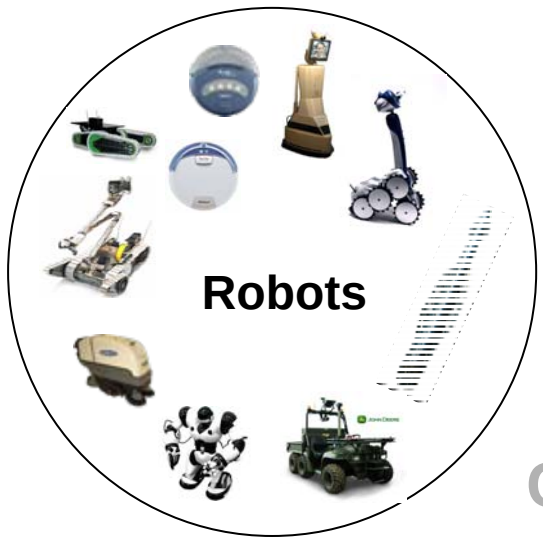
The Robot Industry



Robots

Home
- Mop
- Mowing
- Security
- Vac

Health
- Hospital
- Long term care
- Home care

Military
- UUV
- UGV
- UAV

Energy & Utility
- Mining
- Oil & Gas

Industrial cleaning
- Wet
- Dry

Toys

Farming

Construction

Soldiers will find more missions for robots than expected

Consequences

- *Potential to completely change the world's labor markets from the way they have developed over the last 50 years*
  - change the need for low-cost labor migration
  - change the face of out sourcing
  - significantly impact the labor requirements for elder-care in societies with changing demographics
  - **CHANGE THE WAY THE MILITARY OPERATES**
- *Potential to create an economic tsunami that rivals or surpasses the silicon valley experience*

iRobot®

THANK YOU!

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