



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

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 <i>The O'Gara Group</i>
1:20 pm	Weaponizing the Spectrum	Mr. Kalle Konston <i>Alion Science & Technology</i>
1:40 pm	Self-Powered Autonomous Next Generation Chem-Bio Sensors	Dr. Richard Waters <i>SPAWAR Systems Center</i>
2:00 pm	Robots: Changing the Way We Fight and Live	VADM Joseph Dyer, USN (Ret) <i>iRobot Corp.</i>
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 <i>Chief Technology Officer, MIT Lincoln Laboratory</i>
3:30 pm	Perspectives on Disruptive Technology	Dr. Frank H. Akers <i>Junior Chairman, Army Science Board and Associate Laboratory Director for National Security, Oak Ridge National Lab</i>
4:00 pm	Science & Technology for Naval Warfare, 2015-2020	Dr. Mark Lister <i>Member, Naval Research Advisory Council</i>
4:30 pm	Resourcing Disruptive Technologies	Mr. Alan Shaffer <i>Director, Plans & Programs, Office of the Director, Defense Research & Engineering</i>

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

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

12:30 pm Conference Adjourns

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

“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

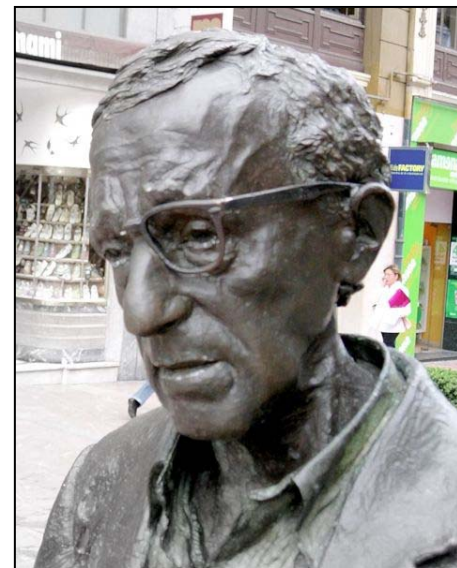
September 4, 2007
Washington, DC



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



“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.”

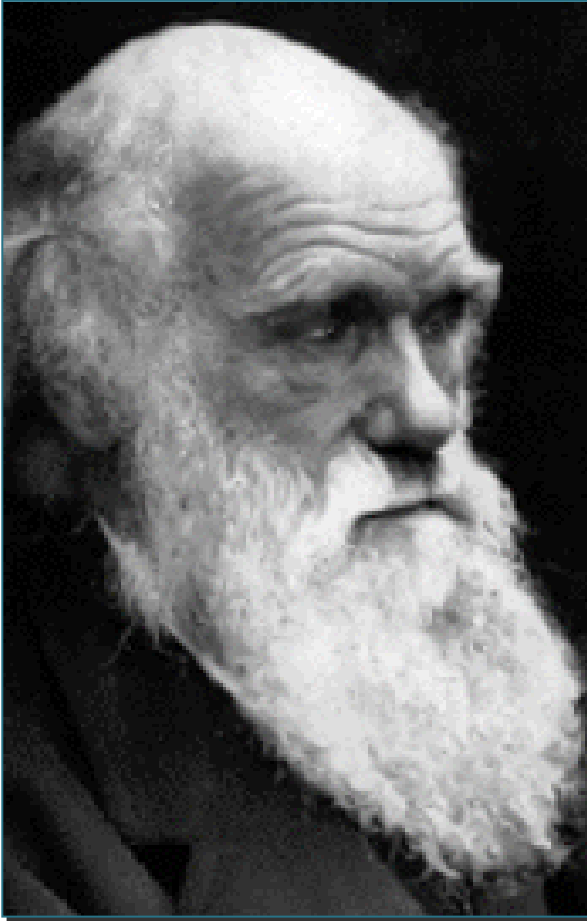


Woody Allen

“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



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

– Charles Darwin

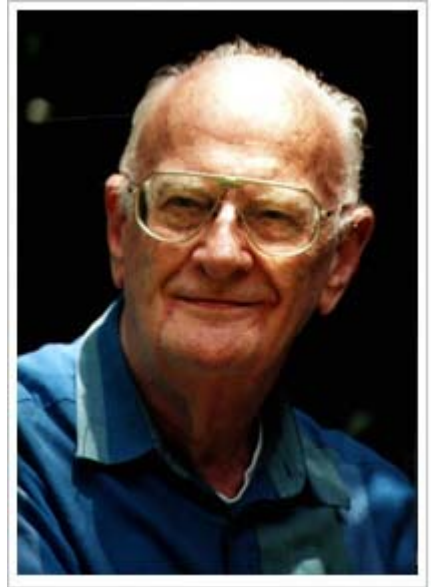


“Every revolutionary idea seems to evoke three stages of reaction. They may be summed up by the phrases...

(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

I NEVER DID THAT.... AND



I'LL NEVER DO IT AGAIN





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

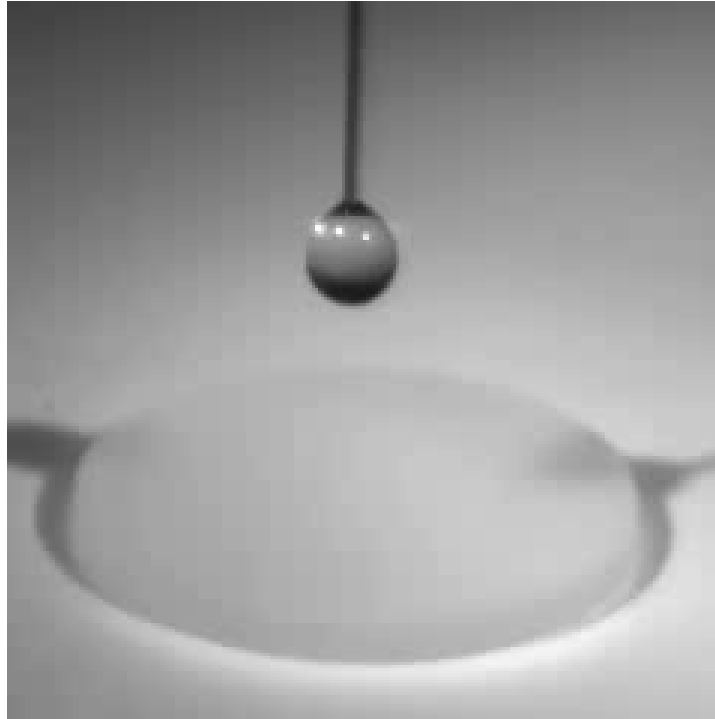
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From *The New Yorker Book of Technology Cartoons*

“Vu ja de”





Reverse The Process

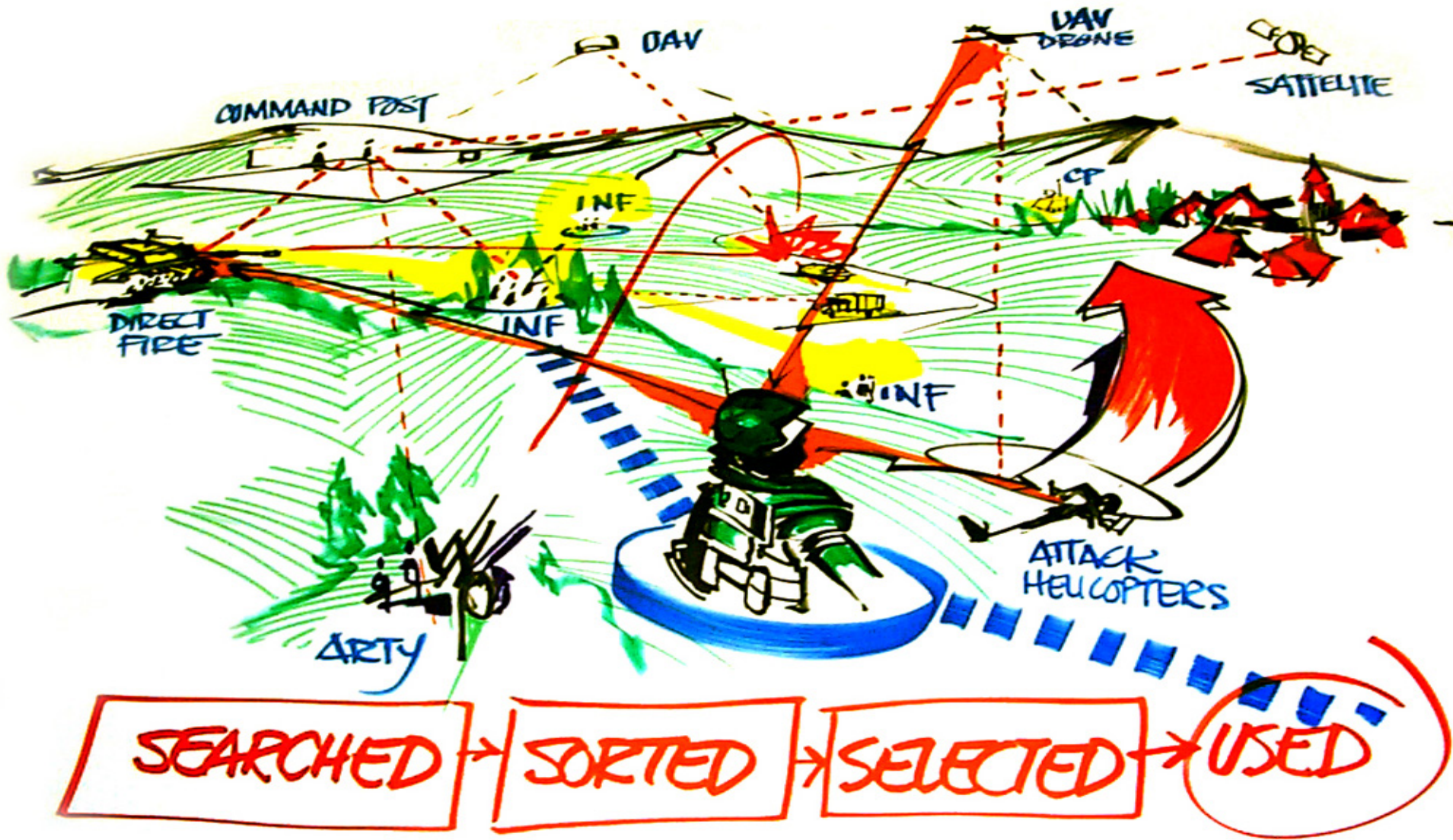


THE PENTAGON'S NEW MAP

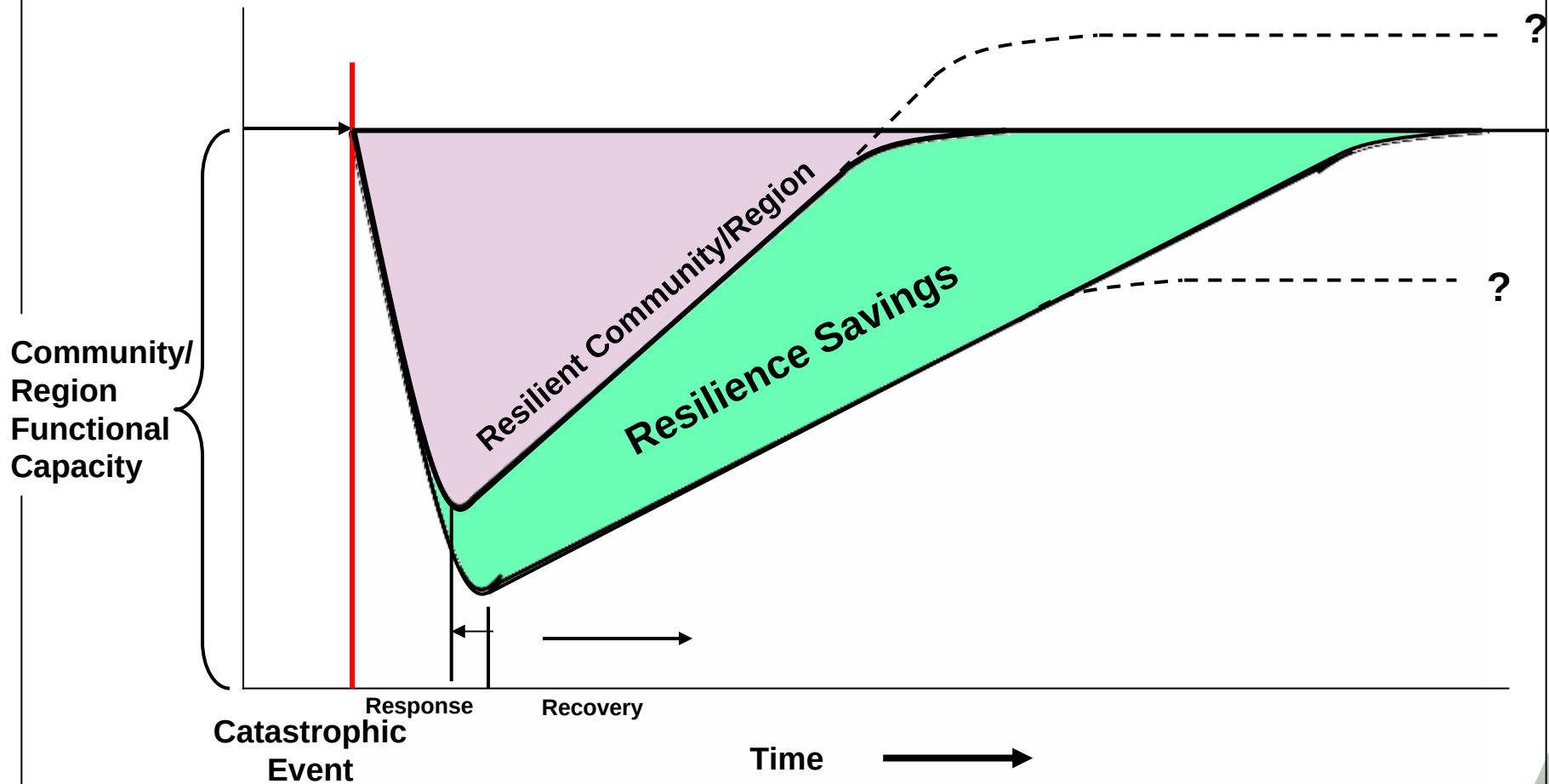




The Art of the Possible – The Visioning Process



Regional Resilience Impact...

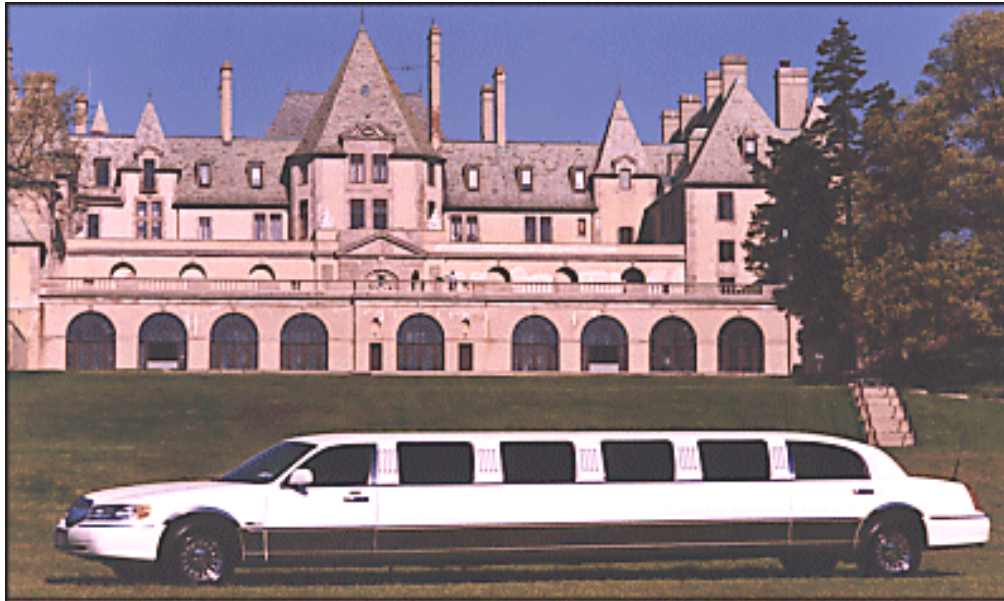


Regional Resilience is an Economic Driver



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

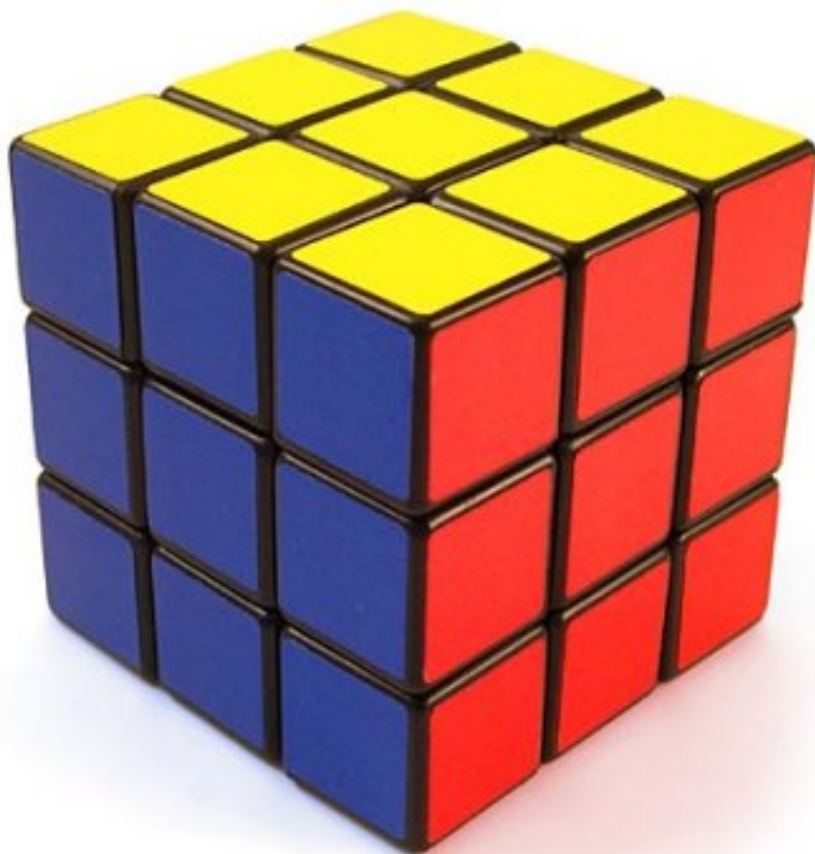
-- Oliver Wendell Holmes

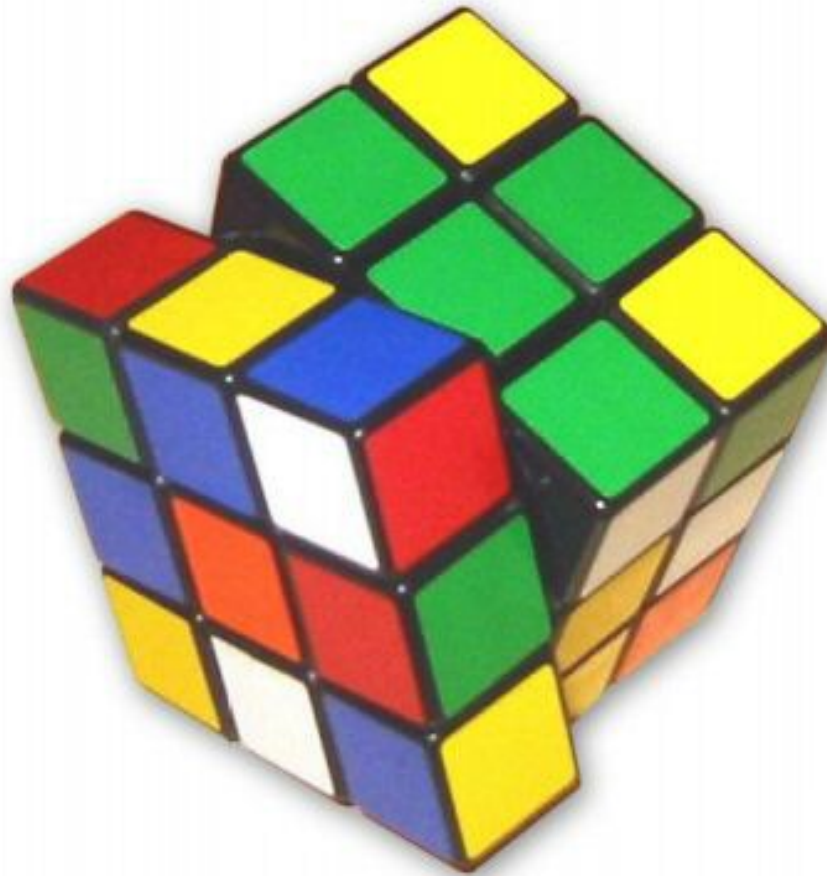


**“Never be afraid to try something new.
Remember, amateurs built the Ark.
Professionals built the Titanic!”**

-- Unknown







“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**



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

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

-- Anonymous





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.



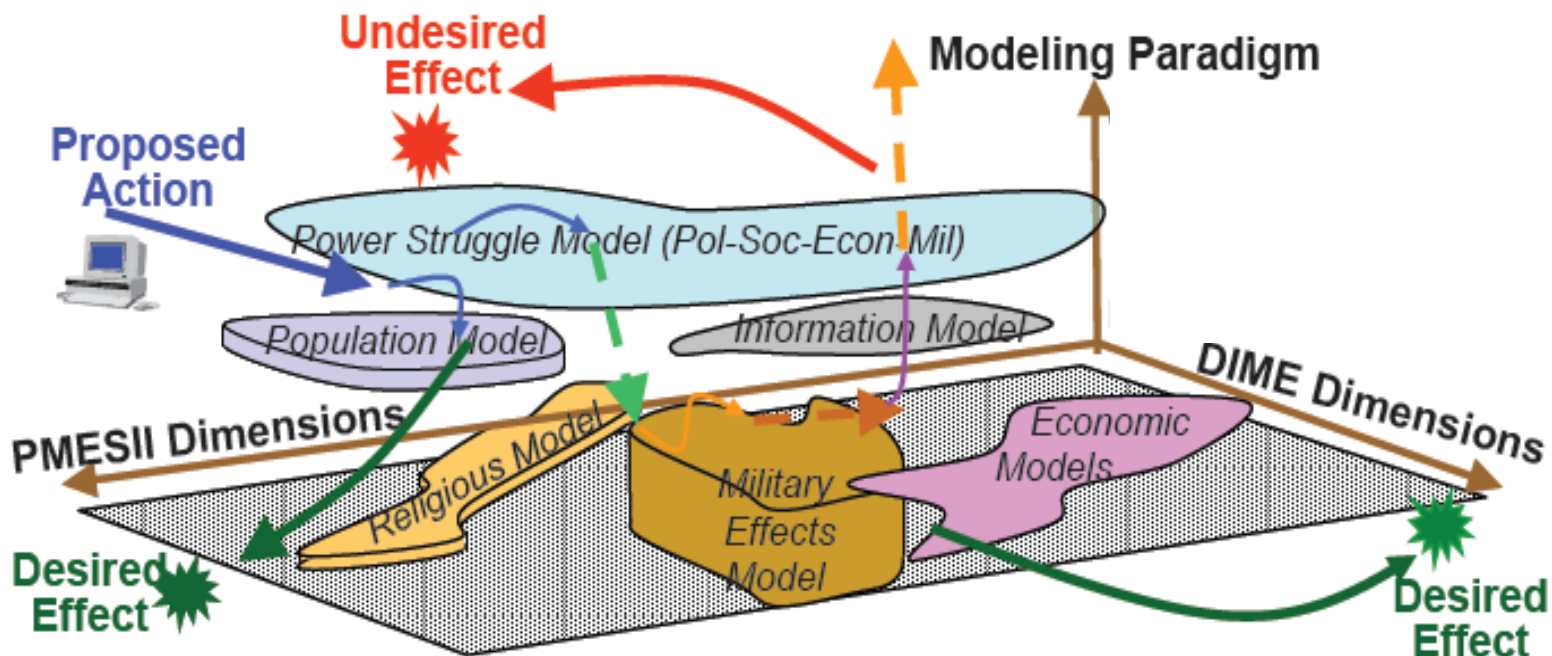
'Predicting' Human Behavior

- 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 -

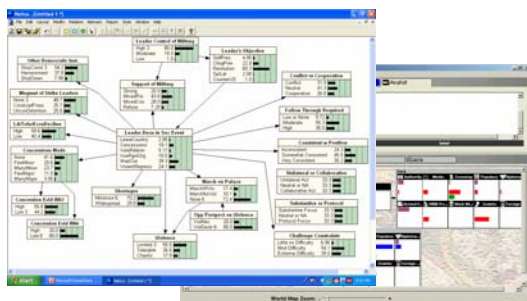


- **No existing U.S. technical HSCB core (in academics, government labs, or industry) for the military domain**
 - Need to develop U.S. commercial and government capability to support GWOT
 - Need to be able to immediately tap HSCB understanding/experiences outside the U.S.
- **Growing ad hoc investment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



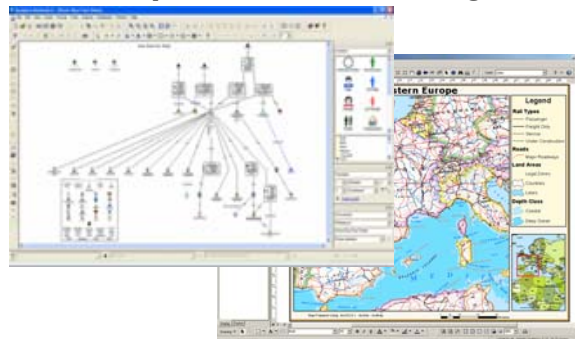
Operational Environments for HSCB Product Use

Intelligence Analysis



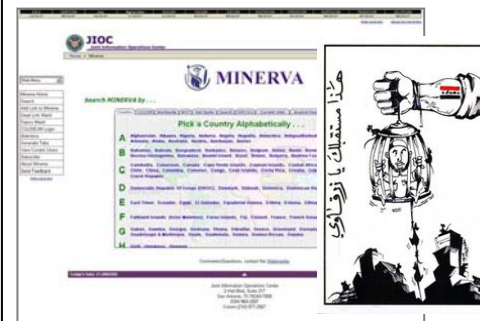
Apollo/Athena
Analysts Notebook
Skope

Operations Planning



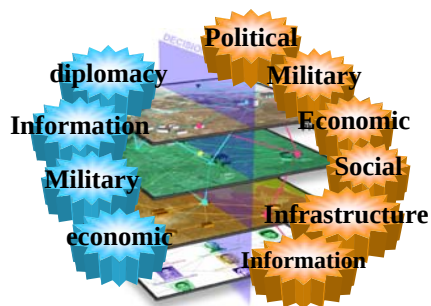
Analysts Notebook
MAP-Human Terrain toolkit
Joint Integrative Analysis and Planning
Capability (JIAPC)

Influence Operations



Assymetrical software kit
Situational Influence Assessment Module
JCURE data collection system

Experimentation



Multinational experiments
Joint Doctrine Experiments

Training & Mission Rehearsal



Tactical Language Trainer
Battle Command Knowledge System

Human Social Culture Behavior Modeling - Program Overview -



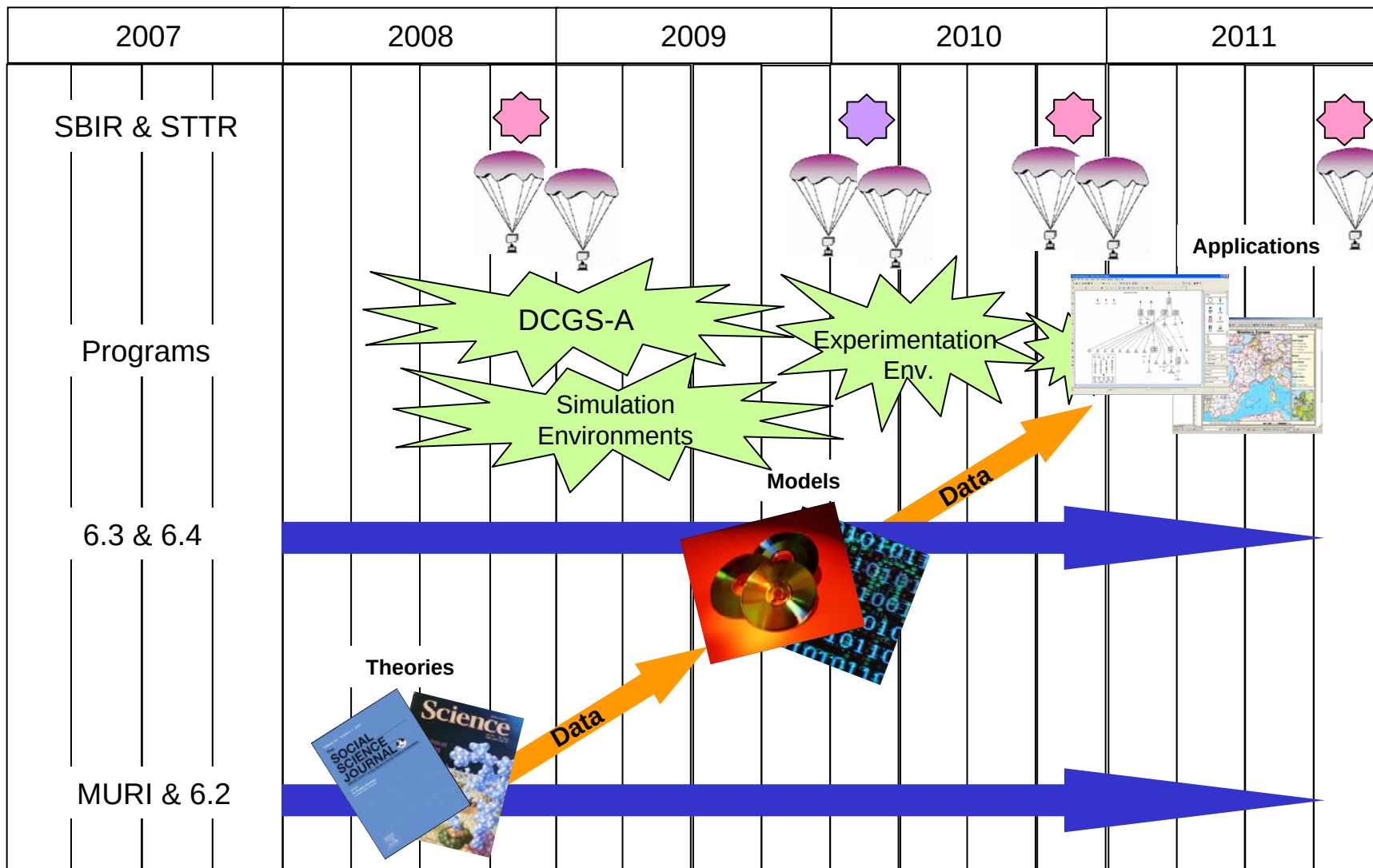
Program Motivation: *Response to QDR and CoCOMS* - models and understanding of societies, cultures, and human behavior for individuals and groups are complex, not fully understood, accurate for use in DoD planning and decision making for “Phase 0” (Pre-planning/shaping) to “Phase 4” (Stabilization) military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



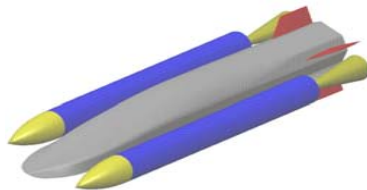
Potential Air Breathing Hypersonic Applications



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

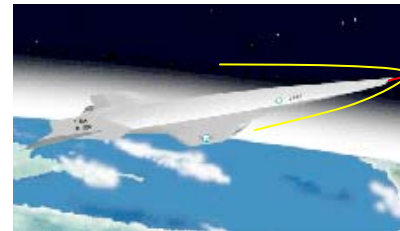
Weapons (missiles)

- 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

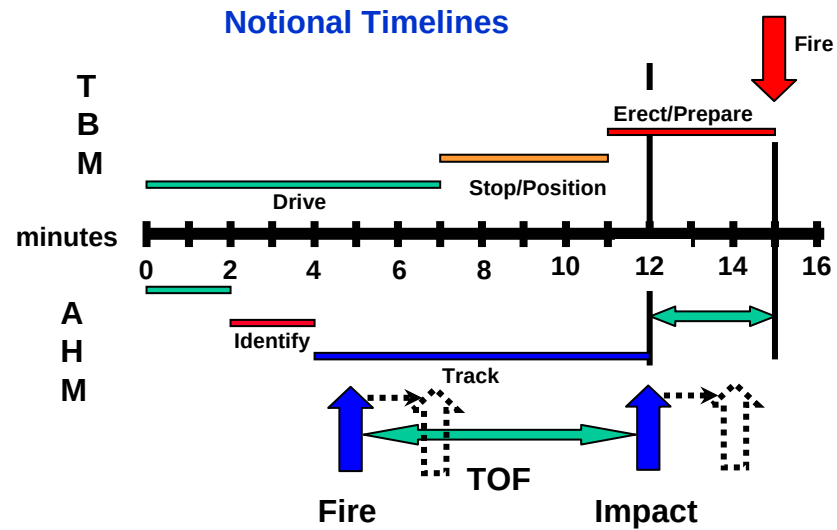
SAB TR 00-03, Cleared for Open Distribution



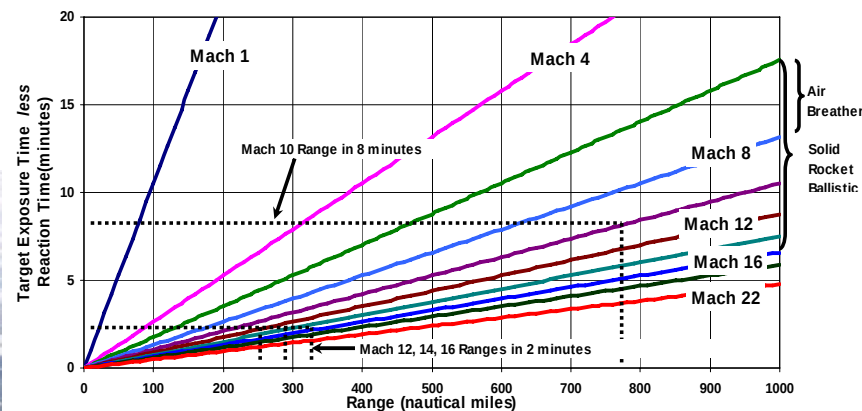
Air Breathing Hypersonic Missile



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



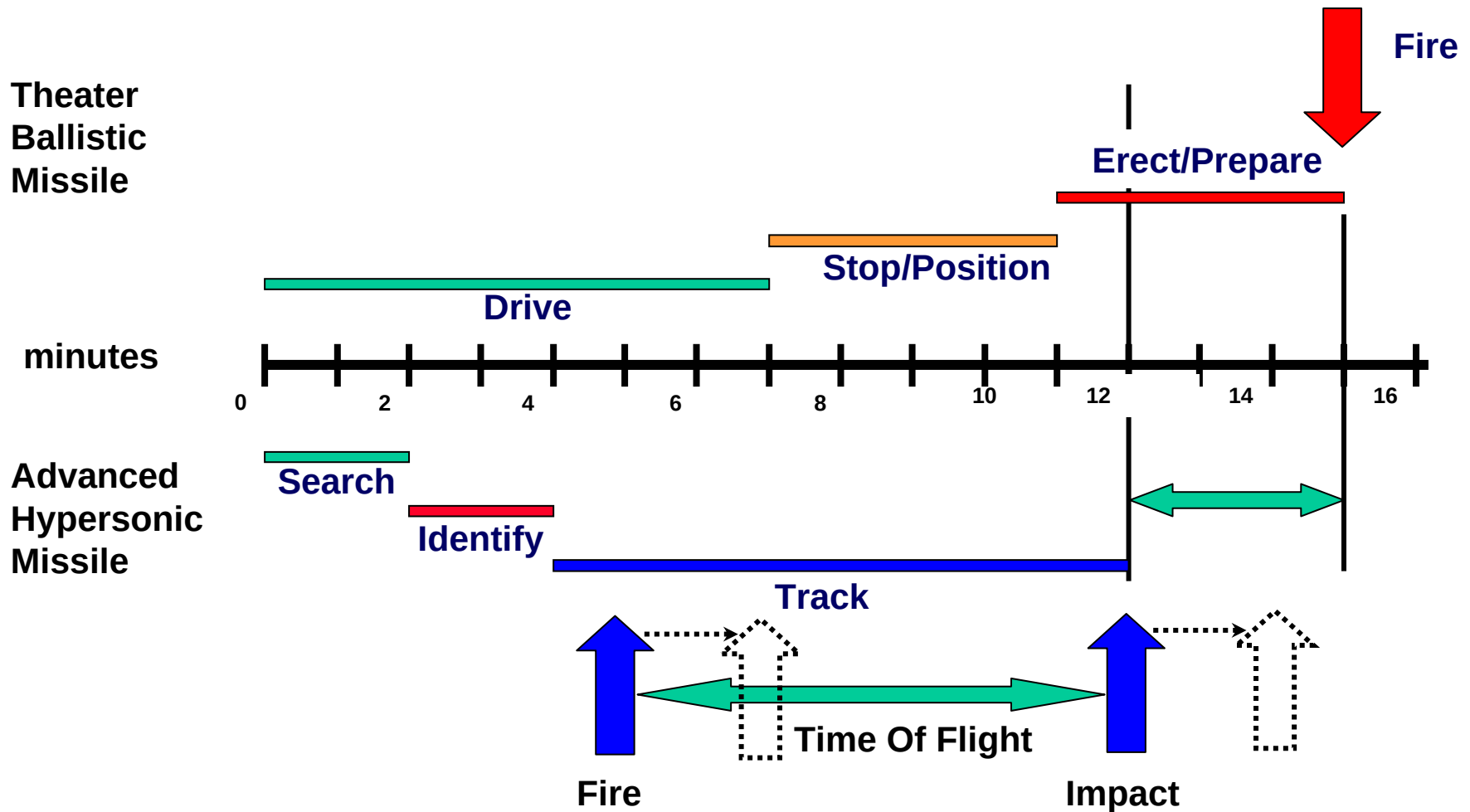
Relies on robust ISR





Notional Timelines

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

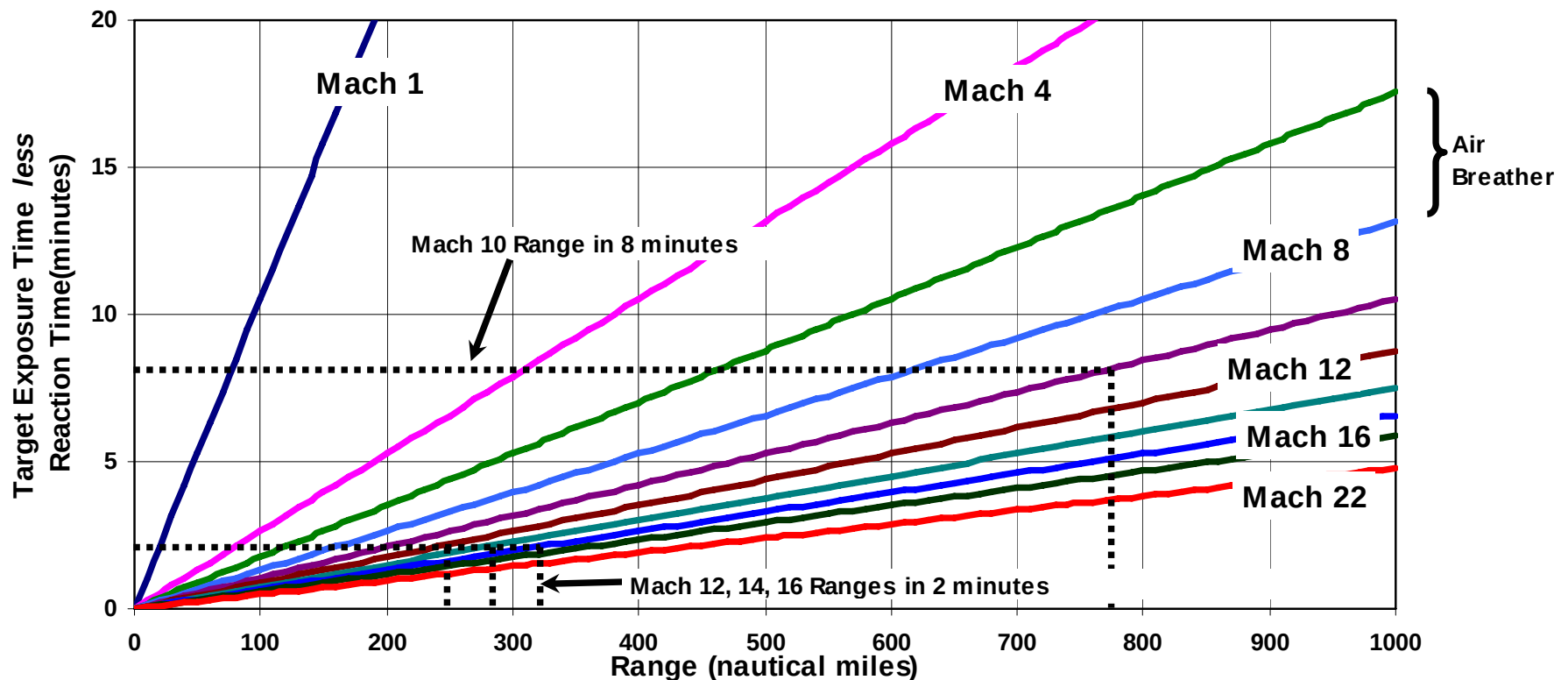




Relies on Robust ISR

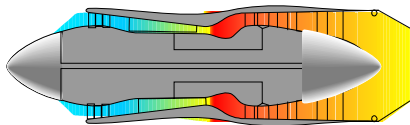


Source: SAB, Why and Whither of Hypersonic Research in USAF, Dec 2000

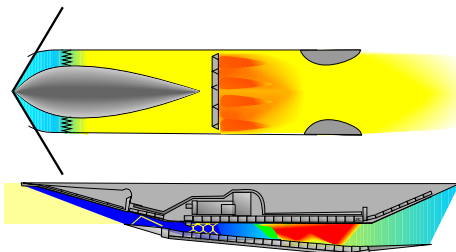




Aircraft: Mach 5-7 Strike/Recce Vehicles



+



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

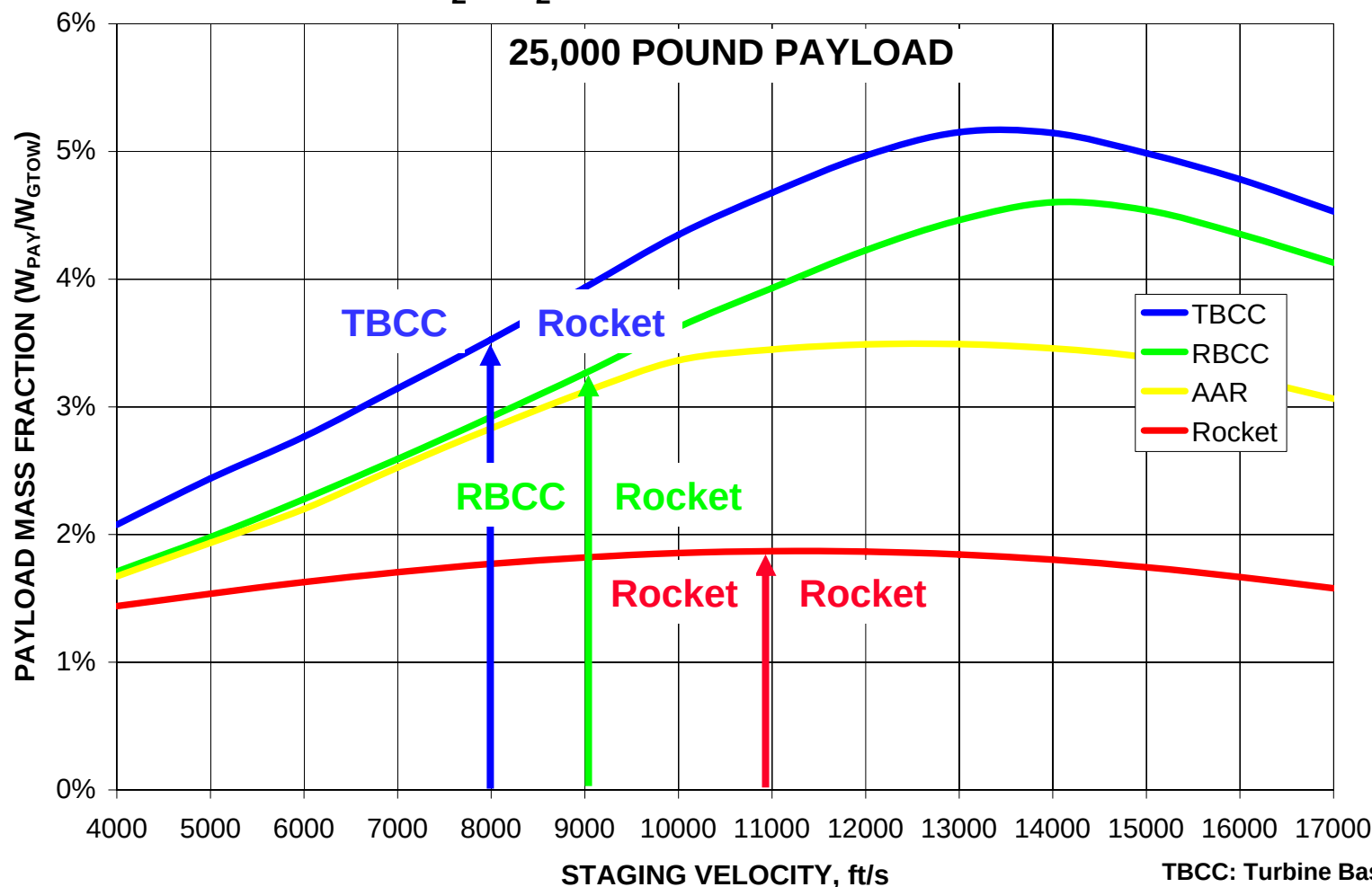
**Typically Turbojet and
Ramjet or Scramjet**



Mach 8 Air-Breathing Propulsion Doubles Payload Fraction to LEO



PAYLOAD MASS FRACTION vs STAGING VELOCITY
FOR H₂ - O₂ TSTO VEHICLES TO 51.7° ORBIT



TBCC: Turbine Based Combined Cycle

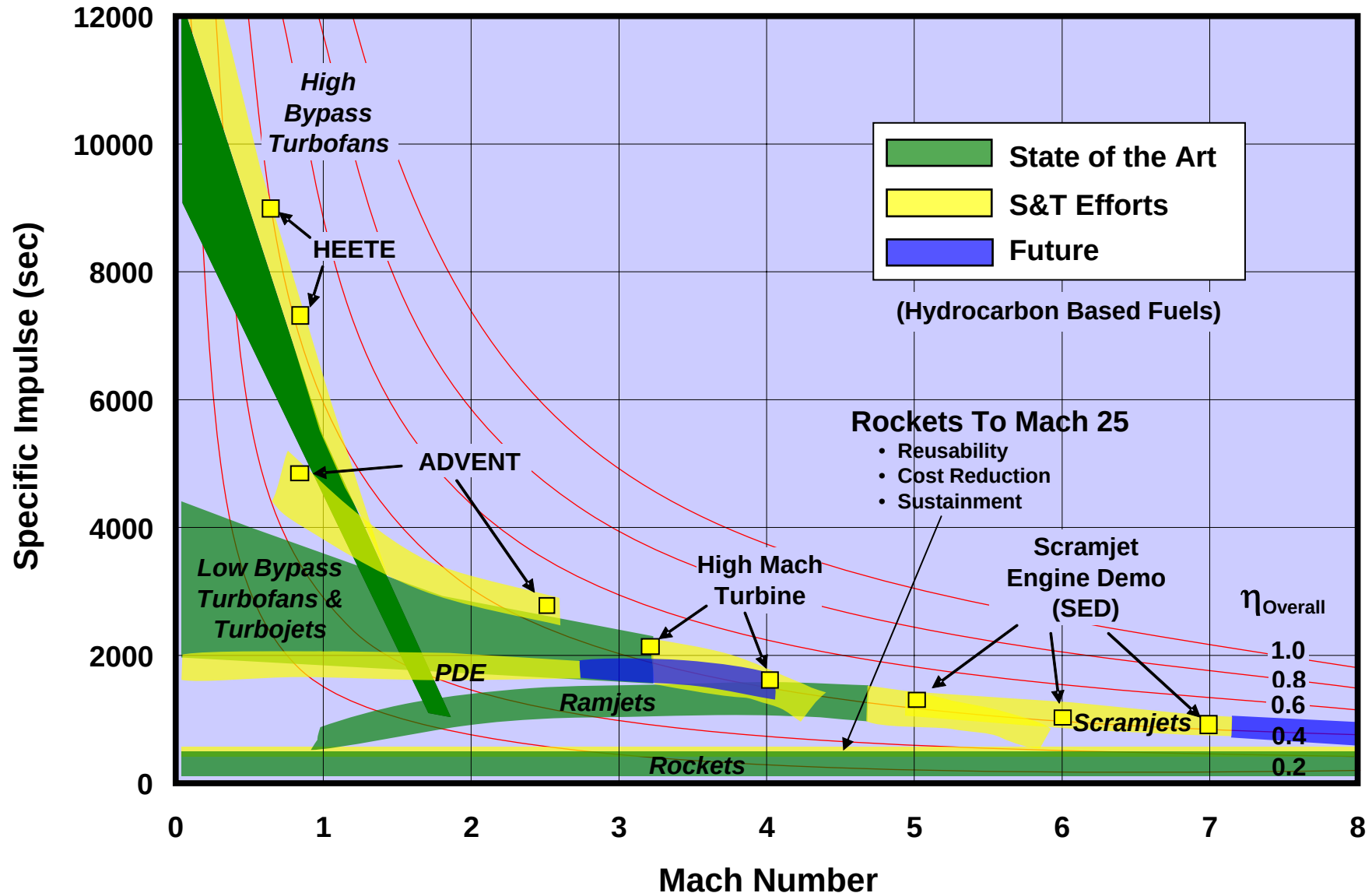
RBCC: Rocket Based Combined Cycle

AAR: Air Augmented Rocket



Aerospace Propulsion Domain

Improving Fuel Efficiency Across Flight Spectrum

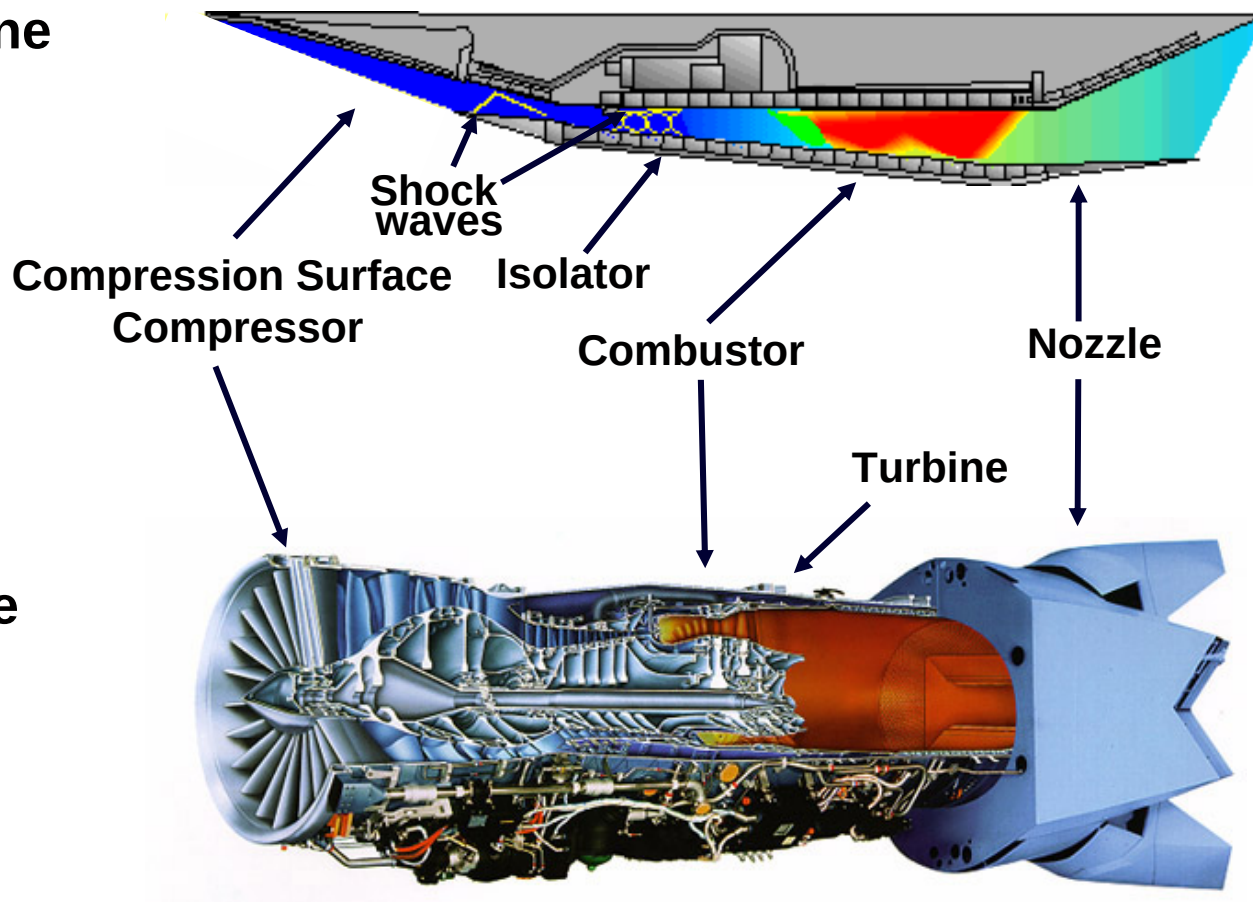




Scramjet Propulsion



Scramjet Engine



Turbine Engine



AFRL's Hypersonic Technology Development Approach



***Stair-step
approach builds
upon prior
successes.***



Hypersonic Missiles
(Time-Critical Targets)

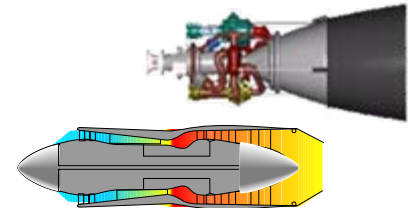


Expendable Space Lift
(On Demand)



Multiple Roles
(Robust, Responsive)

***Large
Scramjets
and CCEs***



***Medium
Scramjets***

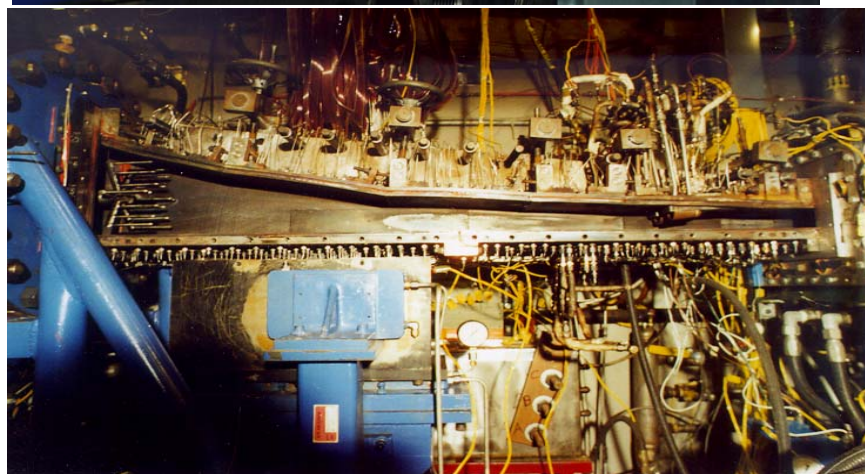
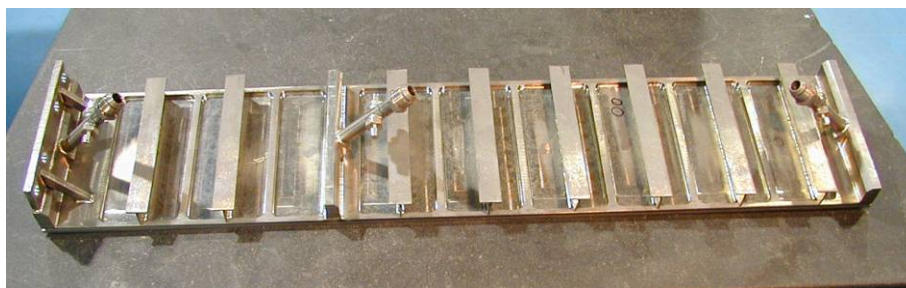
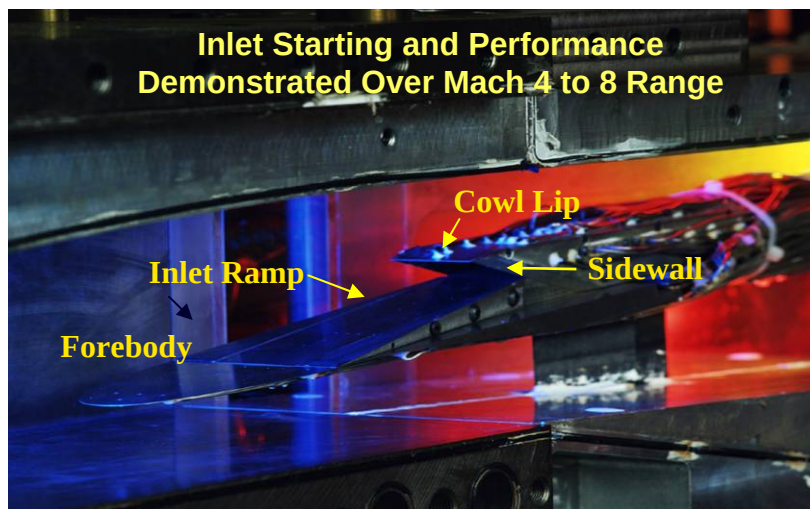


***Small
Scramjets***





HyTech: HYDROCARBON SCRAMJET COMPONENT TECHNICAL CHALLENGES HAVE BEEN MET



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



Freejet Test of Integrated Heavyweight Engine Demonstrated Performance & Operability



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!**



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



X-51A Scramjet Engine Demonstrator (SED)



HyTech Ground Demo Engine



- 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

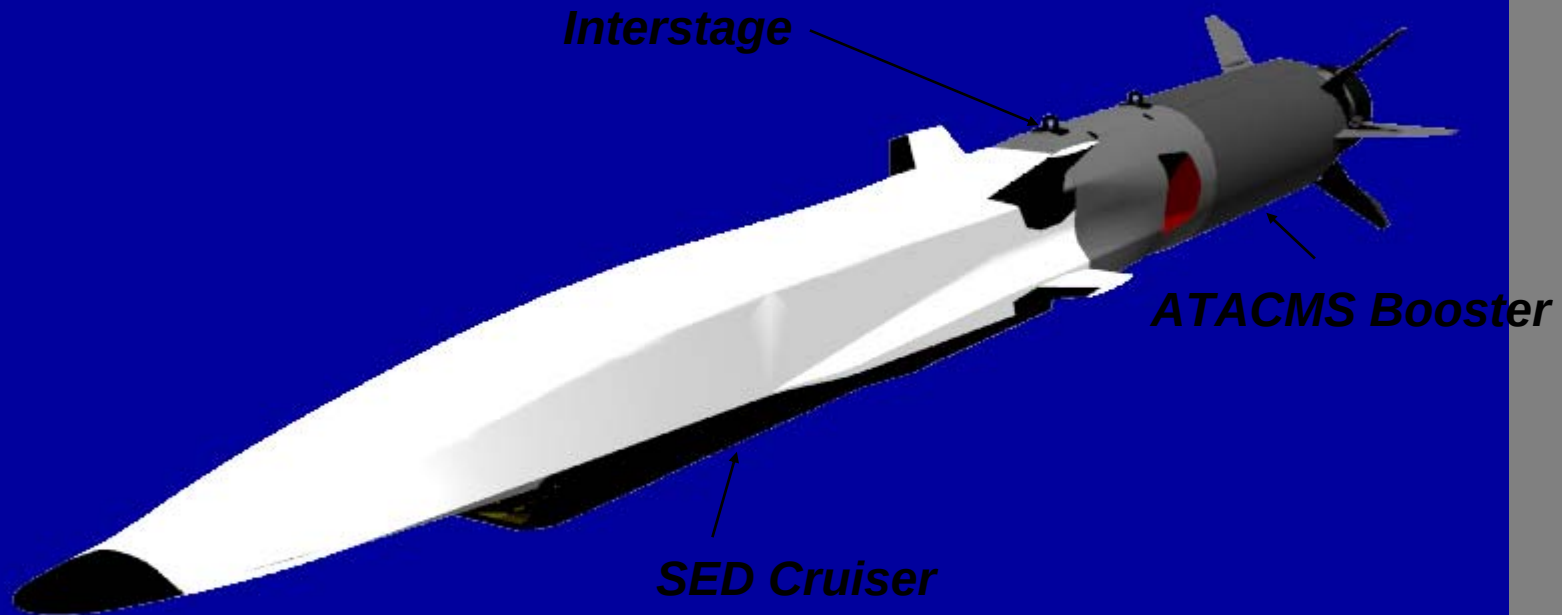
Potential Hypersonic Weapon



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)

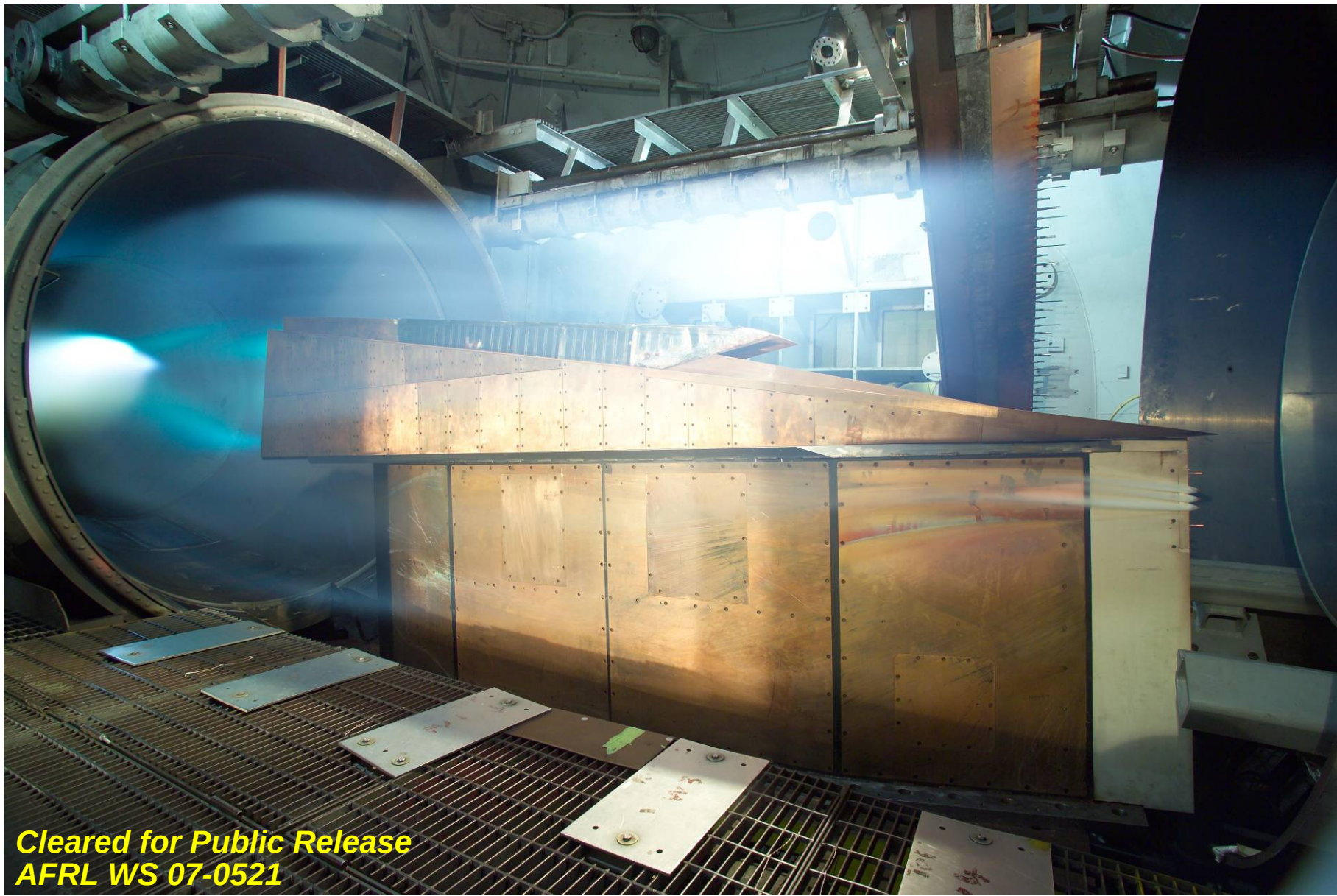
X-51A Configuration



- *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*



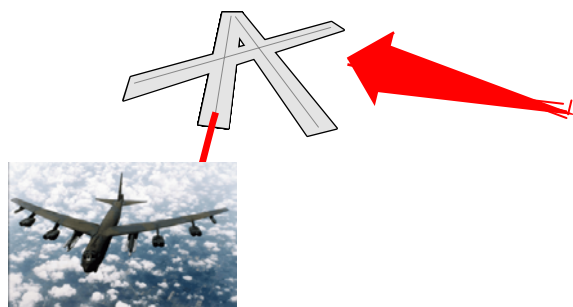
SJX61-1 Testing at LaRC



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



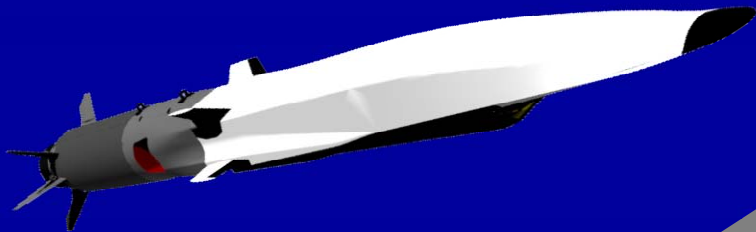


AFRL Hypersonic Propulsion Technology Programs



Scramjet Engine (SED)

- Demo Hypersonic
- First

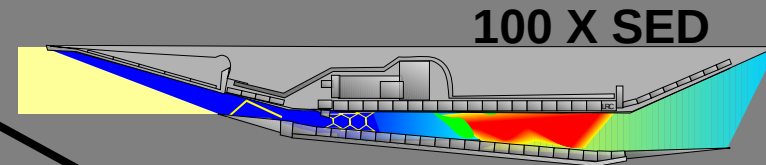


Robust Scramjet

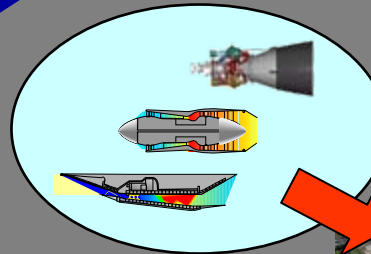
- 10X – 100X scale
- Increased durability
- Improved operability



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

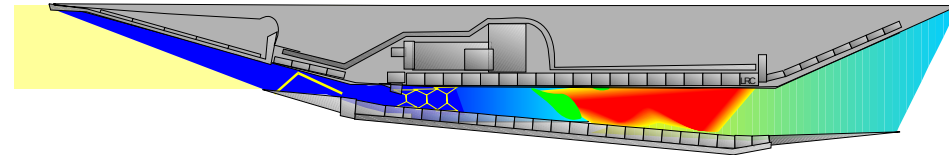
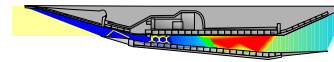




Robust Scramjet Program



- 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

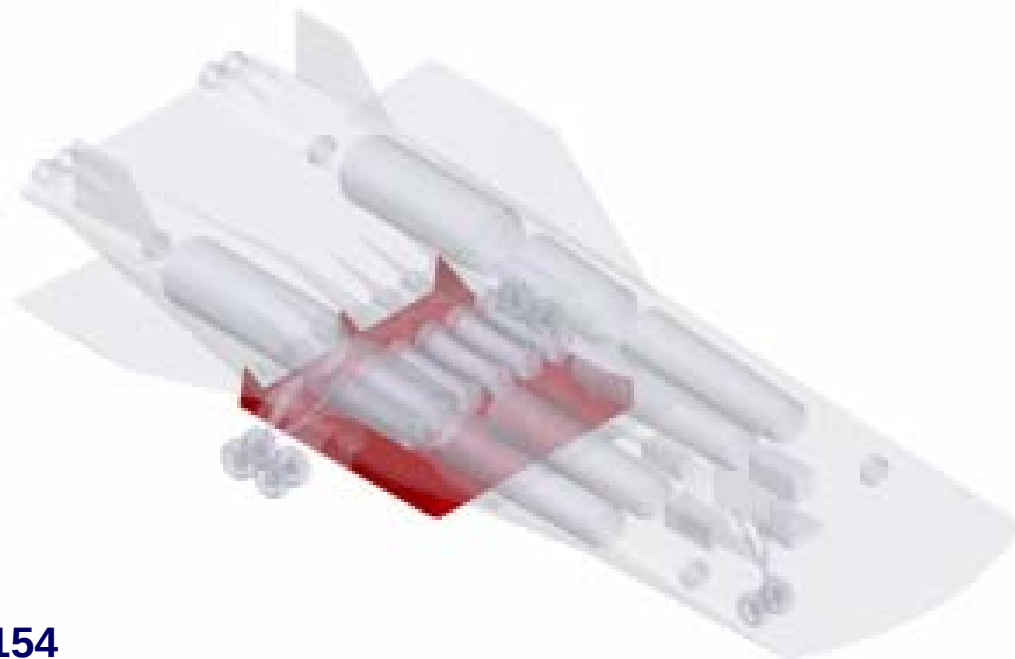
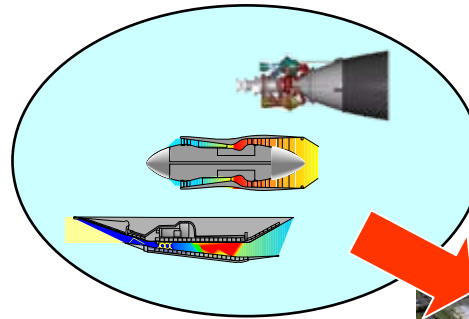




Combined-Cycle Engine Component Development



- 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





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**



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 . . .

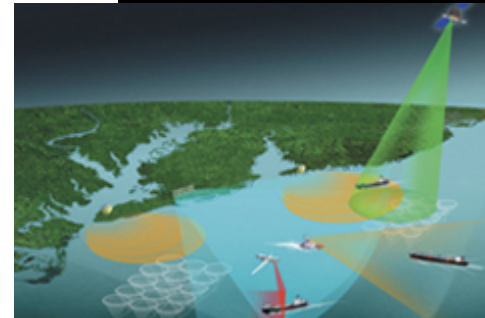
- **Persistent ISR/All Weather Sensors**
 - Tactical Satellites/UAVs
- **Communications**
 - Minimize effects of communications/navigational losses
 - Agile frequency ranges
- **Computer network defense**
 - Individual and network intrusion detectors and identifiers
- **Rapidly changing tactics for terrorist 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**



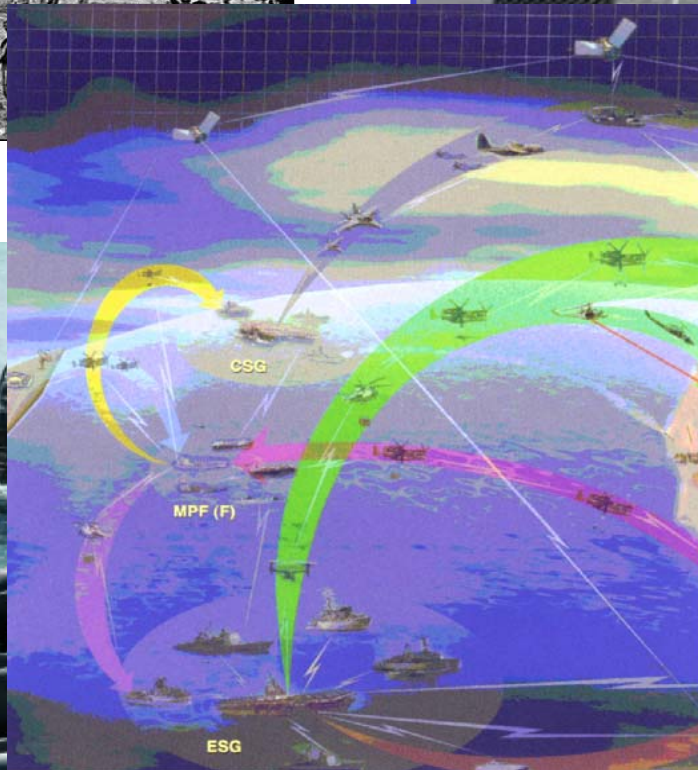
Disruptive Technologies Transform the Force



**Forward Observer
Civil War, 1863**



**Forward Observer
Talisman Saber, 2007**



Coalition
Interoperability
and
Commonality
are Key

Service
Transformation
must support
Joint
Transformation





Contact

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Chief, Transformation & Experimentation

USPACOM J81

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mel.chaloupka@pacom.mil

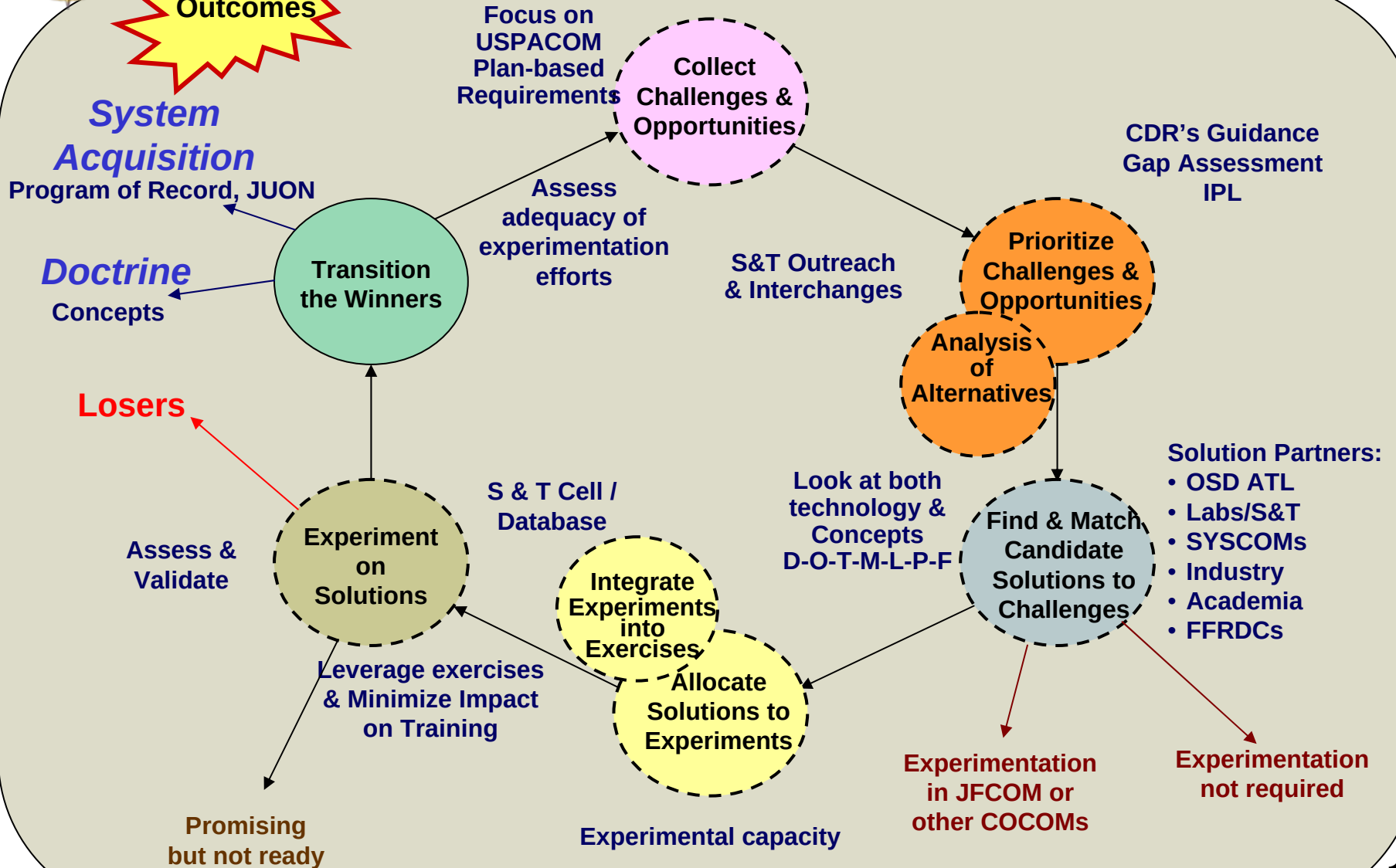
mel.chaloupka@pacom.smil.mil

How Does it Work?

...A Snapshot of the Overall Process (U)



Outcomes



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.



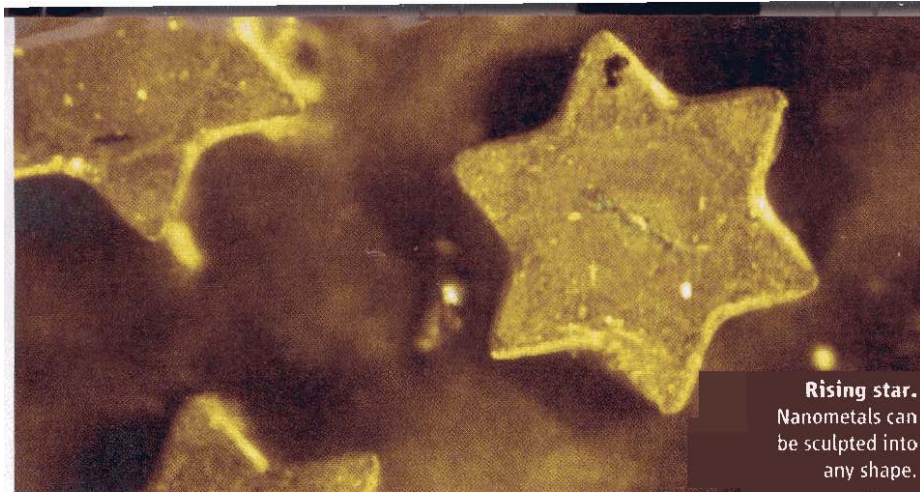
Disruptive Technologies – the future role of computing



- **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

THE DISRUPTOR: RAYDIANCE

Lasers: Old vs. New

TRADITIONAL CONTINUOUS WAVE LASER

- 1 Beam is made up of a continuous stream of photons.
- 2 It heats up everything in its path, as well as the surrounding area.
- 3 It can't be fine-tuned to destroy a particular kind of matter.

Good for reading CDs and DVDs; OK for LASIK eye surgery or tattoo removal.

RAYDIANCE ULTRASHORT PULSE LASER

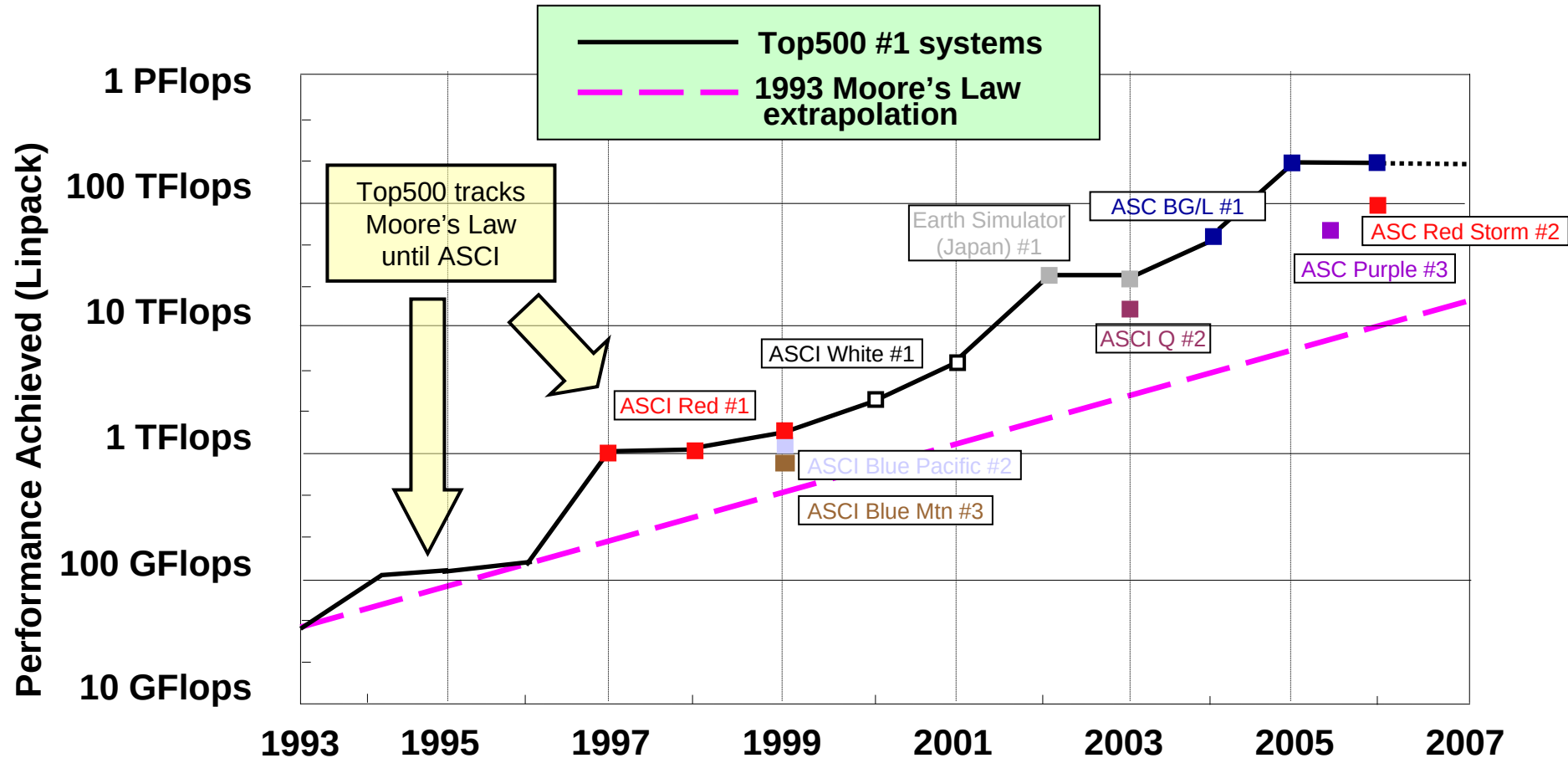
- 1 Beam consists of photon "pulses" lasting a trillionth of a second.
- 2 Pulses are so fast that they generate no heat at all.
- 3 Beam can "tune in" to any given atom and instantly vaporize it.

Excellent for LASIK, destroying tumors, removing tattoos, and cutting diamonds or steel.



Example of NNSA Impact on Technology

Worldwide Computation



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

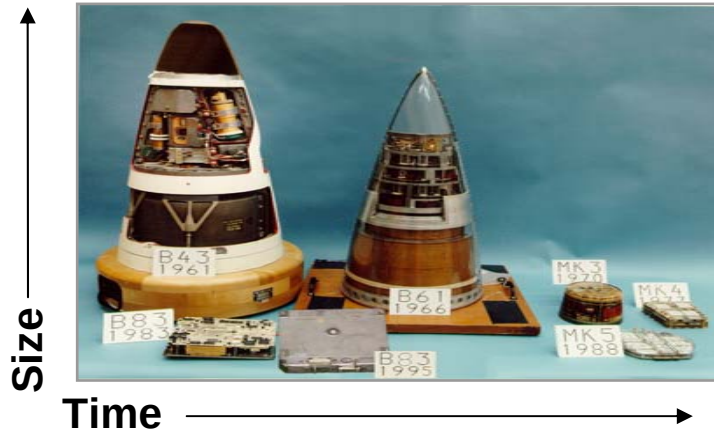


Miniaturization

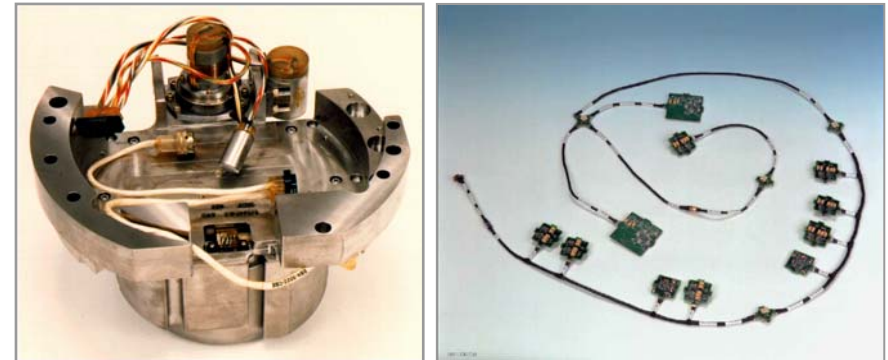
Design layout expertise, applied engineering and manufacturing technologies for product miniaturization



RADARS



TELEMETRY



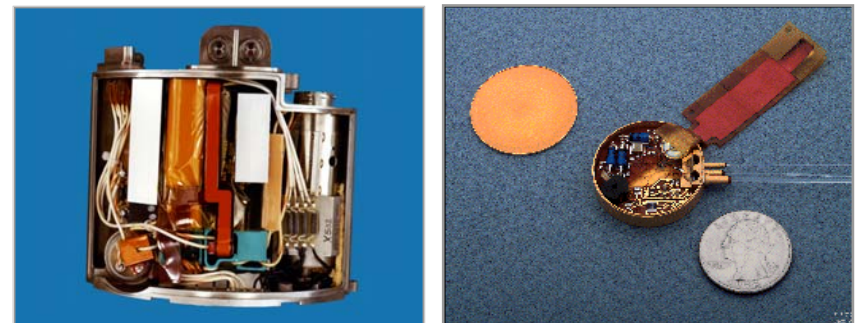
Telemetry → Distributed Telemetry

MECHANISMS



Precision Machining → Micromachines

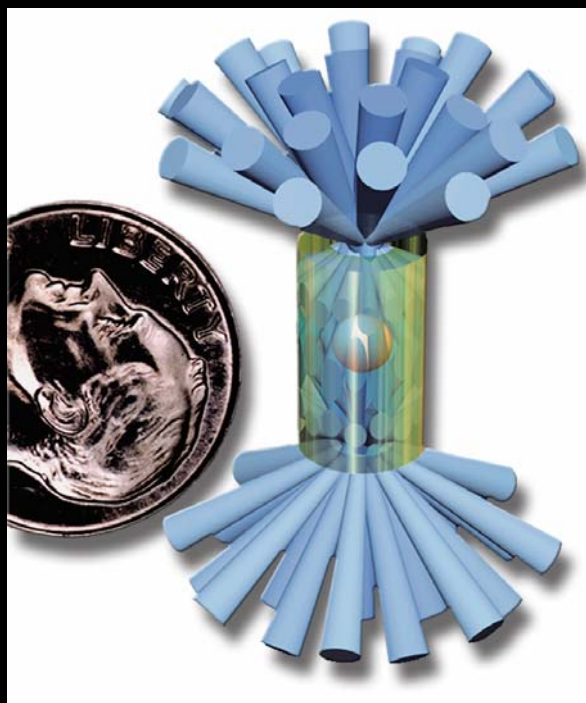
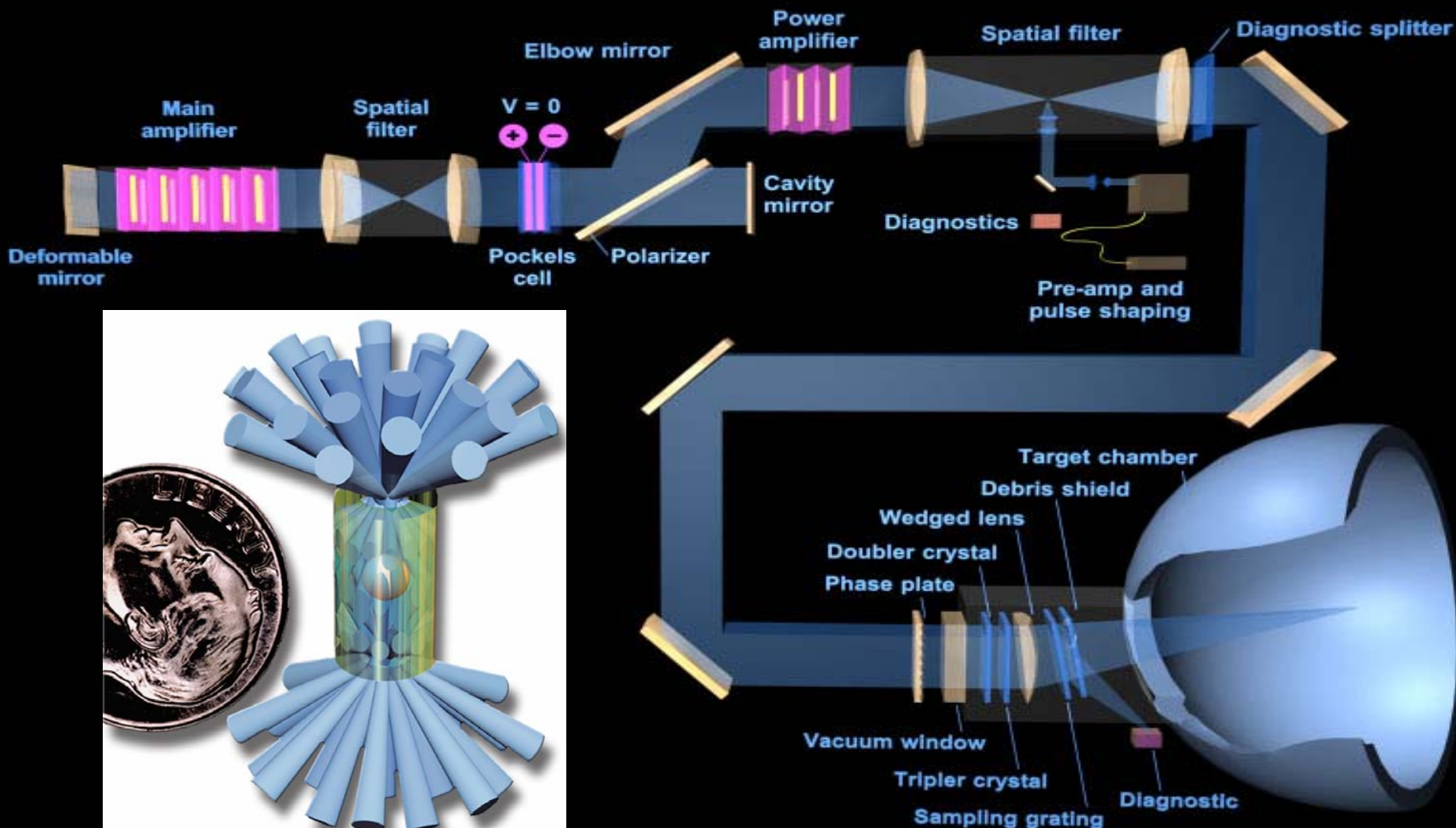
FIRESETS



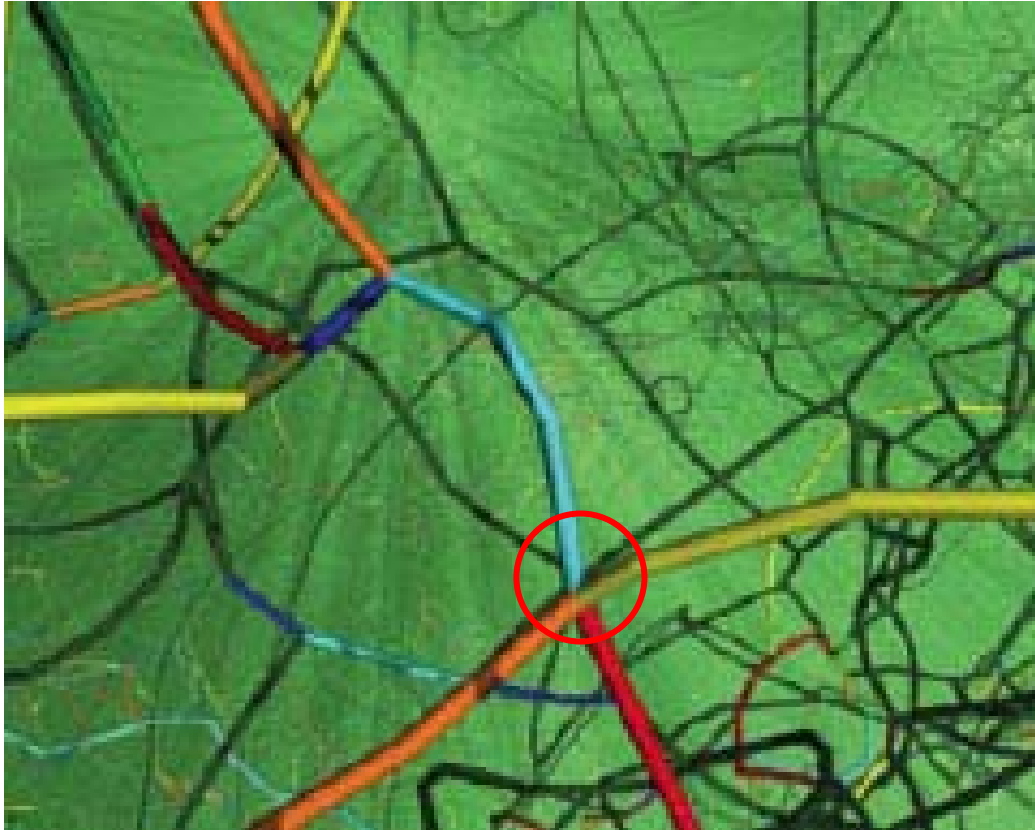
Fireset → Micro Fireset



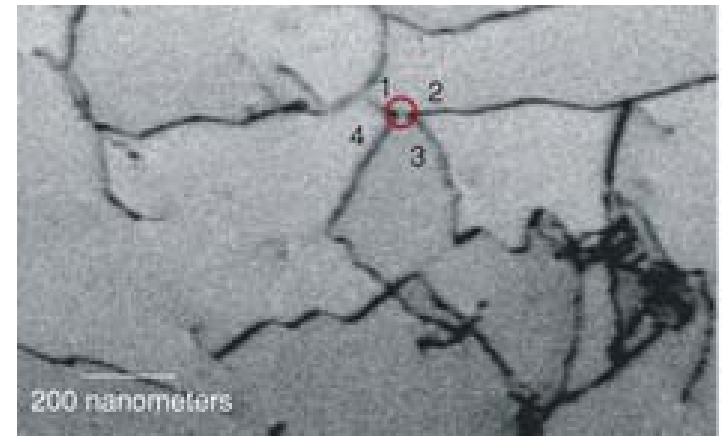
Schematic of NIF Beam Line



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



Traditional

Basic Exploration



Lab work



Discovery & proto type



Products (transistor)

Future

Model



Computation



Selected lab work



Model/Computation (discovery)



Products (materials fracture)

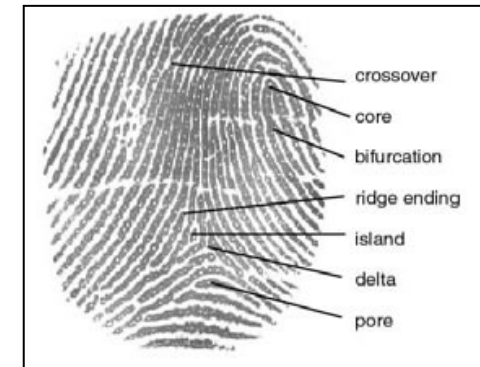


DoD Biometrics

NDIA Disruptive Technologies

5 Sep 2007

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





Outline

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



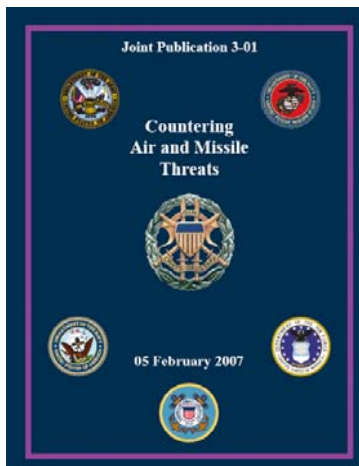
Friend? Enemy? Neutral?



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?

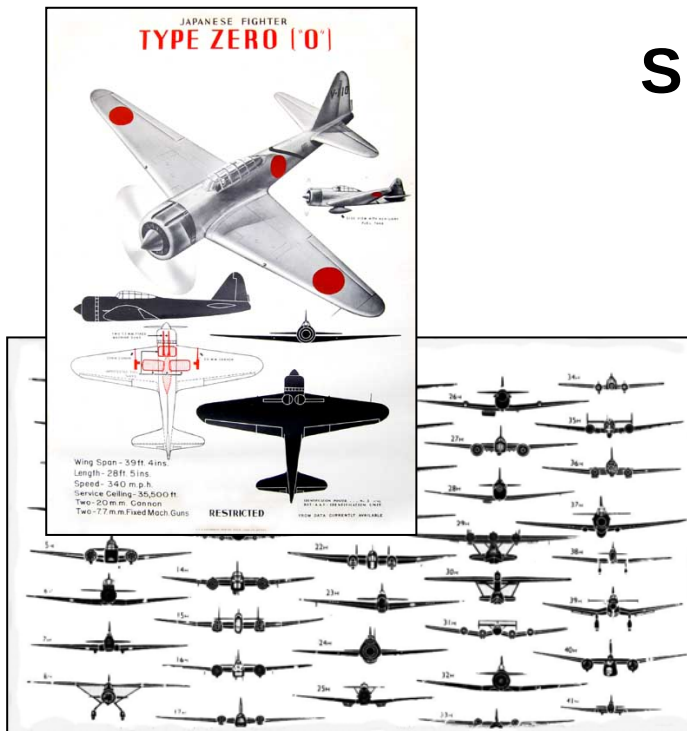
Shapes?

Markings?

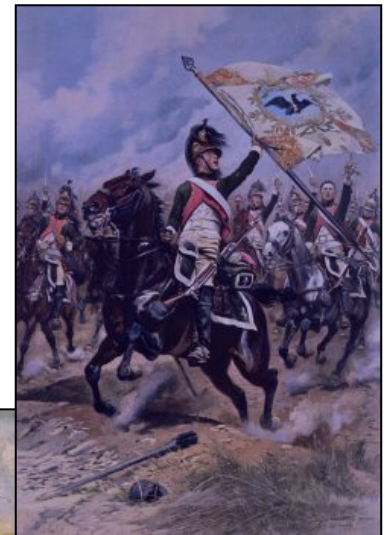
Signatures?

Signals?

Platforms



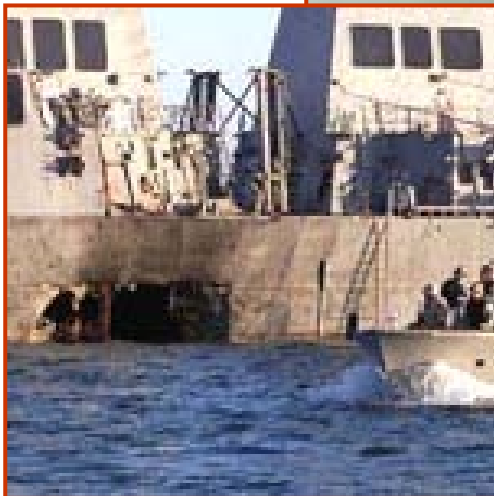
People





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

Enemy?



Neutral?



Friend?



Classification

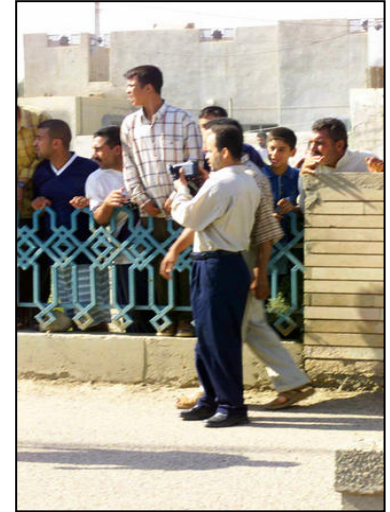
• Tactical decisions require:

- Detection
- **Classification**



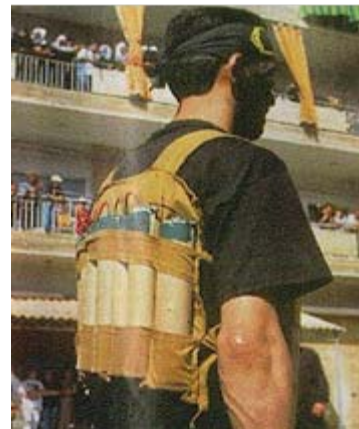
Airspace control integrates different airspace users and provides them with responsive and timely support.

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
Unclassified



And... What If You Get It Wrong

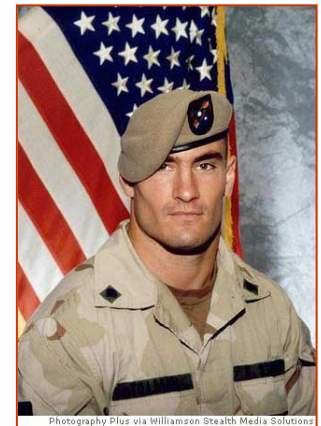
- **Consequences**

- Tactical
- Operational
- Strategic

USS Cole



Friendly Fire



9-11



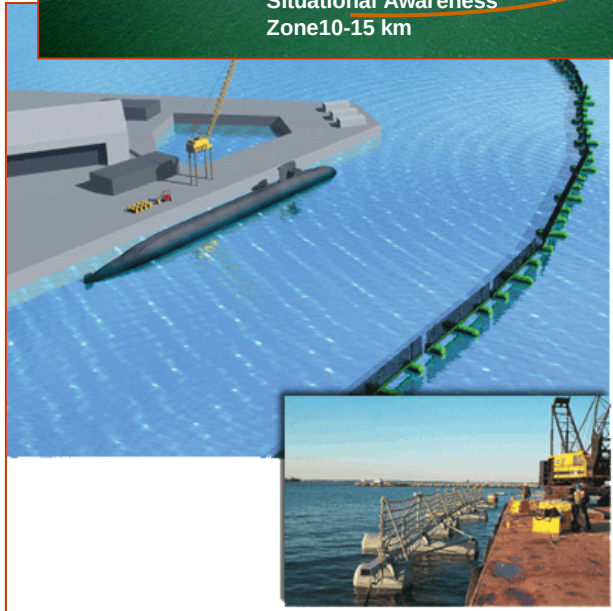
Iran Air 655



*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



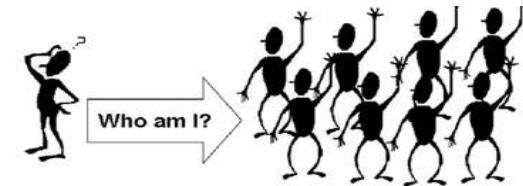
Terms of Reference

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 one-to-one matching process



Identification – a one-to-many 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."

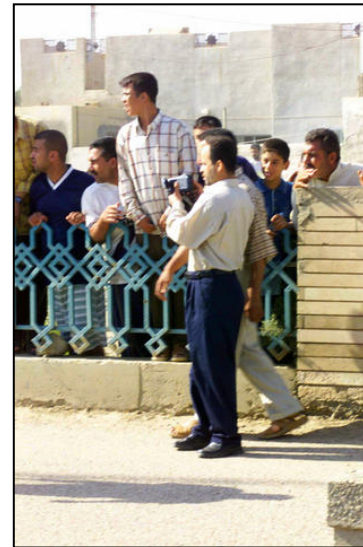
- **Business Functions**

- 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

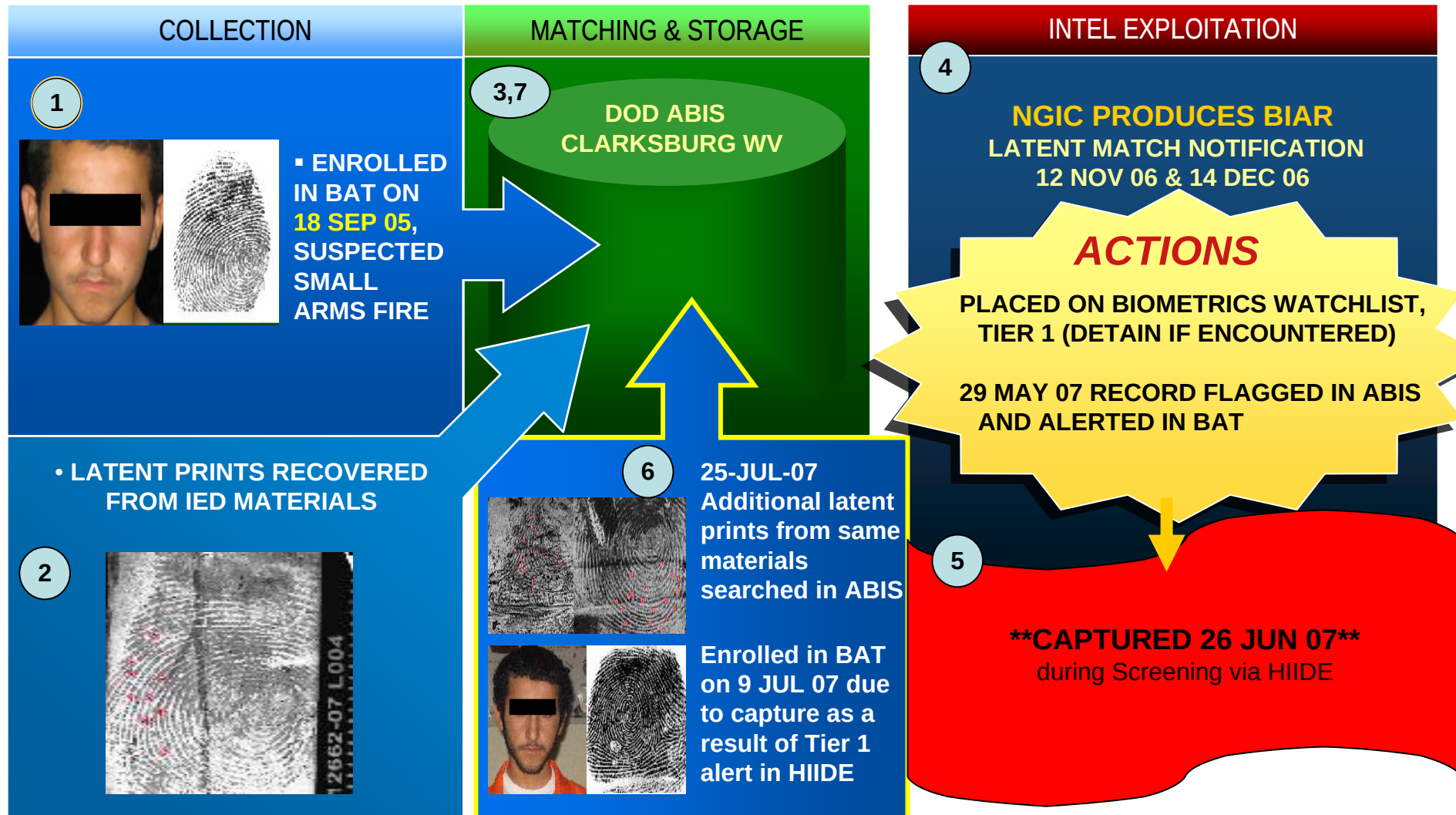
- Confidence level of ID?
- Consequences of a wrong ID?
- Operational situation?
- ROE?



Reuters Video photographer

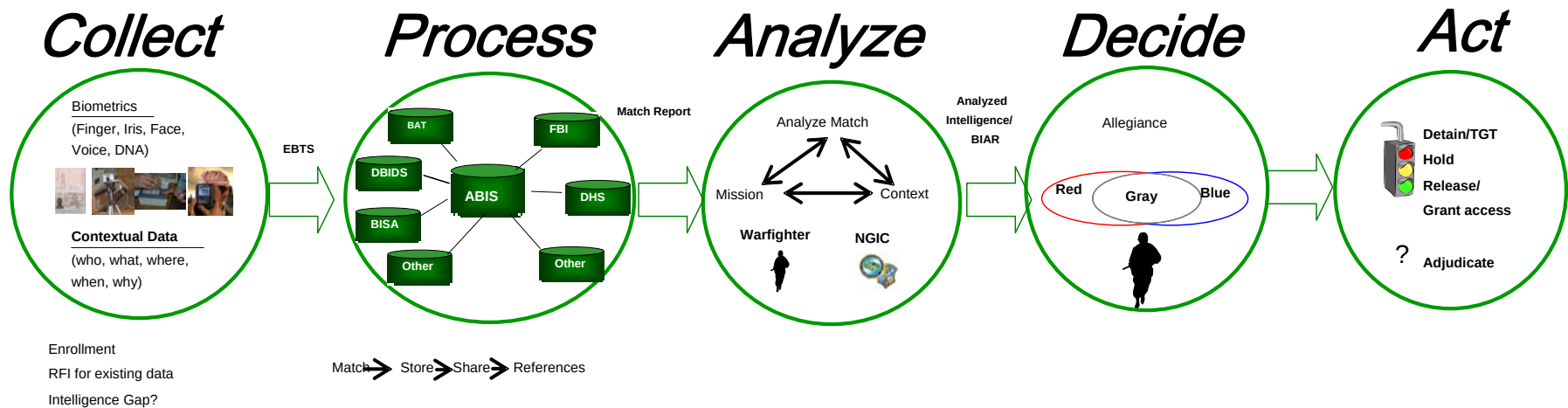


DoD Use of Biometrics





Supporting Requirements



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

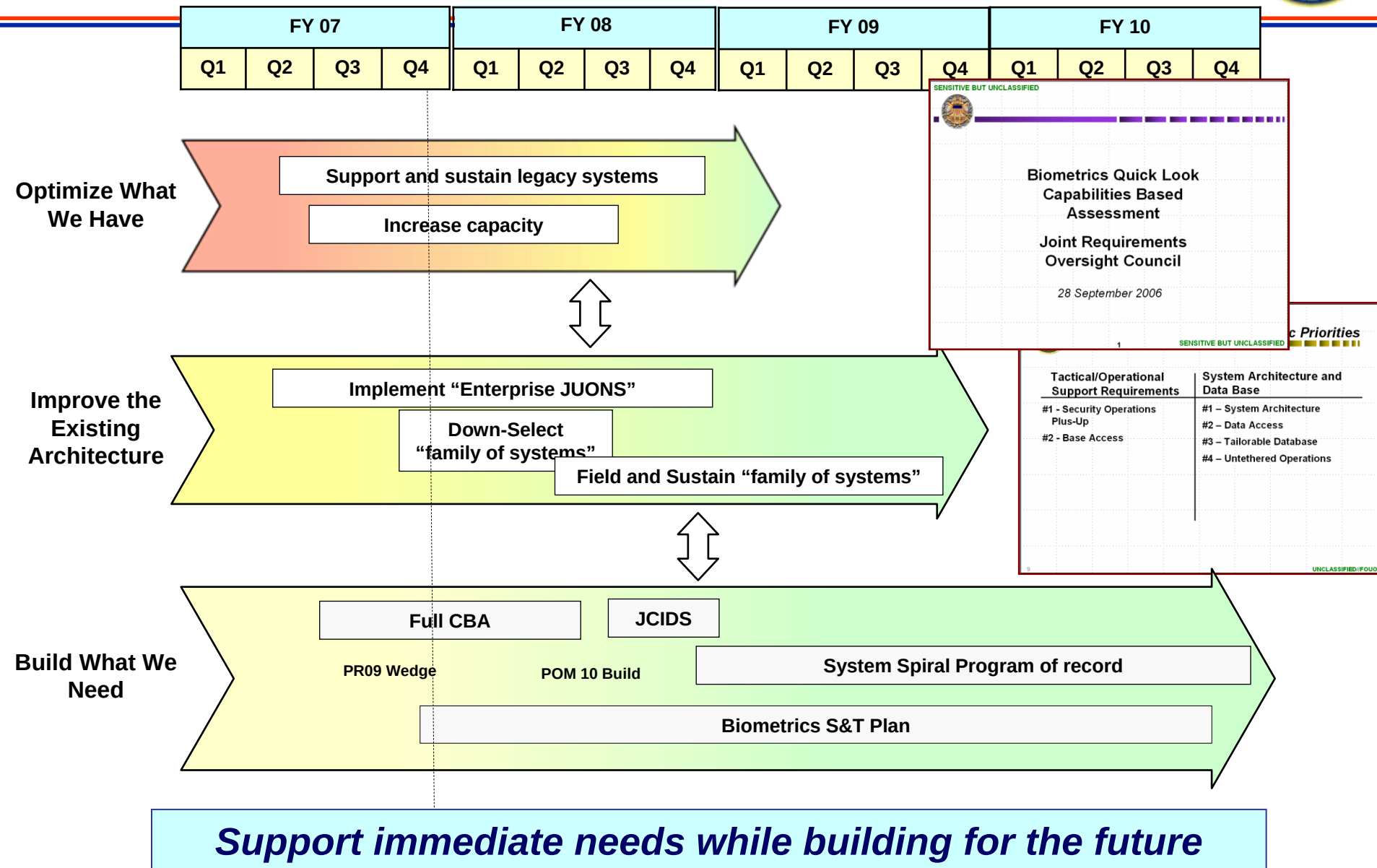
Biometrically Enabled Systems In Theater



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, 10 th Mtn Div in Afghanistan; also used in detention facilities	Flat Fingerprint, Photo, & Iris



DoD Biometric Strategy





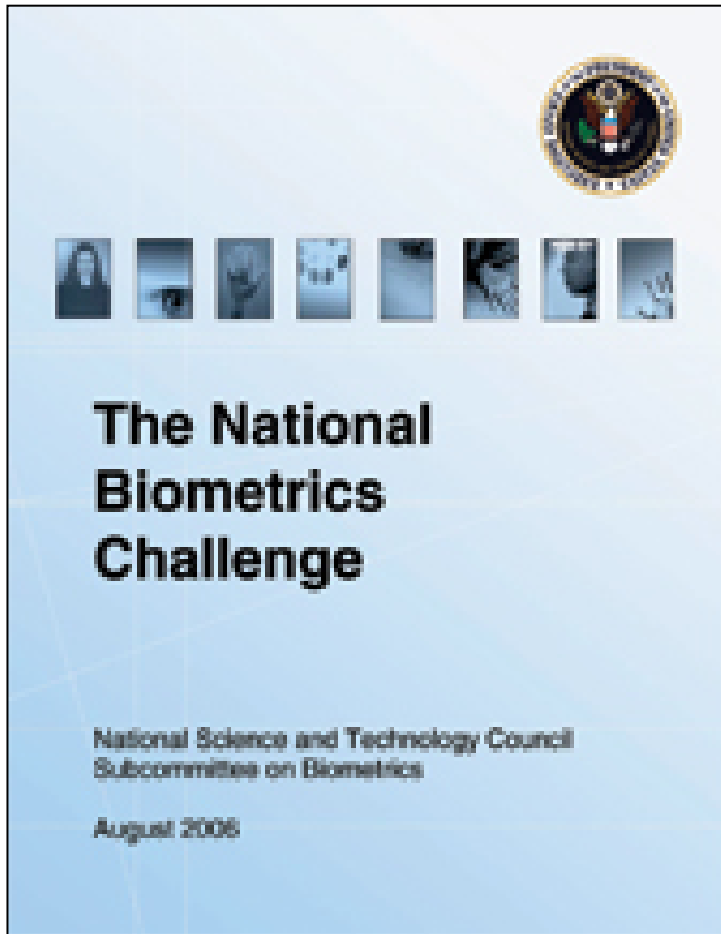
DOD Roles and Responsibilities

- **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***

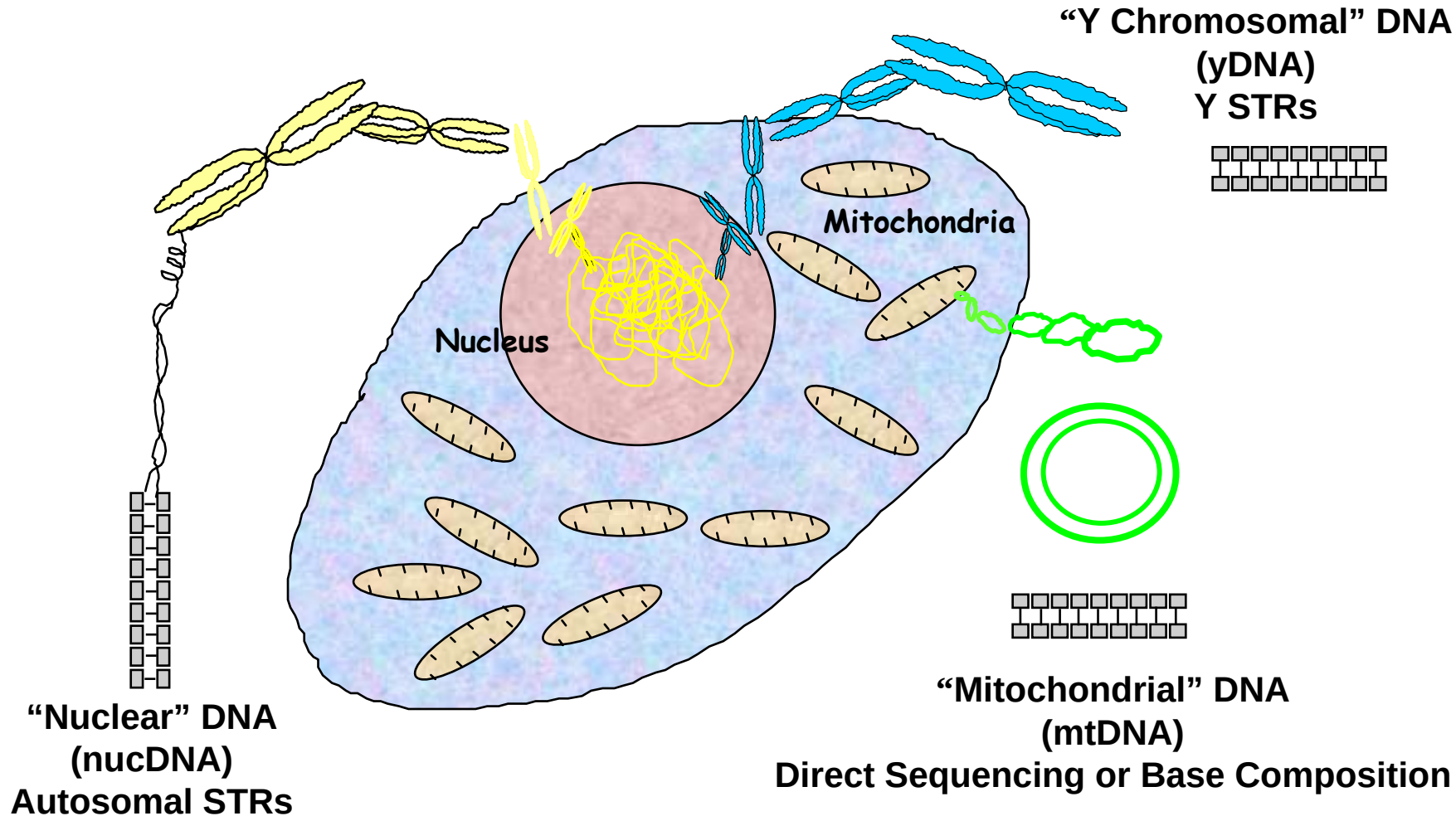


Discussion



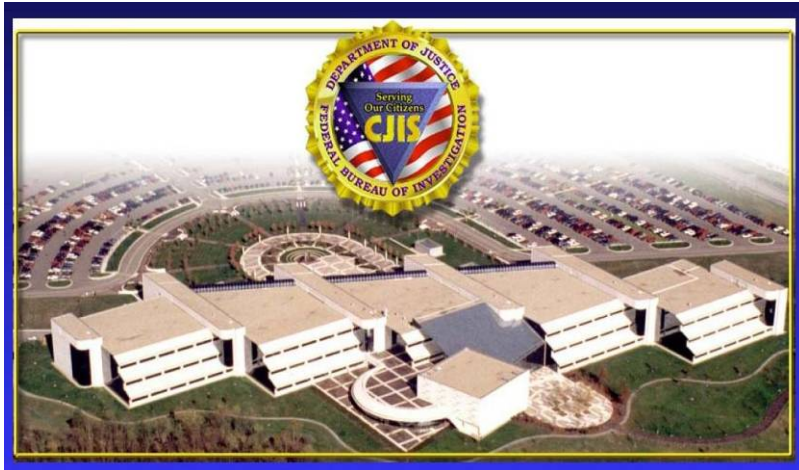
Human Genome

as the subject of forensic analysis



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

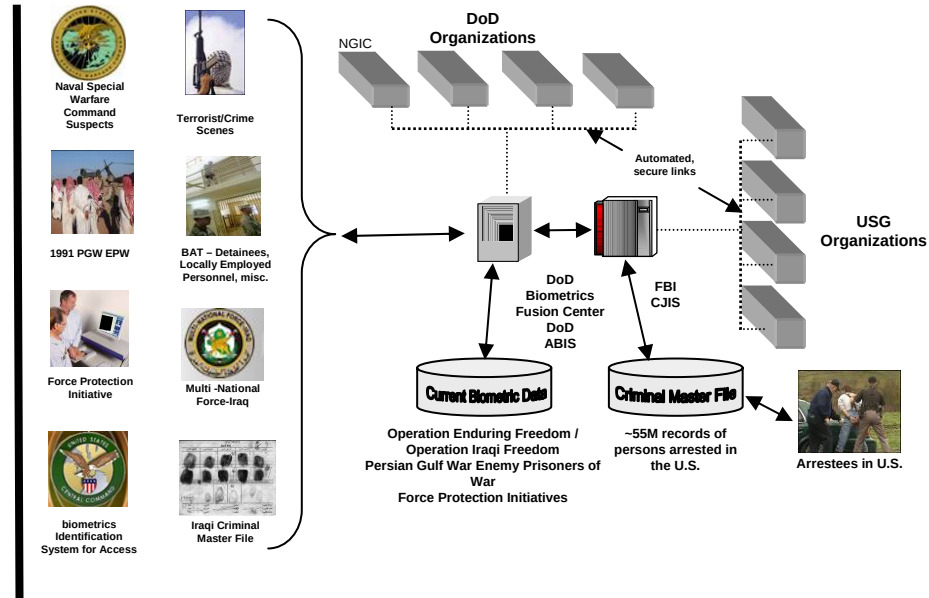
- Located at the Criminal Justice Information Services (CJIS) Division, Clarksburg, WV
- Maintains the world's largest biometrics database currently holding about 66 million records
- Has been in operation since July 1999
- Model for the DoD Automated Biometric Identification System (ABIS)

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)

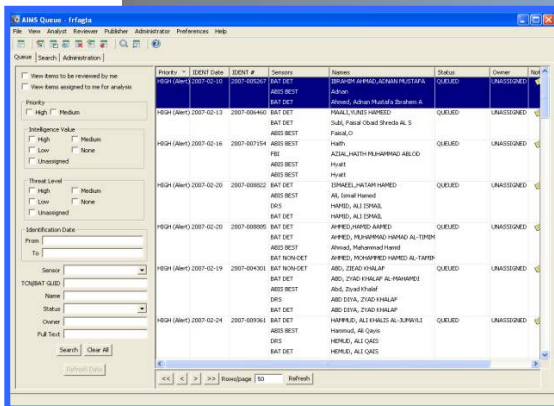
ABIS Operations Tasks:

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



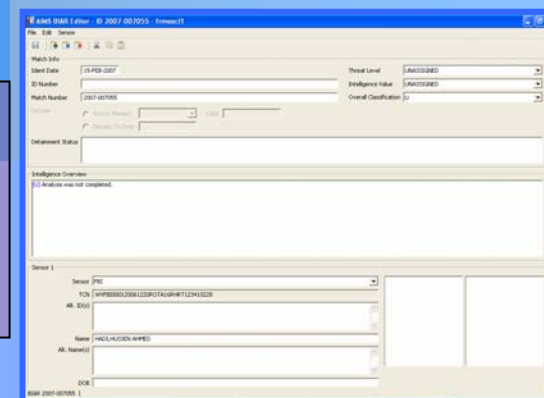
Automated Identity Management System (AIMS)

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

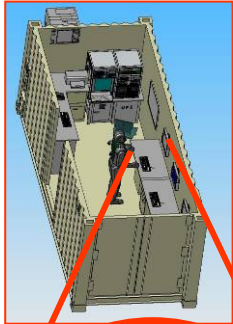
Prediction:

- 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

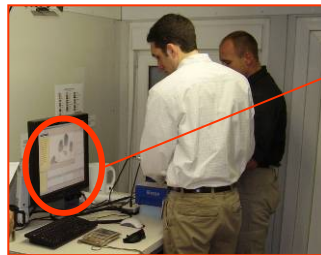
1. Enrollment Center and Kit



2. Iris-Scan and creation of digital image



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



3. Fingerprint Scan and creation of digital image



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

Biometrics Automated Toolset (BAT)



BAT Enrollment Station



Optional Equipment:

500GB Hard Drive



Badge Printer



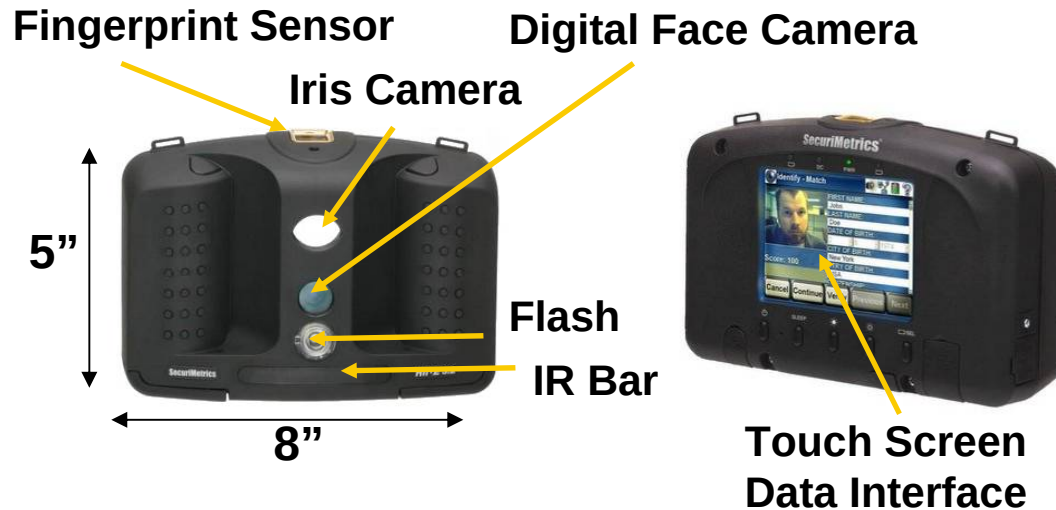
Bar Code Scanner



- **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 (SOLD) – 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

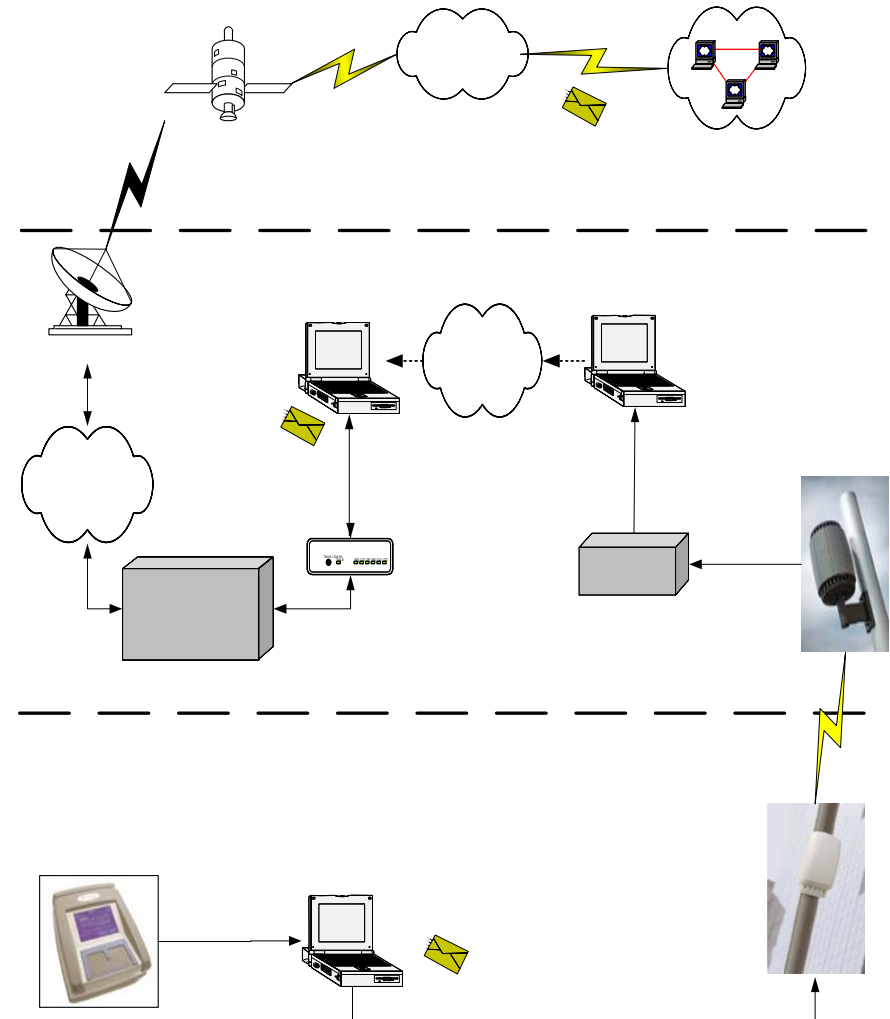
- Responsibility for adjudication of matches currently resides with the commanding officer of the vessel dispatching the VBSS team (ONI will receive match response)
- System for passing data between boarded vessel and host vessel in development
- Funding for TBCMS follow on systems/IDS not yet secured

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**



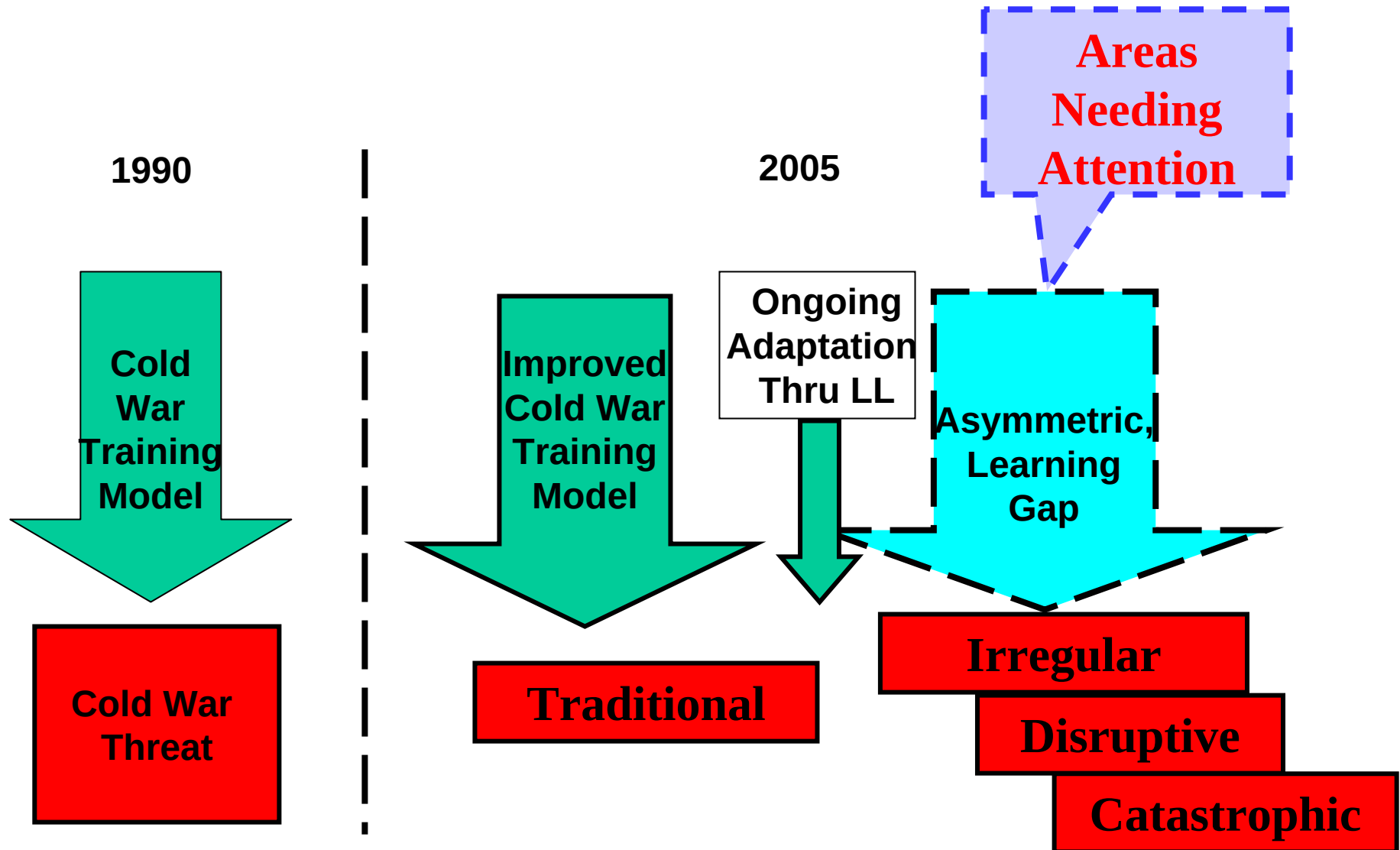
Asymmetric Warfare and Training to Adaptability



- **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





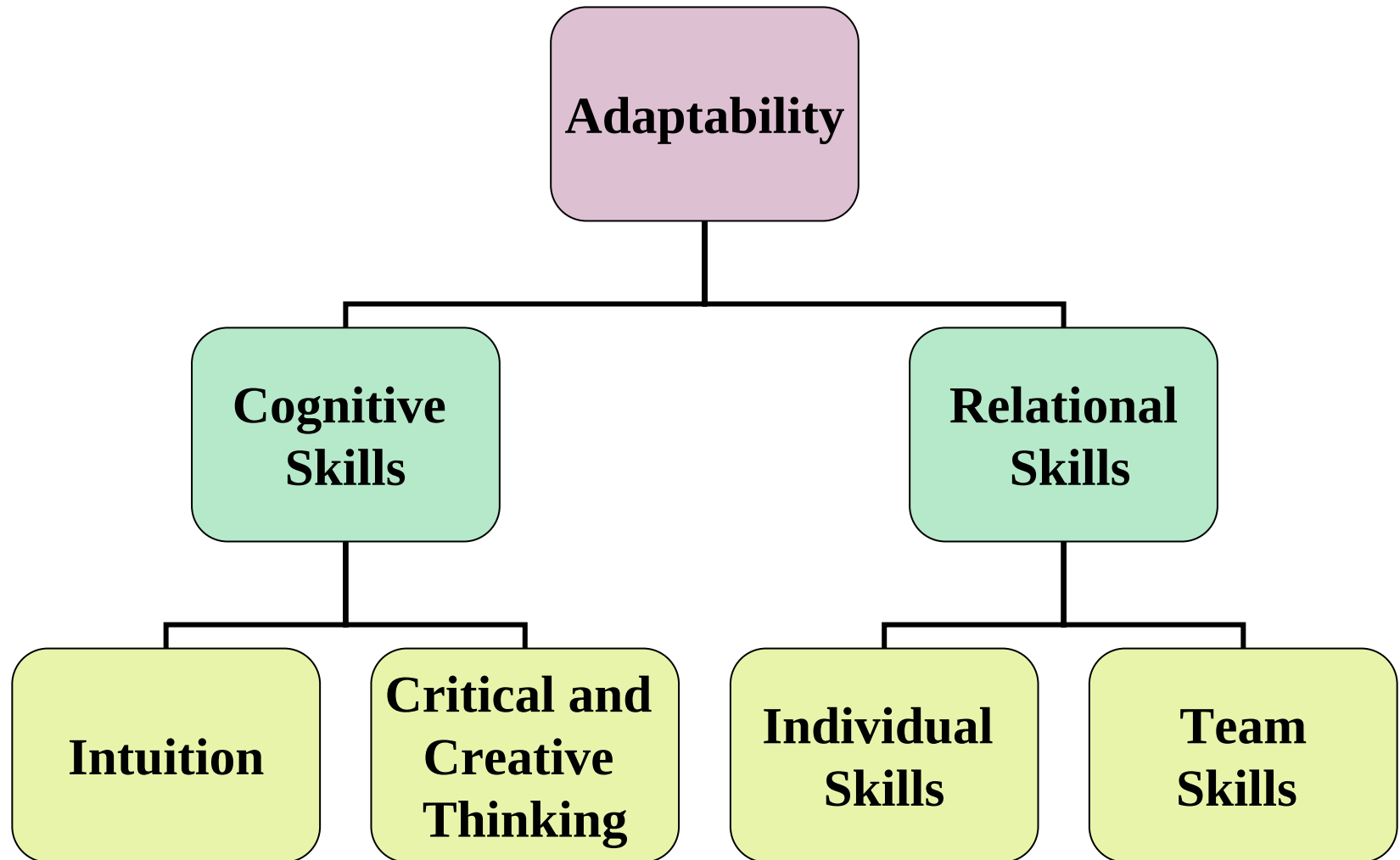
Asymmetric Warfare and Training to Adaptability Basic Findings



- **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

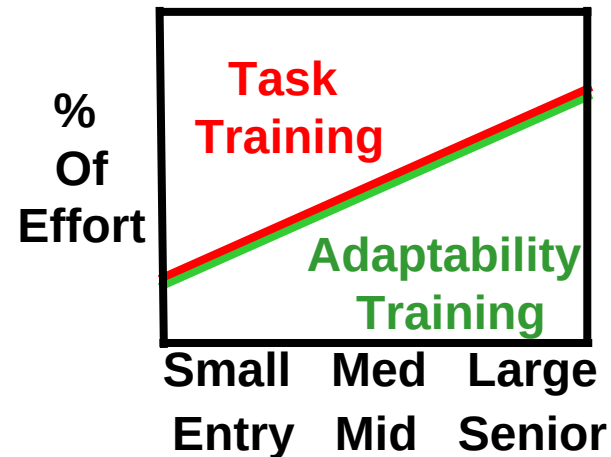
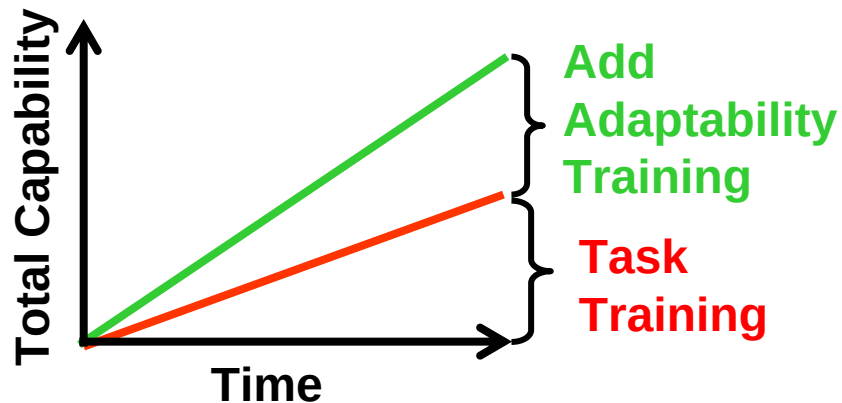




Adaptability Learning Goals



- 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
- Bottom Line: 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





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+

<i>Effectiveness of threat mitigation</i>	Very Effective	Effective if lucky on intelligence	Ineffective/expensive
<i>Risk of technical surprise</i>	Low to medium	High	Very High
<i>Effectiveness of intelligence collections tools</i>	Good for R&D direction	Low because development concealed and hard to collect against	Good for <i>deployed</i> system
<i>Maturity of technology</i>	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.*”



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

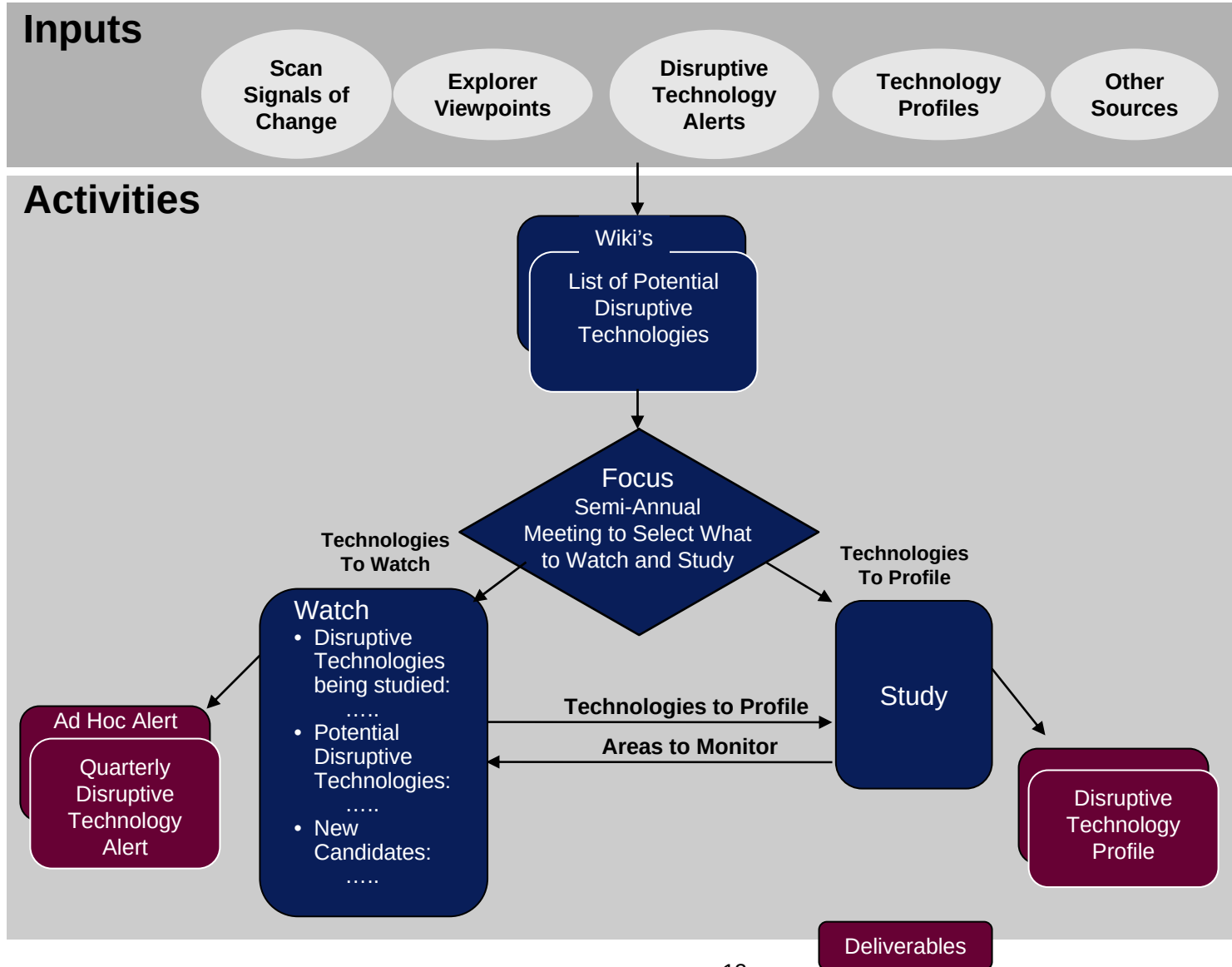
Those emerging technologies and integration capabilities identified as most significant to **advance or degrade** US security broadly defined. Must cross the **“major” threshold of interest** – if not satisfactorily resolved would result in a noticeable but temporary degradation of US geopolitical, economic,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

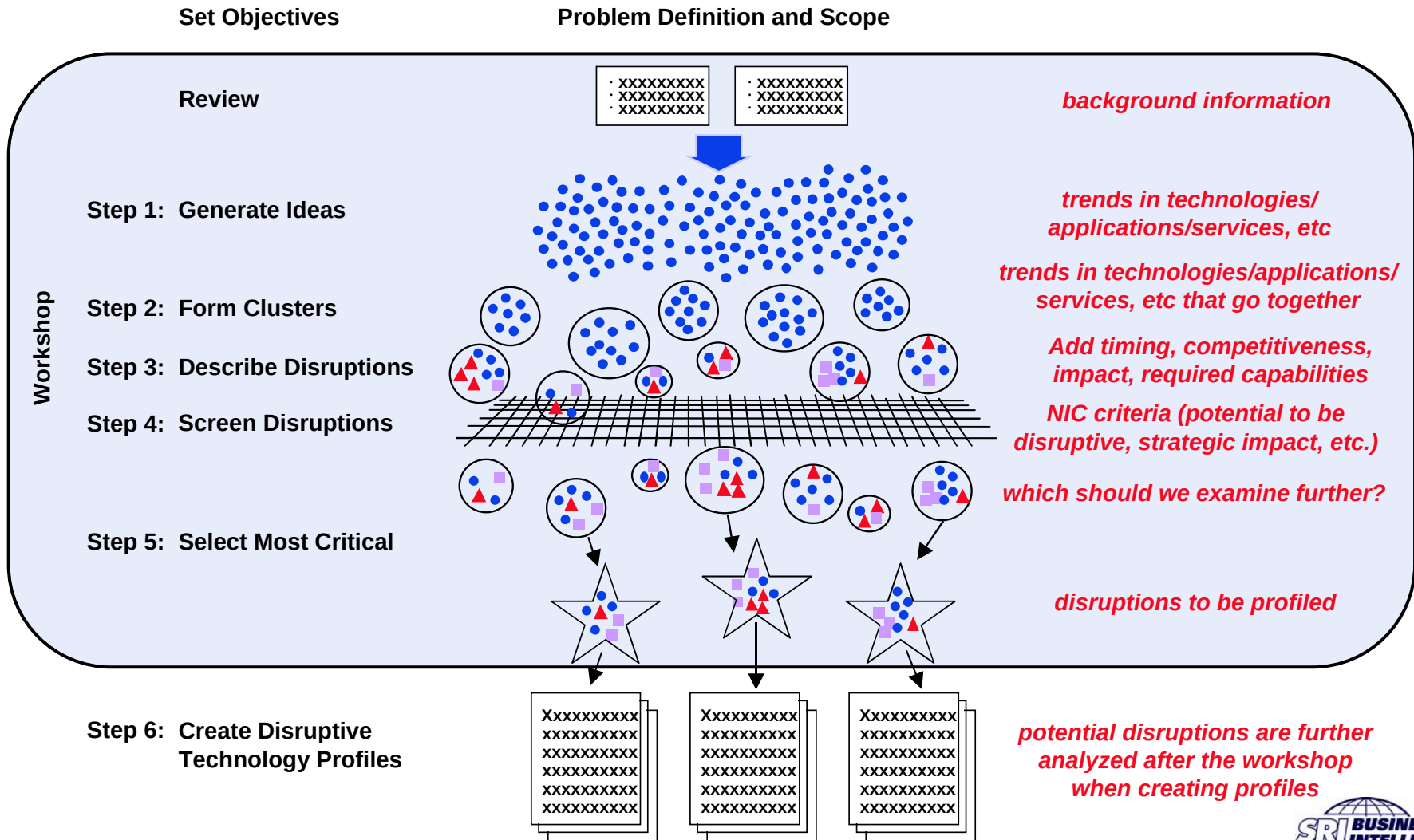
Overall Process for Identifying and Monitoring Disruptive Technologies



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)

Task 3: Disruptive Technology Workshop— Example Process Flow





Process Initiatives

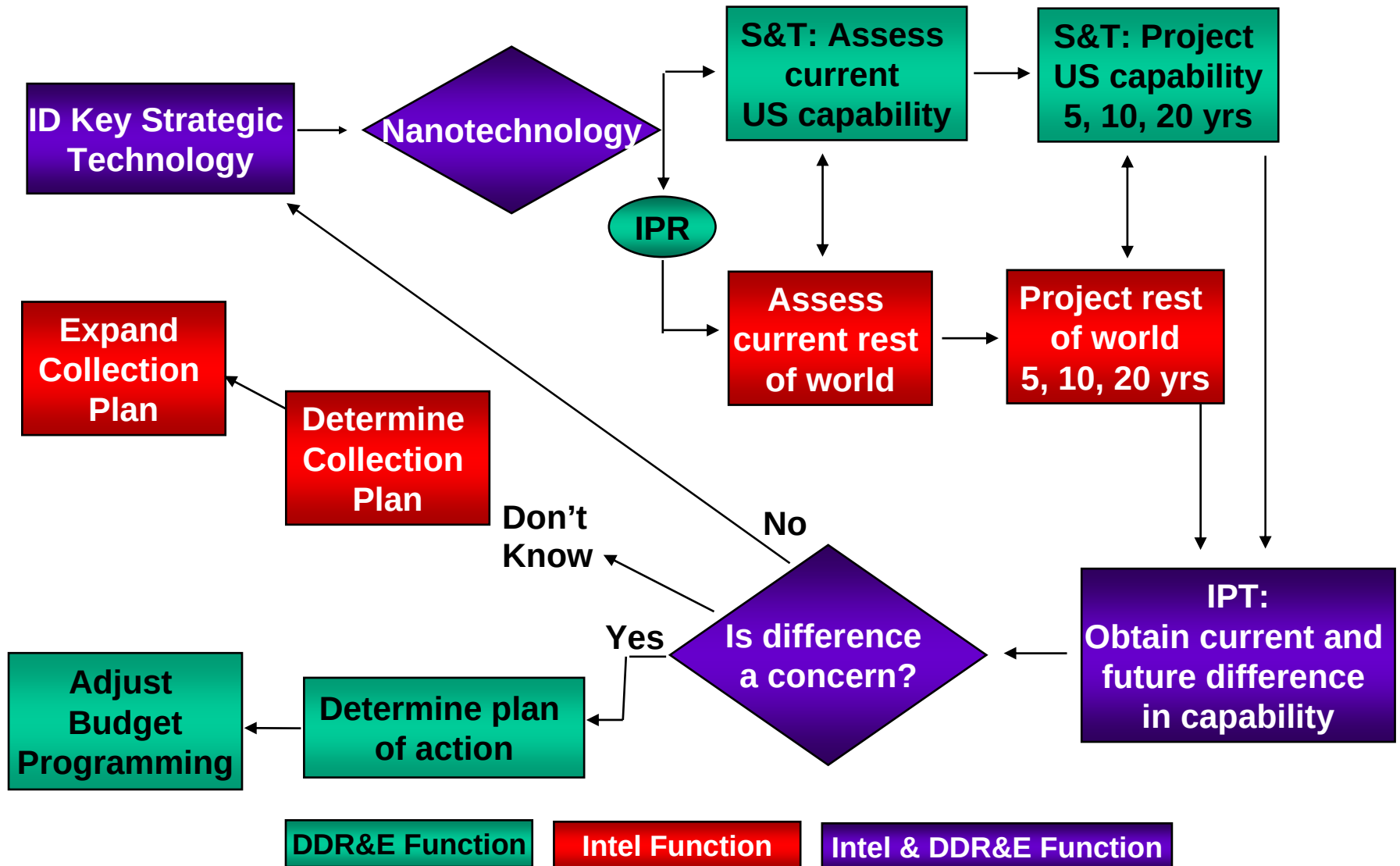
But in the end, by and large, the processes give you lists.

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**

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.”



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?



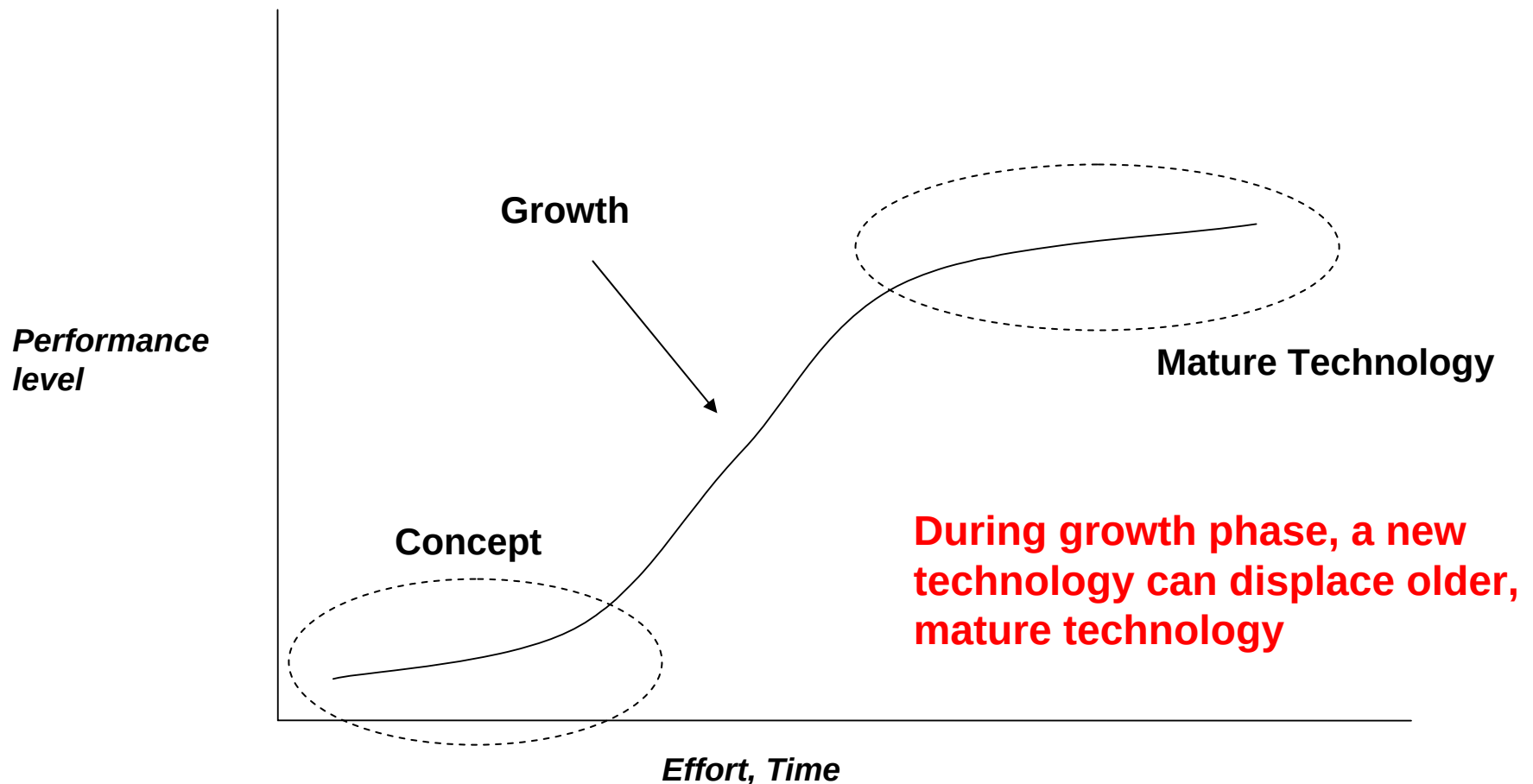
© Scott Adams, Inc./Dist. by UFS, Inc.

A Final Concept *Technology S-Curve*



Most Technology maturation follows S-curve:

Initial Discovery, “Product-ization”, then Incremental Improvement



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

Higher

- ❑ 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)

Lower

LIKELIHOOD

Lower

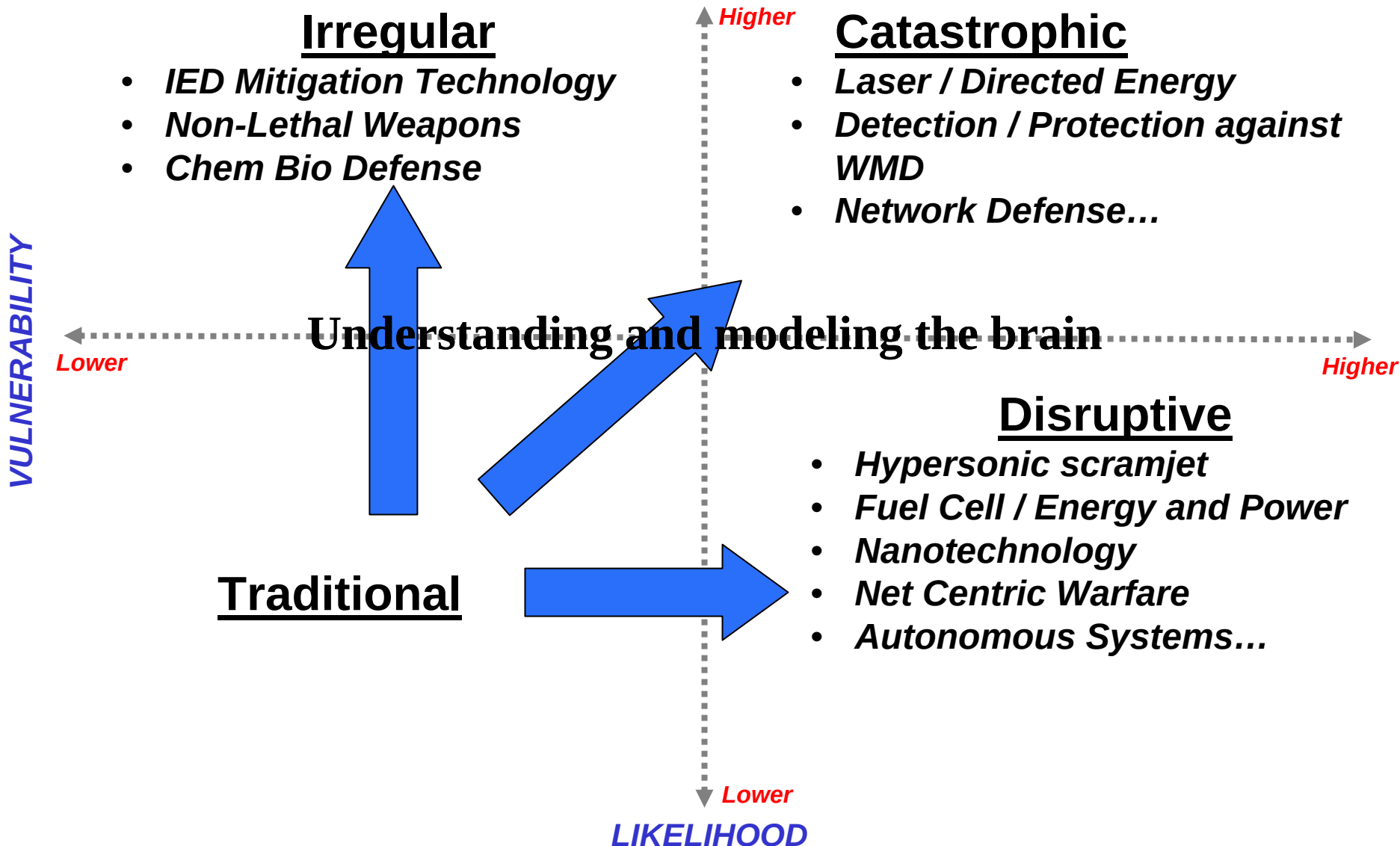
Higher

VULNERABILITY

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)

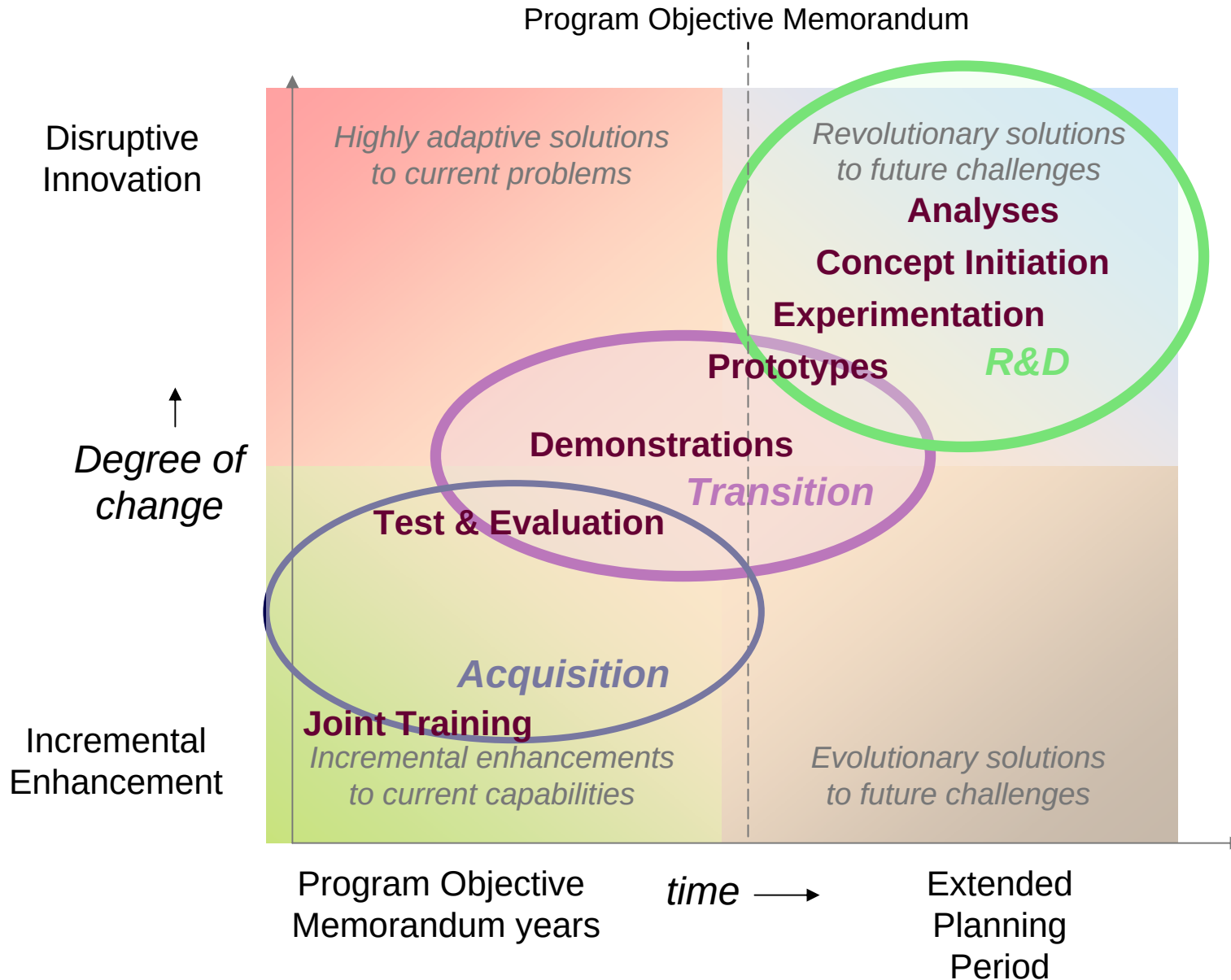
Defense Research & Engineering

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Capability Transition Environment

Defense Research & Engineering



Joint Capability Areas

Defense Research & Engineering



↑
No implied prioritization
↓

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

Development Model for Acquisition Solutions

Defense Research & Engineering



more

**Maturity
of
Operational
Concept
and
Technology**

less

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

6.4

6.5

6.7

Proc

O&M

Science & Technology

Research & Engineering

TRL 1

TRL 2

TRL 3

TRL 4

TRL 5

TRL 6

TRL 7

TRL 8

TRL 9

Technology Development

System Development & Demonstration

Production & Deployment

Operations & Support

A

B

C

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 acquisition 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



Defense Research & Engineering

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

UNCLASSIFIED



Disruptive Technologies Conference

Evolving Joint Needs & Desired Joint Military Capabilities

UNCLASSIFIED

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

- ✓ 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

Agile/“Limited” Acquisition Process

Delivers between 1 and 3 years

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
- Military assessment of utility

Functional Validation; Tailored Form/Fit/Function

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Technical Concept Design & Development

- Prototyping

Alternatives Development & Assessment

- Experimentation
- Red Teaming Analysis

Conceptualization

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

***Foreign Comparative Testing
Defense Acquisition Challenge***

ACTDs JCTDs

JI&I JFIIT JSIC

Joint Experimentation

JWP

JAWP

Aligned with your needs.

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*

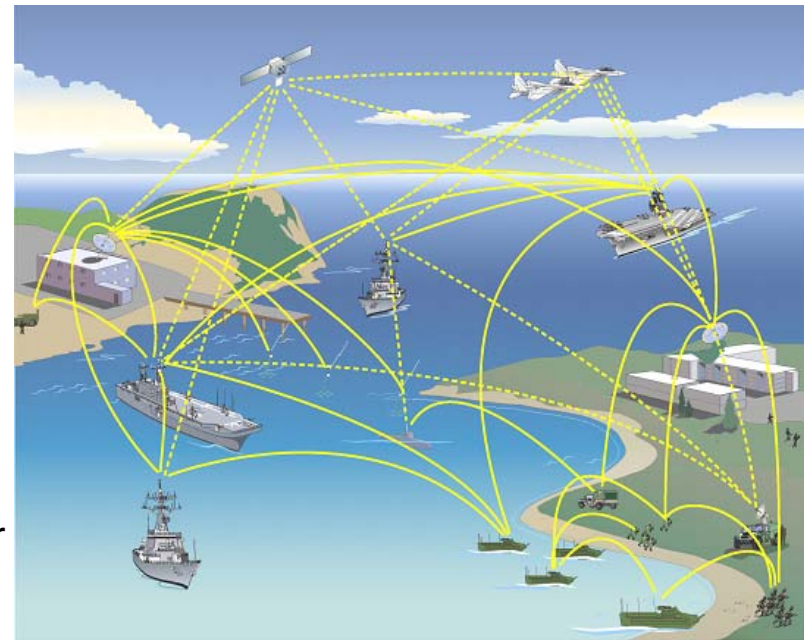
Response

**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!**

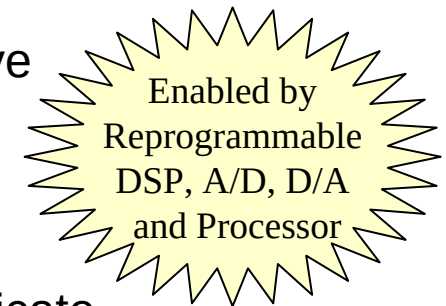


Disruptive C4ISR Devices and Systems



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.



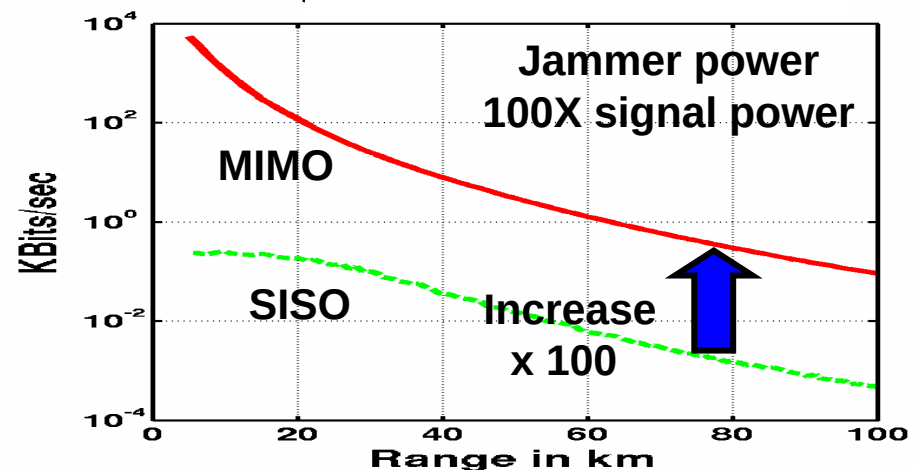
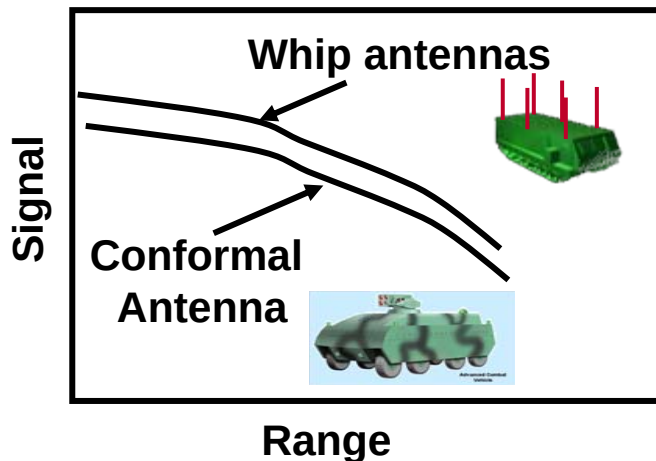


Functional Power: C4ISR & EW Agility/Redundancy

- 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

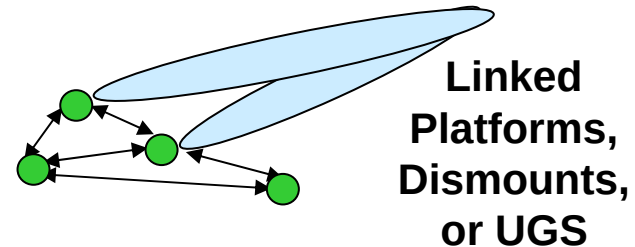




Disruptive Technology: Antenna Opportunities & Issues

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

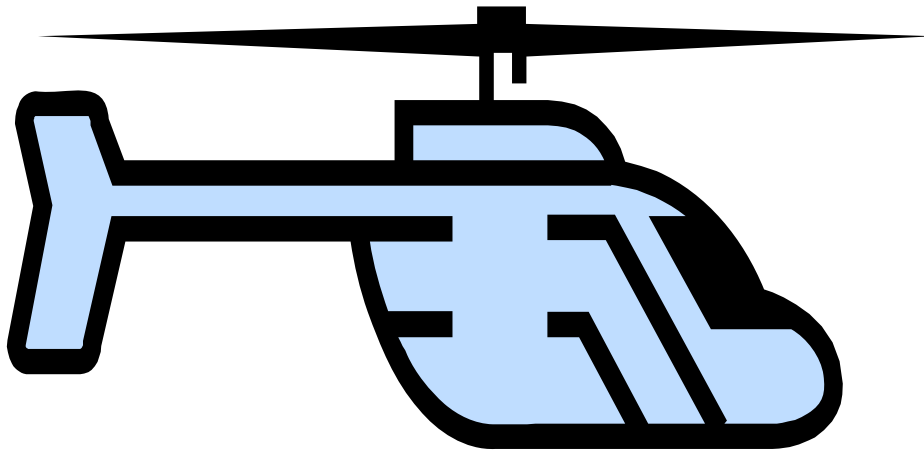
Single Platform



- 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

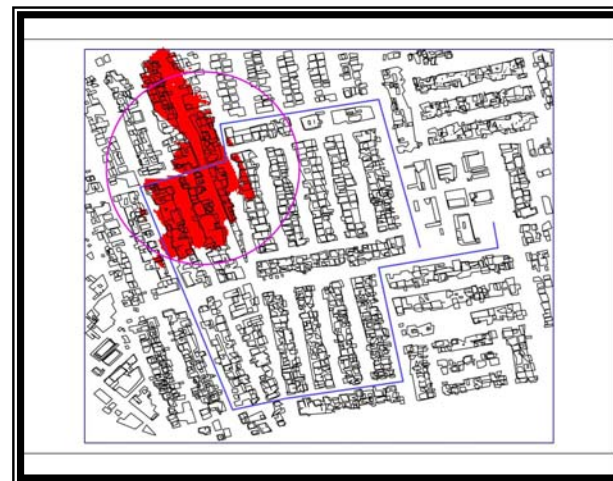
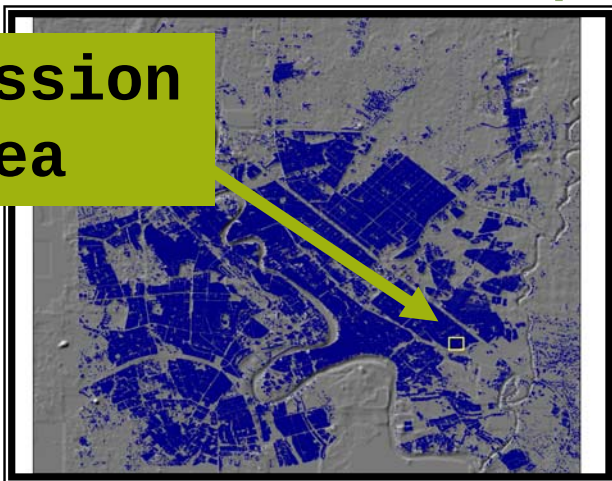
- RF MANET mesh-net node
- Sensor

*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

Mission Area





Disruptive NETOPS and Battle Command at the “Edge”



Net-Centric Ops Battle Command Technology

Provide Net-centric Operations RF management 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



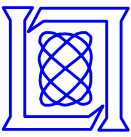
Advantages

- 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

Zachary J. Lemnios

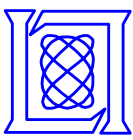
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MIT Lincoln Laboratory**

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**

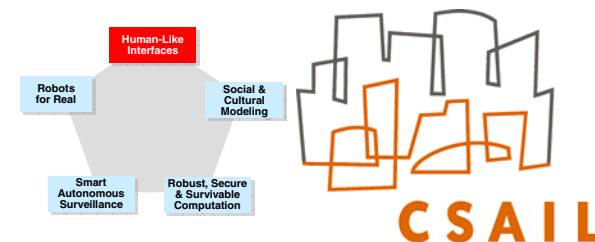
Contextual exploitation

- **Mega-scale data management**
- **Situation dependent info extraction**
- **Human/system collaboration**

Scalable effects delivery

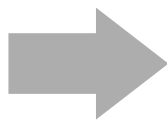
- **Consequence-modeled decision making**
- **Information ops**
- Time critical fires
- WMD mitigation

Computer: Yesterday and Today



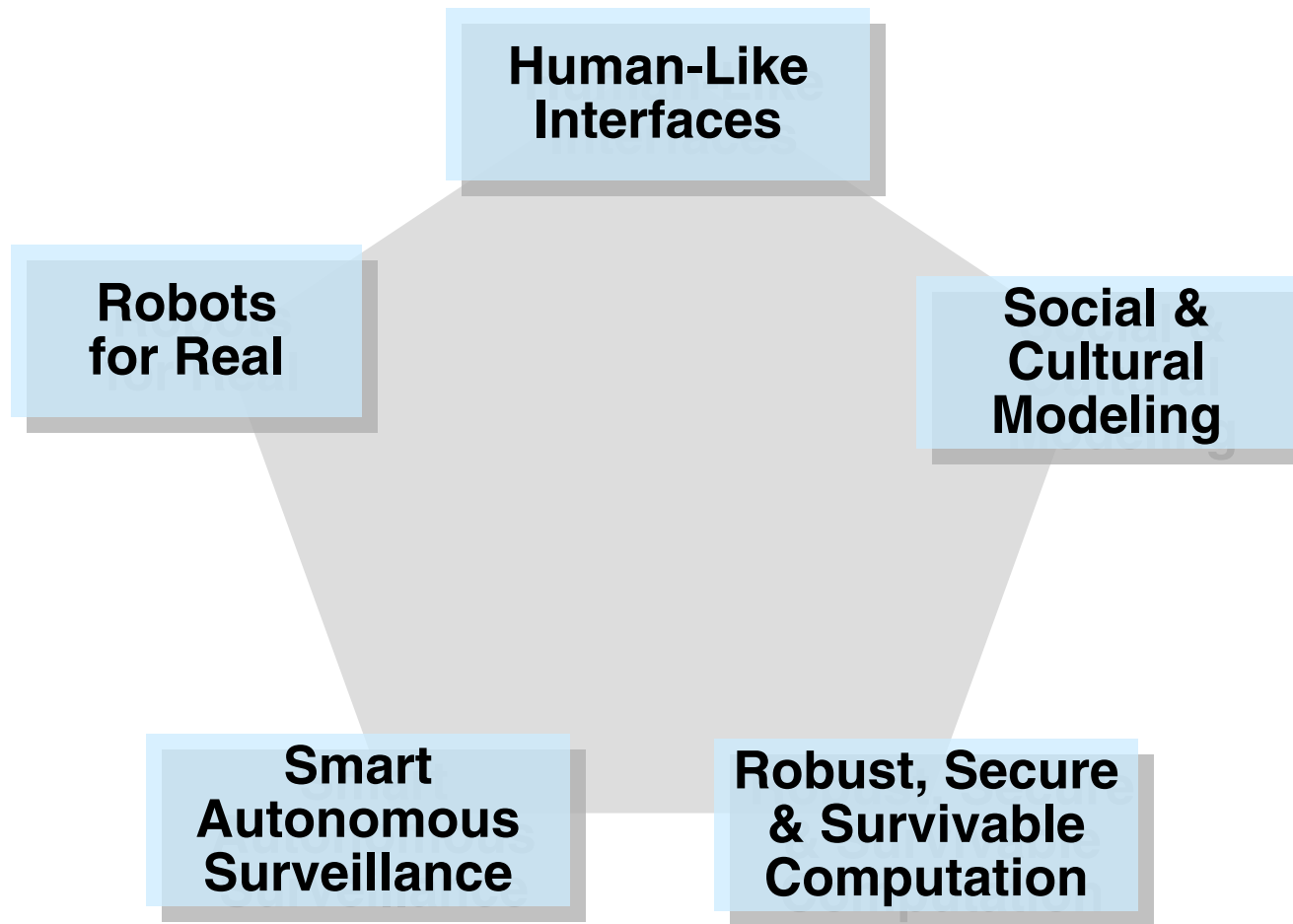
- Computation of static functions in a static environment, with well-understood specification
 - Computation is its main goal
 - Single agent
 - Batch processing of text and homogeneous data
 - Stand-alone applications
 - Binary notion of correctness
- Adaptive systems operating in environments that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

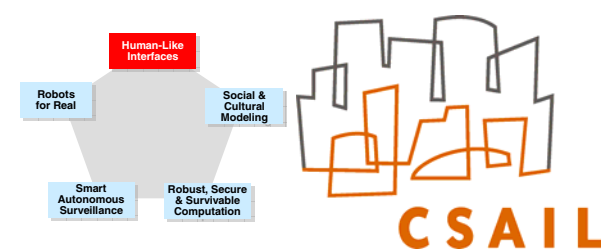


Environment

**High tempo
Enormous data loads
Civilian clutter
Deep hide threats**

**Wicked problems
Unstructured environments
Cultural interaction
High consequence**

Challenge 1: *Human-like Interfaces*

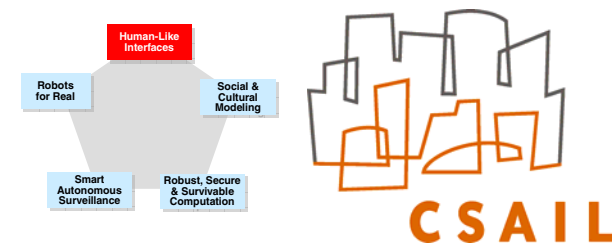


- Interacting with computation should be as natural as interacting with people.



- 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



Today

individual modalities

controlled
environments

pre-specified
language

pre-specified
multimodal
interactions

*understand structured
language*

3-5 years

selected combinations

noisy environments

learn new vocabulary
interactively

opportunistic use of
multimodal interaction

*understand
conversation*

5-10 years

multimodal interaction

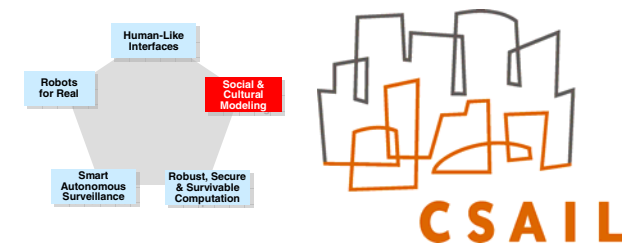
uncontrolled
environments

learn new vocabulary
by example

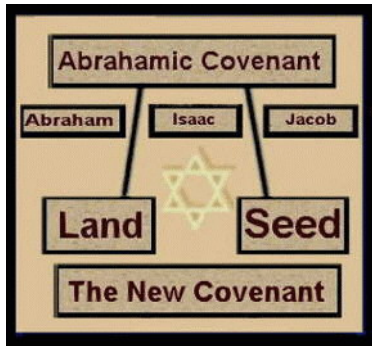
adapting
opportunistically to
modalities available

*non-distracting
interaction with a
teammate*

Challenge 2: *Operate in Foreign Cultures and Coalitions*



- ... 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

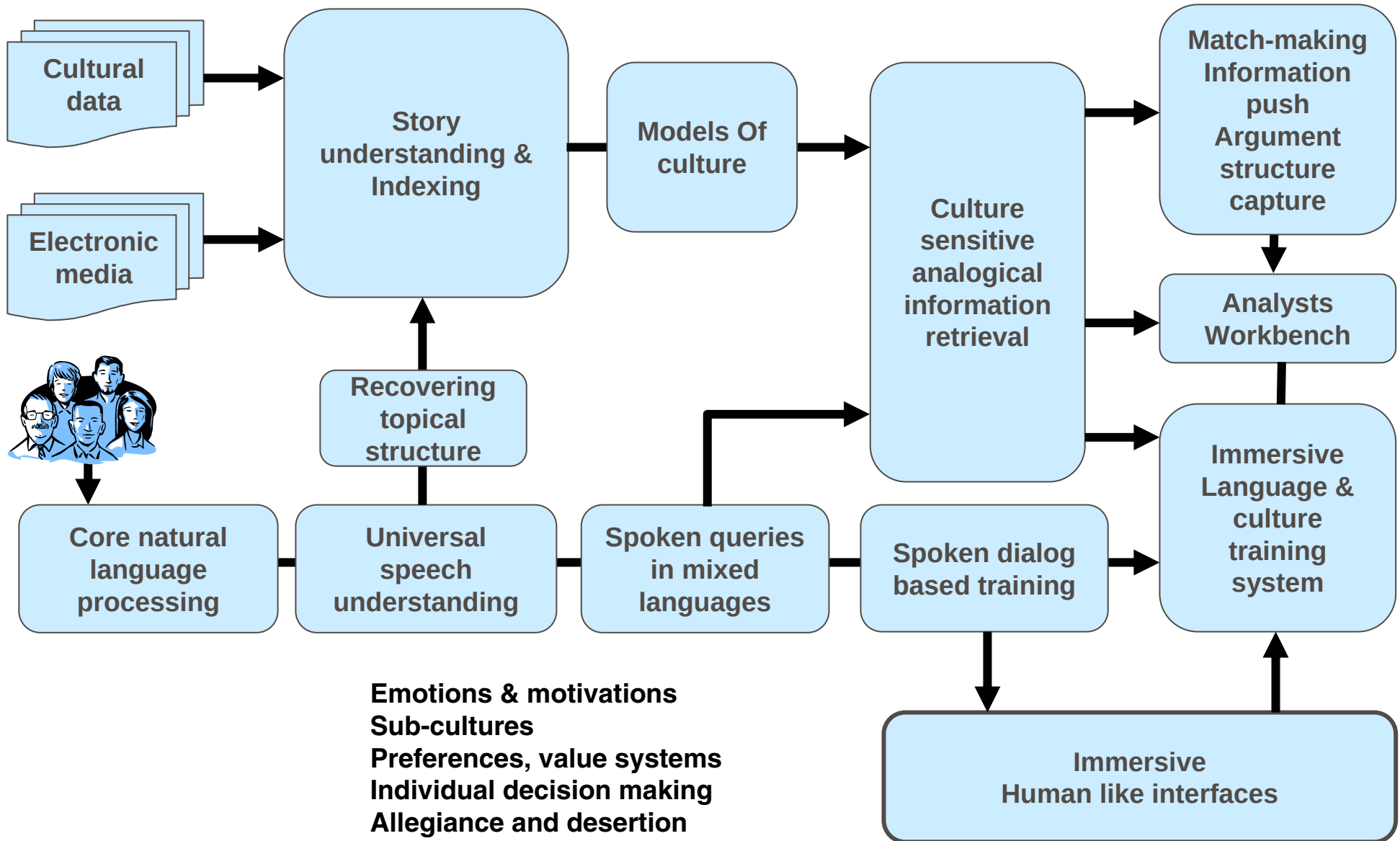
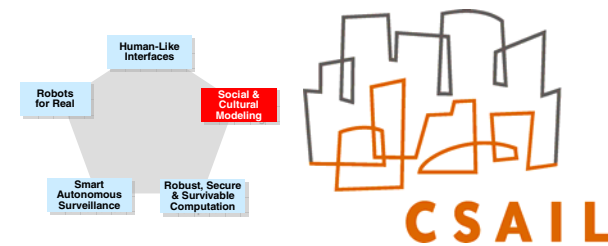


Muslims Praying at the
Dome of the Rock

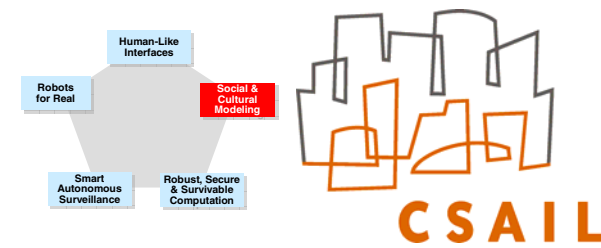


The Ascension of
Muhammad

Key Research Elements



Social & Cultural Operations Today, Tomorrow, and Beyond



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

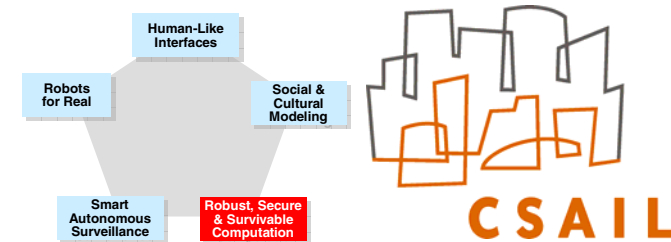
Robust understanding of causal structures

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



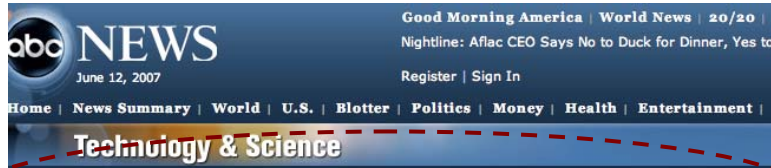
Software glitches leave Navy Smart Ship dead in the water

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



“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.**



[Home > Technology](#)

White House Spy Probe Shows Computer Vulnerability

Digital Tools Exist to Spot Leaks, Corporate Spies, But May Not Have Been Used

Oct. 6, 2005

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

abc NEWS

Font Size
A A A
E-mail
Print

Talk Back

- Tell us what you think
- Add new facts
- Talk straight to the news

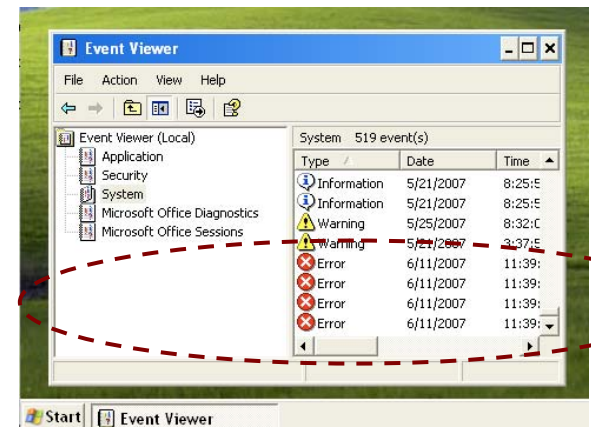
Comment

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

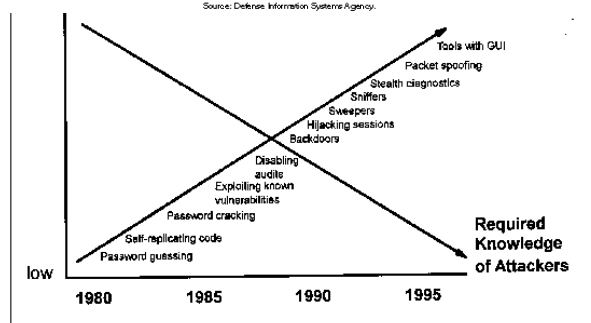
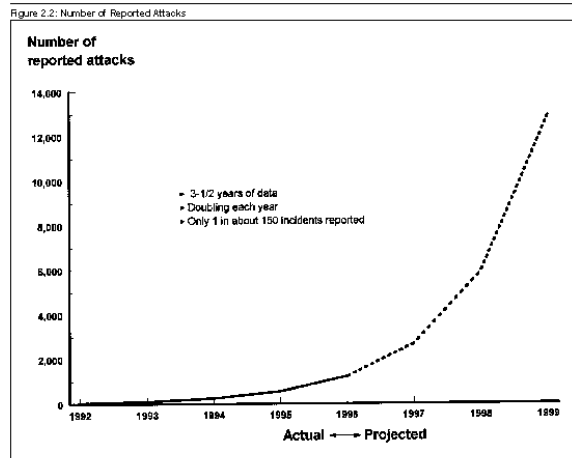


Why Is This Hard?

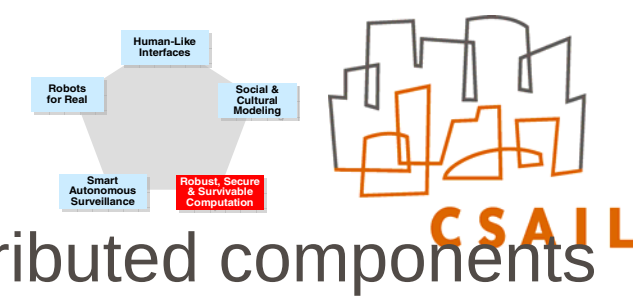
Harsh Environments



Capable and dedicated opponents



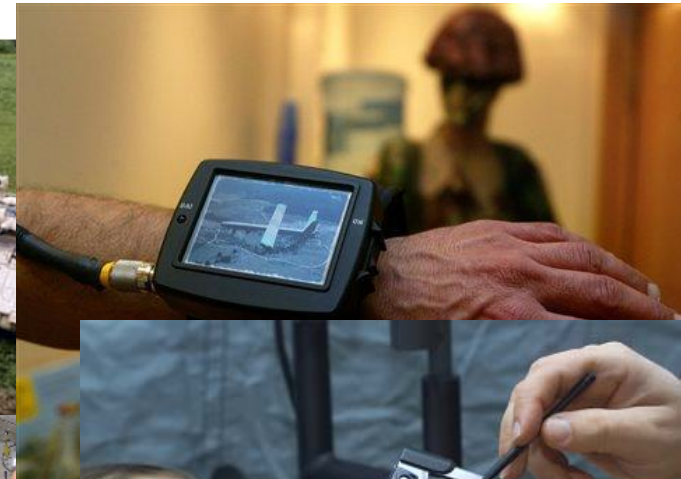
Source: Department of Defense.



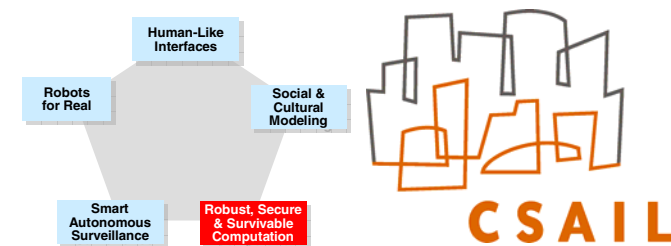
Mobile and distributed components



Heterogeneous systems

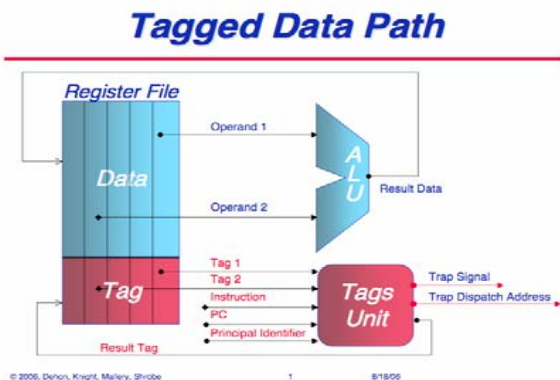


Key Research Elements

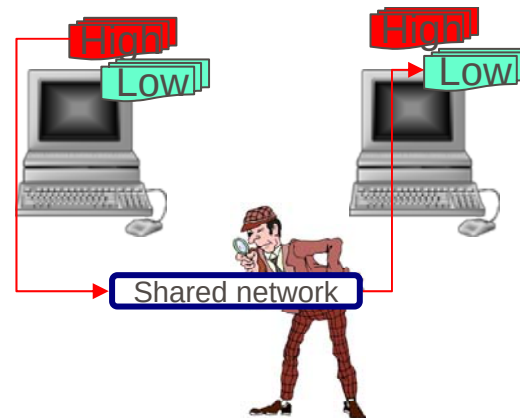


1. A highly secure and sustainable computer architecture
2. Model-based self checking and self-healing frameworks
3. Information flow control
4. New algorithms for dynamic distributed systems
5. High performance embedded networked security monitor
6. Abstractions and compilation for emerging multi-cores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

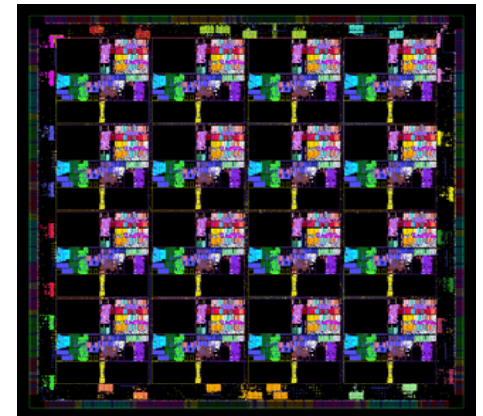
Secure and sustainable computing
Using hardware enforced integrity



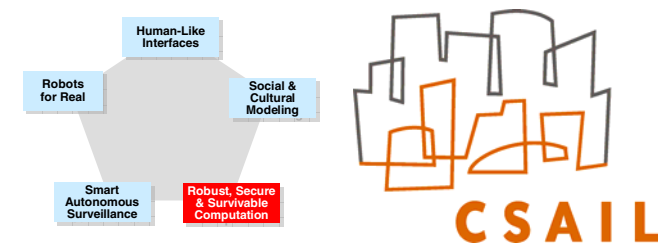
Model based self-checking &
information flow control



High performance
network security
monitor



Secure and Survivable Systems Today, Tomorrow, and Beyond



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

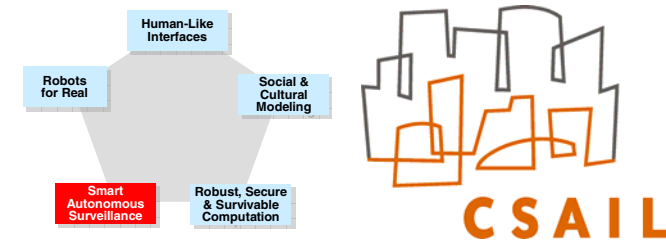
5-10 years

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)



Mexico City



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



Predator



Global Hawk

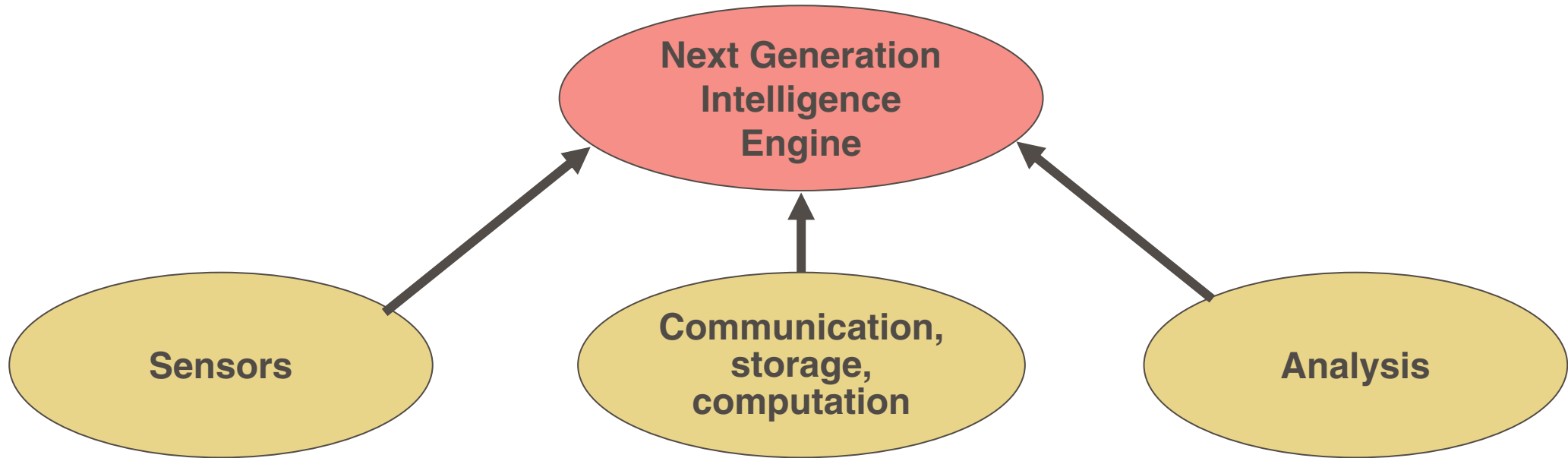
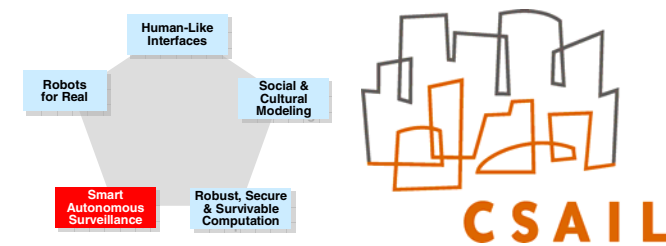
Avg. 6 people needed to interpret data from 1 Predator



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



Smart Autonomous Surveillance: from Forensic to Prediction Tools

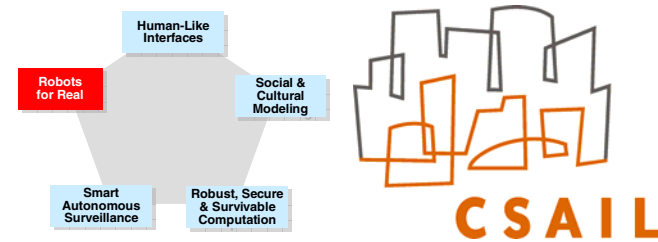


- Computational cameras
- Coded aperture sensors
- Queuing sensors

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

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

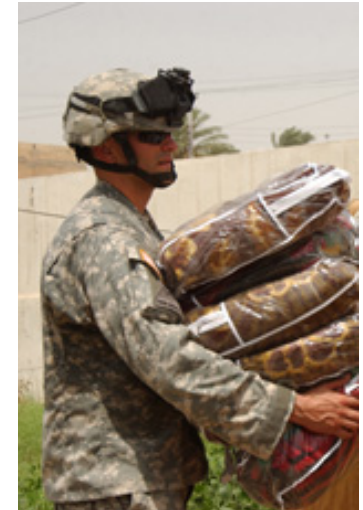
Challenge 5: Robotics for Real



- **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
- **Better robots for monitoring**
 - *Enable* soldiers w/ persistent and pervasive ISR, including from hard to reach places (e.g., inside buildings/caves/bunker networks)
- **Better robots for logistics**
 - *Replace* soldiers in the supply chain with capable autonomous robots and vehicles

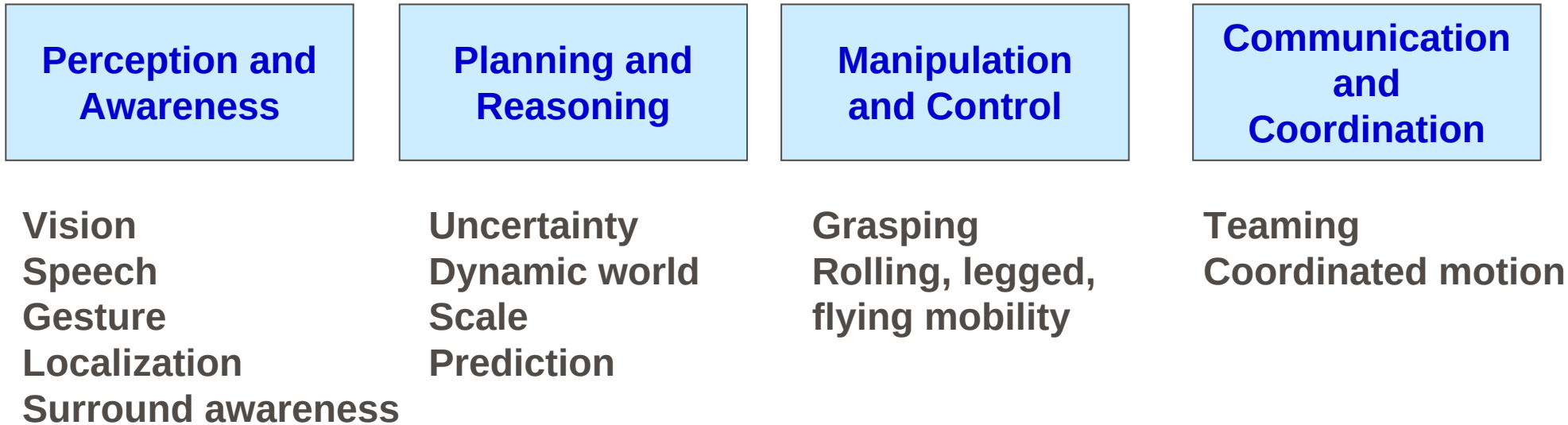
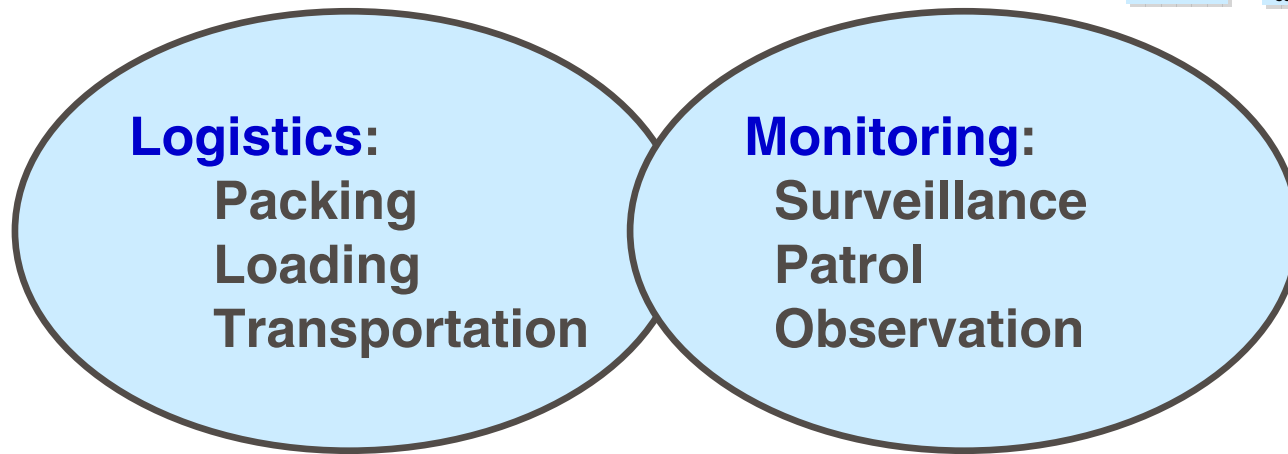
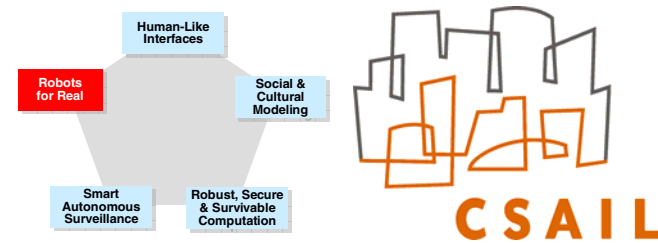


RQ1-Predator GCS



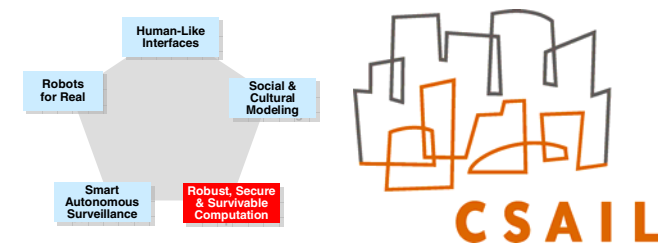
Supply-chain task

Key Research Elements



← Enabling Technical Areas →

Robotics Today, Tomorrow, and Beyond



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

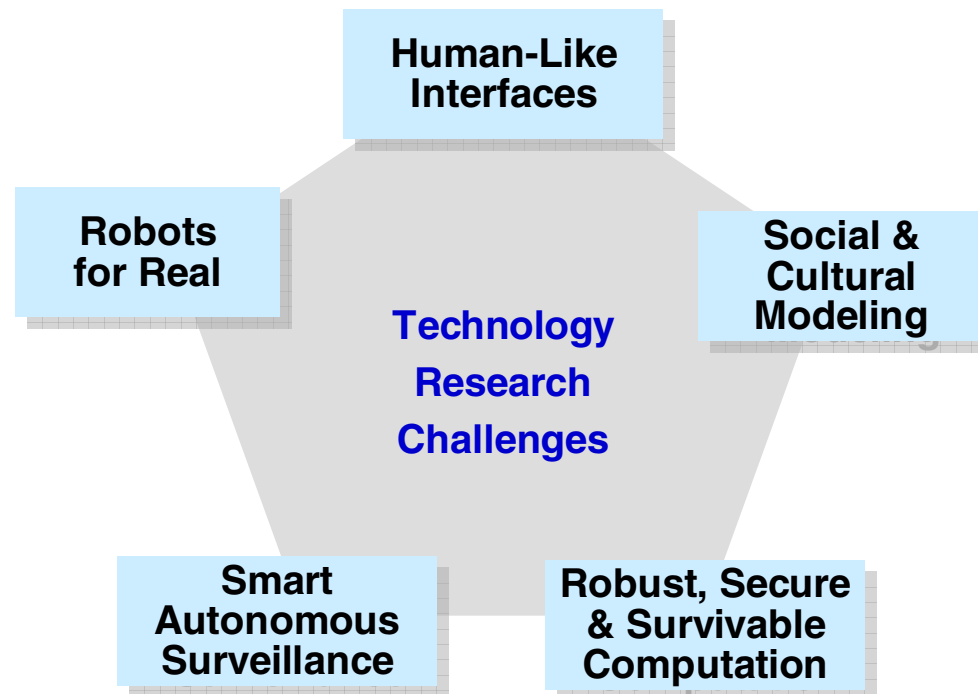
Robotic supply chain improves efficiency and surge response, greatly reducing the danger to humans

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

		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		●								

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

		Threats Impacting Missions										Mission-Enabling Technologies									
Counter-Threat Technologies	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	Advanced AAW	Antenna Technology	Coordinated, Multimode ASW	Effective C2 in EMCON	Environmental Sciences	Lower-Cost Platforms	Offensive Mine Warfare	Pattern Recognition & Anomaly Detection	Robust Offensive Information Warfare	Upstream Information Fusion
		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
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	Provide Seaborne Missile Defense	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Provide Seaborne Support for GWOT	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Protect Maritime Areas of Interest	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Project Military Power	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Threaten Adversary Military Forces	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	Deter Nuclear Attacks	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
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		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Technology Traceability to Missions and Threats

		Threats Impacting Missions										Mission-Enabling Technologies									
		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	Advanced AAW	Antenna Technology	Coordinated, Multimode ASW	Effective C2 in BMCON	Environmental Sciences	Lower-Cost Platforms	Offensive Mine Warfare	Pattern Recognition & Anomaly Detection	Robust Offensive Information Warfare	Upstream Information Fusion
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						•														
Overarching Issues																					
Formal mechanism for assessing U.S. vulnerabilities Fundamental understanding of COTS 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 Long-range S&T review																					

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

Mission-Enabling Technologies Investments

- Tactical/Operational
 - Advanced AAW
 - Coordinated, multimode ASW
 - Effective C² 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

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



Approved for Public Release Distribution Unlimited



POWER



ELECTRONICS

SENSORS



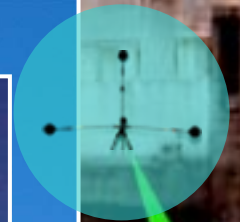
Persistent ISR



“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



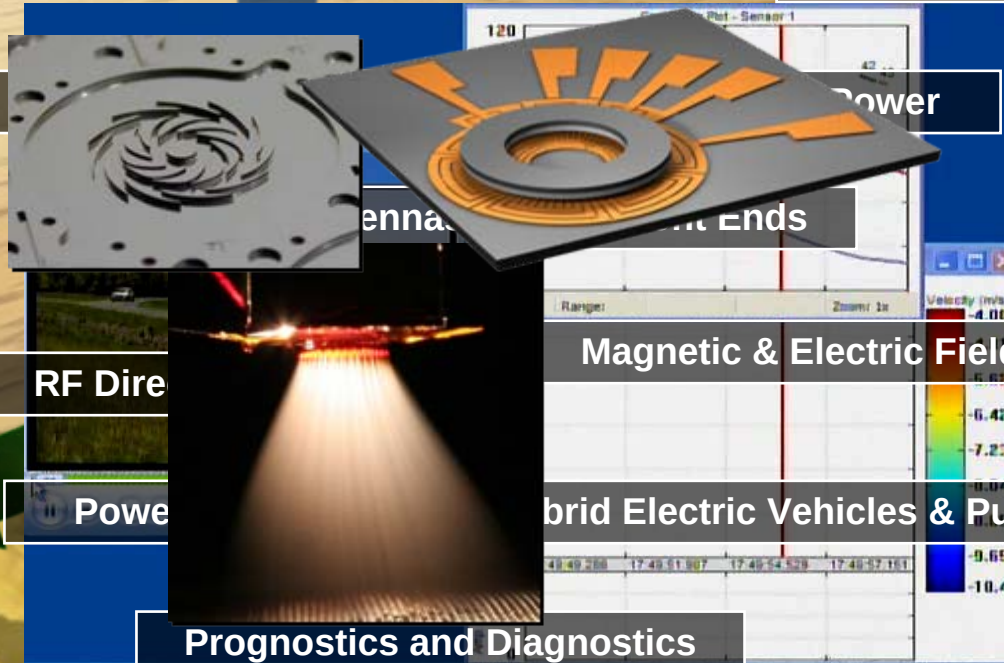
Enabling Electronics

Photonic Devices

Nanoelectronics and MEMS

Flexible Displays

Advanced Concepts



Urban



Borders/Perimeters



Caves



Riverine



Jungles/Canopy



**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**



Persistent ISR to OIF



Microsystems



Family of UGS



Wearable Sensors



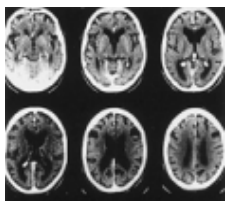
Persistent Threat Detection System to OIF



Unmanned Equipment for Scouting and Detection

Decade of the 1970's

Structural Imaging



1971 – First Practical X-ray
Computed Tomography Image

Microprocessors



1971 – First 4 Bit Microprocessor
in Production



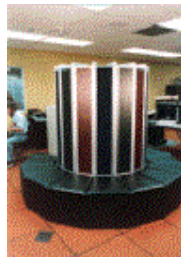
**Arcade
Games**

Artificial Intelligence



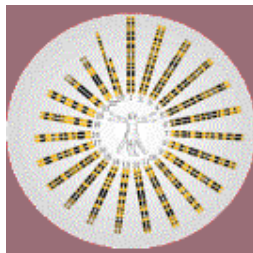
1970-Shakey the robot

Supercomputing



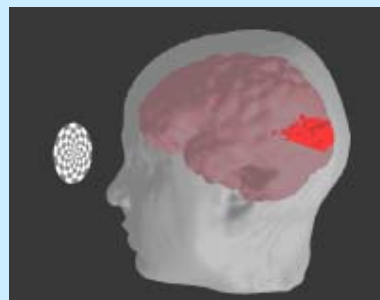
1975 – Cray I
Supercomputer

Genetic Engineering



Today for 2020 and beyond...

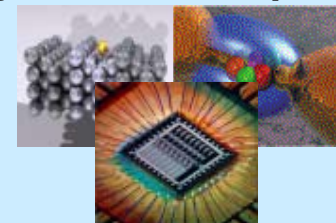
Functional Brain Imaging



Robotics



Quantum Computing



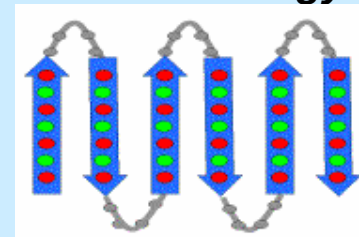
Nanotechnology



Immersive Environments

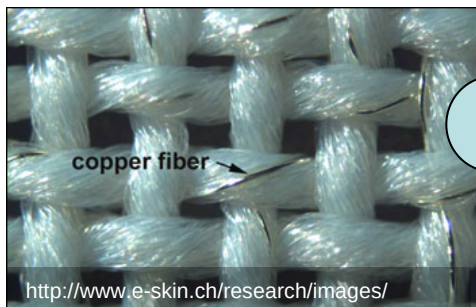


Biotechnology

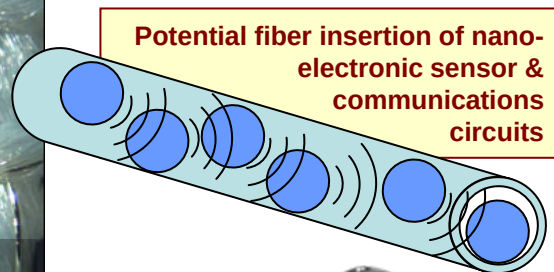


GOAL: Multifunctional 3-D nanodevice architectures for electronic textiles and networked microsystems for remote sensing applications

OBJECTIVE: Fundamental research on integrated nanoelectronic devices



Current Technology for E-textiles



Nanoelectronic sensor & communications devices for networked microsystems



Fundamental nanoelectronic device research for future soldier requirements.

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

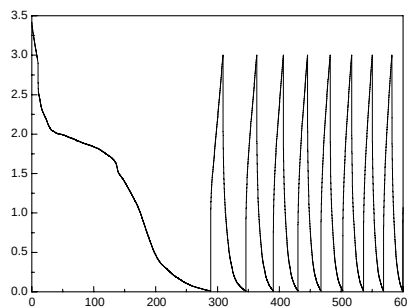
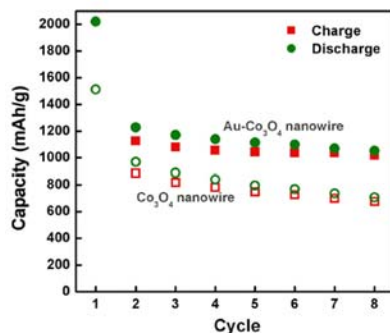
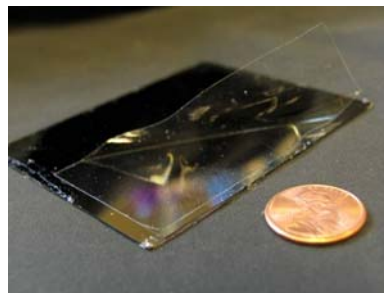
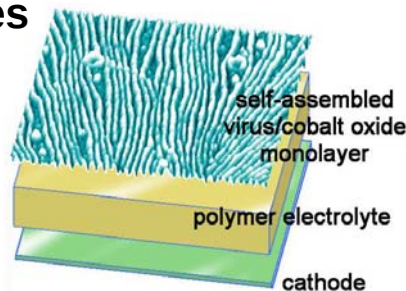
- Discrete nanodevice fabrication:
 - Thermal CVD SW-CNT growth
 - Directed nanoscale assembly
 - Nanoscale manipulation
 - 3-D nanoscale architectures
 - Microfluidic channels
- Nanoelectronic device testing:
 - Micro- to nanoscale probing
 - DC to 110 GHz
 - 4.5-475 K
 - fA sensitivity
 - Controlled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

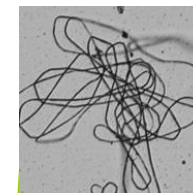


Higher Capacity, Faster Reaction Rates

Prof. Angie Belcher, MIT

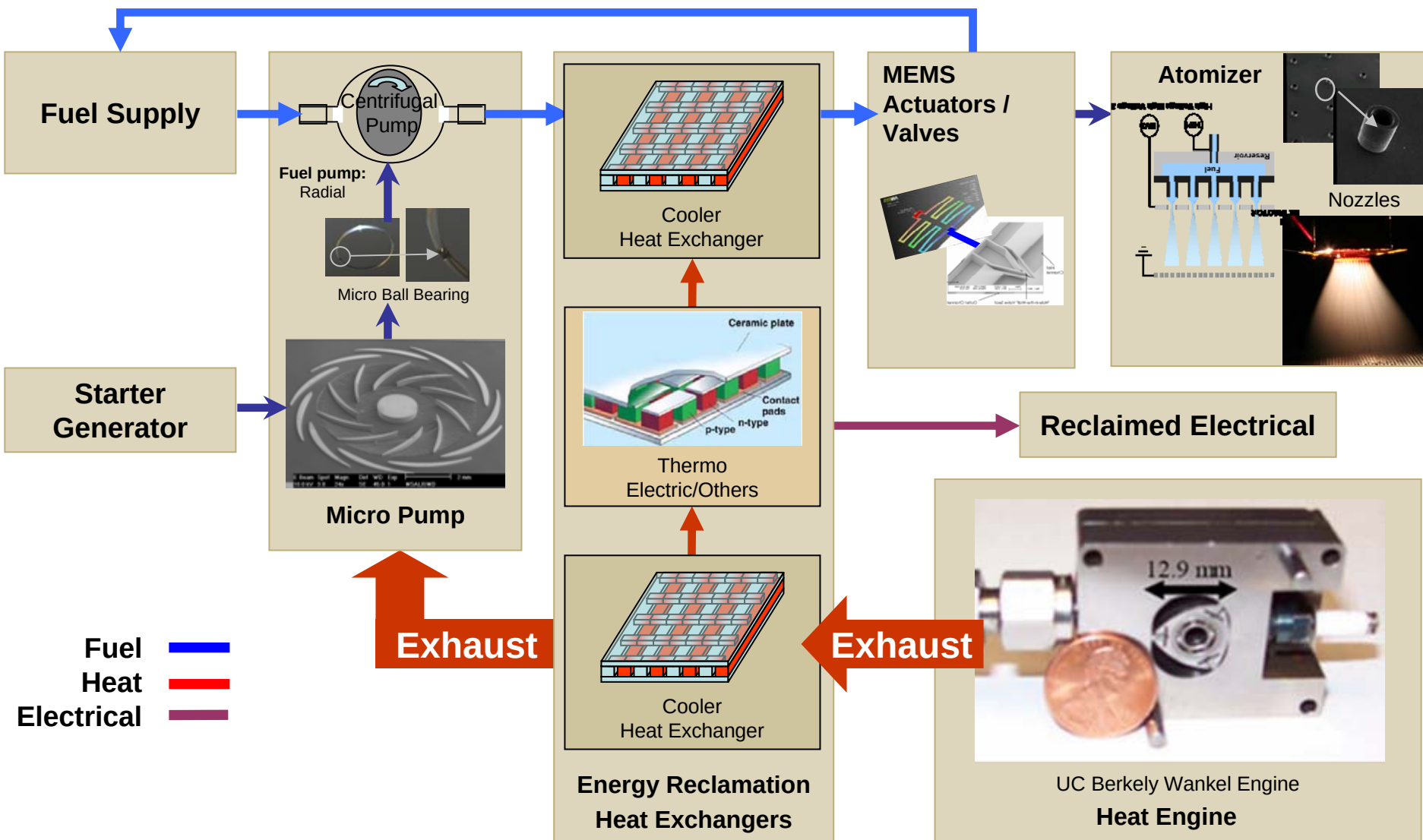
Virus fibers for use in multi-functional textiles:

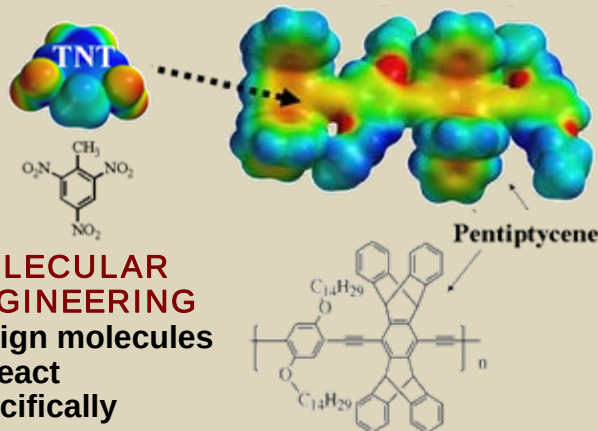
- Virus-assembled barcodes
- Electro-spun virus fibers for sensor & electronics applications



Prof. Angie Belcher, MIT

Dr. Charlene Mello, NSRDEC



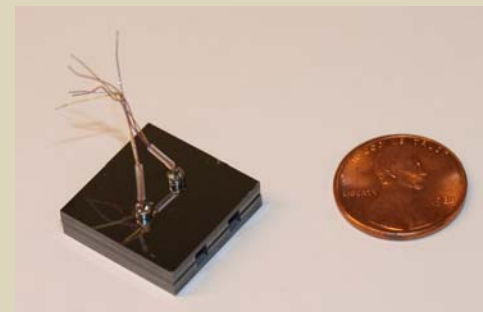


TNT Detected

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

Fido
Explosives Detector

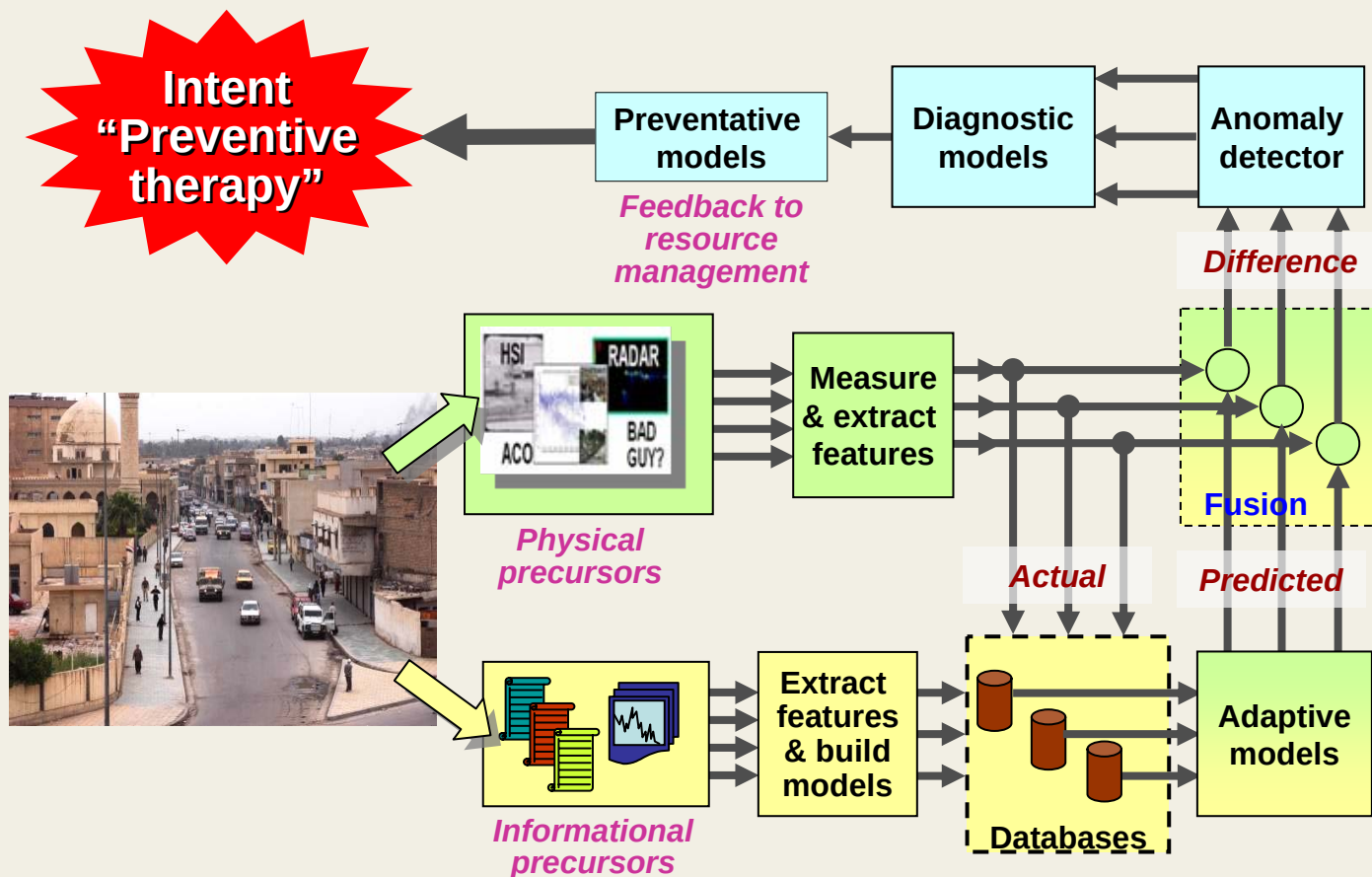


DETECTION OPPORTUNITY
Hidden explosives give off traces of chemicals, which may be detected.

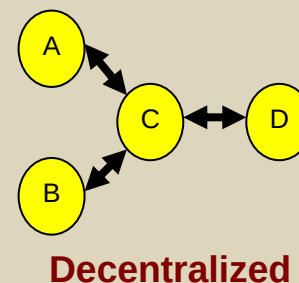
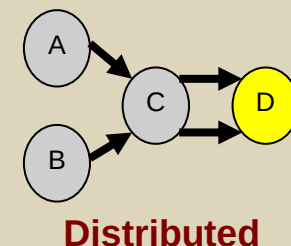
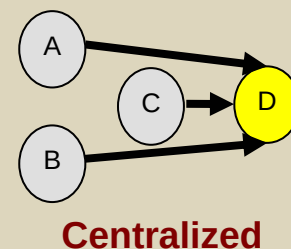
FIDO Units in Iraq for Evaluation (2005) – Integrated on robot and handheld



Integration of Chemical / Biological Sensing with Electronics.



Data Flow Architecture



Characteristics:

- Scalable
- Expandable
- Adaptive
- Modular

Challenges:

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

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



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

SOAL-T





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

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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

- 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

- **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 (JRRCC) Process Was Modeled on this USSOCOM Process



Example: Urgent Deployment Acquisitions



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



Coalition VTC



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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

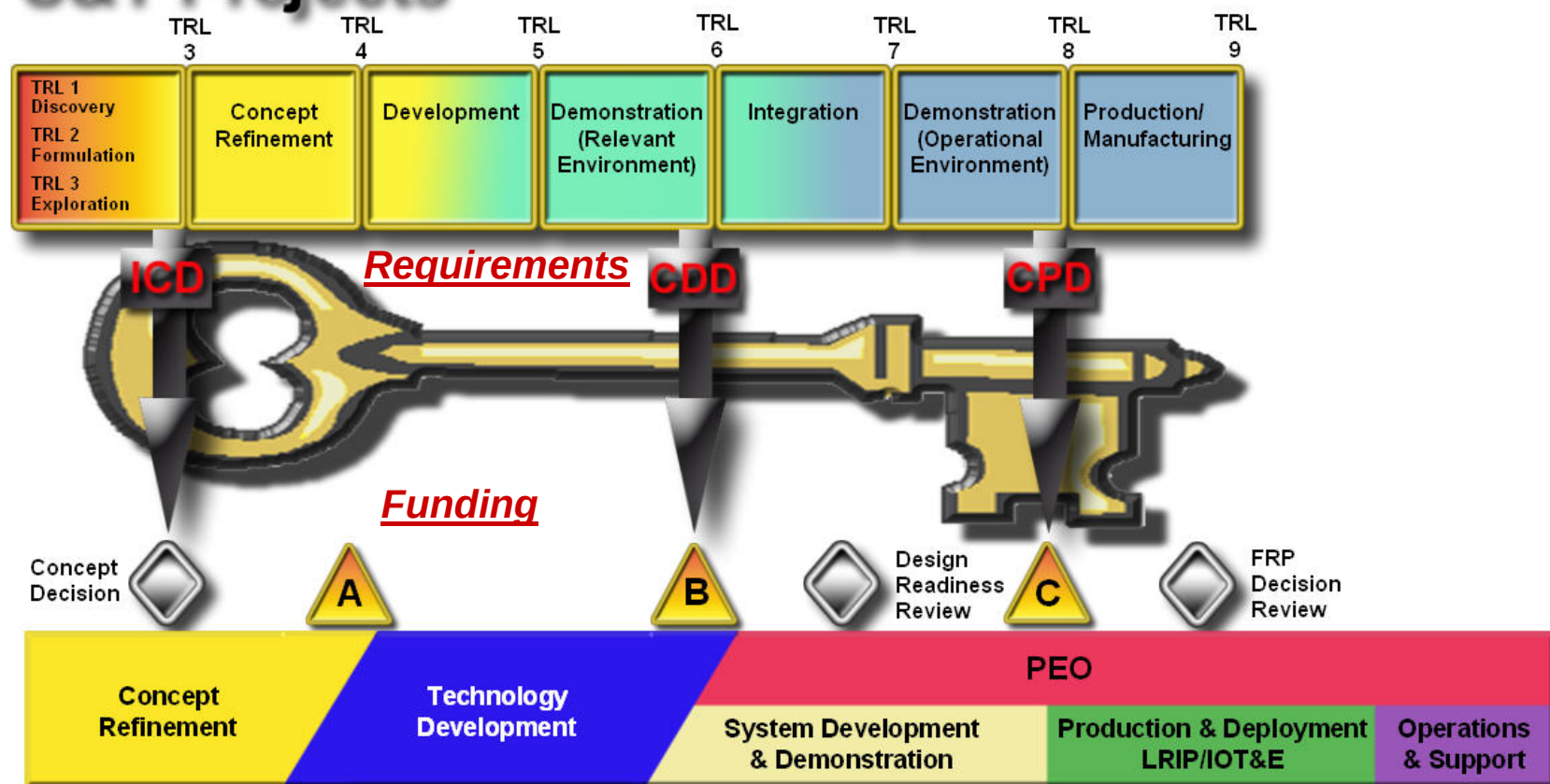
- **Program Executive Offices (PEOs)/Program Managers (PMs) Maintain Portfolio Plans that Identify Technology Needs and/or Insertion Points**
- **Technology Insertion Funding is Planned with the PEO/PM Program Budget**
- **Conduct Effective Institutionalized Outreach Between PEOs/PMs and S&T Community – 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

S&T Projects

Defined By DoD Directives and Public Law



Acquisition Programs of Record

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

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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?



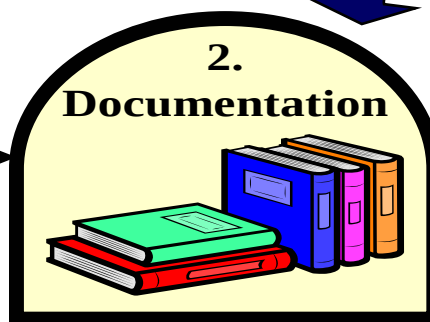
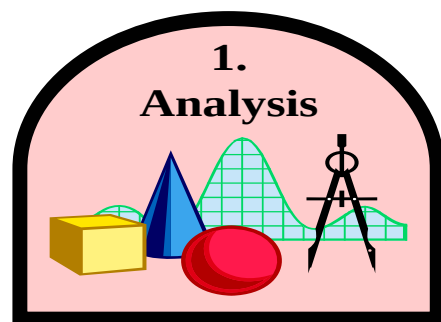
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SOF CIDS Process

Four Phases of the SOF Capabilities Integration and Development System

DEFICIENCY/OPPORTUNITY

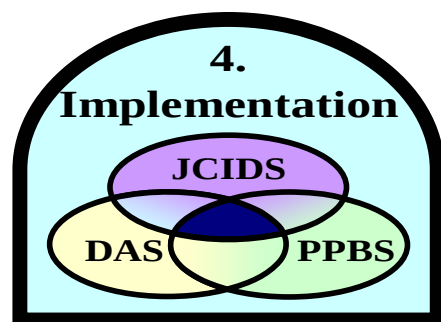


Initial Capabilities Document (ICD)

Capability Development Document (CDD)

Capability Production Document (CPD)

SOF CIDS



CAPABILITY



Special Operations Command Requirements Evaluation Board

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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

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 (20350-0001)
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 superiority in capabilities essential to the naval mission. Investment priorities shall emphasize: (1) Naval unique research, where D&I is important and advanced; (2) dramatic, networked improvement in capabilities; (3) development of an electromagnetic railgun prototype; (4) development of significant capabilities for the Joint Sea Base and Ship-to-Shore; (5) improving the naval tactical use of Space. The S&T review and approve future INP candidates.

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.

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

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.

Future Naval Capabilities (FNCs). This area includes Applied Research (6.2) and Technology Development (6.3) focused on requirements-driven, transition-oriented thrust areas. Its objective is to provide enabling capabilities (ECs) to fill gaps in Naval Power 21 warfighting and enterprise capabilities identified by MCCDC requirements analyses. The FNC Technology Oversight Group shall establish priorities for investments in this area, and the FNC Integrated Management Structure should be utilized to the fullest extent to assure connectivity of requirements, technology, and acquisition.

Naval Prototypes (INPs). This area includes Applied Research (6.2) and Technology Development (6.3) of naval system level capabilities initially technology exploitation aimed at broad areas of naval need. INPs should be based on a balanced combination of naval need and technology exploitation. INPs should be planned with the critical path to transition within 4 - 8 years. Programs should be planned with the critical path to transition within 4 - 8 years. Programs should be planned with the critical path to transition within 4 - 8 years.

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 ...

2

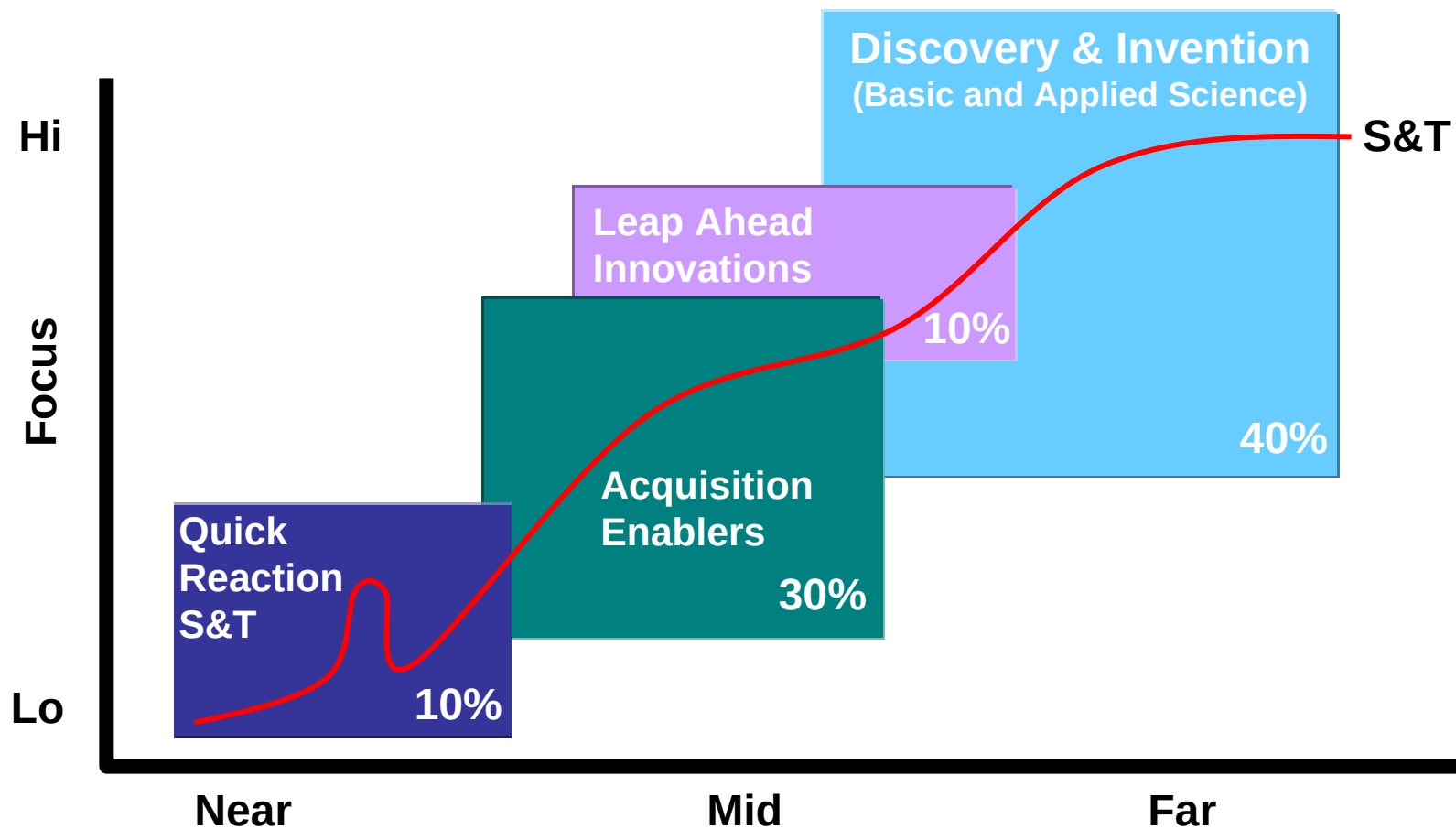
a time, cost and technology readiness level (TRL), Management Regulations and mutually agreed to by FNC (2) complementary to—or independent of—FNC associated with an adequately planned and funded INP, a desired capability during the FYDP (without guarantee of transition to a program of record) at greater 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

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

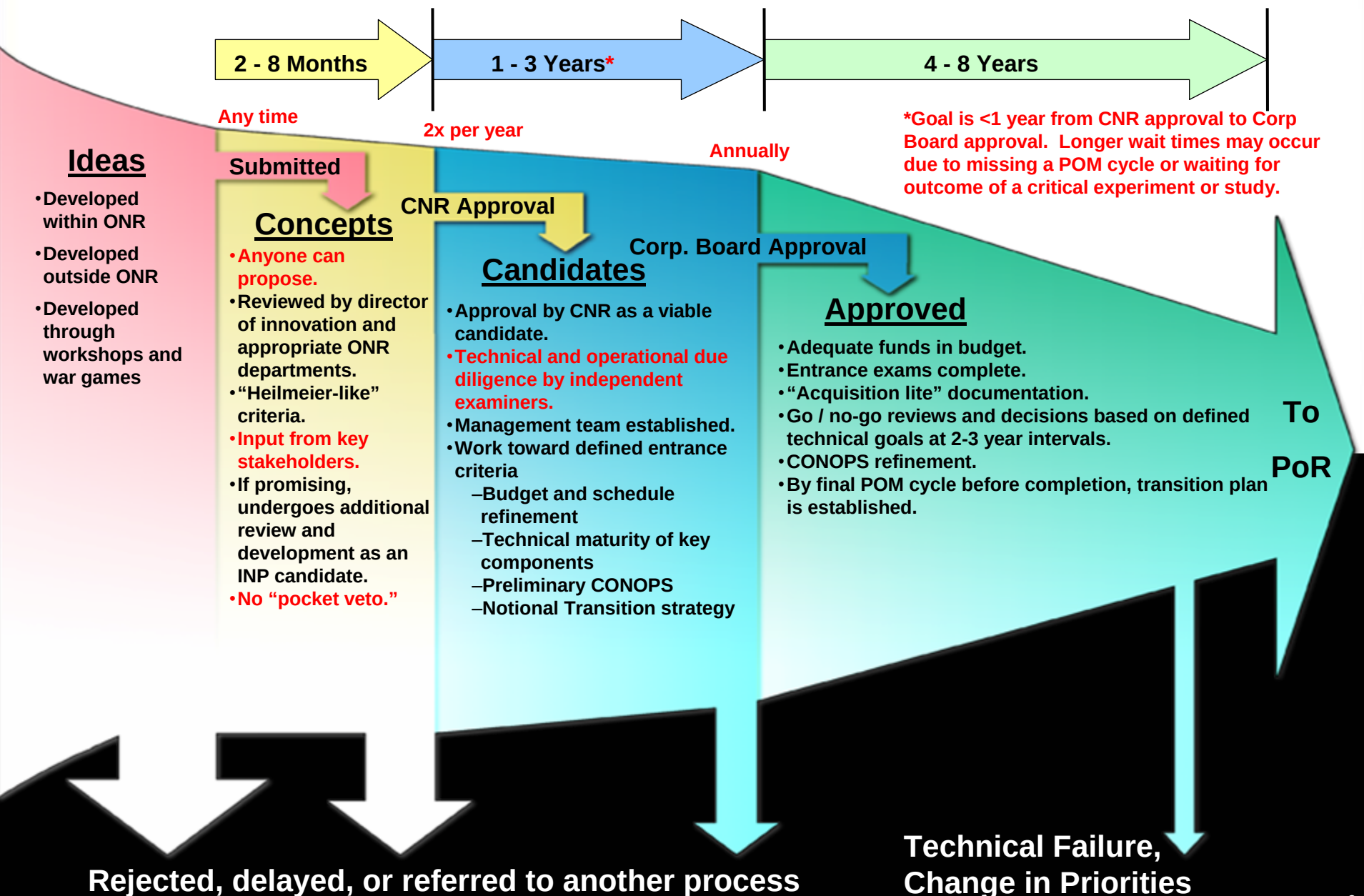


Navy S&T has a long-term focus but is responsive to near - term Naval needs

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

◆ Guidance

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

\$991M

**Planned / Proposed
FY08-13**

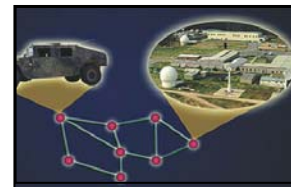
Current INPs



EMRG



SBE



TACSAT



PLUS

FY-10 INPs

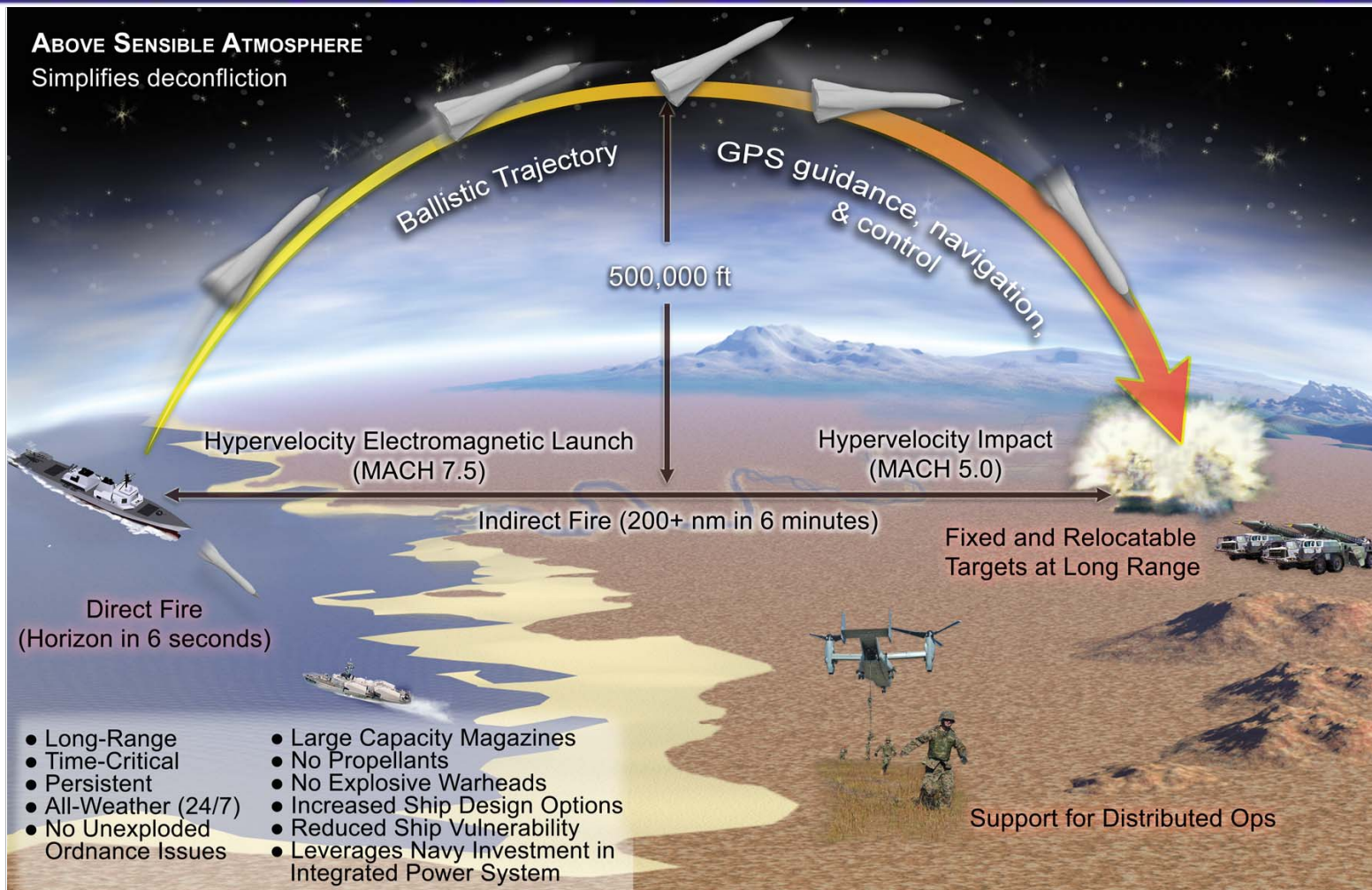


FEL



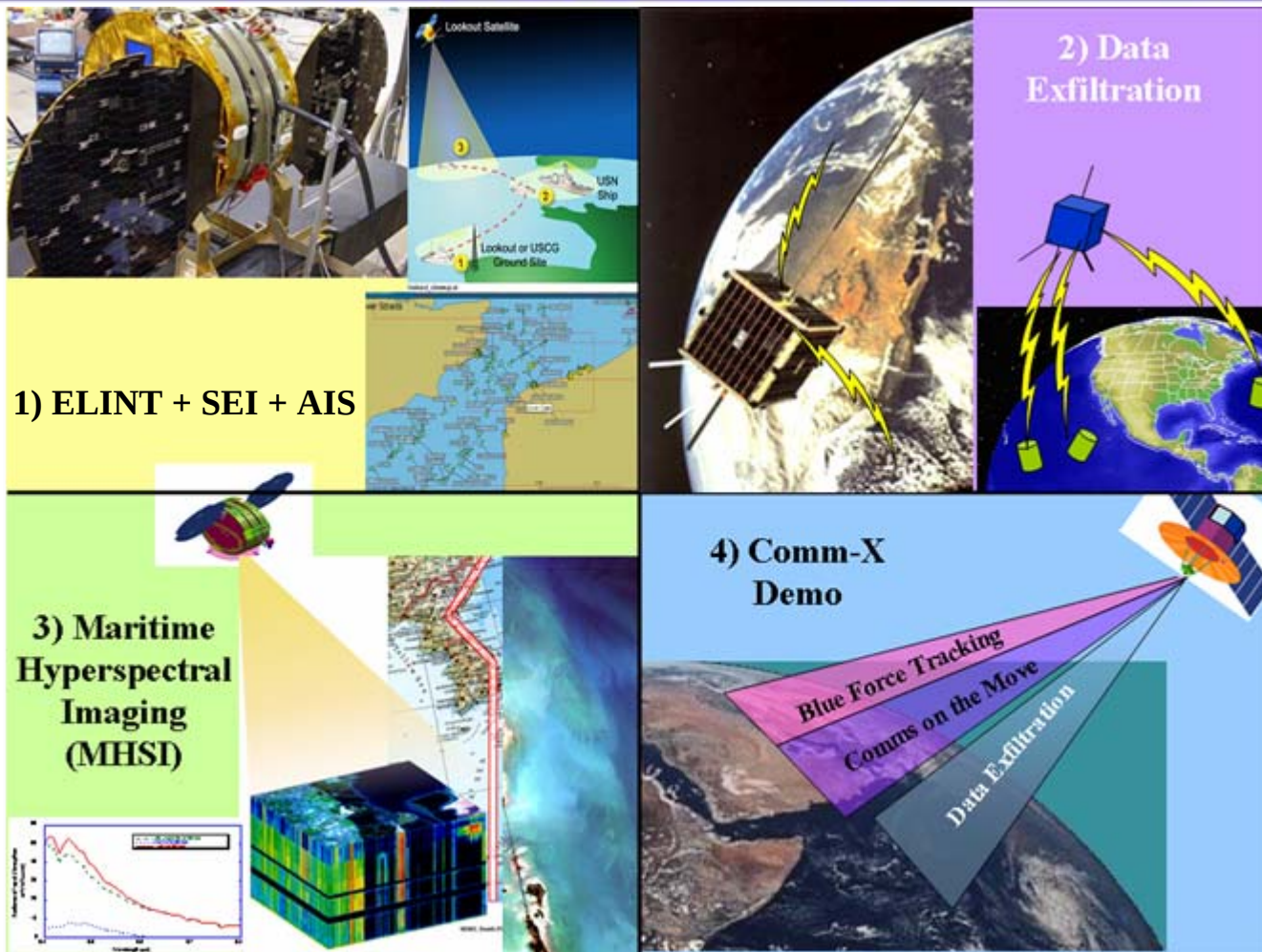
INT TOPSIDE

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

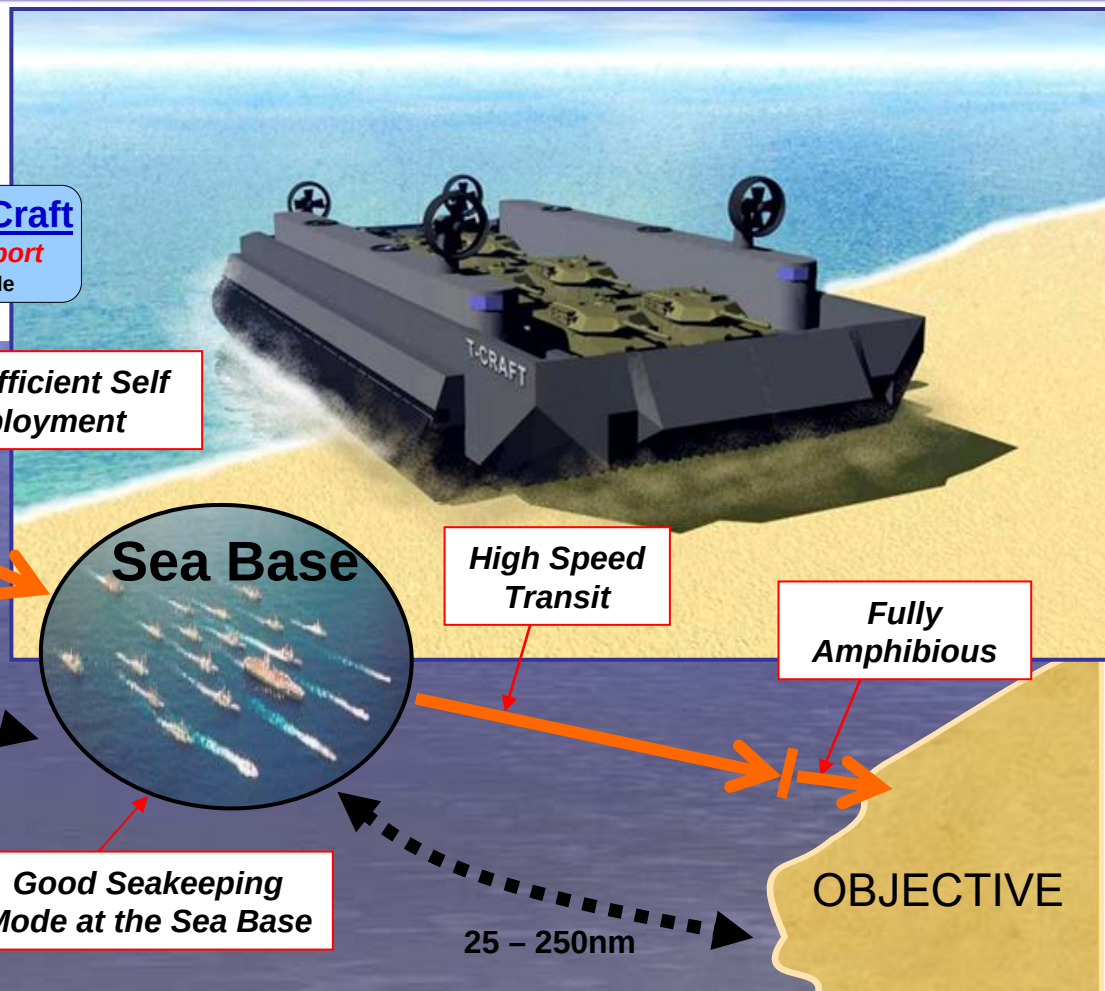
Seabase Enablers INP

T-Craft

Multi-Mode Vehicle Delivery Craft

T-Craft: High Speed Beach-able Transport

40kt in SS-4 with beaching & amphibious mode



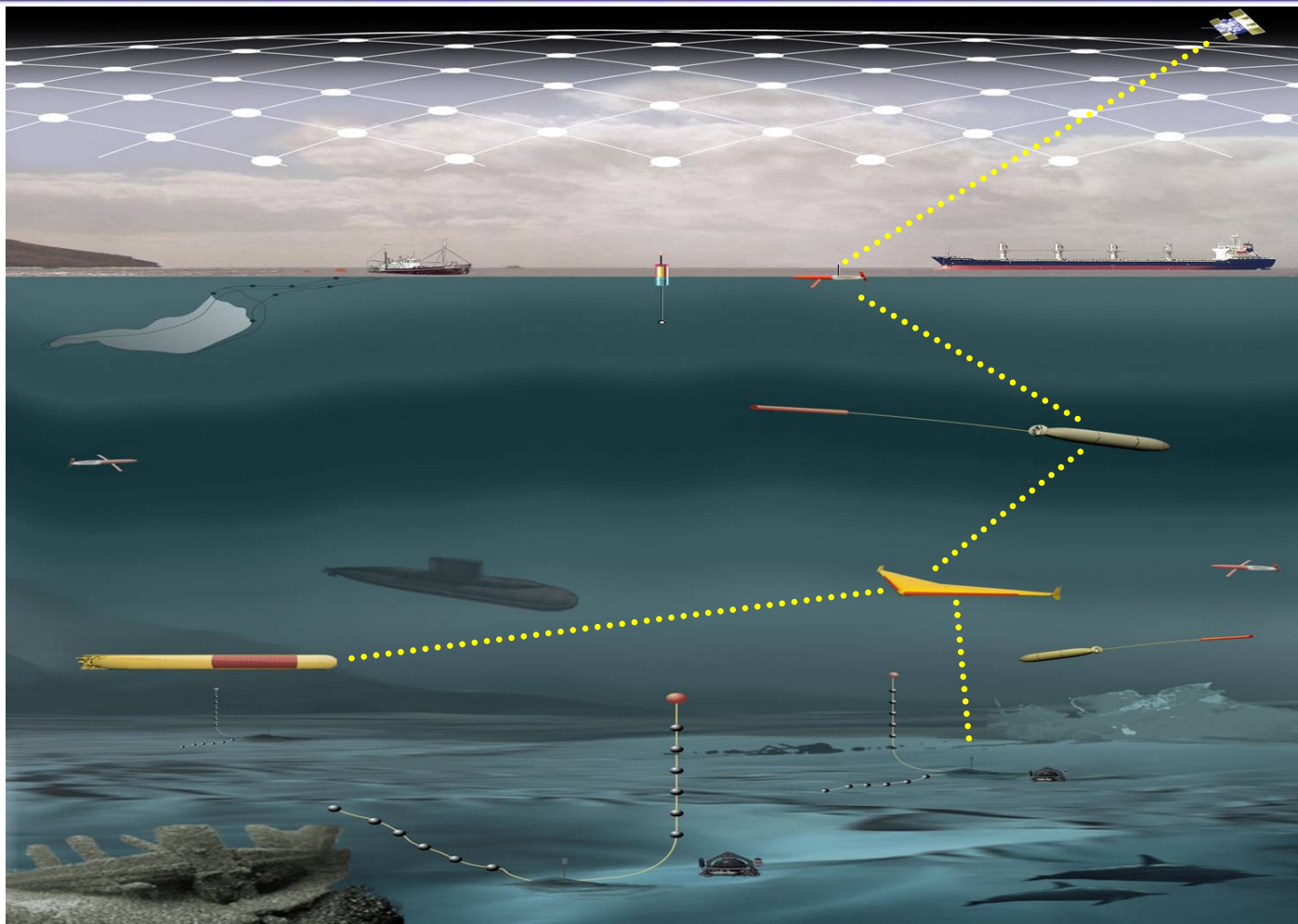
T-Craft Payload Capacity:
Between 4 and 10 M1 Tanks



Good Seakeeping
Mode at the Sea Base

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



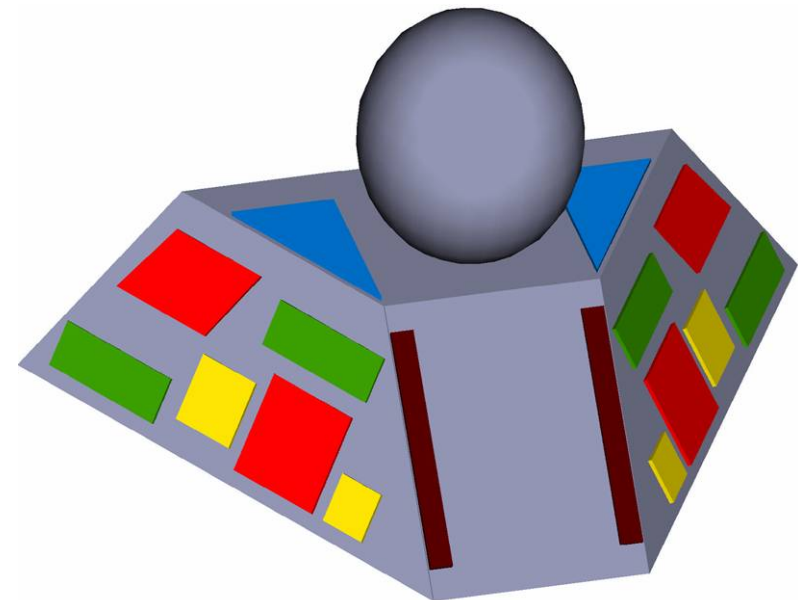
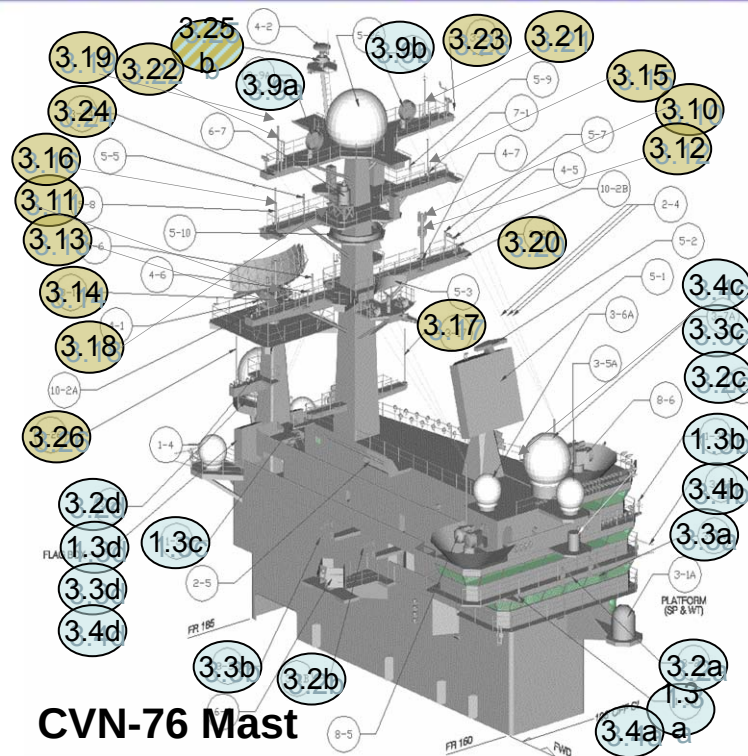
PLUS	Relationship to Strategic Plan	"Leap Ahead" Characteristics
	Assured Access and Hold at Risk – ASW, distributed surveillance	•Find quiet diesel subs without putting high value platforms at risk •High end ASW capability embedded in distributed network of low-cost autonomous mobile nodes.

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
> 3500 pounds (Ant. Only)



4 panels , 20 meters ²
< 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 Diligence
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?

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INNOVATIVE NAVAL PROTOTYPES
Disruptive Innovations



United States Strategic Command

***Mr. Shawn Spencer
Chief, Future Capabilities Division
4 September 2007***



UNCLASSIFIED

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



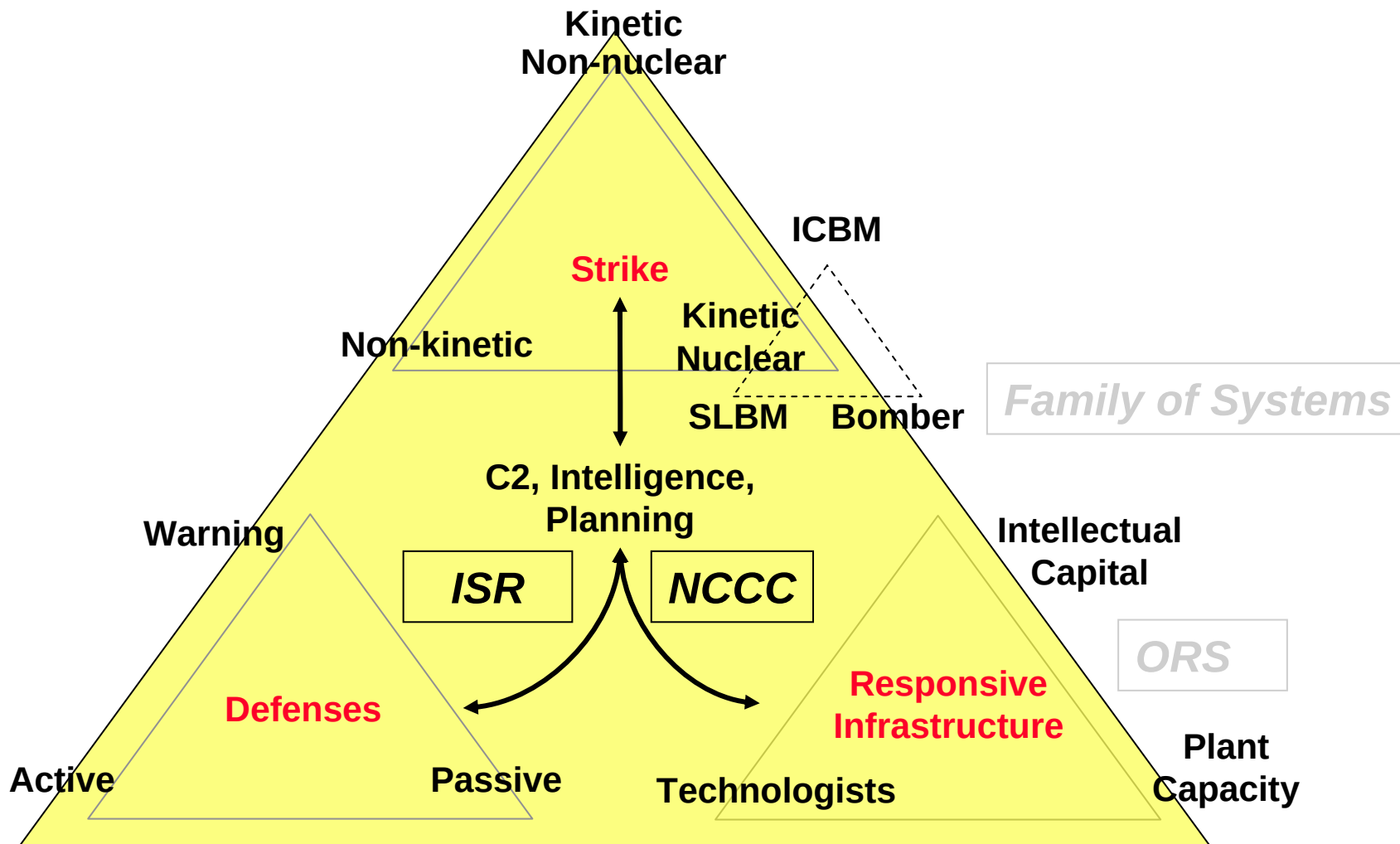
CDR USSTRATCOM Highest Priority

“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



C2, Intelligence and Planning





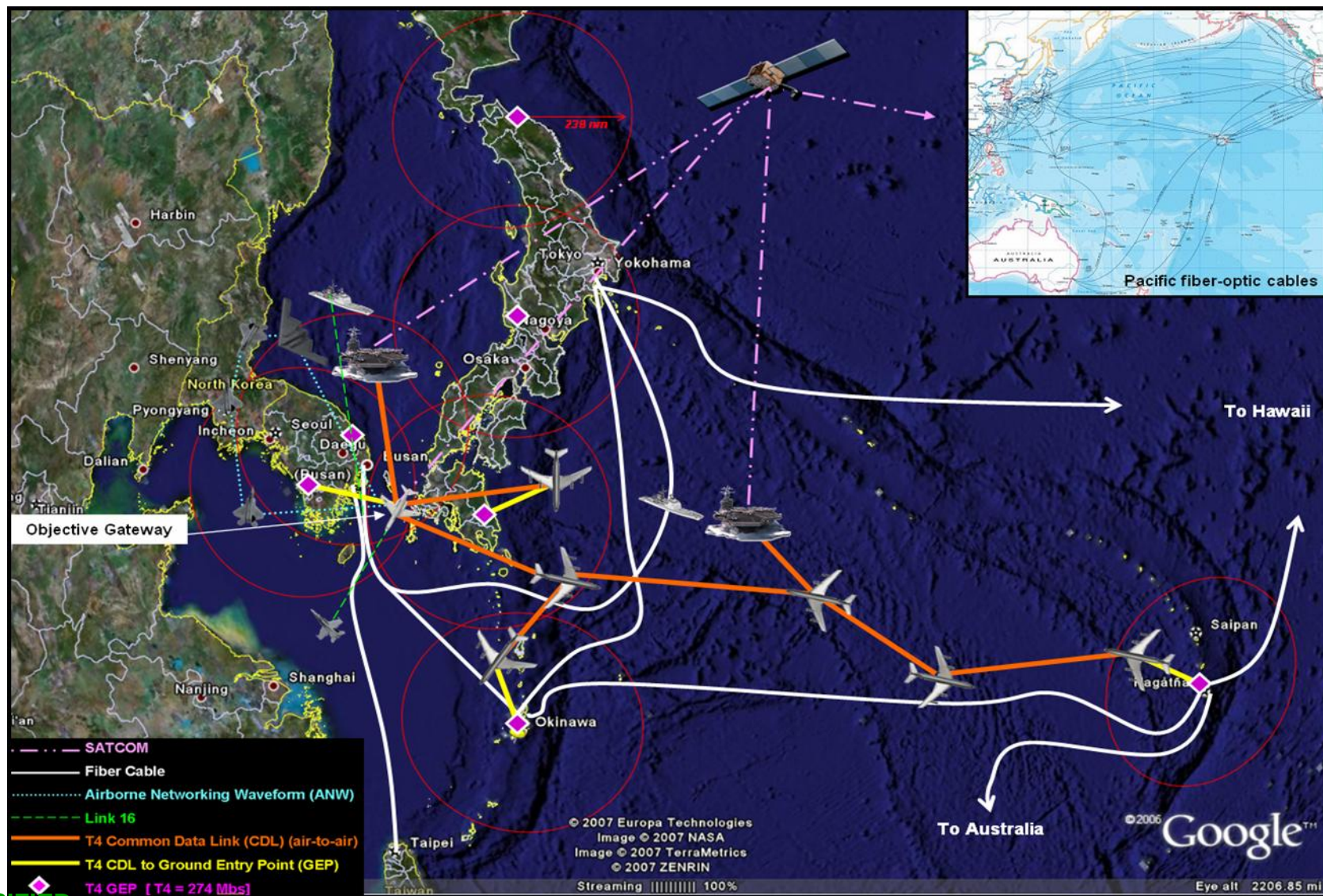
Integrated Missile Defense





DRAFT Pre-Decisional

Communications Pathways



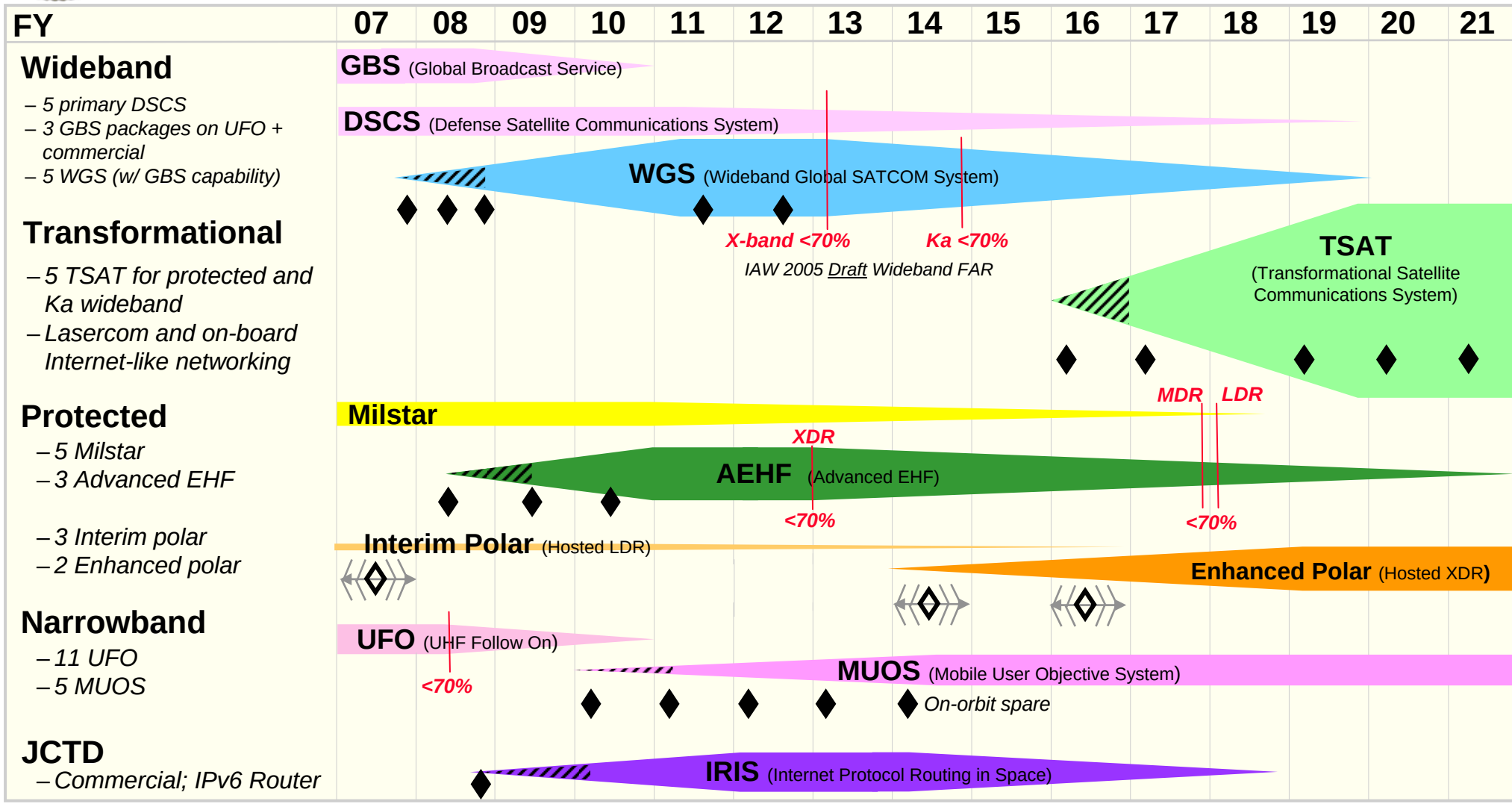
UNCLASSIFIED



MILSATCOM Overview

System of Systems Schedule

As of: 23 May 07



UNCLASSIFIED

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

	TARGET ID		TARGET	ENGAGE	ASSESS
FIND	FIX	TRACK			
			Sensor to weapon		
			Sensor to Shooter		
			Non Kinetic		

Expand Missions

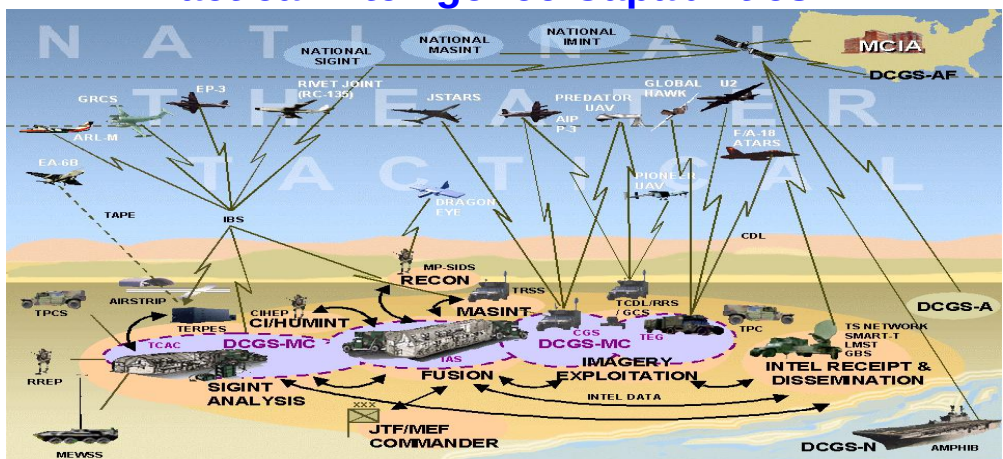


Constructing a Capabilities-Based Network Roadmap

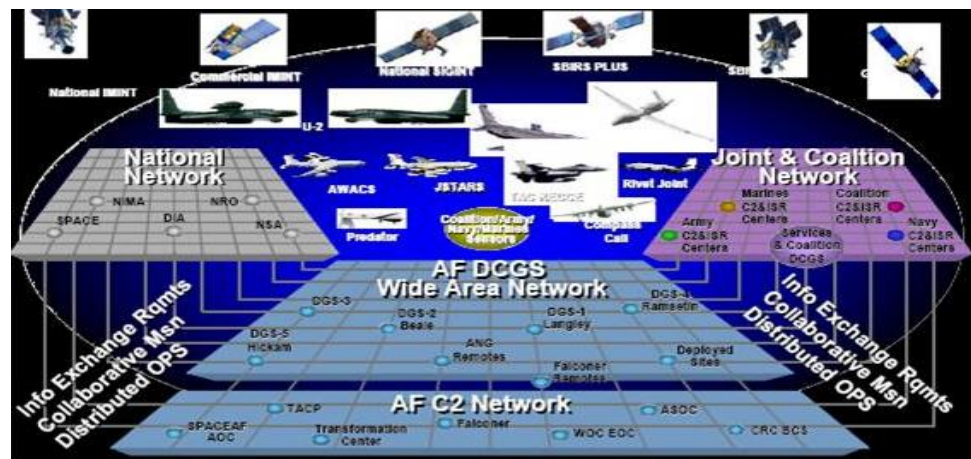


DCGS Development Strategy

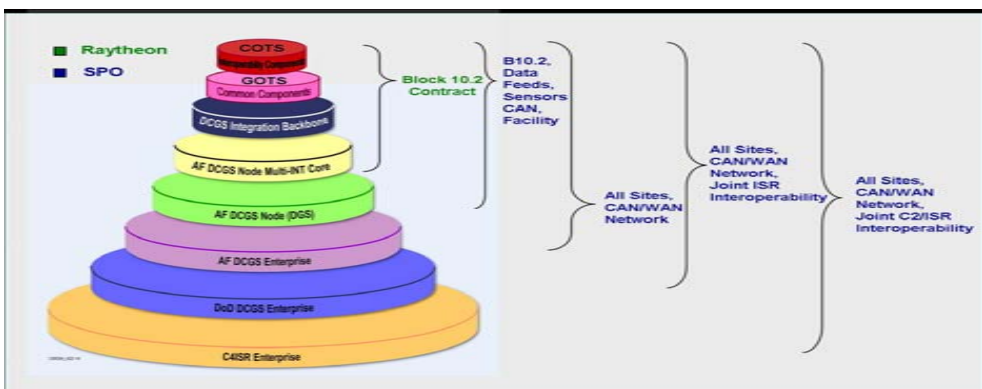
Tactical Intelligence Capabilities



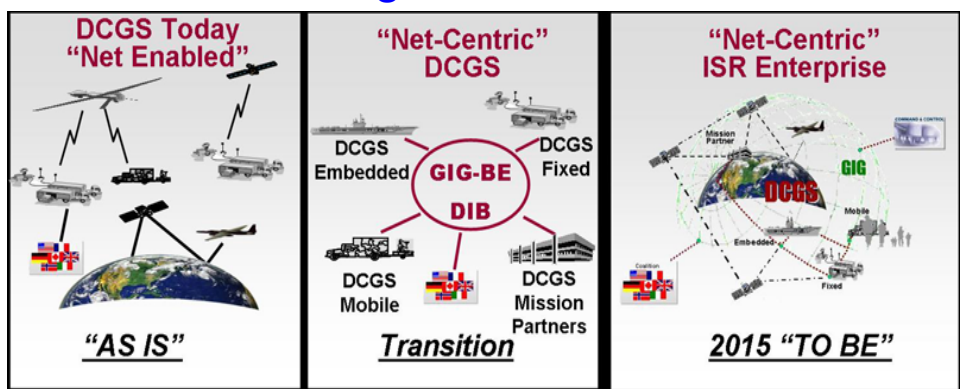
Platforms and Sensors



TPED Advancements



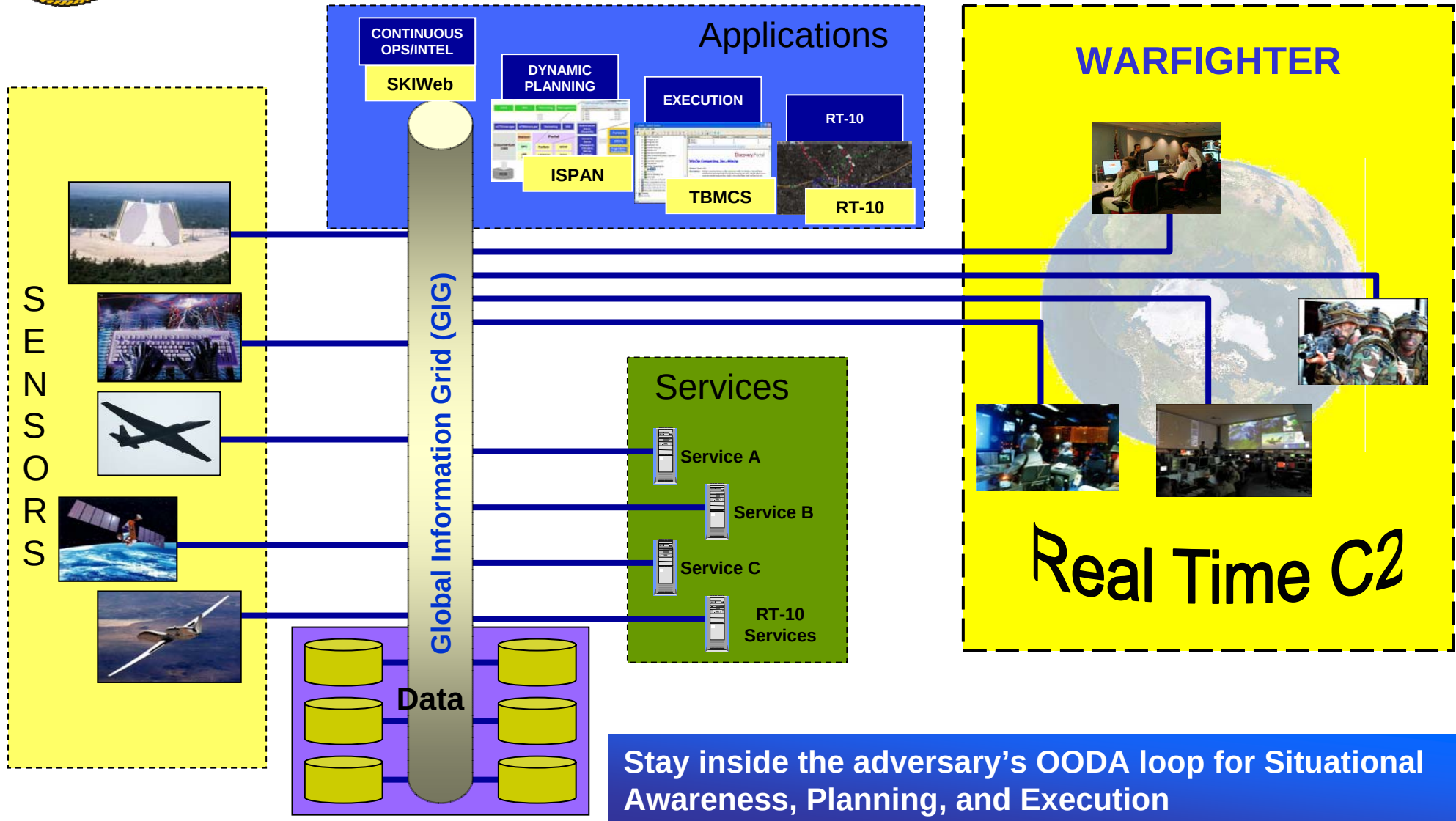
Moving to Net-Centric



Moving Towards a Net-Centric Tactical ISR Enterprise

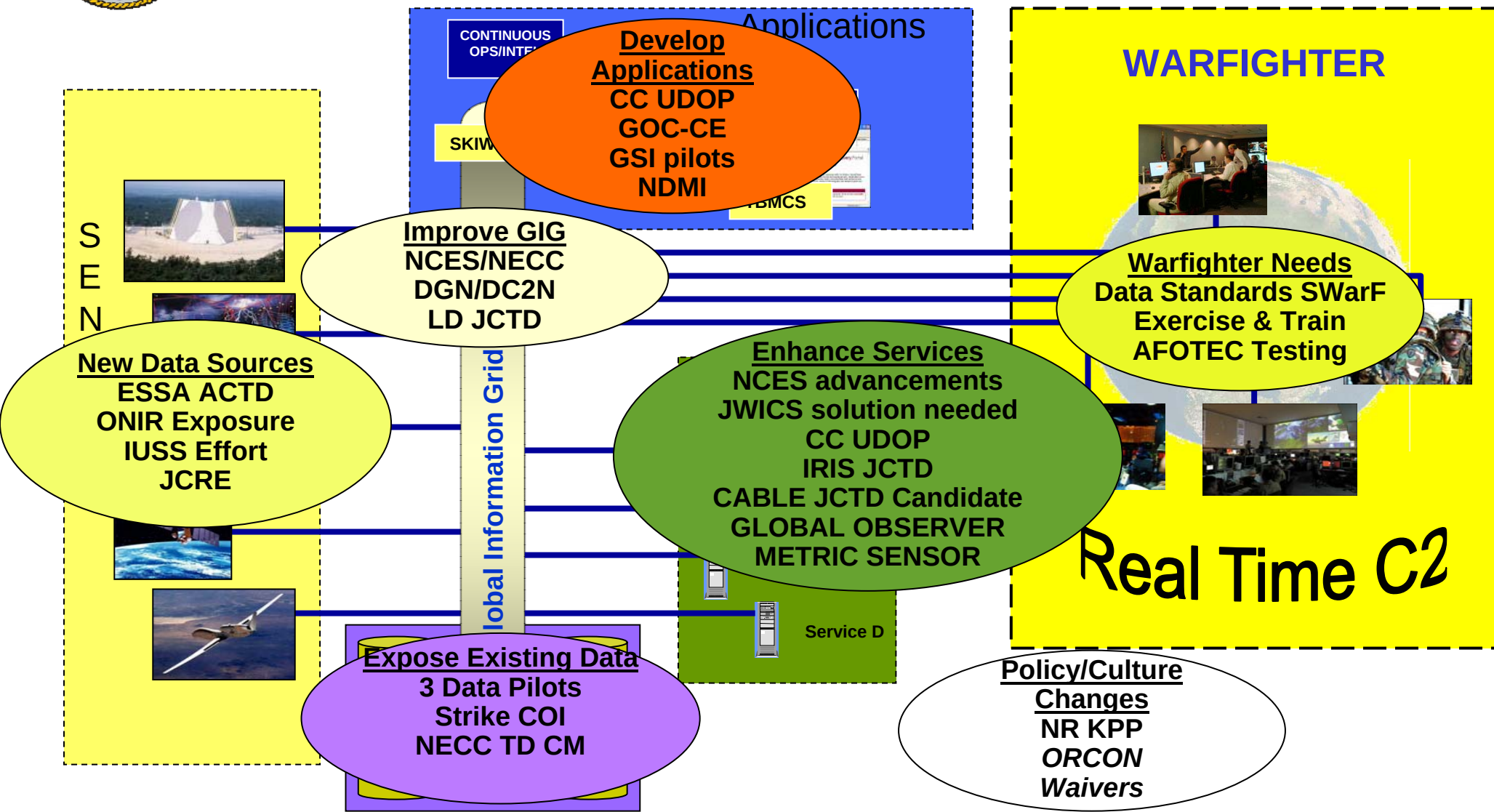


C2 Vision





Aligning Efforts to Provide Information to the Warfighters





USSTRATCOM Triad

Prompt Global Strike

Kinetic
Non-nuclear

Strike

ICBM

Non-kinetic

Kinetic
Nuclear

SLBM

Bomber

Family of Systems

Sensors

Warning

C2, Intelligence,
Planning

ISR

NCCC

Intellectual
Capital

RRW

ORS

Shooters

Defenses

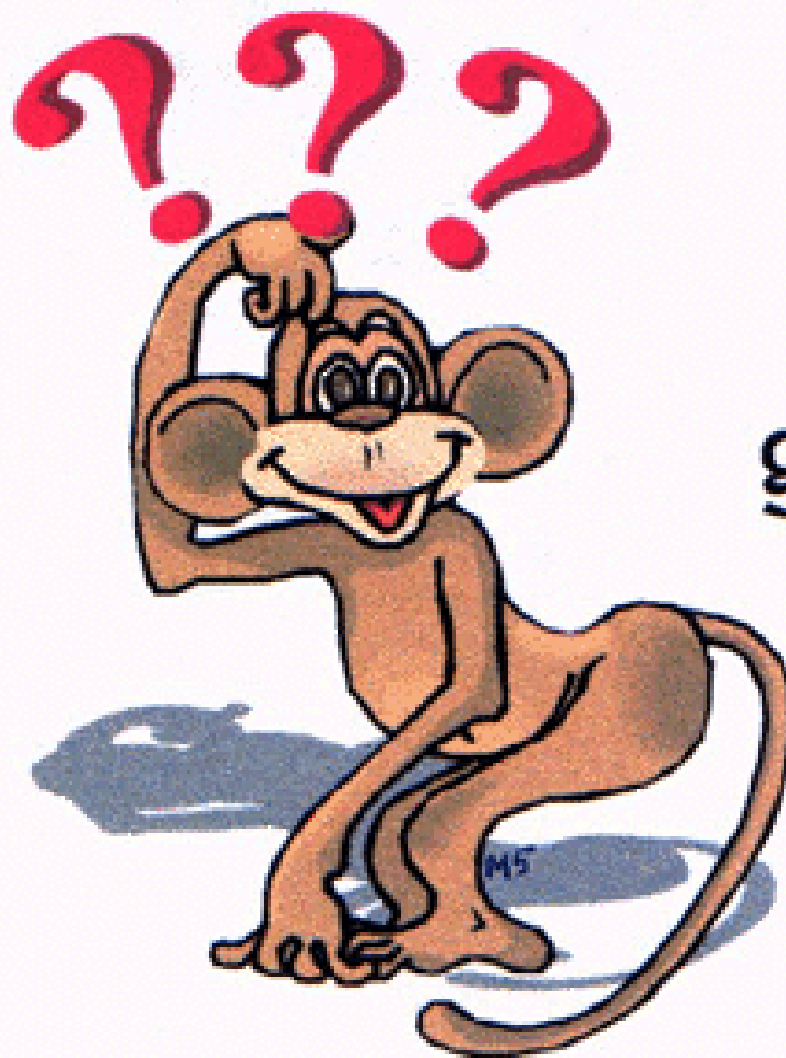
**Responsive
Infrastructure**

Active

Passive

Technologists

Plant
Capacity



Questions
are
guaranteed in
life;
Answers
aren't.



SPAWAR
Systems Center
San Diego

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



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:

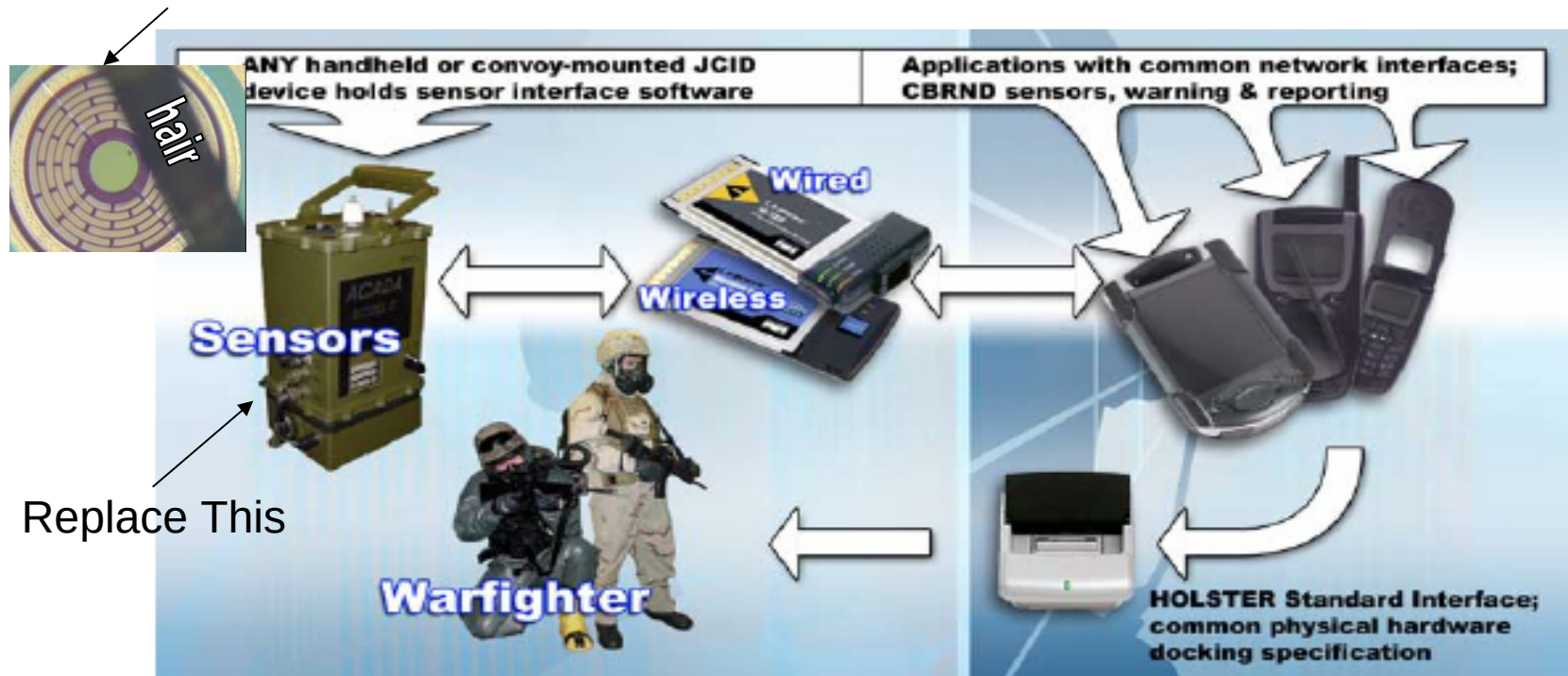
Develop small, inexpensive, highly accurate sensors to detect these life threatening agents. If possible, sensors should be small enough and cheap enough to distribute as needed at potential threat areas, e.g. ports, borders, reconnaissance missions, etc.

Solution:

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

Big Picture

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



Existing CBRN Sensors

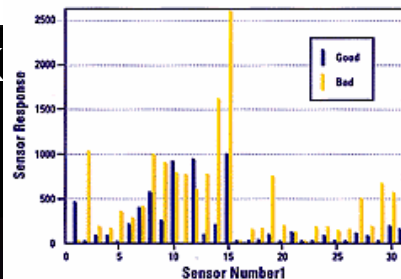
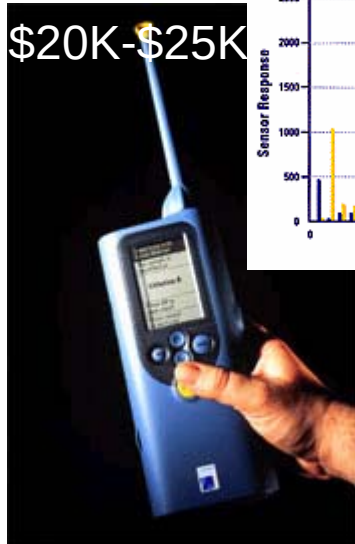
1. Too large
2. Too expensive (particularly for distributed arrays)
3. Consume too much power
4. Require user intervention by a trained technician (not applicable for autonomous operation)
5. Subject to false positives due to technology limitation + single point detection (i.e. lack of multiple sensor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



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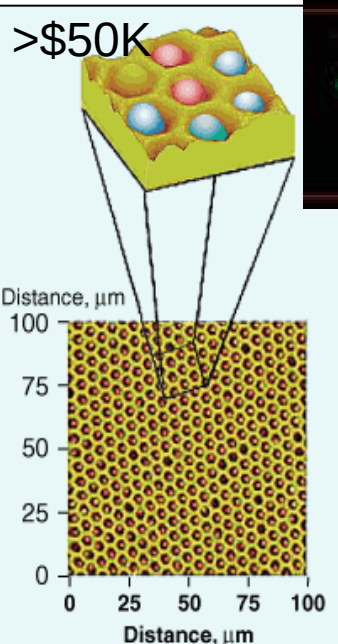
Examples of Commercially Available, Portable Sensors

\$20K-\$25K



Cyrano 320:
An electronic
nose using
chemiresistor
sensors

**Illumina: artificial
nose; fluorescence**



>\$5K

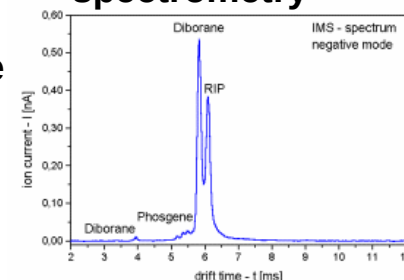


HAZMATCAD:
electronic nose
using SAWs
and ECs

>\$10K

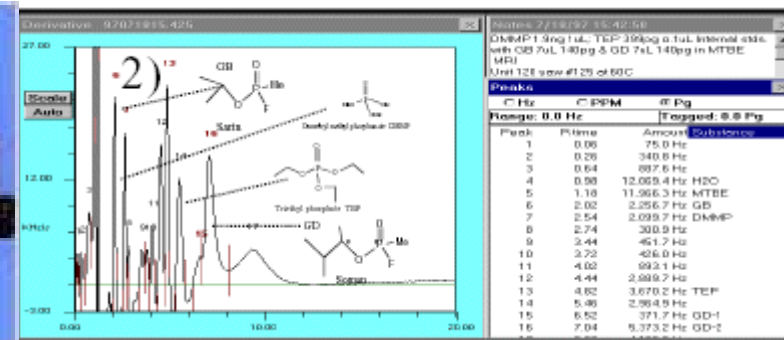


**CAM: ion mobility
spectrometry**

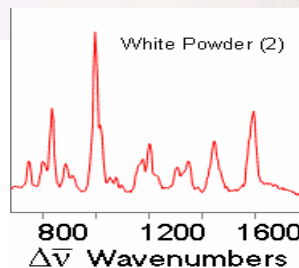


ZNOSE 4200: GC/SAW

\$21K-\$26K



\$16K



**Inspector
Raman**

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

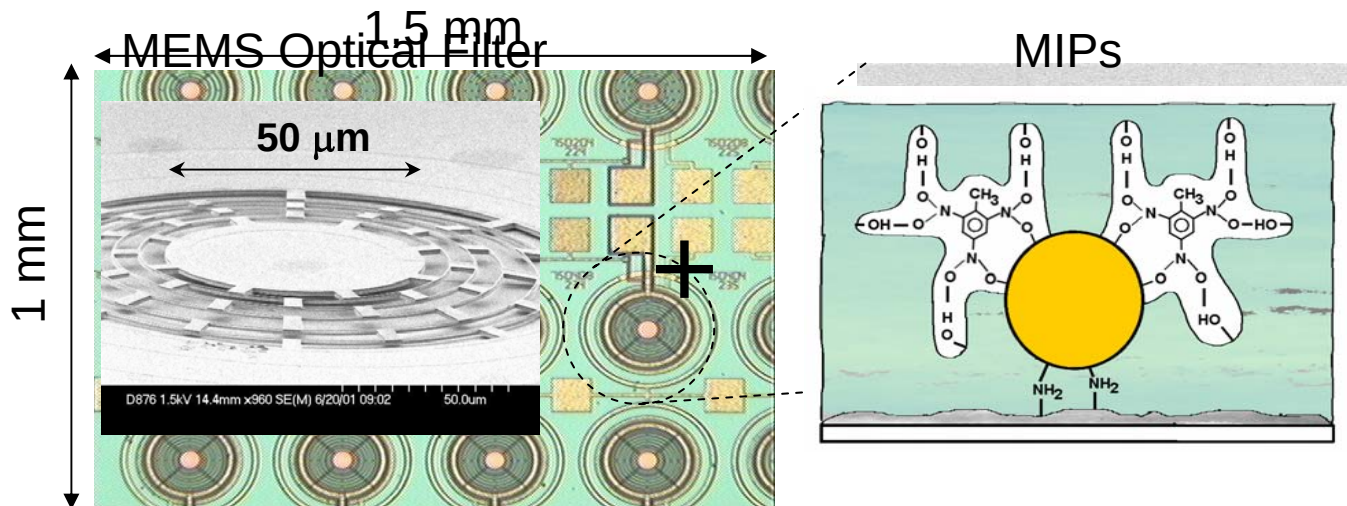
- SAW devices
- CHEMFETs
- Microcantilevers
- Chemoresistors

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.

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



Approach

Utilize Energy Scavenging Techniques for self-powering remote nodes

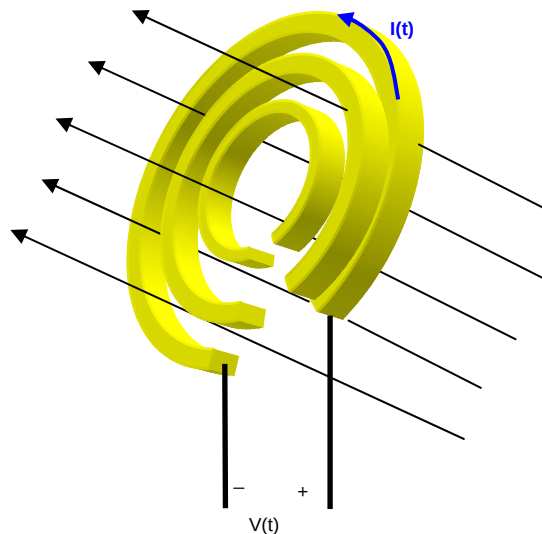
1. Develop vibrational energy harvesting device based on electro-magnetics.
2. Couple energy harvesting device to existing wireless sensor nodes.
3. Integrate other energy harvesting technologies to platform .

$$\oint_{\ell} \mathbf{E} \cdot d\boldsymbol{\ell} = -\frac{d}{dt} \int_s \mathbf{B} \cdot d\mathbf{s} = -\frac{d\psi_m}{dt}$$

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

$$\frac{d}{dt} \int_s \mathbf{B} \cdot d\mathbf{s} = \frac{d}{dt} A(B + B_0 \cos(\omega t))$$

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



Advantages of Concept

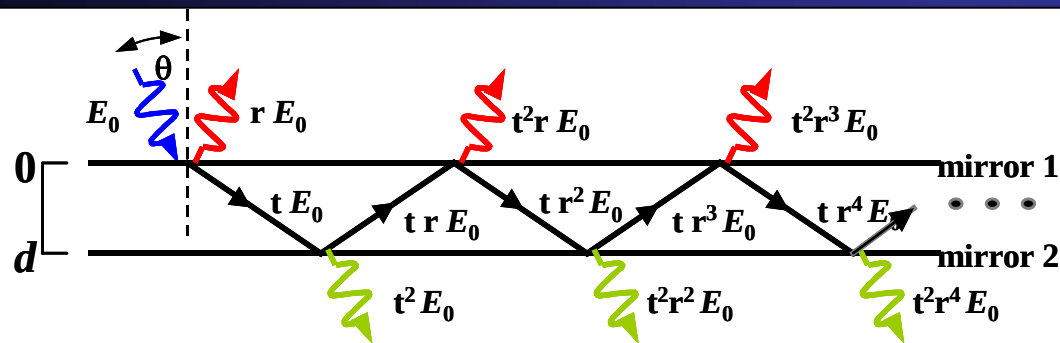
- Three optical techniques in one device:

- **SERS Analysis**

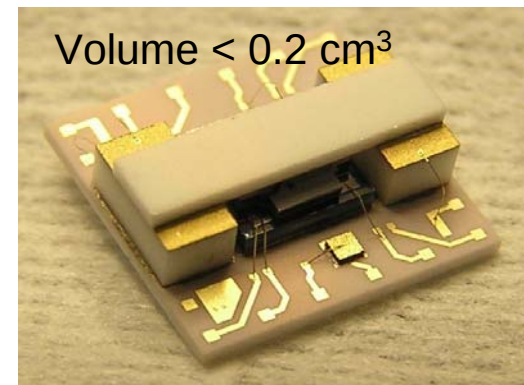
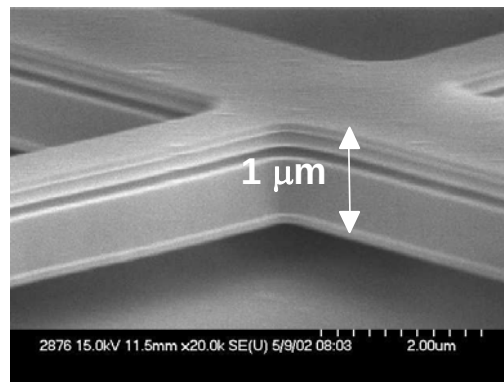
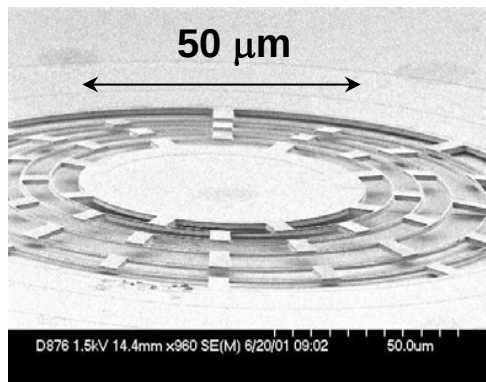
- Fluorescence Detection
 - Change in Absorption

- **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 in³ – 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**

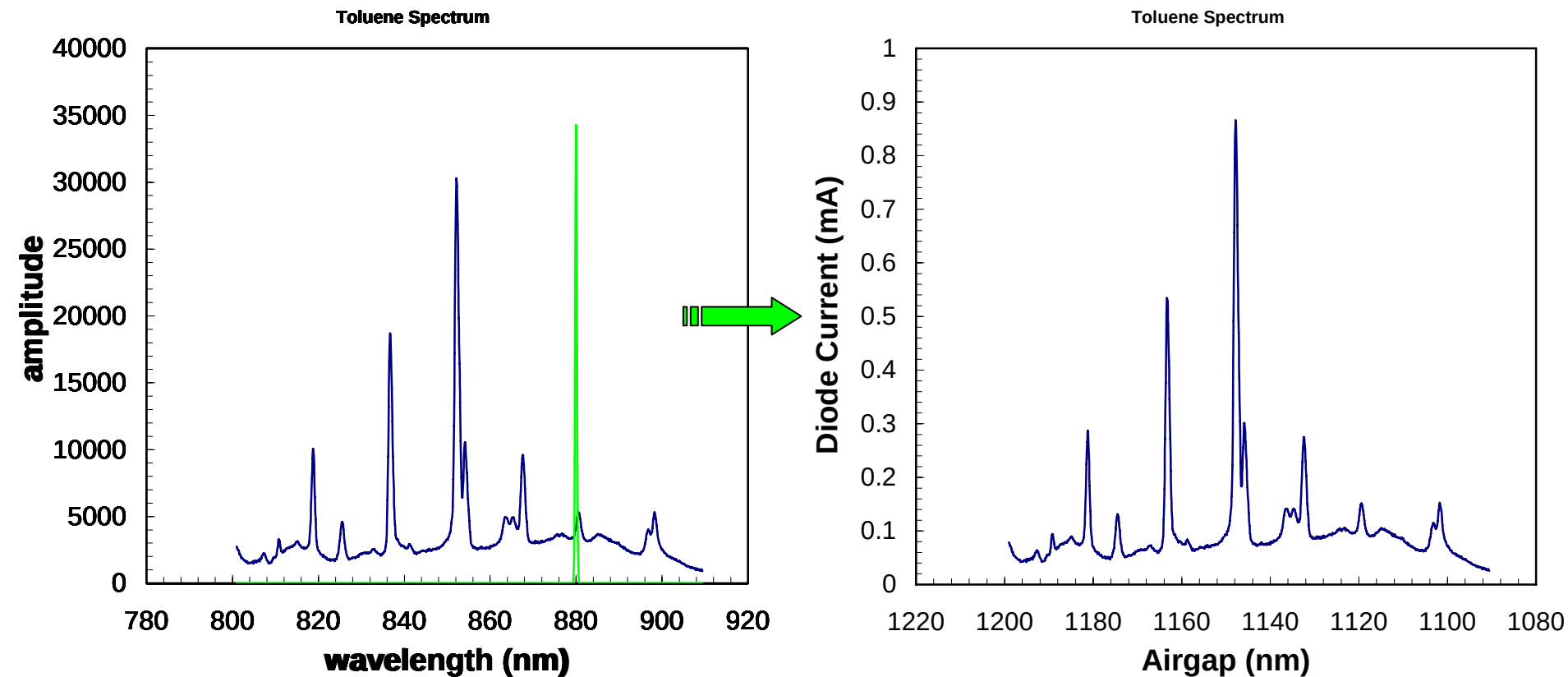
Fabry-Perot Etalon / Interferometer



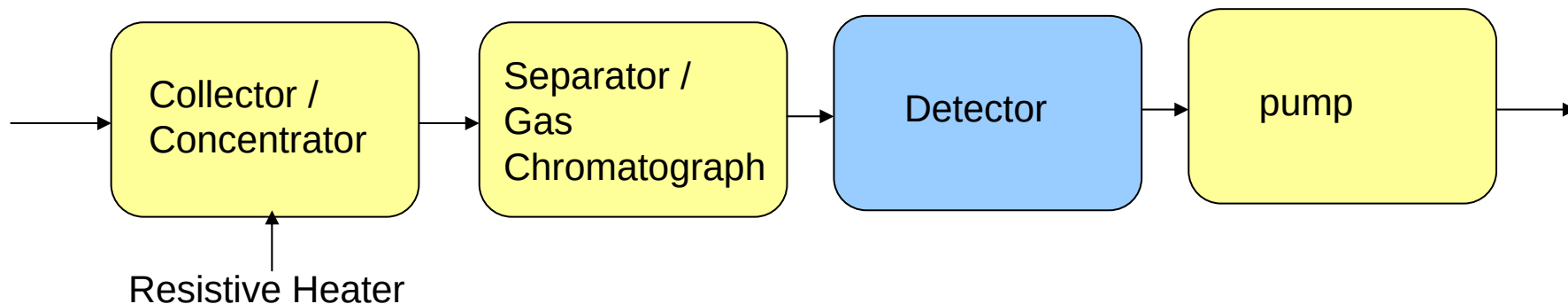
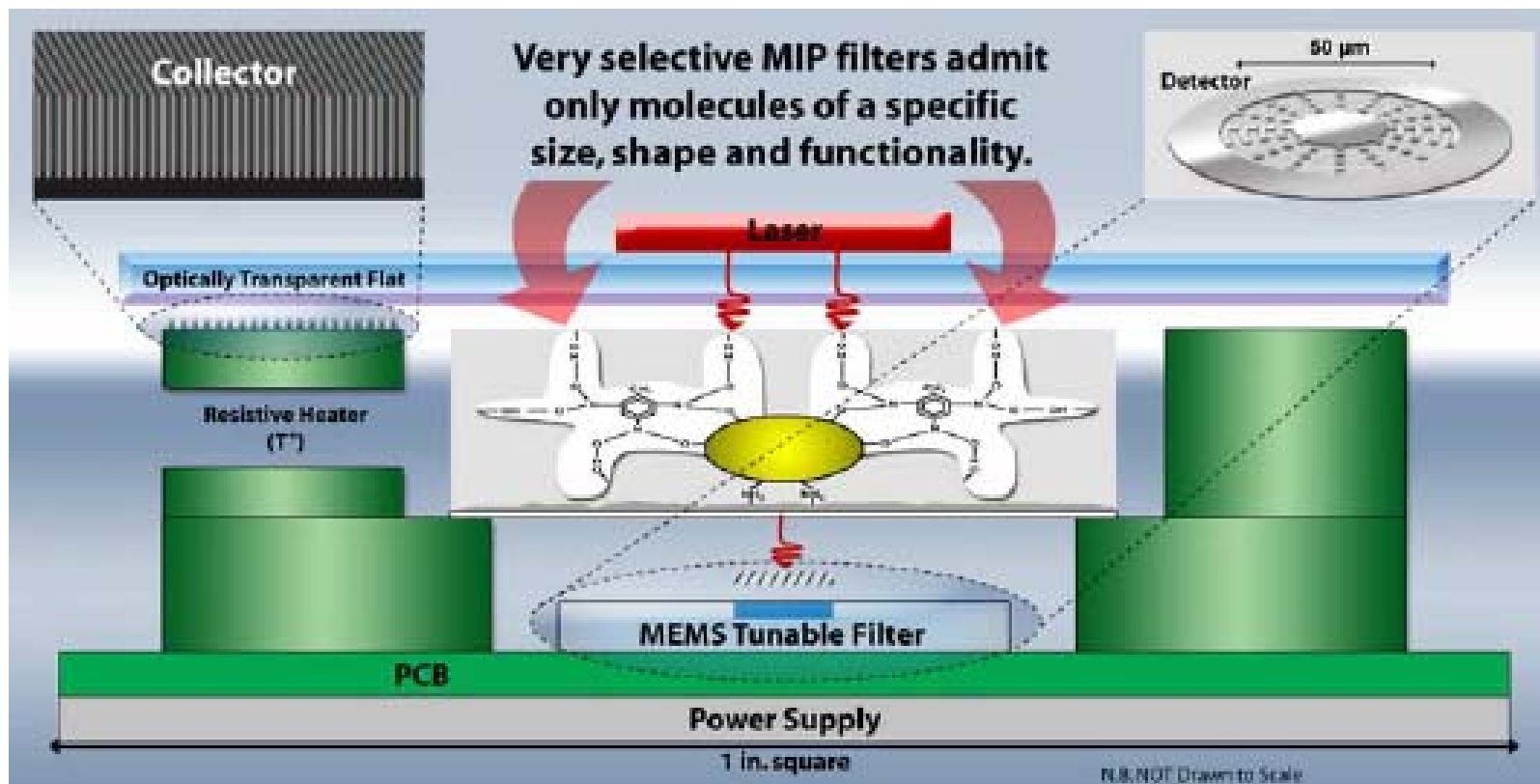
Fabry-Perot Interferometer is comprised of two optically flat parallel mirrors where one of the two mirrors is allowed to move thereby adjusting the spacing between the mirrors. If the spacing is an integral multiple of half wavelengths, a resonance occurs with a corresponding peak in transmission.



Spectrometer: Ideal Operation

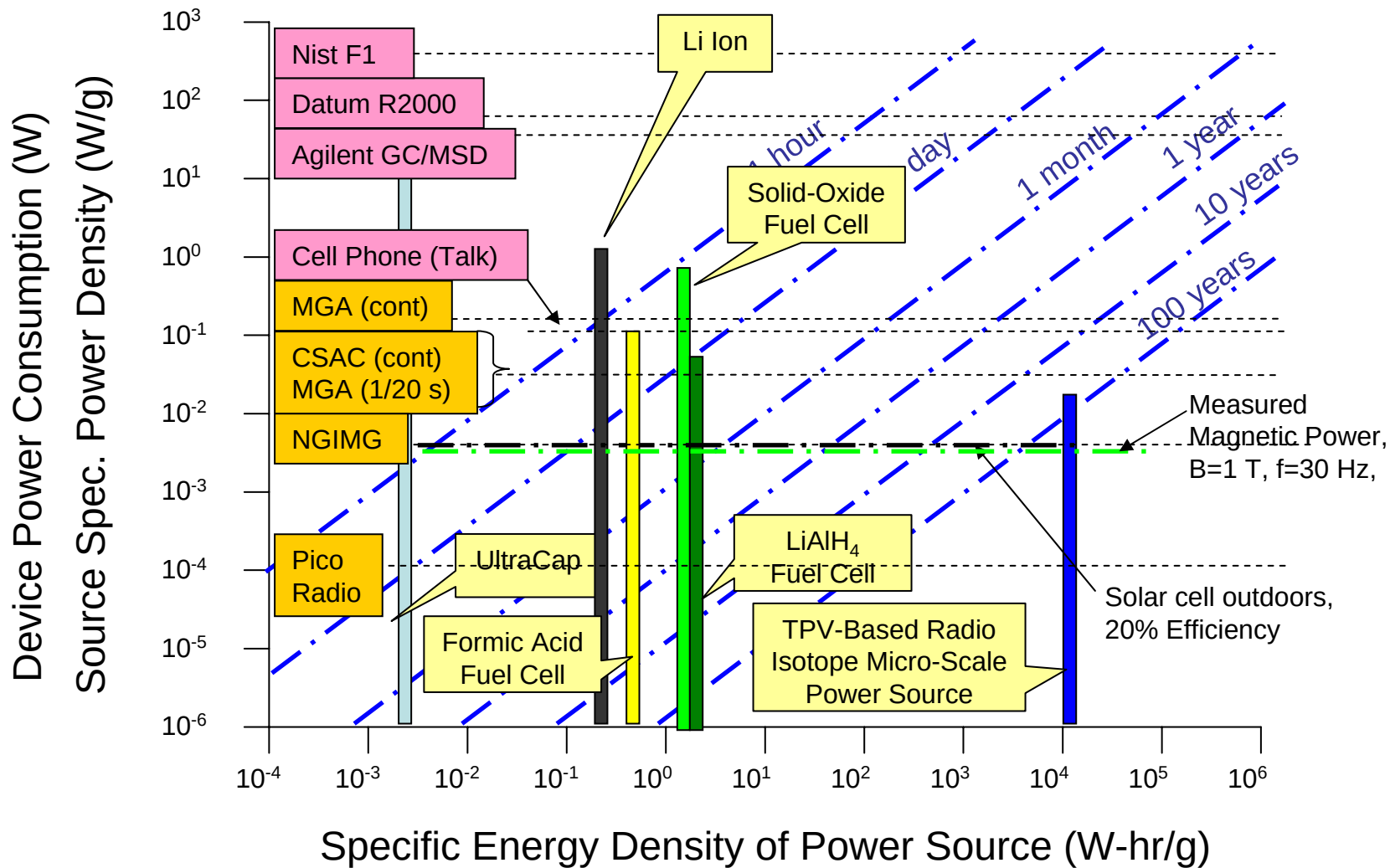


System Description



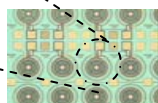
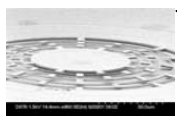
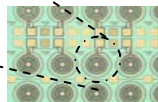
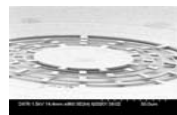
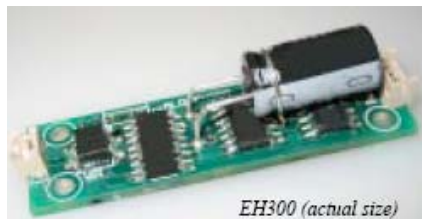
ENERGY HARVESTING

Power Consumption vs. Longevity

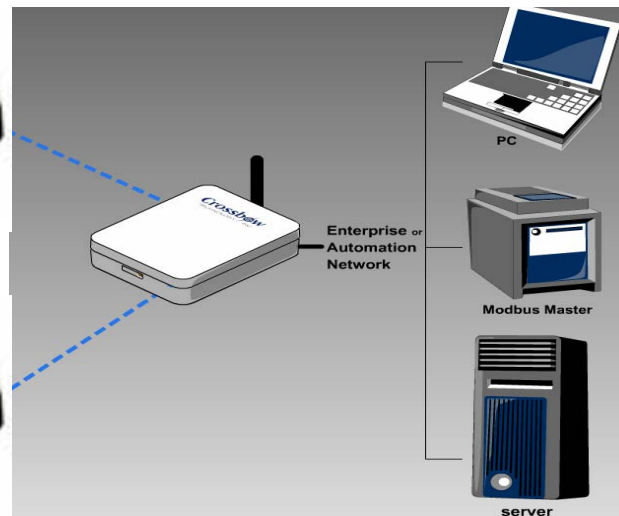


Energy Harvesting Demonstration Vehicle

Energy Harvesting
Module



Crossbow environmental
wireless sensor network



Energy
Harvester

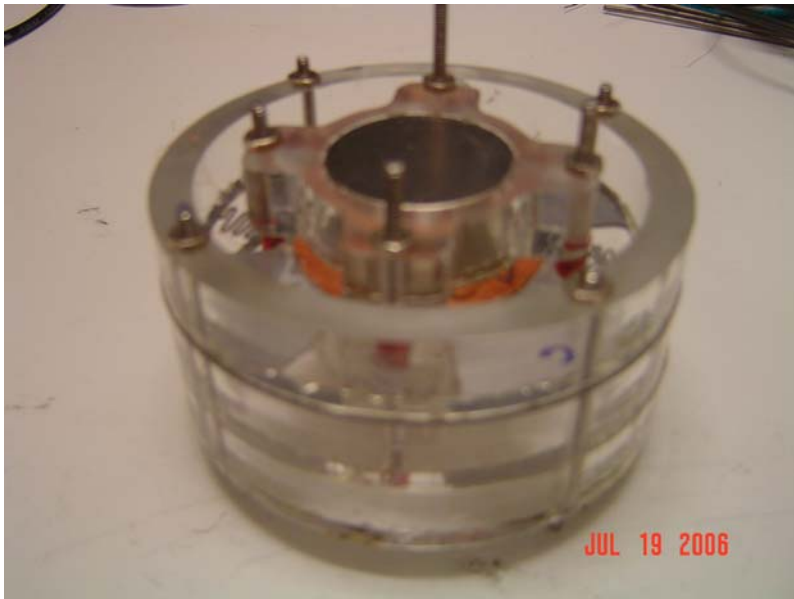


VIBRATIONS

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

Energy Harvesting Prototypes

1st Generation: 3.85 mW/cc/g

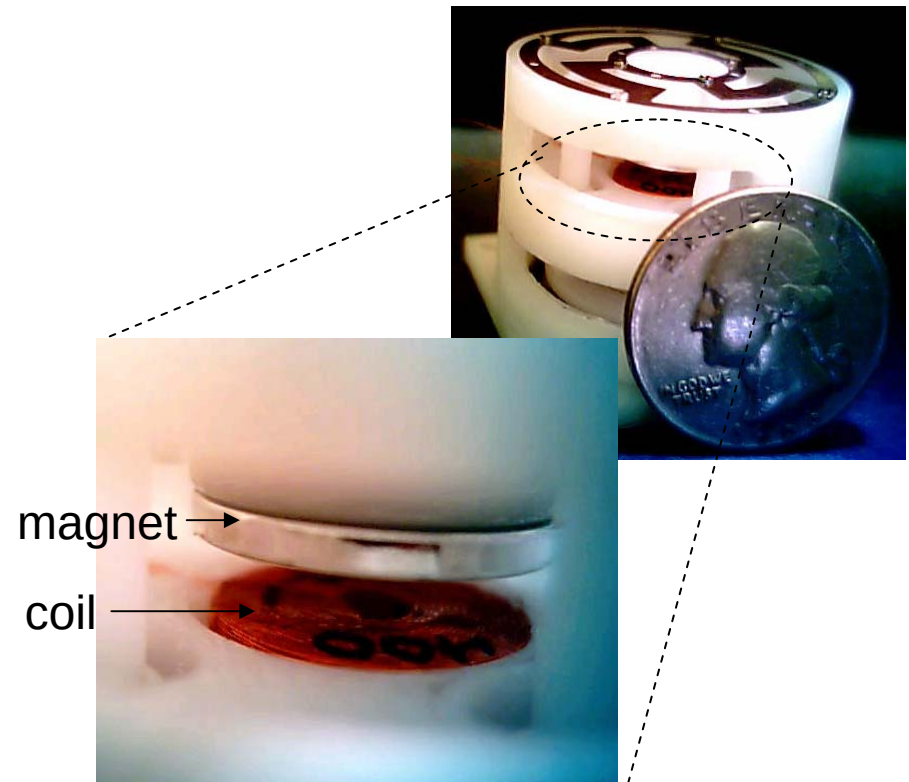


Hockey puck size

Resonant Frequency ~30Hz

Maximum acceleration ~120 mg

2nd Generation: 9.9 mW/cc/g



Volume ~19 cm³

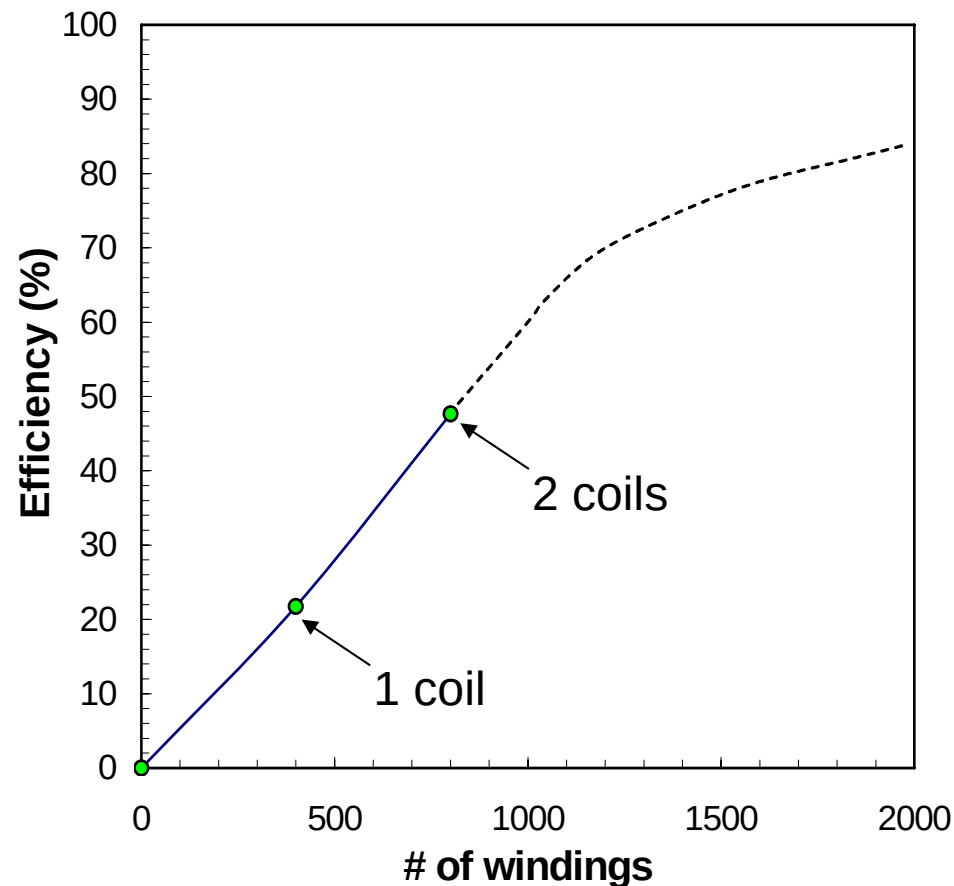
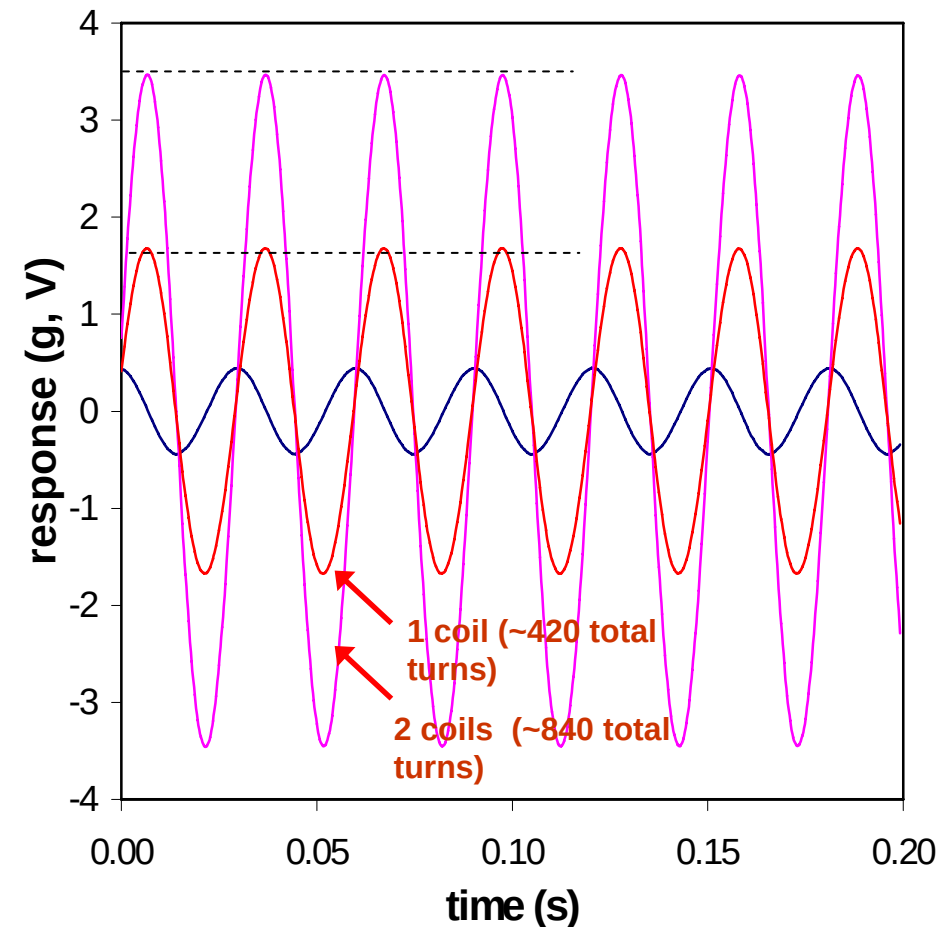
Resonant Frequency ~90Hz

Maximum acceleration ~1 g

FY07 Experimental Results @35 Hz

Voltage doubles when # windings doubles

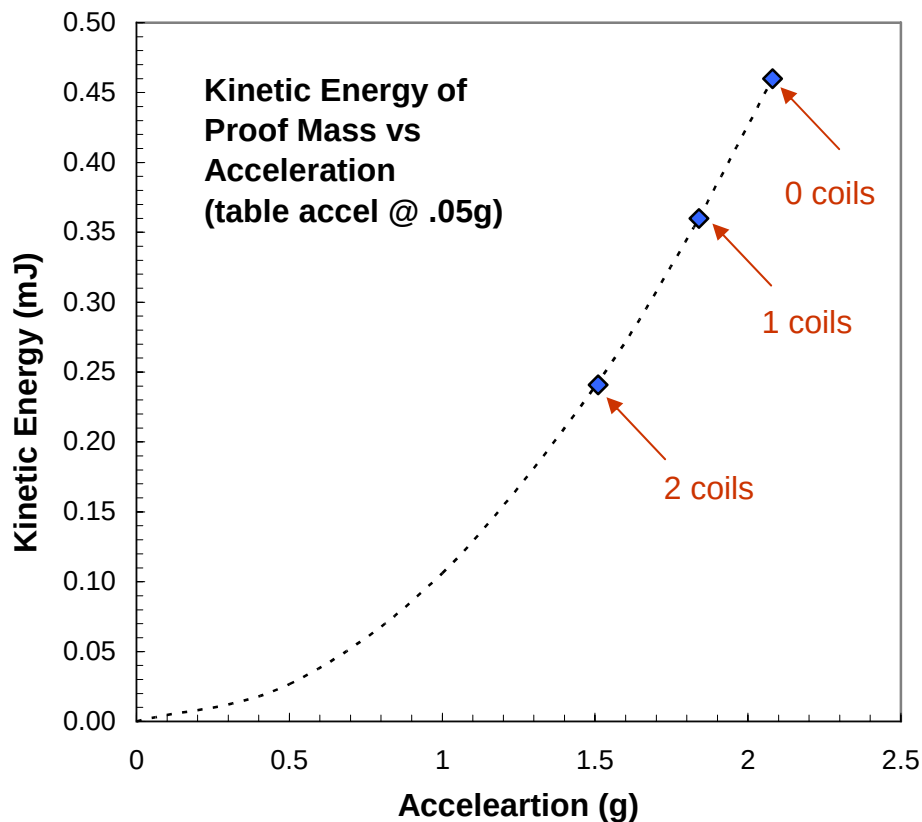
- We have not saturated
- We can still extract more energy with better coil design / smaller wire diameter.



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

- $\frac{P(1\text{ coil})}{KE(\text{no coils}) \cdot f} \times 100$
- Power eff ~ 21.5%

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

Summary

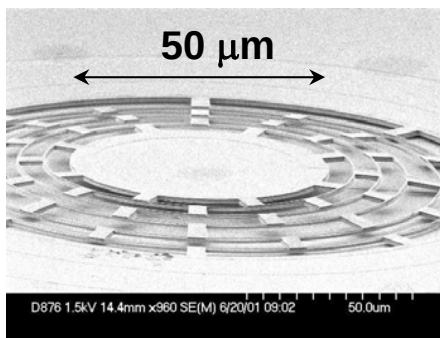
- SSC-SD is developing
 - Micro arrayable spectrometers to replace large, expensive, user intensive laboratory grade analysis equipment.
 - Sensors will be low-cost, expandable to meet emerging threat conditions, accurate, and consume less than 10 mW.
 - Will utilize JWARN, JCID and HOLSTER in its final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

Backup

Our Concept

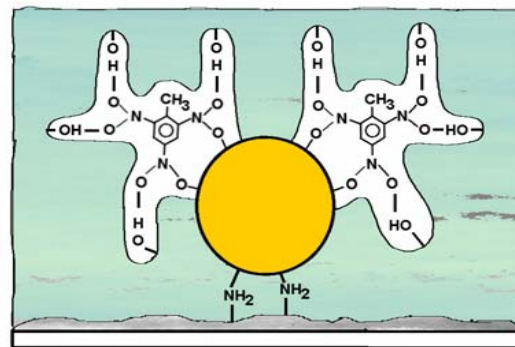
Combine demonstrated MEMS tunable optical filters with Molecularly Imprinted Polymers (MIPs) for Surface Enhanced Raman Spectroscopy (SERS).

MEMS Optical Filter



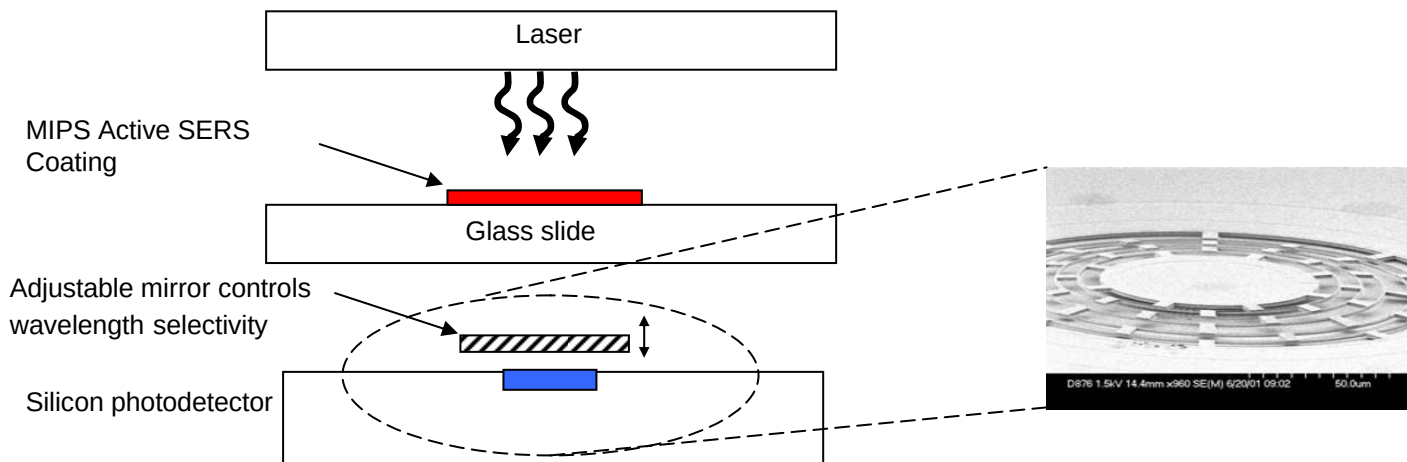
+

MIPs



Operational Concept (How it Works)

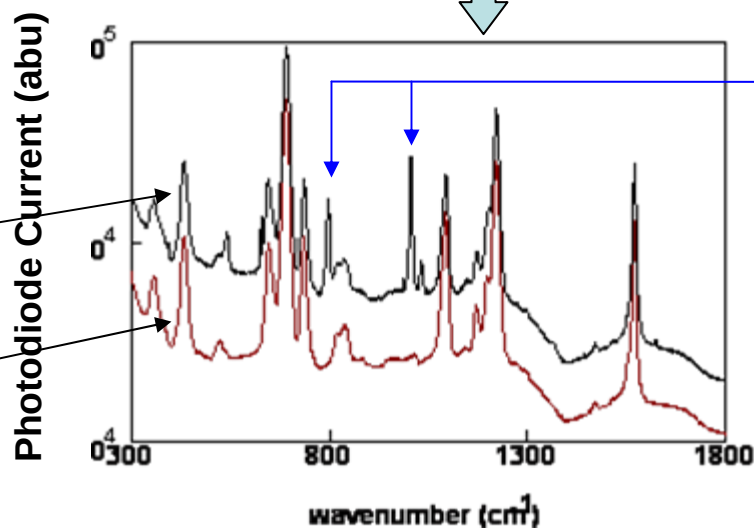
Depiction of proposed assembly for testing. Assembly includes FPI sensor, glass slide with coating and halogen or broad spectrum LED light source.



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)

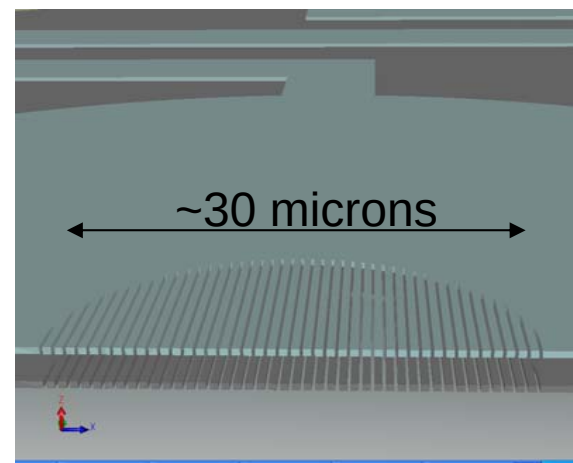
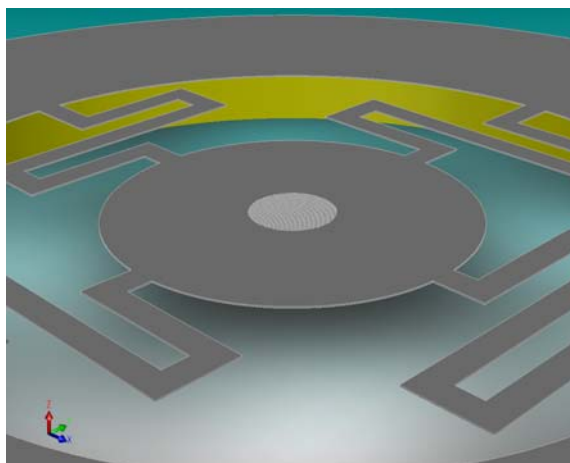
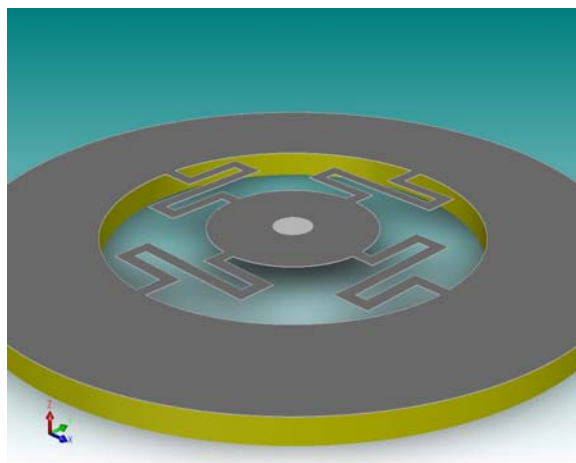
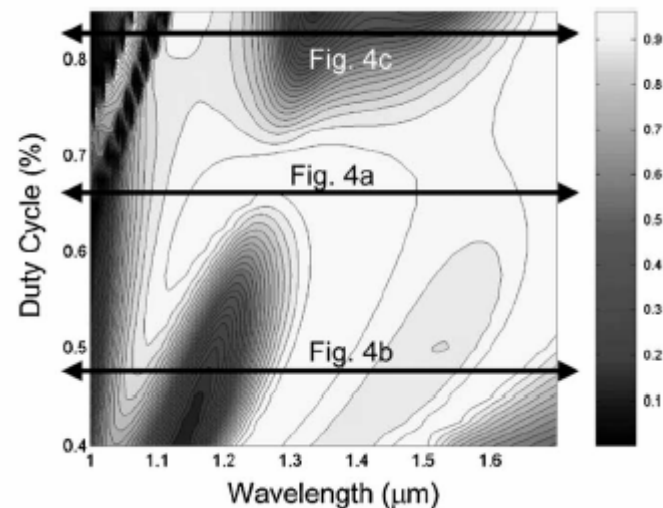
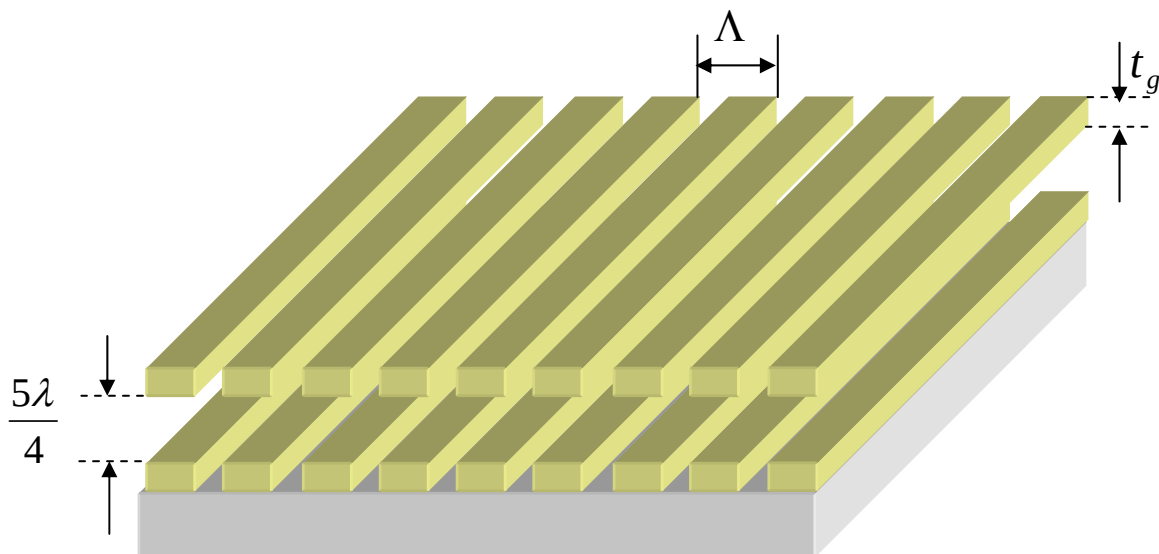
Binding + optical detection greatly reduces false positives

Proportional to Distance between mirrors



SPAWAR
Systems Center
San Diego

High-Contrast sub-wavelength Grating (HCG) Mirror



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 CLOSSES	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



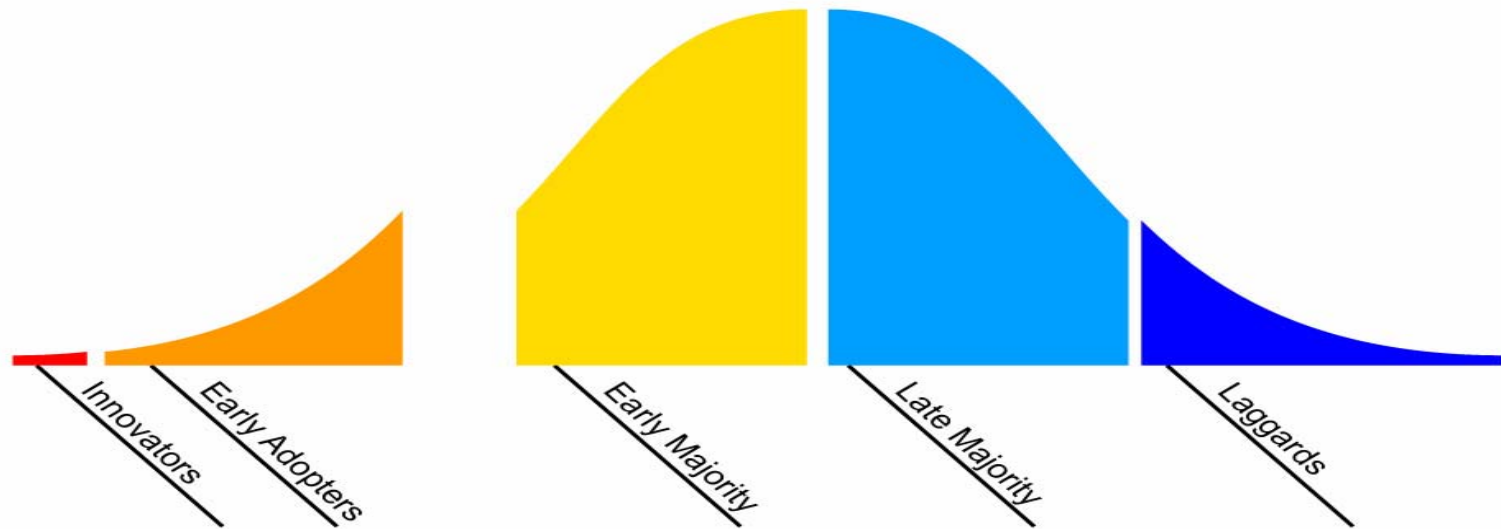
60000BC



CROSSING THE CHASM

High-Tech Marketing Illusion

The Revised Technology Adoption Life Cycle



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





PackBot #129

**Killed In Action
Iraq**



iRobot[®] 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

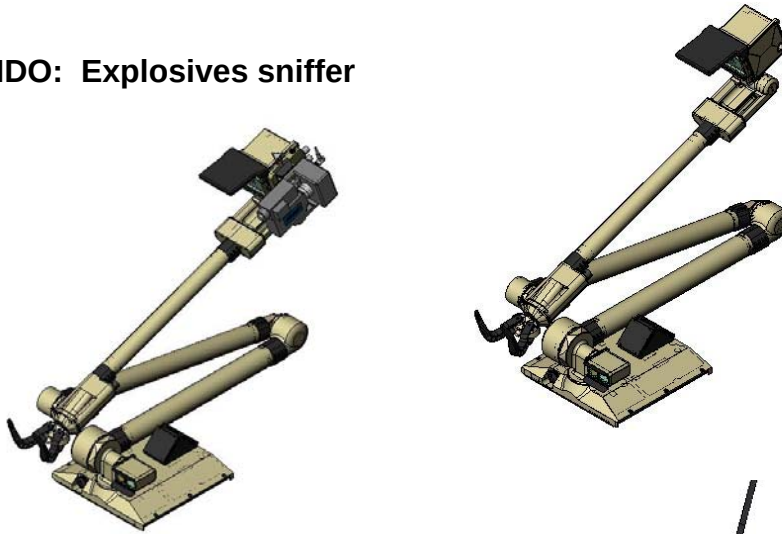
- **Scene: 09 Dec 2005 -- The experimental force commander and five of his team (from team leader to trooper) at Q&A session chaired by Gen William S. Wallace (new TRADOC 4 star)**
 - **First question: "Captain, of all the new technologies and capabilities you've used during this AAEF experiment, which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



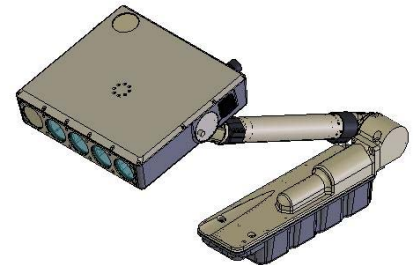
PackBot: Digital Modular Architecture

EOD: Explosive Ordnance Disposal

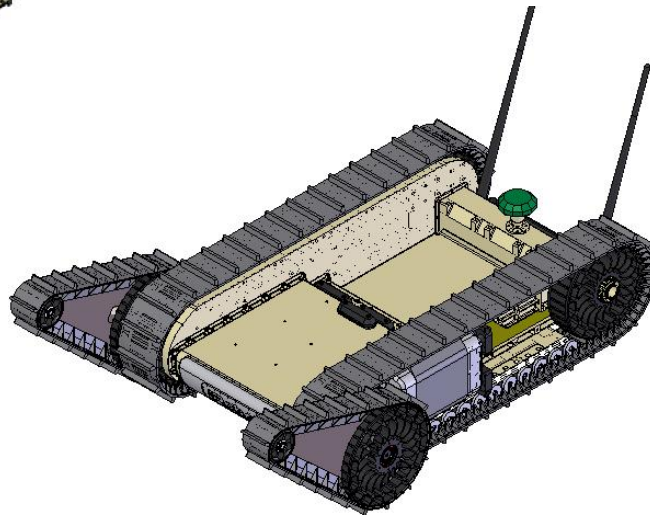
FIDO: Explosives sniffer



Explorer: Recon & Surveillance



Scout: Recon & Surveillance



PackBot: Modular Chassis



Digital Architecture & Systems Integration





Nomadics FIDO + iRobot PackBot



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



Fido™
**Explosives
Detector**

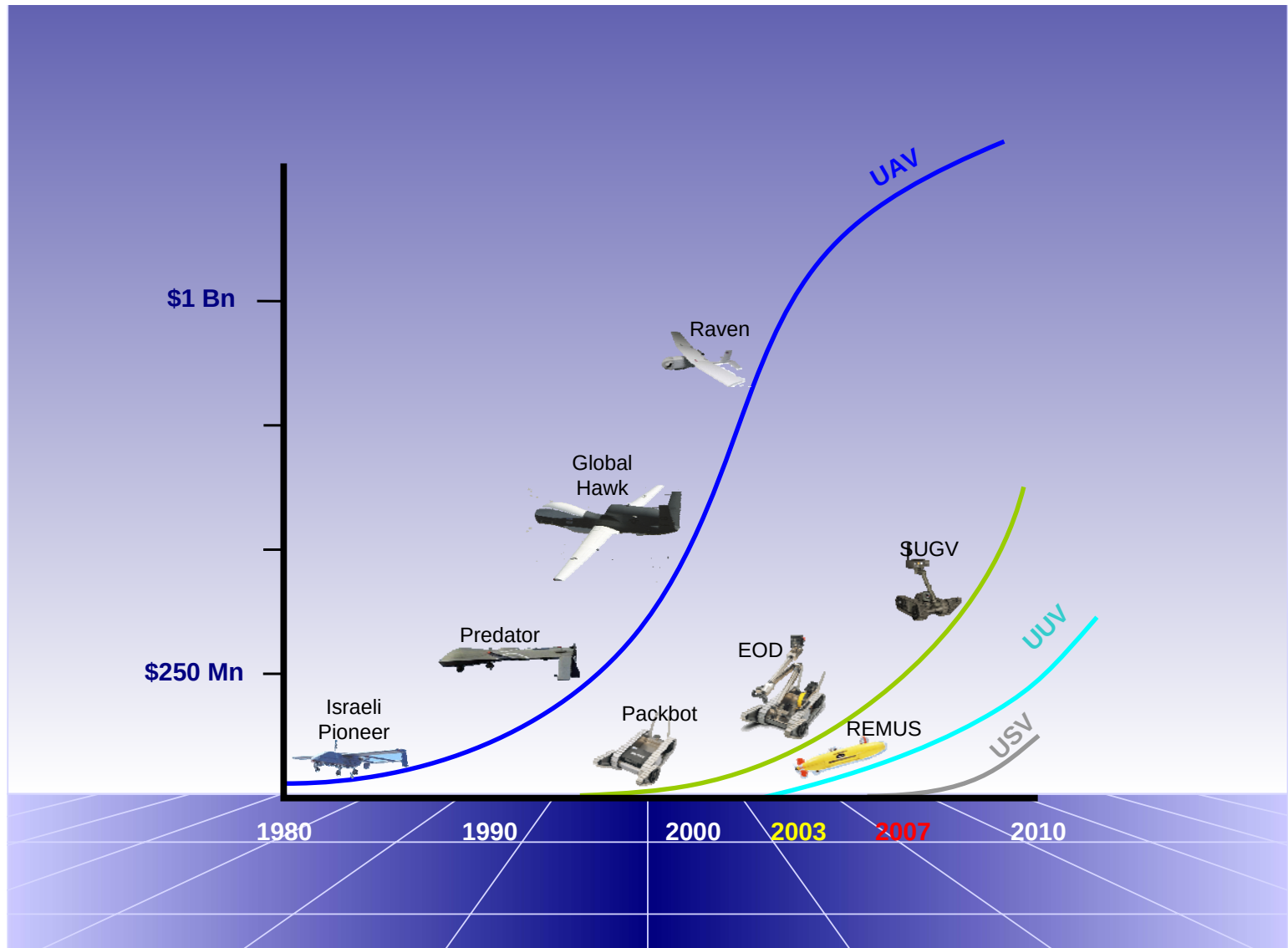


THE DETECTION OPPORTUNITY:
Explosives leave invisible traces of
vapors which FIDO can sniff and detect.

“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

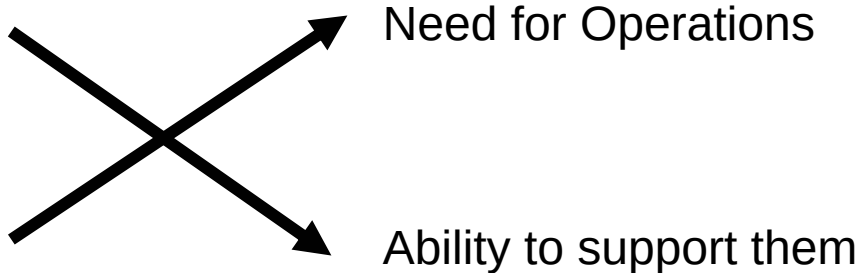
- Locked away from public
 - too dangerous for computers
- Used inside large companies
- Operational use in military
- First few “home” computers
 - in the form of games
- Computer hacking clubs
- How-to-build-your-own books
- Undergraduate majors appearing
- First mass market “serious” home computer 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 casualties and POW's.
- U.S. volunteer force resources are being stretched



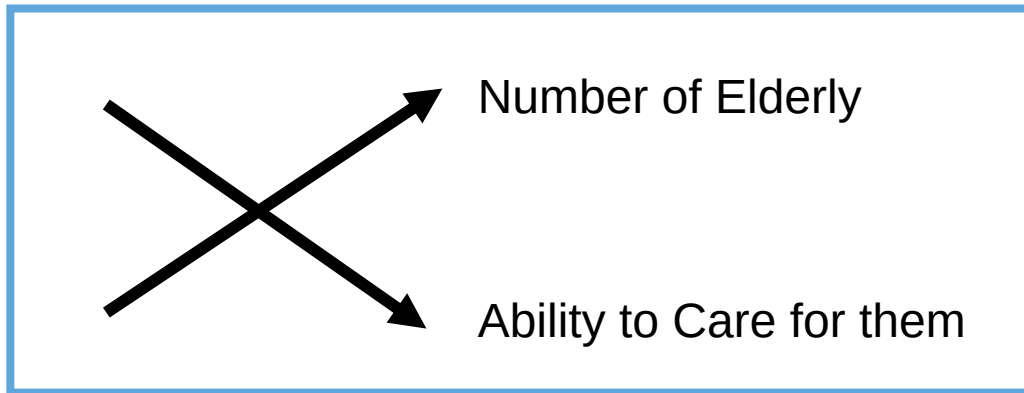
We have over 350,000 SOLDIERS overseas in 120 countries

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

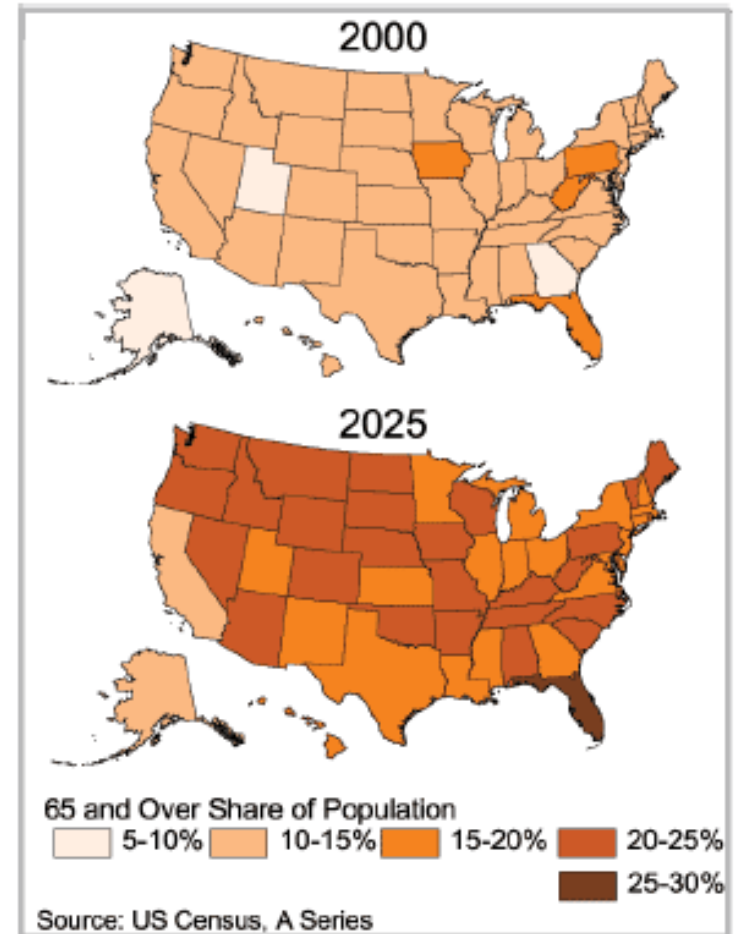


Long Term Driver

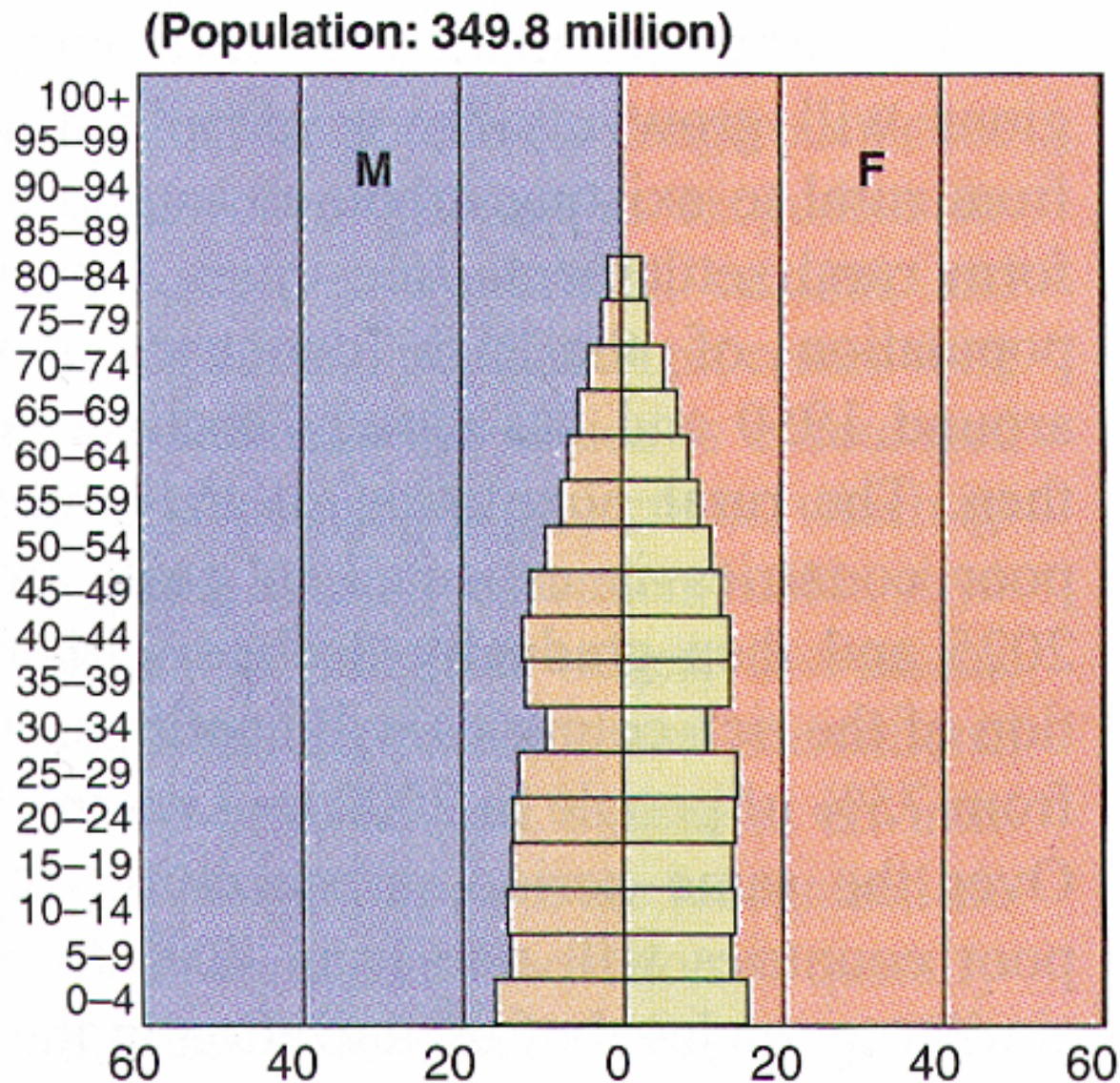
- Our current ability to care for the elderly is barely adequate and in decline
- A massive increase in the number of elderly people is imminent



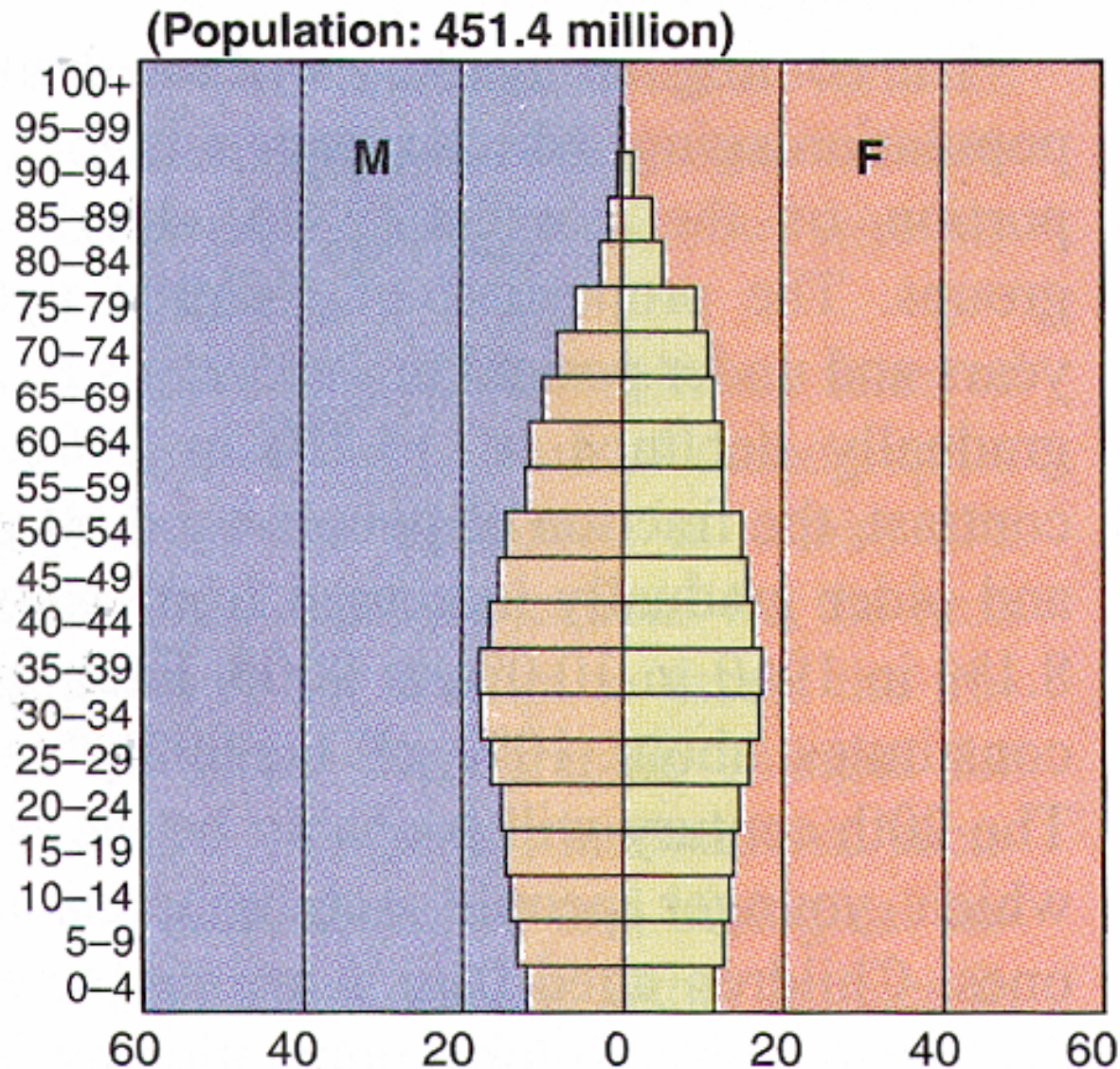
- **We cannot simply spend our way to a solution.**



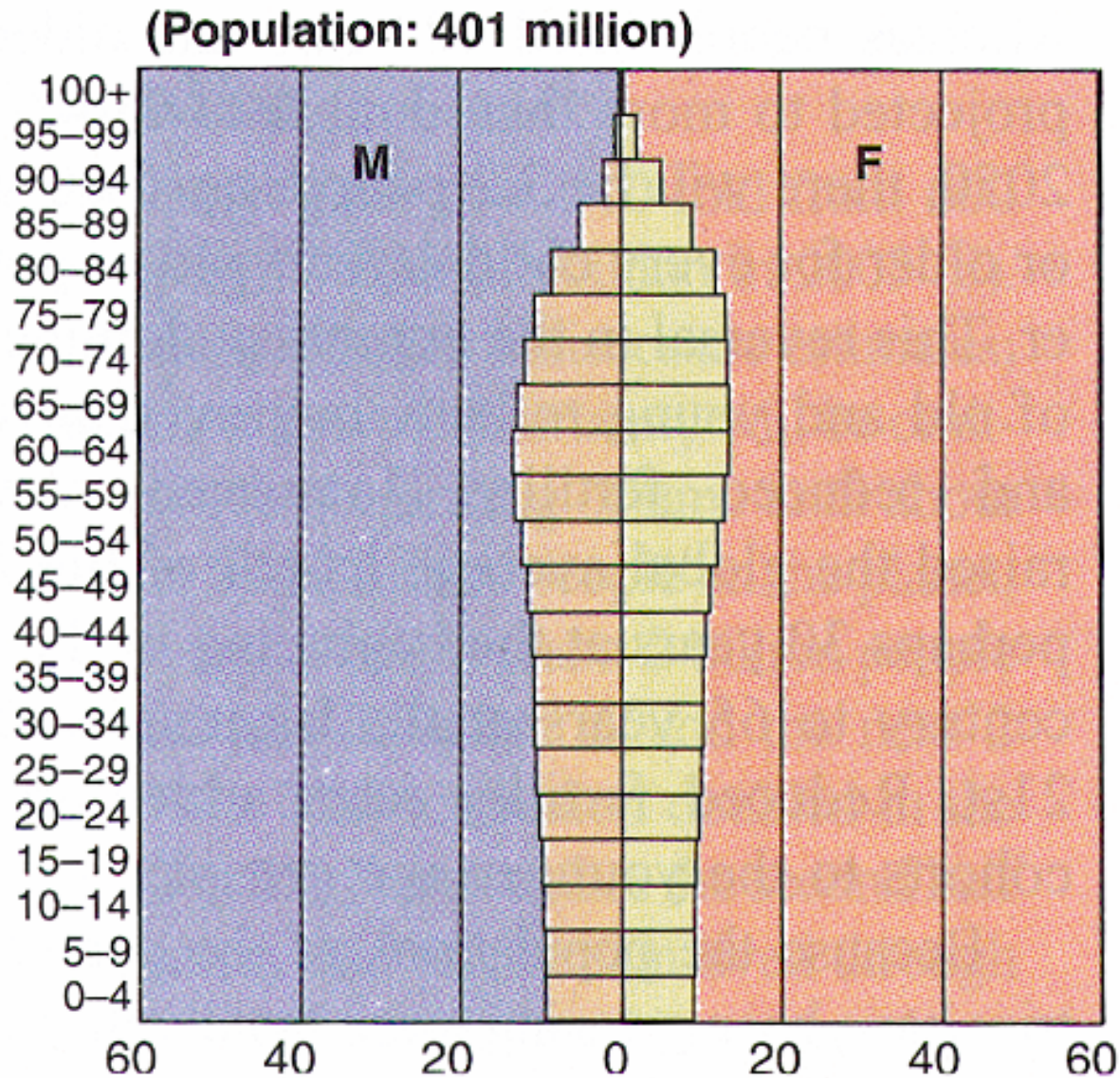
Europe - 1950



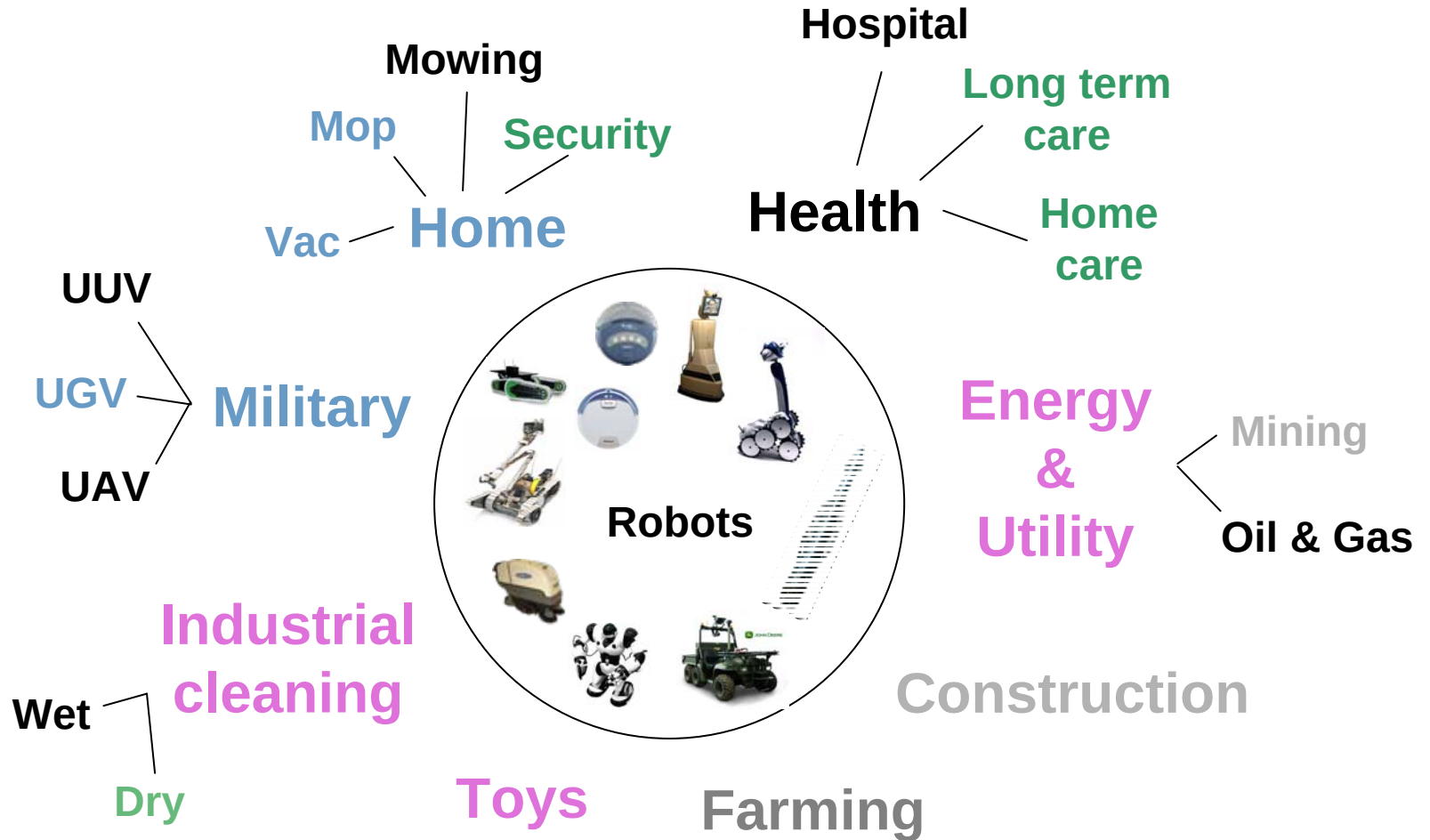
Europe - 2000



Europe - 2050



The Robot Industry



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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jdye@irobot.com

781.481.3361

