**Pacific Operational Science & Technology Conference**

**2-4, April 2007**

**Honolulu, HI**

Agenda

**Tuesday, 3 April 2007**

**Current Theater Environment – FY07-FY09**

**HQ USPACOM**

- **USPACOM J2**, *"Intelligence Prospective", RADM Andrew M. Singer,* USN, Director for Intelligence, J2, US Pacific Command

- **USPACOM J4**, *"Logistics, Engineering, and Security Assistance (J4)", Brigadier General Kenneth S. Dowd,* USA, Director for Logistics, Engineering and Security Assistance, J4, US Pacific Command

**Homeland Security Perspective:**

- **Department of Homeland Security**, *"DHS Science & Technology: Alignment for Success", Rear Admiral, (Retired), Jay Cohen,* USN, Under Secretary for Science & Technology

**International Perspective:**

- **Australia**, *"Current Theatre Environment An Australian Perspective",* Dr. Roger Lough, Chief Defense Scientist, Defence Science and Technology Organization
- **Singapore**, *"Security challenges from the perspective of a small city state", Rear Admiral (Retired) Richard Lim,* Chief Executive, Defence Science and Technology Agency
- **Republic of Korea**, *"Perspective on S&T Collaboration", Dr. Tae In Choi,* Vice President, Agency for Defense Development

**Banquet w/Special Guest Speaker:**

*"Breakthroughs, the Product of Innovators",* Mr. Burt Rutan

**Wednesday, 4 April 2007**

**Near Term Solutions to Current Challenges – How the World will Change: FY07-FY09**

***Military Services Research and Development***

- **Army Research and Development**, *"Army Science & Technology Overview", Dr. Thomas H. Killion,* Deputy Assistant Secretary for Research & Technology/Chief Scientist, Department of the Army.
- **Navy Research Enterprise**, *"Naval Science and Technology Update", Rear Admiral William E. Landay, III,* USN, Chief Naval Research
- **Air Force Research and Development**, *"Solutions to Current Challenges: FY07-FY09", Major General Ted F. Bowlds,* USAF, Commander, Air Force Research Laboratory

**DoD Agency Research and Development**

- **DARPA,** *"DARPA Networking and Communications Overview", Dr. Larry B. Stotts,* Deputy Director, Strategic Technology Office, DARPA

- **OSD/Nuclear, Chemical, Biological**, *"Nuclear, Chemical and Biological Defense Research and Development", Dr. Thomas Hopkins*, Acting Assistant to the Secretary of Defense (NCB)

**Lunch w/Guest Speaker:**

*"Strategic Challenges in the Asia-Pacific Area", Lieutenant General (Retired) E.P. Smith*, USA, Director, Asia-Pacific Center for Security Studies

**Industry Panel:**

**Panel Members:**

- **ISR-UAVs**, *Future Solutions – ISR", Mr. John Grabowsky*, VP & GM – Small UAVs, AeroVironment
- **Maritime Domain Awareness**, *"Future Industry Solutions….FY10 and Beyond", Mr. Tom Williams*, VP Advanced Concepts, Integrated Systems Sector, Northrop Grumman Corporation
- **Undersea Warfare**, "*Undersea Warfare", Mr. Roger Bagbey*, SVP & Group Manager – Engineering and Technology Center, Alion Science & Technology

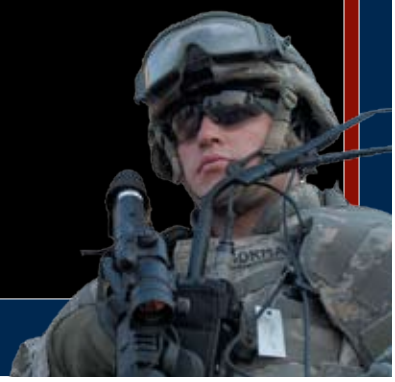
**Game Changing Technology Panel**

**Panel Topics:**

- **Knowledge Management – from SA to BDA,** "*Connecting the Dots", Lieutenant General (Retired) George Fisher*, USA, Director, Department of Defense Programs, National Security Directorate, Oak Ridge National Laboratory
- **Computational Imaging,** "*Game Changing Technologies, Computational Imaging Systems", Dr. Timothy Persons*, Technical Director, Disruptive Technologies, ONI
- **FiberWeb Linear Sensor,** "*The ATLAS, Powered Rope Ascender", Major Rex Blair, USA and Mr. Nathan Ball*, MIT Institute for Soldier Nanotechnologies

# Pacific Operational Science & Technology Conference

***April 2-4, 2007***
***Hilton Hawaiian Village***
***Mid-Pacific Conference Center,***
***Coral Ballroom***



http://www.ndia.org

# Pacific Operational Science & Technology Conference

**Hilton Hawaiian Village**
**Mid-Pacific Conference Center**
**Coral Ballroom**

**Monday, April 2, 2007**

5:00 PM – 6:30 PM — Registration and Ice Breaker Reception
Exhibit Hall, Coral Lounge

5:00 PM – 6:30 PM — Exhibits Open, Coral Lounge

## Tuesday, April 3, 2007

*Coral Ballroom IV*

## Pacific Theater Environment: Today and Beyond

7:00 AM – 8:00 AM — Registration Open / Continental Breakfast
*Exhibit Hall, Coral Lounge*

7:00 AM – 8:00 AM — Exhibits Open
*Coral Lounge*

7:20 AM — **Administrative Remarks / Conference Overview**
*Dr. Charles H. Kimzey, PhD*
*Science & Technology Advisor, U.S. Pacific Command*

7:30 AM — **Commander's Overview**
*Lieutenant General Dan Leaf, USAF*
*Deputy Commander, U.S. Pacific Command*

***Current Theater Environment – FY07 –FY09***

***HQ USPACOM***

8:00 AM — **USPACOM J2**
*RADM Andrew M. Singer, USN*
*Director for Intelligence, J2, U.S. Pacific Command*

8:15 AM — **USPACOM J3**
*Brigadier General Martin Post, USMC*
*Deputy Director for Operations, J3, U.S. Pacific Command*

8:30 AM — **USPACOM J4**
*Brigadier General Kenneth S. Dowd, USA*
*Director for Logistics, Engineering and Security Assistance, J4, U.S. Pacific Command*

8:45 AM — **USPACOM J5**
*Rear Admiral Michael C. Tracy, USN*
*Director for Strategic Planning & Policy, J5, U.S. Pacific Command*

9:00 AM — Panel Discussion
*Chair: Rear Admiral Michael C. Tracy, USN*
*Director for Strategic Planning and Policy, J5, U.S. Pacific Command*

9:20 AM — Break
*Coral Lounge*

# Pacific Operational Science & Technology Conference

### *Homeland Security Perspective*

9:40 AM **Department of Homeland Security**
*Rear Admiral, USN, (Retired), Jay Cohen*
*Under Secretary for Science & Technology*

### *International Perspective*

10:10 AM **Australia**
*Dr. Roger Lough*
*Chief Defence Scientist*
*Defence Science and Technology Organization*

10:35 AM **Singapore**
*Rear Admiral (Retired) Richard Lim*
*Chief Executive, Defence Science and Technology Agency*

11:00 AM **Republic of Korea**
*Dr. Tae In Choi*
*Vice President, Agency for Defense Development*

12:00 PM Lunch - *Coral Ballroom V*
**Keynote Speaker**
*Lieutenant General Dan Leaf, USAF*
*Deputy Commander, U.S. Pacific Command*

1:30 PM – 7:00 PM Exhibits Open

## LISTEN UP! Warfighter's Perspective

1:30 PM CAPT Kirk Brinker, *SOCPAC*
SGM William Smith, USA, *HQ USARPAC G357*
EODCS Michael Lentz, USN, *EOD MU Five*
CSM Elroy Alcivar, USA, *RDCOM*
SSG Keith Frain, USA, *Tripler Army Medical Center*
SFC Kevin Kennedy, USA, *SOCPAC*
SGM Errol Snyder, USA, 1-21 *1-21 Infantry, 25th ID*
SFC Mario Miramontiz, USA, *1-21 Infantry, 25th ID*
SGM George Garcia, USA, *1-21 Infantry, 25th ID*
SMSgt John Anipe, USAF, *25th Air Support Operations Squadron*
SSG Tanner Catrett, USA, *706th EOD*
SSG Brad Joehen, USA, *706th EOD*

2:30 PM **Panel Discussion**
*Chair: Sergeant Major William T. Kinney, Senior Enlisted Leader, U.S. Pacific Command*

2:50 PM Break
*Coral Lounge*

# Pacific Operational
# Science & Technology Conference

***"Over The Horizon" Theater Challenges – FY10 and Beyond***

3:10 PM Panel Members: **General Larry D. Welch, USAF (Retired)**
*CEO Institute for Defense Analysis and*
*Former Air Force Chief of Staff*

**General Charles R. Holland, USAF (Retired)**
*Former Commander, U.S. Special Operations*

**Admiral Thomas B. Fargo, USN (Retired)**
*President, Trex Enterprises Corporation and*
*Former Commander, U.S. Pacific Command*

**Panel Chair:** **General Larry D. Welch, USAF (Retired)**
*CEO Institute for Defense Analysis and*
*Former Air Force Chief of Staff*

5:30 PM Pre-Dinner Social - Exhibit Hall
*Exhibit Hall, Coral Lounge*

6:00 PM Banquet w/Special Guest Speaker – Mr. Burt Rutan
*Coral Ballroom V*

## Wednesday, April 4, 2007

### Solutions to Theater Challenges
*Coral Balroom IV*

7:00 AM Registration Open / Continental Breakfast
*Exhibit Hall, Coral Lounge*

7:00 – 8:00 AM Exhibits Open

7:50 AM Administrative Remarks / Program Overview
*Dr. Charles H. Kimzey, Science & Technology Advisor*
*U.S. Pacific Command*

***Near Term Solutions to Current Challenges - How the World will Change: FY07-FY09***

***Military Services Research and Development***

8:00 AM **Army Research and Development**
*Dr. Thomas H. Killion*
*Deputy Assistant Secretary for Research & Technology /*
*Chief Scientist, Department of the Army*

8:45 AM **Navy Research Enterprise**
*Rear Admiral William E. Landay, III, USN*
*Chief of Naval Research*

9:30 AM **Air Force Research and Development**
*Major General Ted F. Bowlds, USAF*
*Commander, Air Force Research Laboratory*

10:15 AM Break

10:35 AM Panel Discussion –
***"How the research community can be more responsive to the Warfighter needs."***
*Chair: Mr. Vincent Vitto*
*President & CEO, Charles Stark Draper Laboratory, Inc. and*
*Vice Chairman, Defense Science Board*

## *DoD Agency Research and Development*

11:20 AM **DARPA**
*Dr. Larry B. Stotts*
*Deputy Director, Strategic Technology Office, DARPA*

12:00 PM **OSD/Nuclear, Chemical, Biological**
*Dr. Thomas Hopkins*
*Acting Assistant to the Secretary of Defense (NCB)*

12:30 PM Lunch w/Guest Speaker - *Coral Ballroom V*
***"Strategic Challenges in the Asia-Pacific Area"***
*Lieutenant General E.P. Smith, USA (Ret)*
*Director, Asia-Pacific Center for Security Studies*

1:30 PM – 4:00 PM Exhibits Open

## *Future Industry Solutions – FY10 and Beyond*

1:45 PM **Industry Panel**

Panel Members: **ISR - UAVs**
*Mr. John Grabowsky*
*VP & GM - Small UAVs, AeroVironment*

**Air & Missile Defense**
*Mr. Dave Kier*
*VP & Managing Director - Protection*
*Lockheed Martin Corporation*

**Maritime Domain Awareness**
*Mr. Tom Williams*
*VP Advanced Concepts, Integrated Systems Sector*
*Northrop Grumman Corporation*

**Undersea Warfare**
*Mr. Roger Bagbey*
*SVP & Group Manager - Engineering and Technology Center*
*Alion Science & Technology*

2:45 PM **Panel Discussion**
Panel Chair: **Dr. Ray O. Johnson**
*SVP & CTO, Lockheed Martin Corporation*

# Pacific Operational
# Science & Technology Conference

***Game Changing Technologies – Significant Future Operational Solutions***

3:05 PM **Game Changing Technology Panel**

Panel Topics:

**Nano Technology - How Small Can You Go?**
*Dr. Susan E. Durham*
*Coordinator for Nanotechnology*
*Intelligence Technology Innovation Center*

**Knowledge Management - from SA to BDA**
*Lieutenant General George Fisher, USA (Retired)*
*Director, Department of Defense Programs,*
*National Security Directorate, Oak Ridge National Laboratory*

**Computational Imaging**
*Dr. Timothy Persons*
*Technical Director, Disruptive Technologies, ONI*

**Directed Energy**
*Dr. Kirk E. Hackett*
*Air Force Research Laboratories, Kirtland AFB*

**FiberWeb Linear Sensor**
*Major Rex Blair, USA and Mr. Nathan Ball*
*MIT Institute for Soldier Nanotechnologies*

**Panel Discsusion**
Panel Chair: **Mr. Vincent Vitto**
*President and CEO, Charles Stark Draper Laboratory, Inc.*
*and Vice Chairman, Defense Science Board*

4:00 PM Exhibit Hall Closes
4:35 PM Adjourn

# *LOGISTICS, ENGINEERING, and SECURITY ASSISTANCE (J4 )*

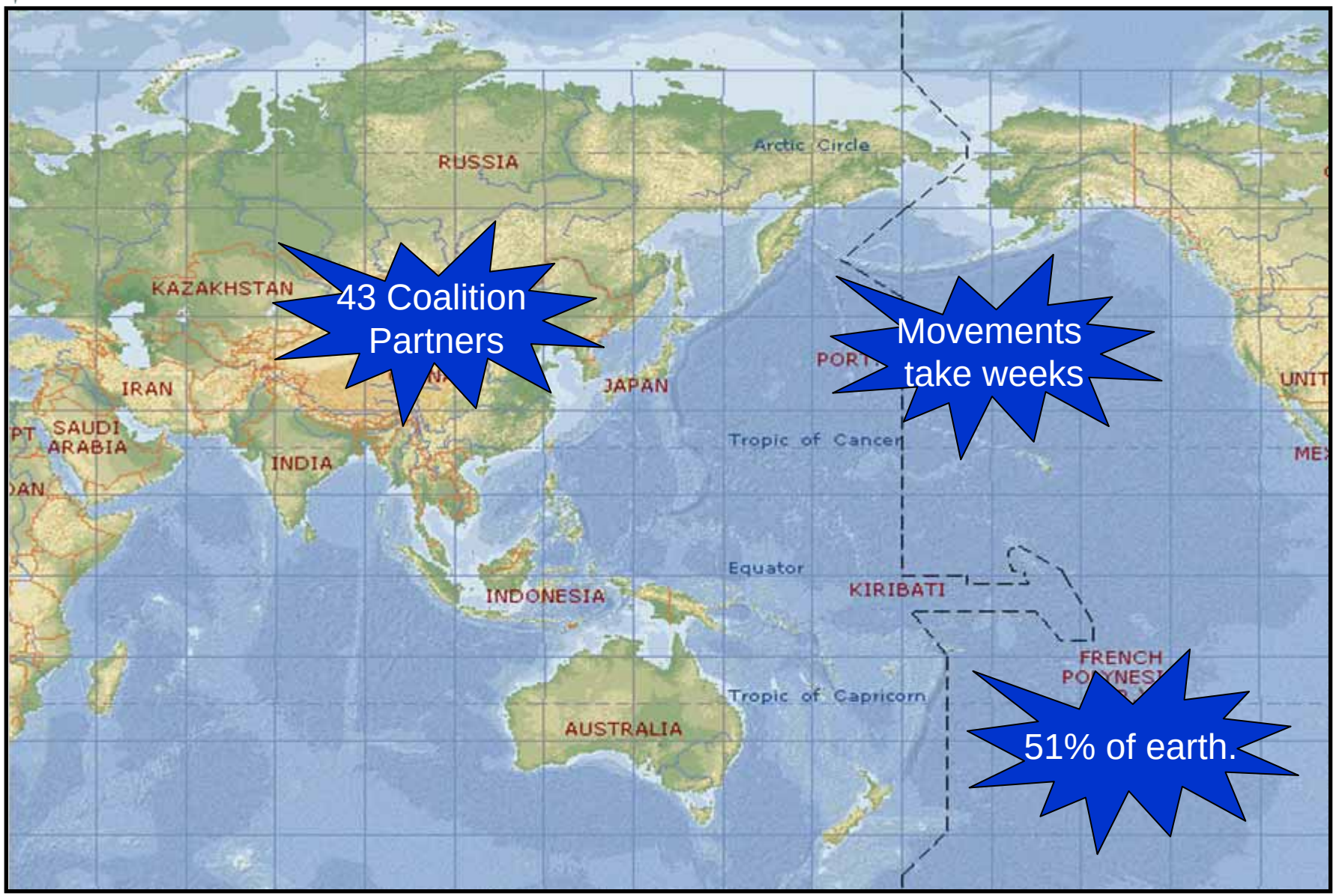
***BG Dowd, PhD***
***USPACOM J4***
***3 APR 2007***

**This brief is classified:**
**UNCLASSIFIED**

# *Agenda*

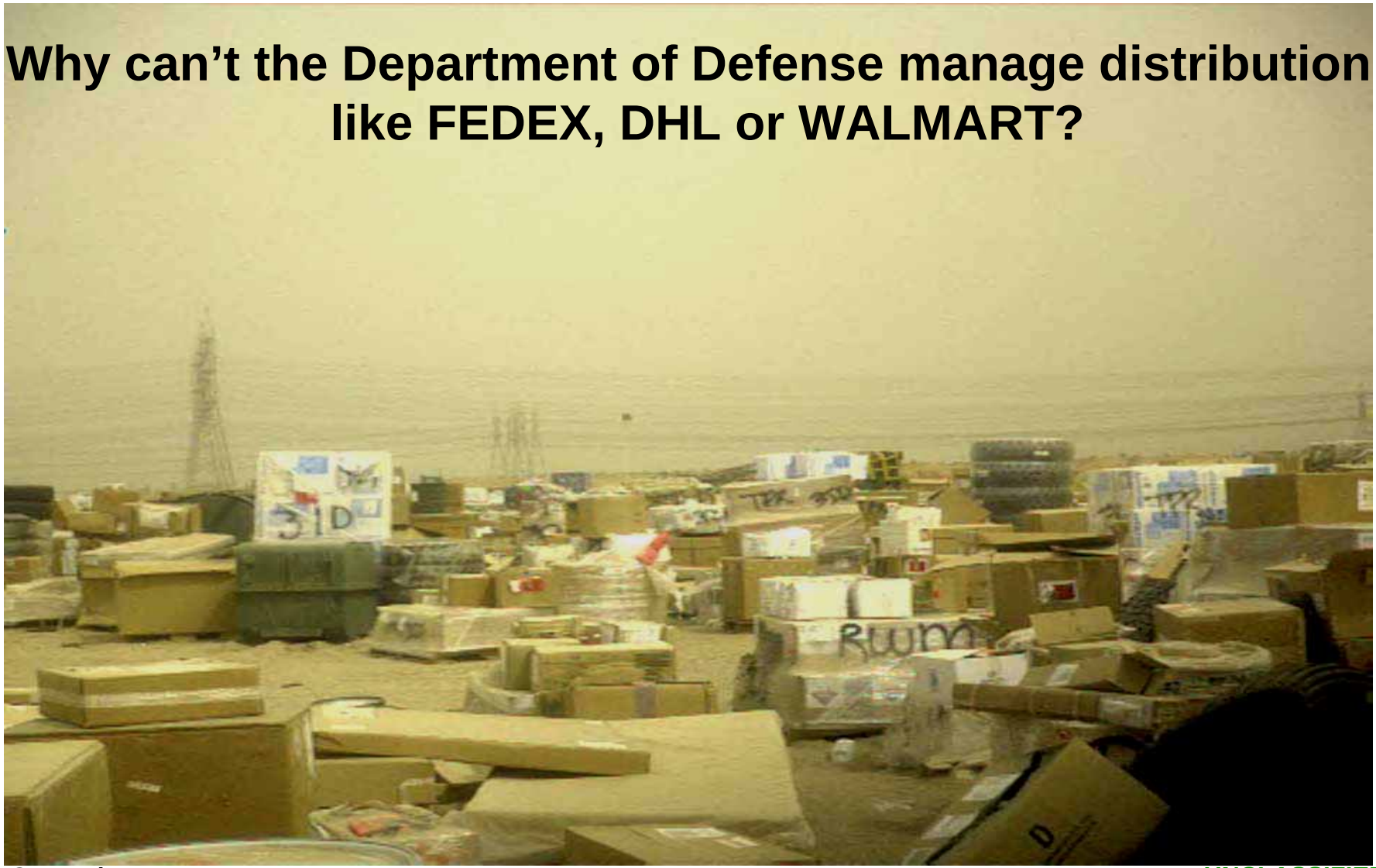
- **The Environment**
- **The Challenge**
- **Discussion**

# *The Environment*

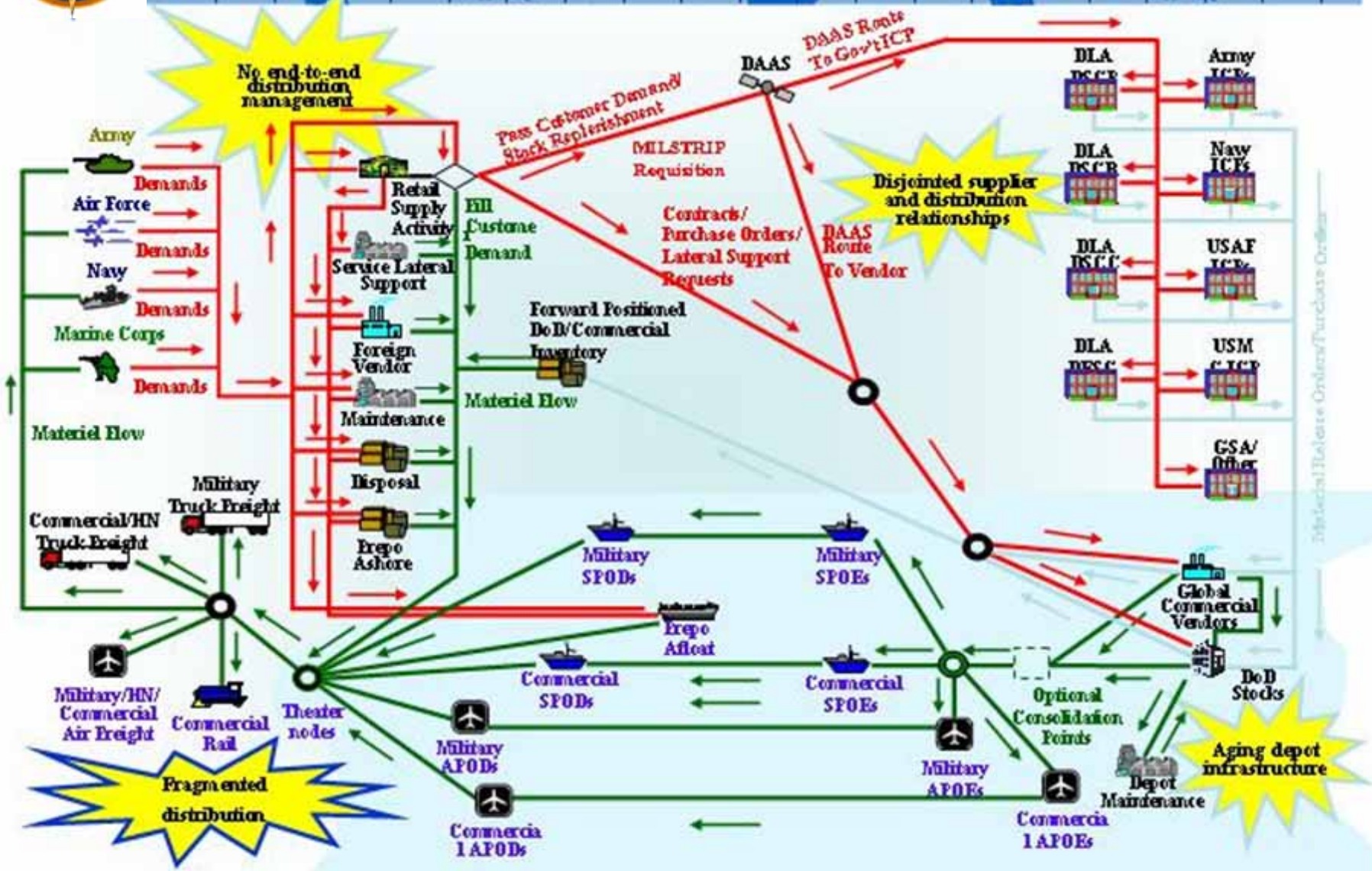


# The Challenge

**Why can't the Department of Defense manage distribution like FEDEX, DHL or WALMART?**

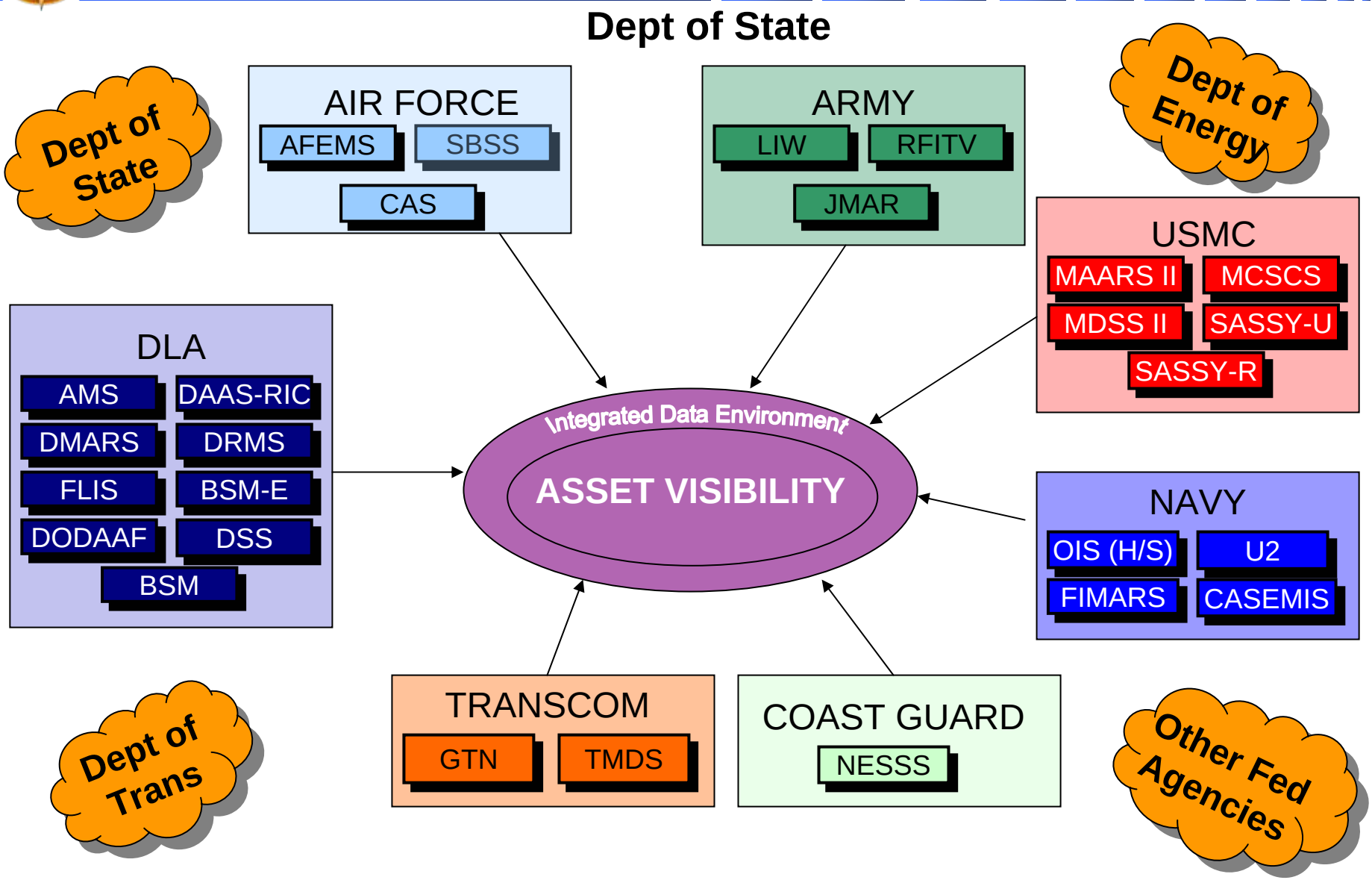


# Distribution Challenge




**Does not include AFFES, DECA, Mail, FEDEX/DHL, LOGCAP/Contractor!**

# The Automation Challenge – too many systems



# *Thoughts*

- Money spent on Log Automation $$$.
- Stop Stovepipes
- Joint Funding
- Joint Solutions

# DARPA Networking and Communications Overview

## 5 April 2007

Dr. David Honey
Director, STO
571-218-4247
david.honey@darpa.mil

Dr. Larry Stotts
Dep Dir, STO
571-218-4346
larry.stotts@darpa.mil

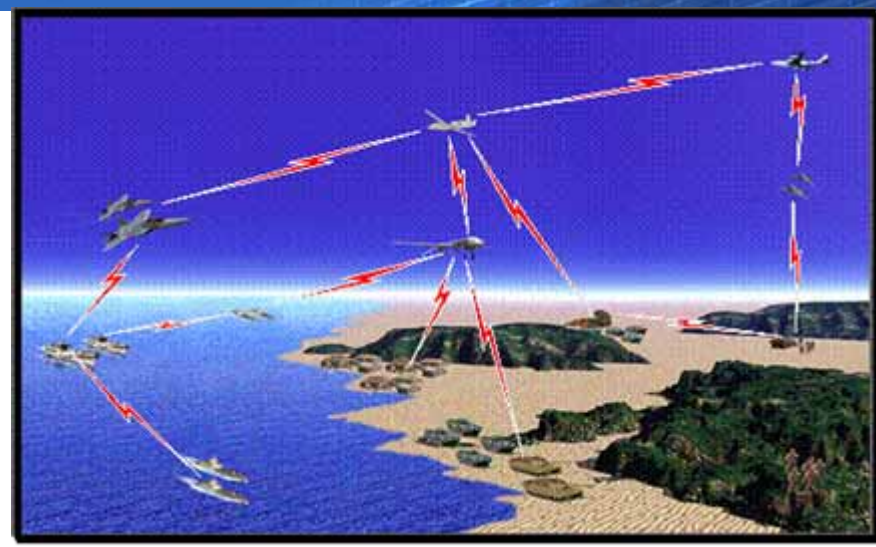
Dr. Brian Pierce
Dep Dir, STO
703-248-1505
brian.pierce@darpa.mil

# Military Operations Structure

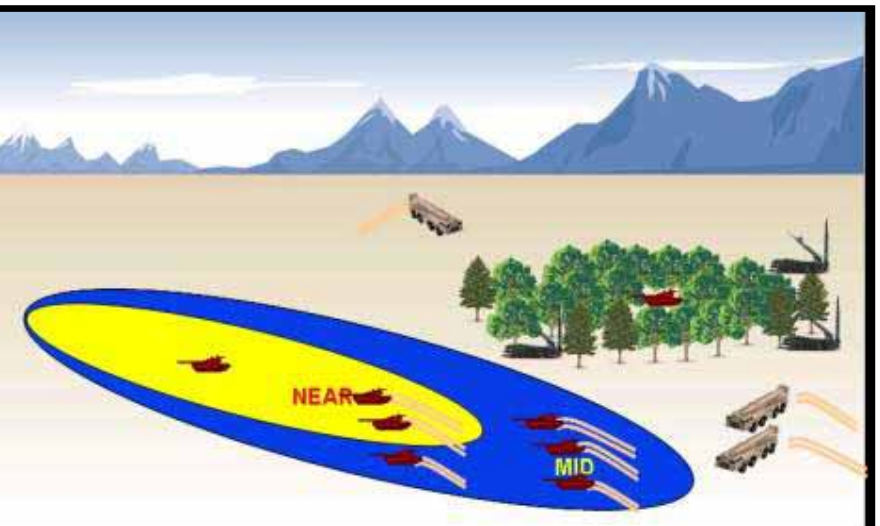
## *Network Centric Enterprise*

***Strategic and operational level of deployment and warfare***

- **Cleared Personnel – TS/SCI**
- **Links air, ground and naval campaigns**
- **Engages by operational maneuver and strategic strikes**
- **Provides information, resources, and sustainment connectivity**
- **Large C4ISR backbone and infrastructure**
  - Rides on GIG and Extensions
  - Can leverage commercial info systems
  - IPv6 early adopter
  - Susceptible to many IA threats



***Bridge the Gap***



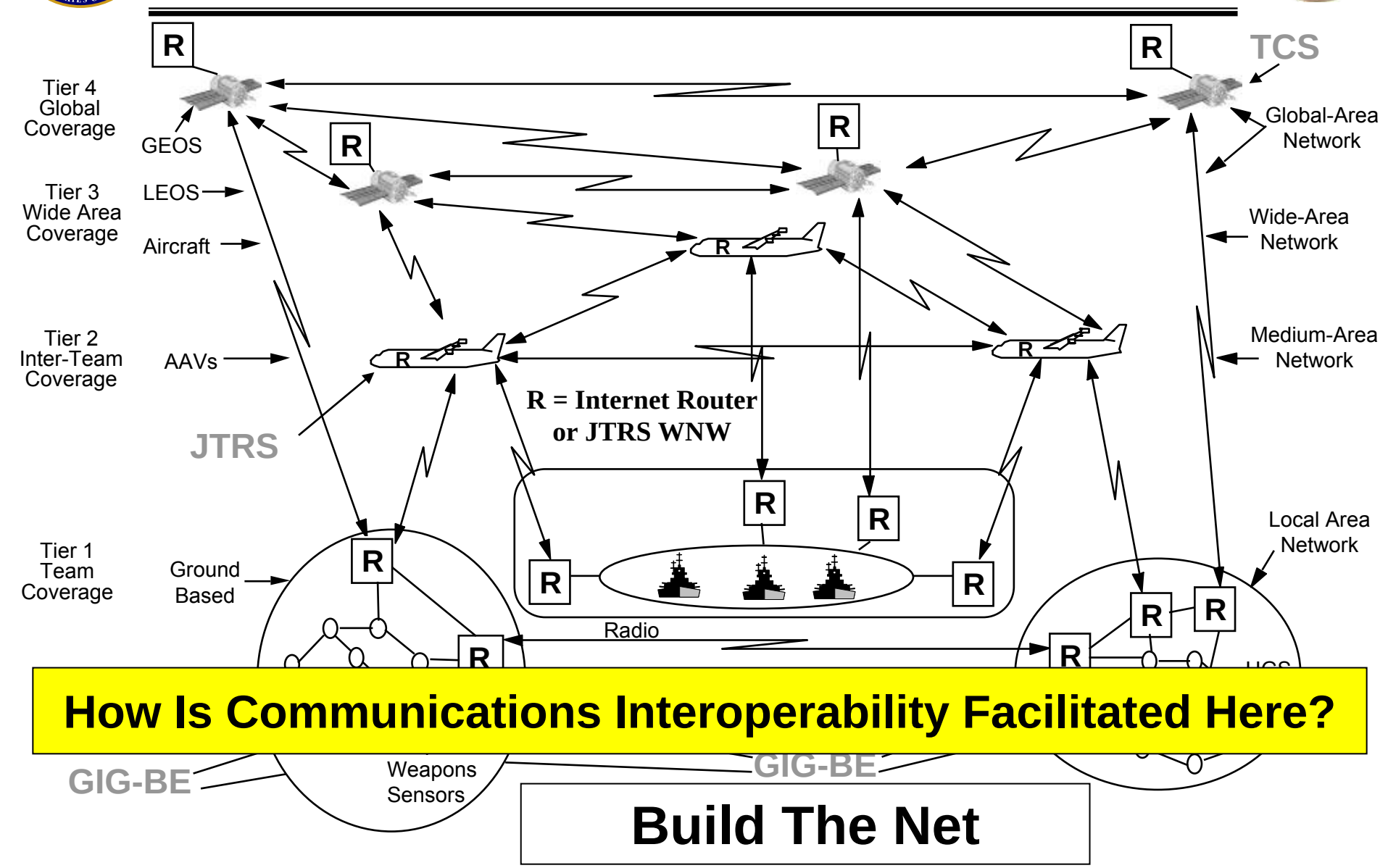

## *Network Centric Warfare*

***Tactical level of deployment and warfare***

- **Uncleared Personnel**
- **Links effects to targets**
- **Engages directly with the enemy**
- **Must be agile, adaptive and versatile**
- **Minimal, "portable" C4ISR infrastructure**
  - Rides on tactical communications
  - Requires LPD/LPI transmission security
  - NCW weapons susceptible to IA attack

Approved for Public Release (DARPA Case #4820 27JUL2005)

# GIG: Transport Layer

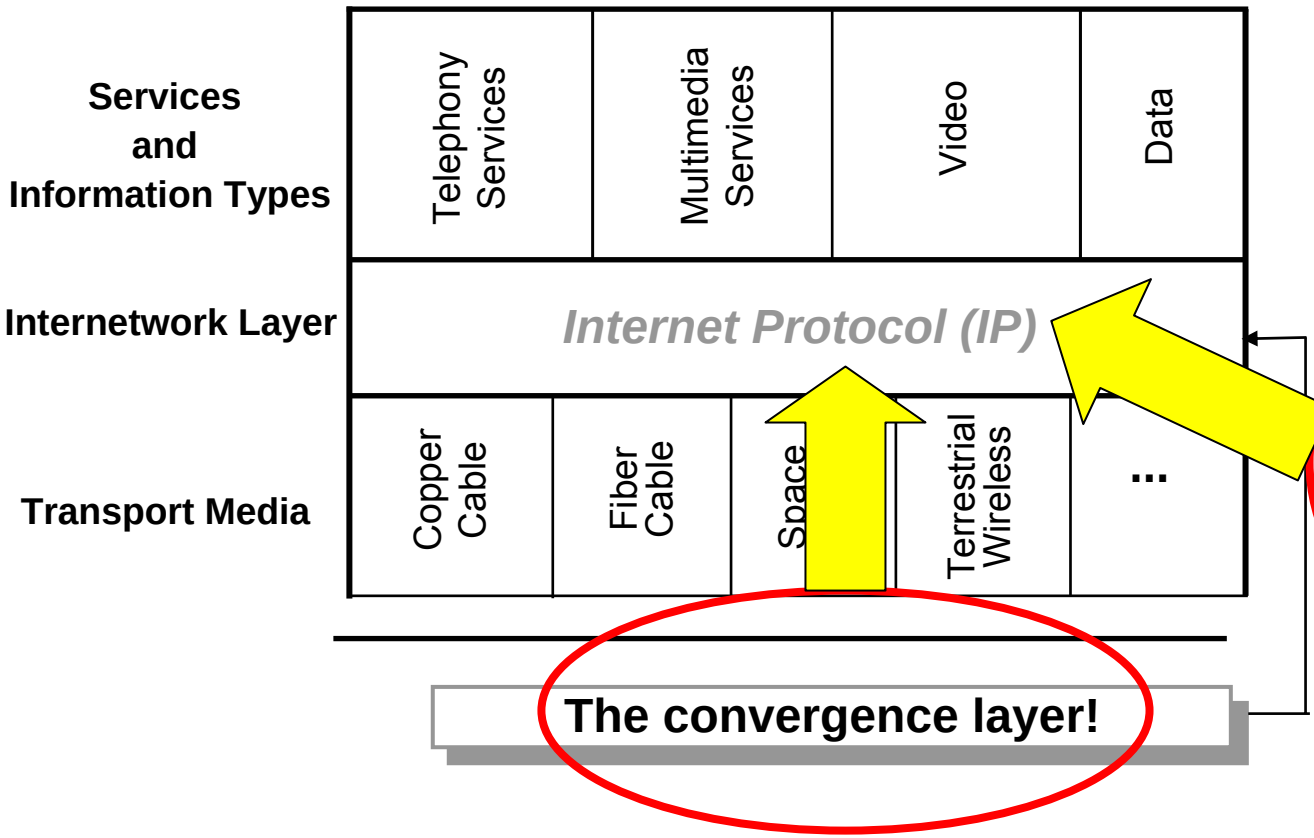



**How Is Communications Interoperability Facilitated Here?**

**Build The Net**

Implementing the Global Information Grid (GIG): A Foundation for 2010 Net Centric Warfare (NCW), M. Frankel, DASD (C3ISR, Space & IT Programs), International Command and Control Research and Technology Symposium, June 2003, (find in www.dodccrp.org/events/2003/8th_ICCRTS/Pres/plenary/1_0915frankel.pdf).

# GIG: IP Based




- *World-wide* acceptance and *use*
- *Packet-switched* Internet transport
- Provides *common-user,* integrated services framework
- Provides *standardized interface* between Application and Transport Services
- Used over many network-level protocols (Ethernet, ATM, WAP…)

**Answer: Communications Interoperability via the Network!**

Implementing the Global Information Grid (GIG): A Foundation for 2010 Net Centric Warfare (NCW), M. Frankel, DASD (C3ISR, Space & IT Programs), International Command and Control Research and Technology Symposium, June 2003, (find in www.dodccrp.org/events/2003/8th_ICCRTS/Pres/plenary/1_0915frankel.pdf).

# How Do You Make This Happen:
# Network Gateways

MultiGbit

GATEWAY 4
Global-Area Network

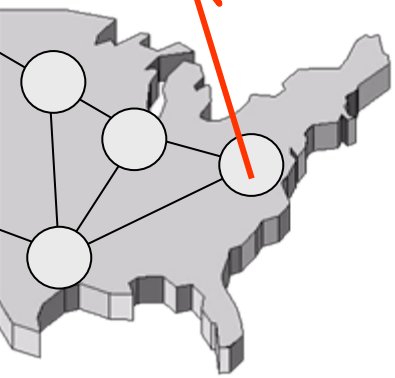
TCS

GATEWAY 3
Wide-Area Network

TCS

Injection Node

Global Hawk

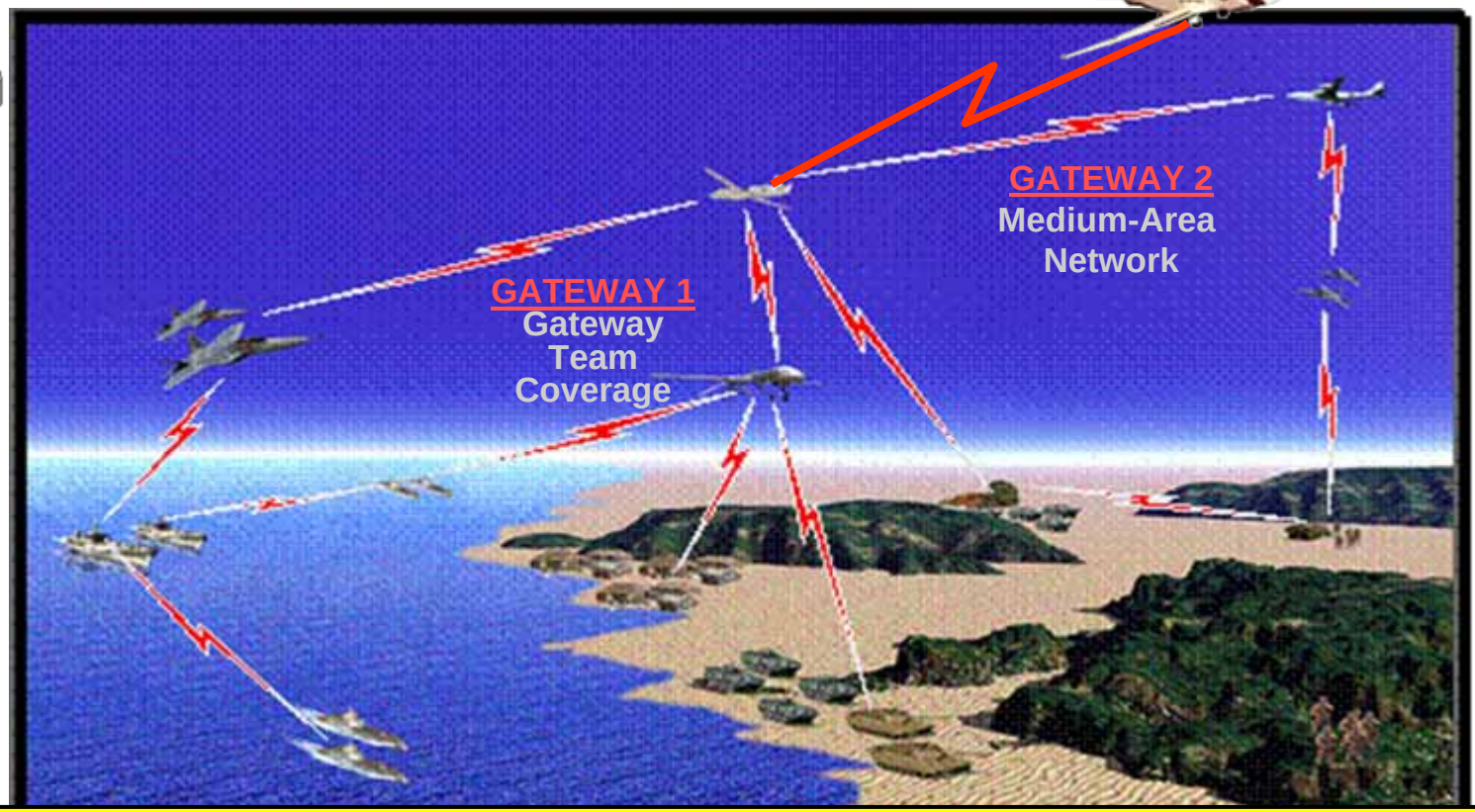


GATEWAY 4:
Strategic Backbone

GATEWAY 3:
Operational Backbone

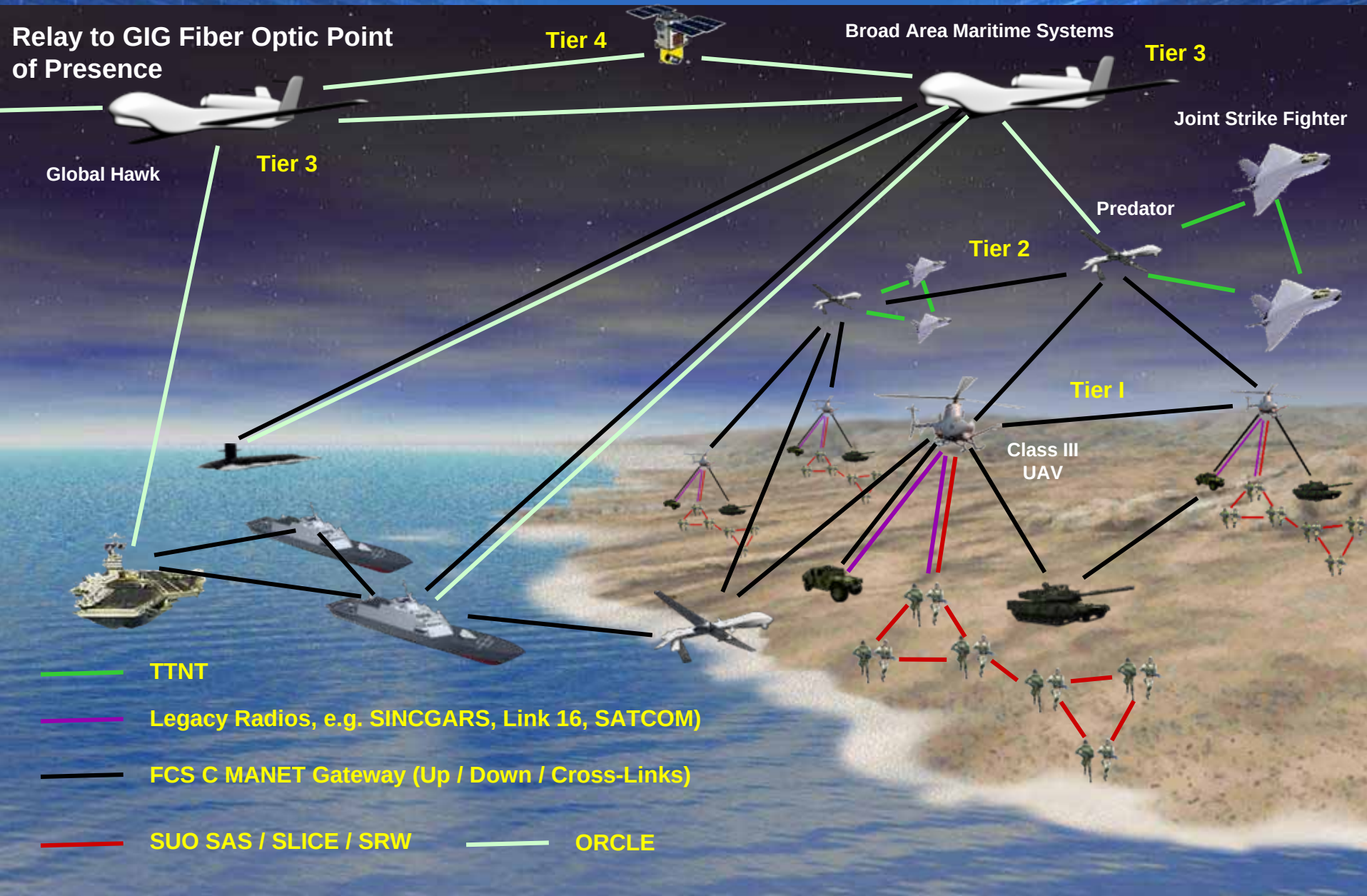
GATEWAY 2:
Tactical Backbone

GATEWAY 1:
Local Relay




**Future Combat Systems Communications Network Centric Demonstration**

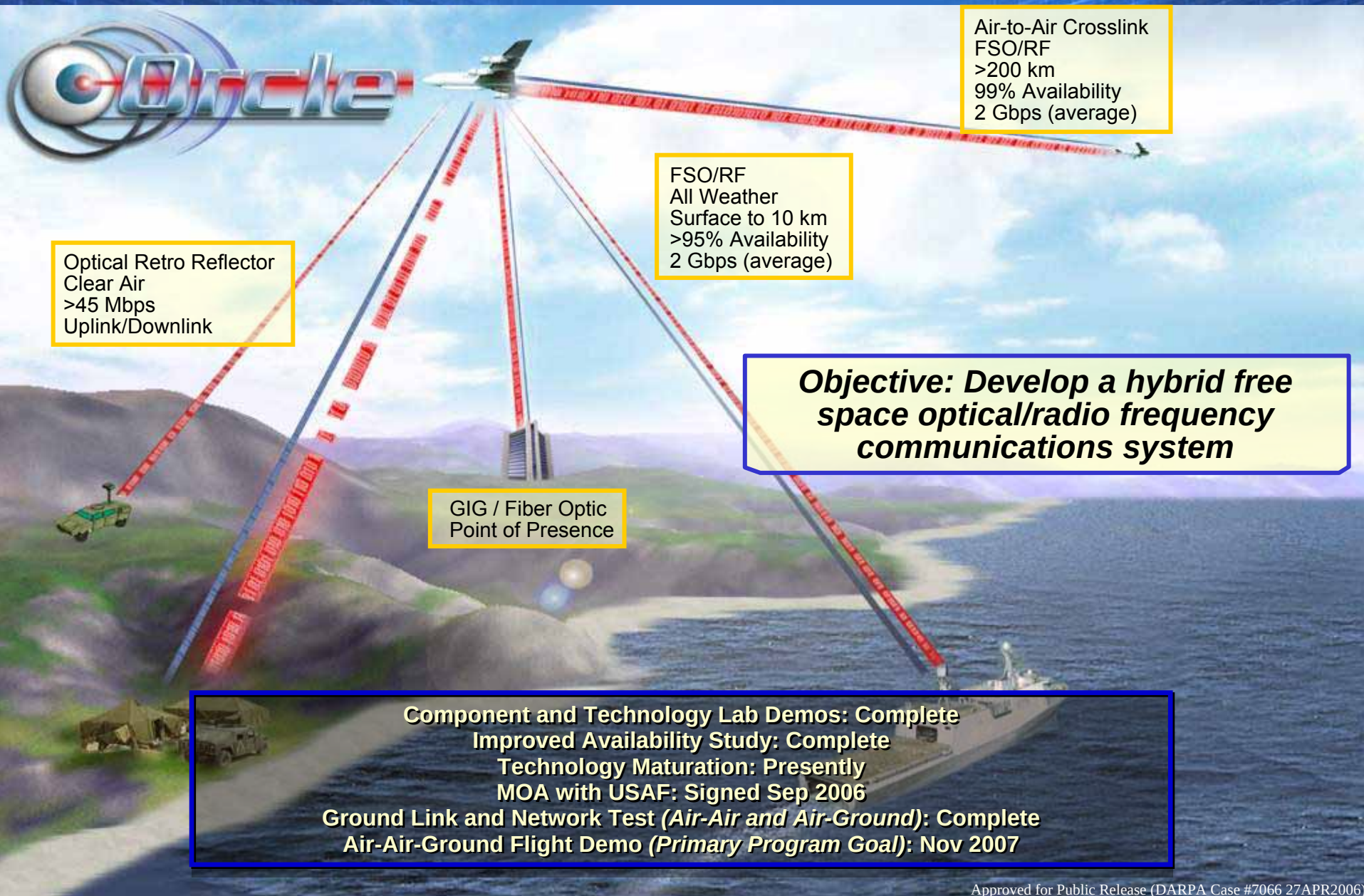
# Possible Architecture Using DARPA Technologies



# Optical & RF Combined Link Experiment (ORCLE)

*Links to forces fixed and on the move*

Strategic Technology Office




***Objective: Develop a hybrid free space optical/radio frequency communications system***

**Component and Technology Lab Demos: Complete**
**Improved Availability Study: Complete**
**Technology Maturation: Presently**
**MOA with USAF: Signed Sep 2006**
**Ground Link and Network Test *(Air-Air and Air-Ground)*: Complete**
**Air-Air-Ground Flight Demo *(Primary Program Goal)*: Nov 2007**

Approved for Public Release (DARPA Case #7066 27APR2006)

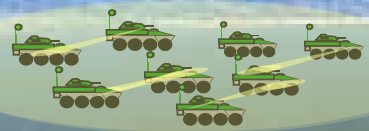
# Future Combat Systems Communications

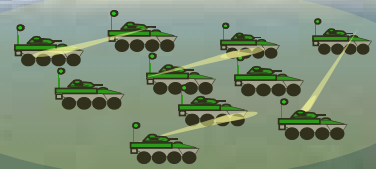
## *A Dual-Rate, Mobile Ad-Hoc Network for the Maneuver Force*

Mobile ad-hoc network *dynamically* reconfigures during operations to *automatically* maintain network connectivity

QoS Provides for Adaptive Communications Capabilities

System automatically schedules non-interfering communications for increased network capacity

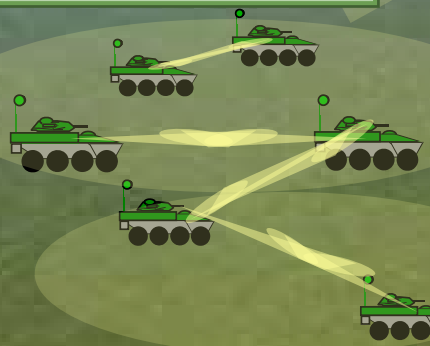


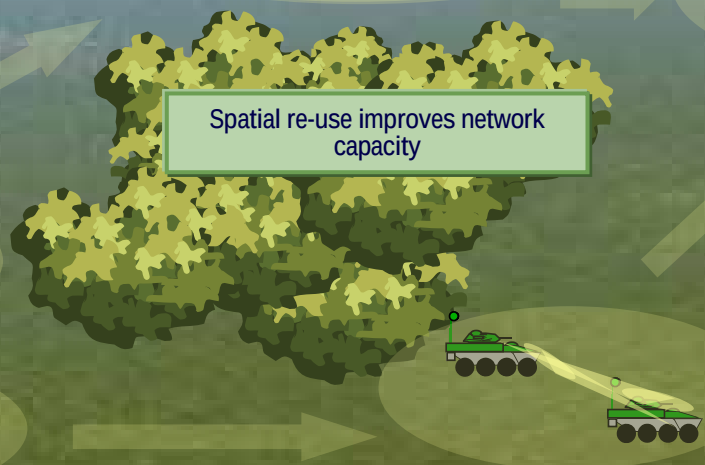


High Band (JTRS NDL-Like)
> 50 Mbps rate high band

Spatial re-use improves network capacity

Low Band (JTRS WNW-like)
> 5 Mbps rate low band





Vehicles automatically leave and join the network – no manual entry

Multi-Mode Connectivity Options:
GND-to-GND, GND-to-AIR, AIR-to-AIR & AIR-to-GND

Networked vehicles automatically communicate when within range – no manual configuration

***Network Centric Field Experiment at Fort Benning – JAN 2006***

# FCS Communications Technology Highlights

- ***Assured high data rate communications:*** **Simultaneous high data rate networked communications in high and low bands. Adaptive data rates 72 Mbps in high band, 10 Mbps in low band. Spatial re-use through directional antennas for increased network throughput.**
- ***High resistance to threat jamming:*** **Directional antennas, supplemented by AV-OFDM waveform in low band and DSSSS in high band. Digital beam forming in low band steers nulls against jammers. Adaptive networking routes traffic around jammers.**
- ***High resistance to threat detectors and intercept:*** **Very narrow directional beams in high band; directional beams in low band, with featureless OFDM waveform.**
- ***Assured multi-path communications:*** **Low band AV-OFDM waveform integrates over frequency and time, outperforms rake receivers at low cost/weight.**
- ***QoS based ad-hoc mobile-mobile networking*** **incorporating the benefits of adaptive waveforms and smart antenna technology in both low and high bands for improved message throughput in threat and non-threat conditions.**
- ***Validated designs validated through relevant field demonstrations*** **air and ground mobile nodes including actual military robotic platforms, airborne nodes, surrogate netfires supplemented by critical laboratory modeling and simulation for validation and scalability.**

# FCS C Demo 3 Go/No-Go Results

| FCS Communications Go/No-Go Metrics | Demo 3 Criteria | Raytheon (FCS-C) |
|---|---|---|
| 20 Node Average Network Aggregate Throughput (Goodput) | **AJ/LPD HDR** | **AJ/LPD HDR** |
| Low Band | **200 Kbps 10 Mbps** | 203 Kbps 10.3 Mbps |
| High Band | **1 Mbps 70 Mbps** | 24 Mbps 50 Mbps |
| LPD/AJ | | |
| Spatial - Low Band (3 dB beamwidth) | **45º** | 39º |
| Spatial - High Band (3 dB beamwidth) | **3.5º x 12º *** | 3.5ºx12º |
| Processing (PG, nulling, etc.) | | |
| Low Band | **40 dB** | 41.6 dB |
| High Band | **14 dB * (19.4 dB)** | 19.4 dB |
| Latency | | |
| Type 1 (10% of the avg sys load) | **90% < 200 msec.** | 90.0% |
| Type 2 (30% of the avg sys load) | **90% < 1 sec.** | 88.8% |
| Type 3 (60% of the avg sys load) (Retrans 3x) | **90% < 30 sec.** | 98.9% |
| HB/LB Transition | **<1 sec.** | 1 sec. |
| Packet Delivery | | |
| Type 1 (10% of the avg sys load) | **90%** | 75.0% |
| Type 2 (30% of the avg sys load) | **90%** | 73.6% |
| Type 3 (60% of the avg sys load) (Retrans 3x) | **90%** | 88.3% |
| 20 Node Network Initialization Time | **<6 min.** | 2 min. |
| Node Entry Time | **<30 sec.** | 10 sec. |
| Detect Node Exit Time | **<10 sec.** | 5 sec. |

***Live Test under operational conditions - User level performance***

NOTE: Items in Red corrected upon return to lab and GO/NO GO validated in Raytheon Parking Lot

# What Was Demonstrated by the FCS C NC Demo

1. **Raytheon Network Centric Radio In Operations**
   - Operates Like WNW would In Network Centric Operations at Tier 1 & Tier 2
   - SCA Compliant, Non-Proprietary Software
     - Raytheon Will supply FCS C Waveform Given to JTRS Library as above
   - High data rate LOS (including LOS airborne extensions to BLOS) networked radio system
     - >100 km Non-LOS Ranges Achievable with Airborne Relays
     - Automatic Adaptation to Lower Data Rates for Increased Range
   - Automated “configuration” and Network Management

2. **Heterogeneous Gateway Architecture Implemented In TCA Structure**
   - Gateways linked end-users via Sample WAN technologies
     - FCS-NC, Ku SATCOM, Inmarsat, Iridium, GlobalStar
   - Gateways linked end-users via Tactical Data Radios (IP Capable)
     - EPLRS, EPLRS micro-Lite, Soldier Radio Waveform (SRW), SECNET 11
   - Gateways linked end-users via Tactical Voice Radios
     - PRC 117, PRC 119, PRC 150

3. **Complete Soldier Operation In Simulated Missions**
   - Initial Training in NOV/DEC 2005 at Fayetteville, TN
   - Heterogeneous Gateway Operations as well as Surrogate UAV Placement for Optimum Connectivity

***Demonstrated Transformational Communications Down to the Platoon***

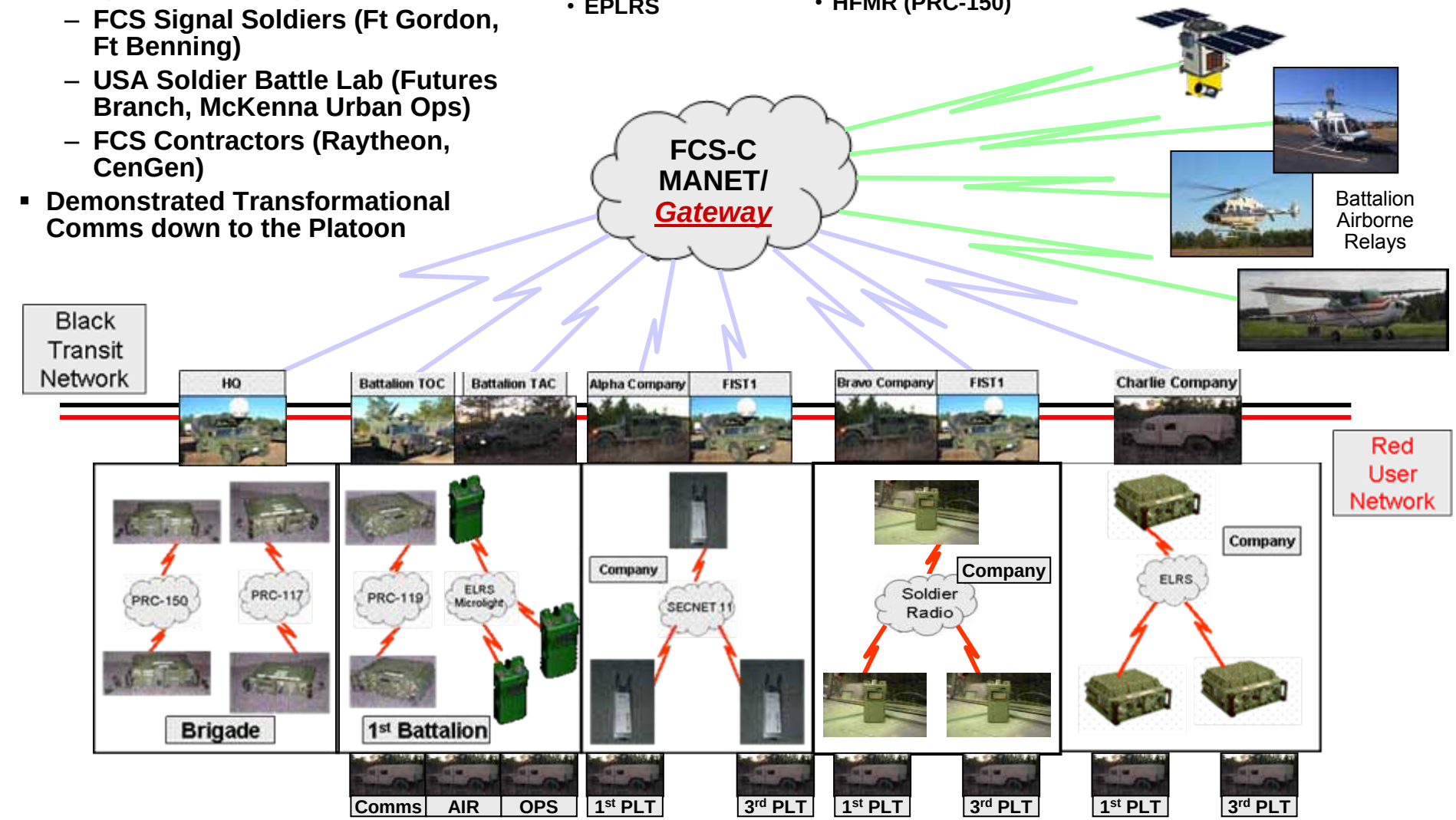
# FCS-C Network Centricity Demonstration

## *Network Connectivity with FCS MANET & Gateway*

- **Network Centric Radio Operations**
- **Heterogeneous Gateway Architecture**
- **Complete Soldier Operation**
  - **FCS Signal Soldiers (Ft Gordon, Ft Benning)**
  - **USA Soldier Battle Lab (Futures Branch, McKenna Urban Ops)**
  - **FCS Contractors (Raytheon, CenGen)**
- **Demonstrated Transformational Comms down to the Platoon**

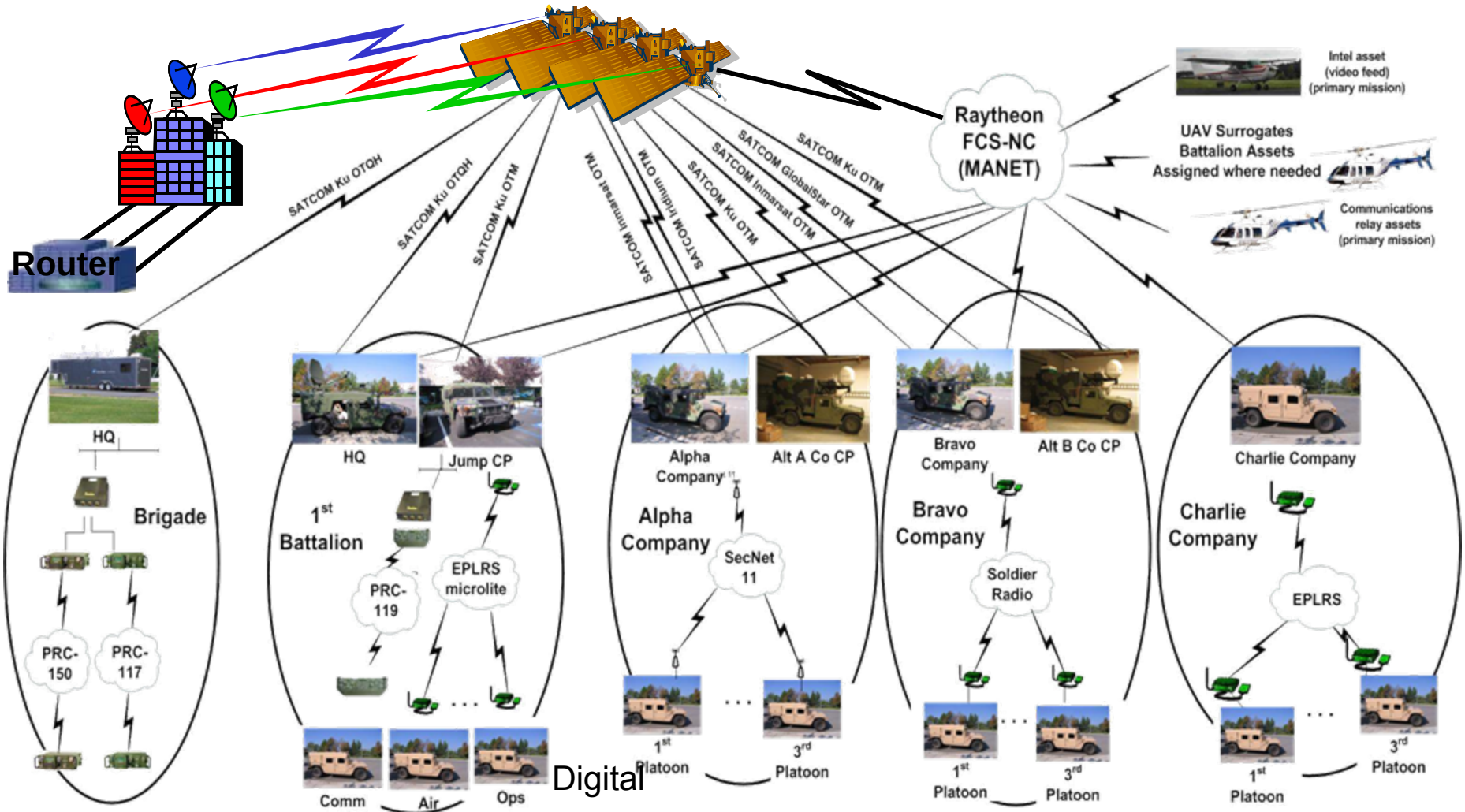
**Interoperable Communications**

- CPOF's VoIP
- ITT Soldier Radio
- EPLRS
- HAVEQUICK I/II (PRC-117)
- SINCGARS (PRC-119)
- HFMR (PRC-150)



# Heterogeneous Network Centric Architecture

## FCS-C NC Demonstration

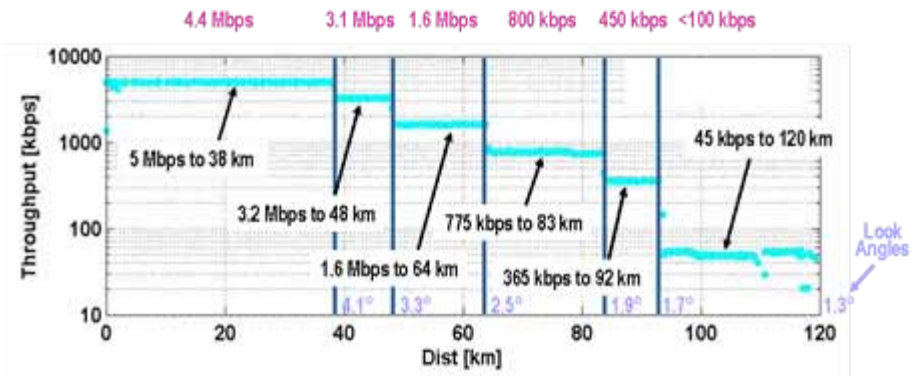



- **Heterogeneity between Radios and Radio-Types (Analog Voice vs Data/VoIP)**
  - **–Translate everything into IP (Analog Voice to VoIP)**
  - **–Interoperate at the Network Layer (OSPF)**
  - **–Demonstrated over 120 km-wide scenarios**

# Comparison of FSC & WNW Performance

| Characteristic | Wideband Network Waveform | FCS C MANET / Gateway [2] |
|---|---|---|
| Demonstrated Max Data Rate at Max line-of-sight, point-to-point mode | • 1 Mb/s @ ~14 miles (Expansion to 2 Mb/s is planned for summer of 2008) [1] | • 5.5 Mb/s @ 23.6 miles<br>• 1.6 Mb/s @ 39 miles<br>• 775 Kb @ 51.6 miles |
| Demonstrated Radio Interoperability with Networking | • Demonstrated hardware running WNW simultaneously with a JTRS version of a legacy signal, which proves the feasibility of key JTRS concepts, waveform portability and simultaneous waveform operation [1] | • Simultaneous demo at Ft Benning of MANET/Gateway communications among the following digital and analog systems: CPoF's VoIP, the ITT Soldier Radio, the Enhanced Position Location Reporting Systems (EPLRS), HAVEQUICK I/II (PRC-117), the Single Channel Ground and Airborne Radio System (SINCGARS/PRC-119) and the High Frequency MAN-PACK Radio (HFMR/PRC-150) and various SATCOM Links. |

**Demonstrated FCS C Performance at Ft Benning**




Note: The Army's Joint Network Node was not included in this comparison as JNN is not a tactical MANET system as JTRS WWW and FCS C. It is on-the-halt (Static) SATCOM (non-MANET) and is designed to be integrated into tactical backbone at Brigade fixed TOCs.

[1] Charlotte Adams, "Editor's Note: Reinventing JTRS", *Avionics Magazine Monthly News,* Volume 1 Issue 1, July 17, 2006.

[2] FCS C Network Centric Demonstration, McKenna MOUT Site, Ft Benning, January 2006

BRIDGING THE GAP
DARPA
50 YEARS
POWERED BY IDEAS

STO
Strategic Technology Office

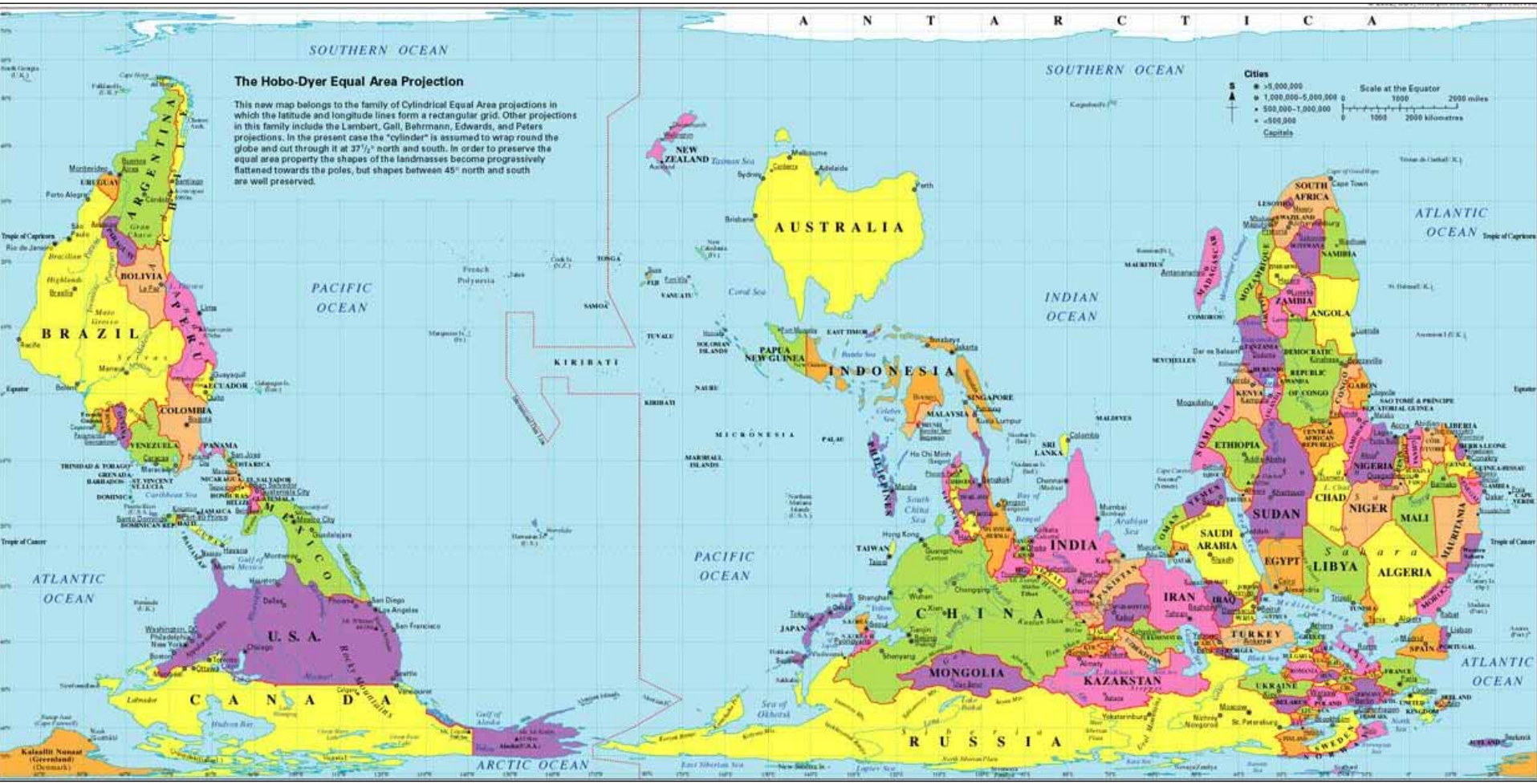
Australian Government
Department of Defence
Defence Science and
Technology Organisation

# Current Theatre Environment
# An Australian Perspective

Dr Roger Lough
Chief Defence Scientist

Pacific Theatre Operational Science and
Technology Conference
Hawaii
April 2007

Australian Government
Department of Defence
Defence Science and
Technology Organisation



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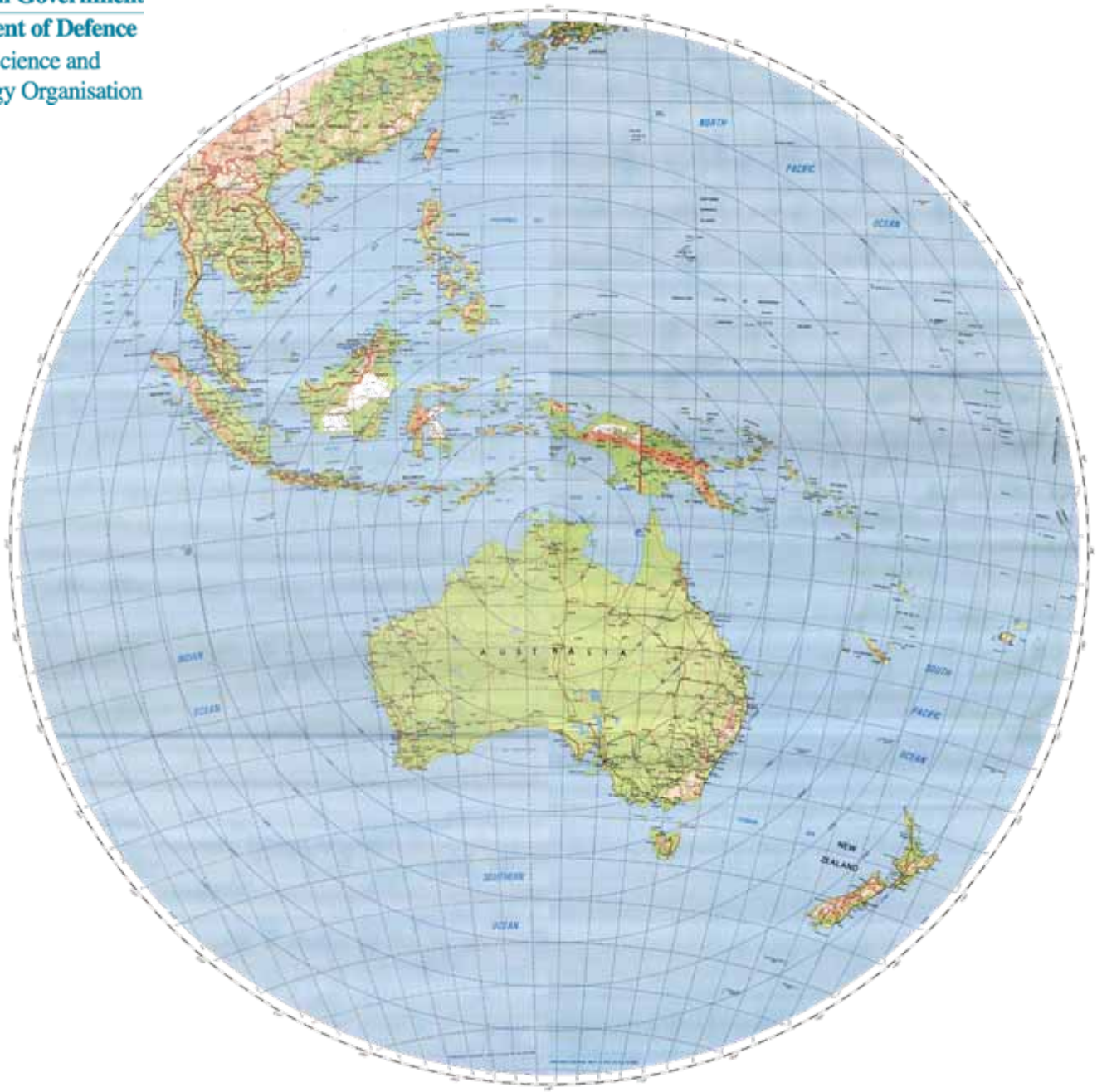
Department of Defence
Defence Science and
Technology Organisation



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Defence Science and
Technology Organisation

# DSTO Mission and Vision

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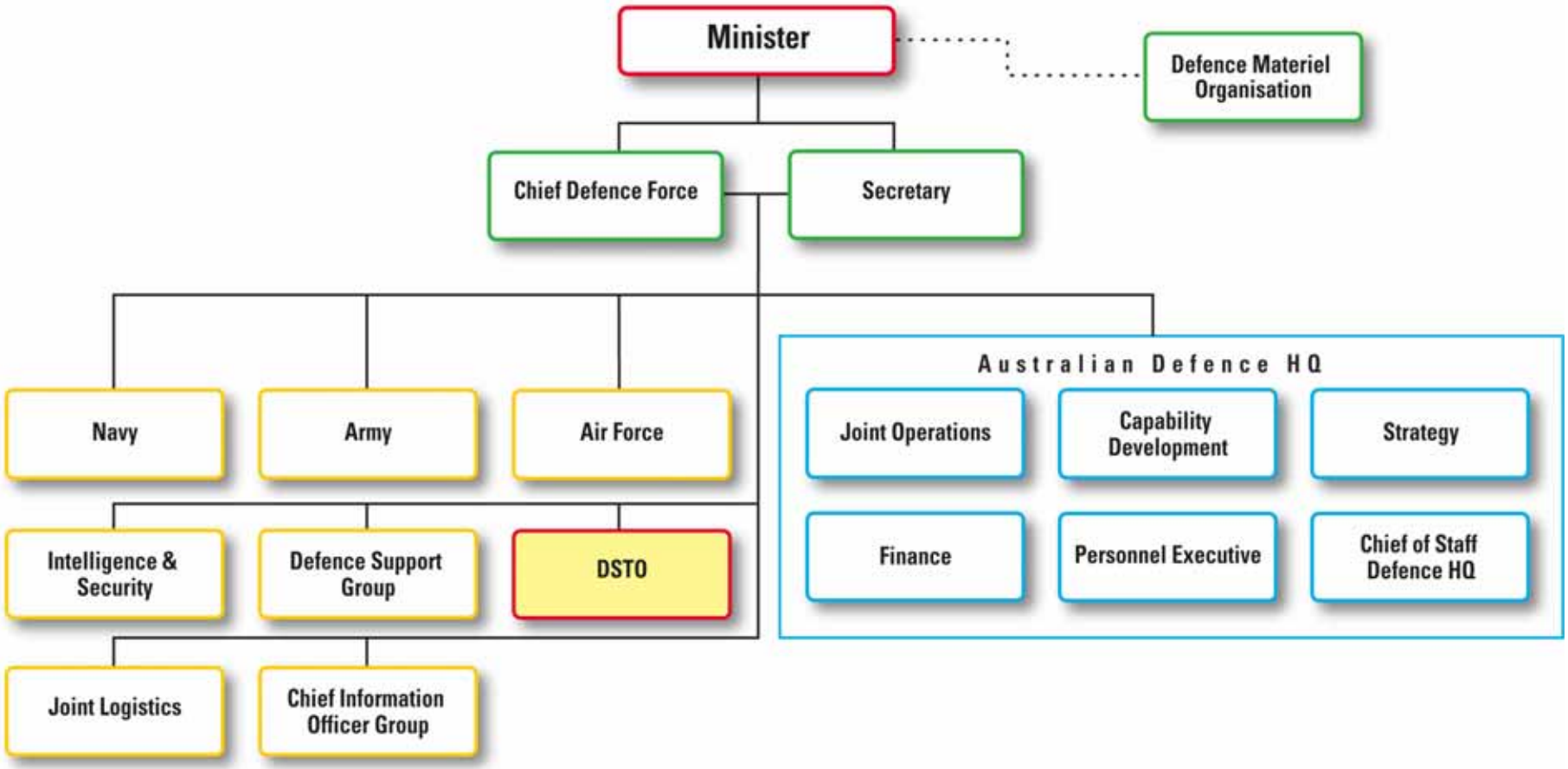
Defence Science and
Technology Organisation

# Defence Structure



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# DSTO at a Glance

- Budget (06-07) – 442 M
- 12 Research divisions
- 2300 staff
- 8 sites across Australia

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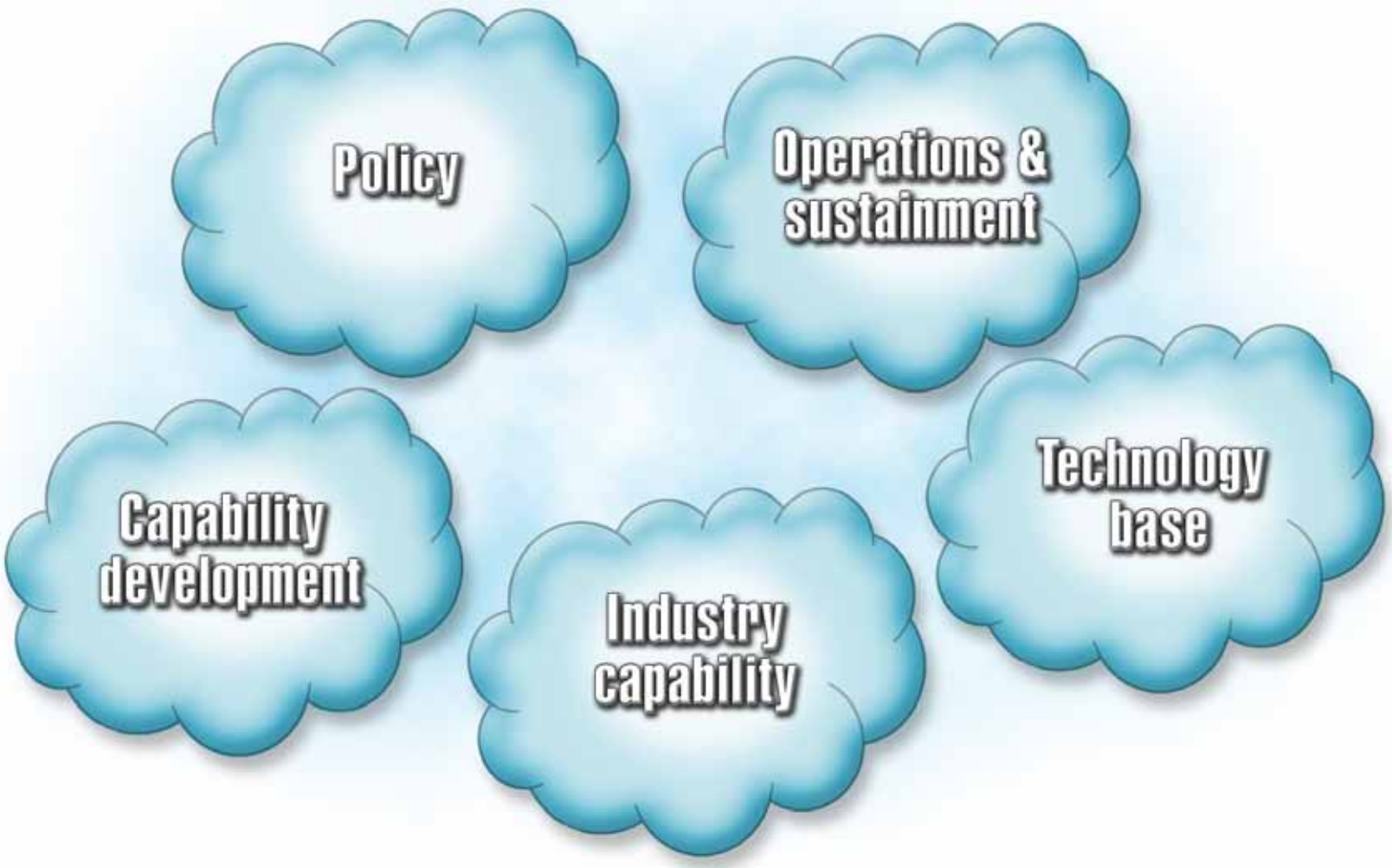
Technology Organisation

# DSTO Functions



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# Program Thrusts

## Wide Area Surveillance

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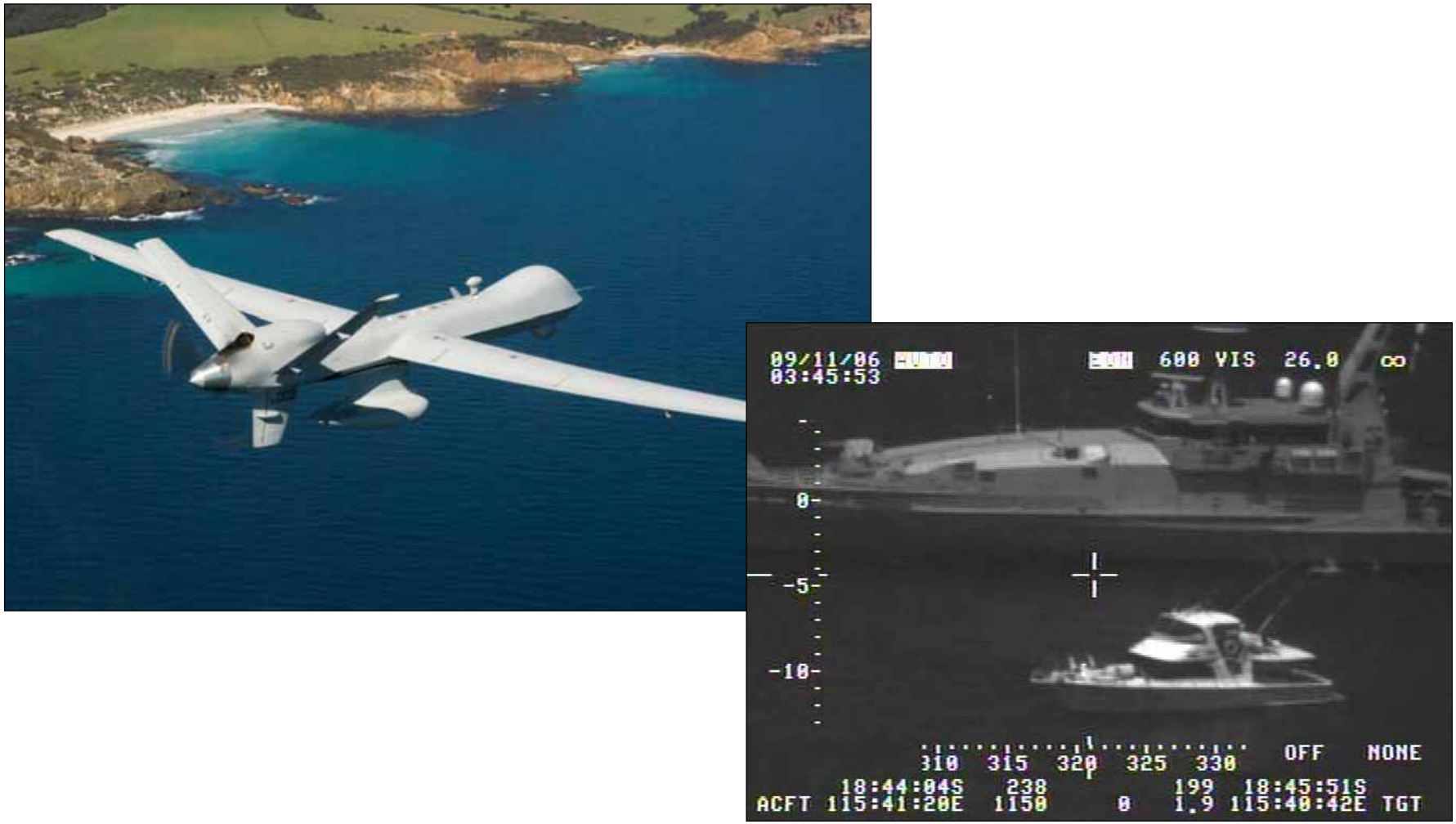
Defence Science and
Technology Organisation

# Program Thrusts

## Network Centric Warfare



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# Program Thrusts

## Interoperability

Joint Australian United States Exercise – Talisman Sabre 07

Coalition Readiness Management System Project Arrangement - CReaMS

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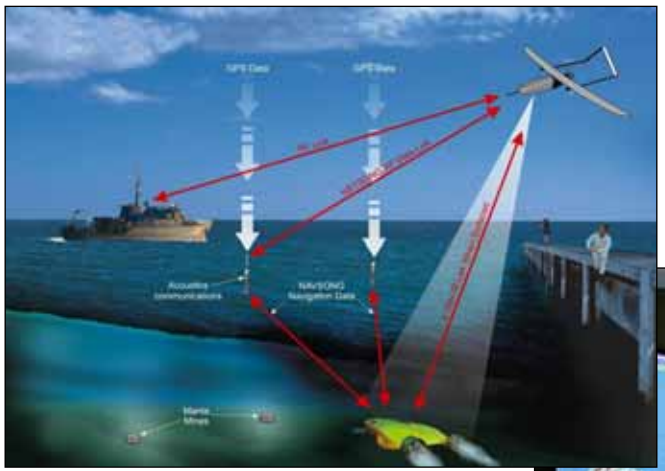
Defence Science and
Technology Organisation

# Program Thrusts

## Experimentation

Automation of the Battle Space Initiative



Headmark

Headline – Concept Exploration and Analysis Laboratory (CEAL)

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Technology Organisation

# Program Thrusts

## Chemical, Biological & Radiological Defence

PC3 Laboratory

Breathable Chemical and
Biological suit

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# Program Thrusts

## Aging Aircraft

Structural test on F/A-18

Smart Structures

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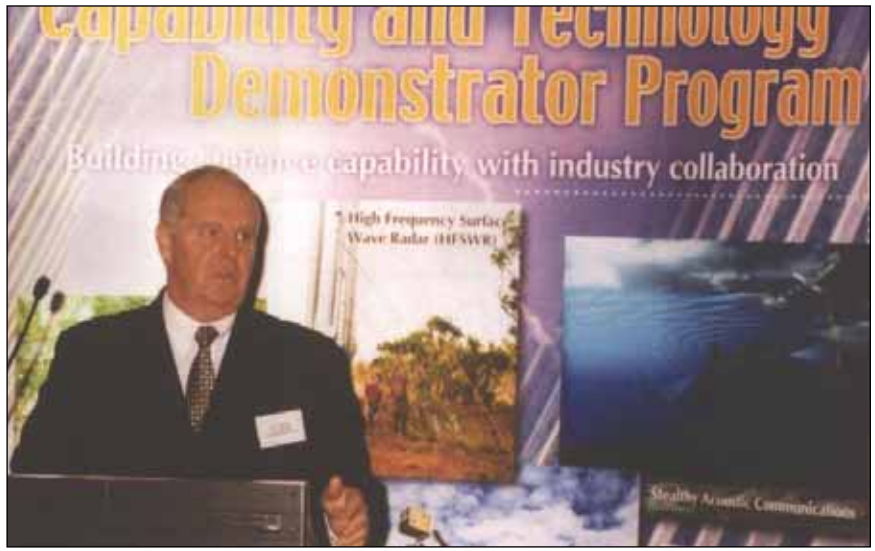
Technology Organisation

# Capability & Technology Demonstrators

- Allows Australian Defence Industry to demonstrate how advanced technology can enhance Defence capability.
- $160 M invested since 1998.
- Average CTD $3m; 3 years.



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Department of Defence
Defence Science and
Technology Organisation

# Capability & Technology Demonstrators

Underwater Personal Computer

Fibre Laser Sonar
(Hydrophone)

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# Capability &Technology Demonstrators

Rassputin

Sonobuoy

Cuttlefish – protection of ships from radar surveillance

# Emerging Issues

Operational Tempo

IEDs

Space (Hypersonics)

Intelligence, Surveillance and Reconnaissance

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Defence Science and
Technology Organisation

# Thank you

# Perspective on S&T Collaboration

**Tae-In Choi, Vice President**

**Agency for Defense Development**

**Operational S&T Conference**

**PACOM, Hawaii**

**April 2007**

# Overview of Talk

- RoK Battle Lab Status
- RoK/US S&T Cooperation
  - Examples of Joint Development
- Conclusion

# Naval Battle Lab.

## Under New SBA System

- The Role of Battle Lab.
- ROKN BL and ADD BL for SBA
- 2007 US-ROK NBE Symposium

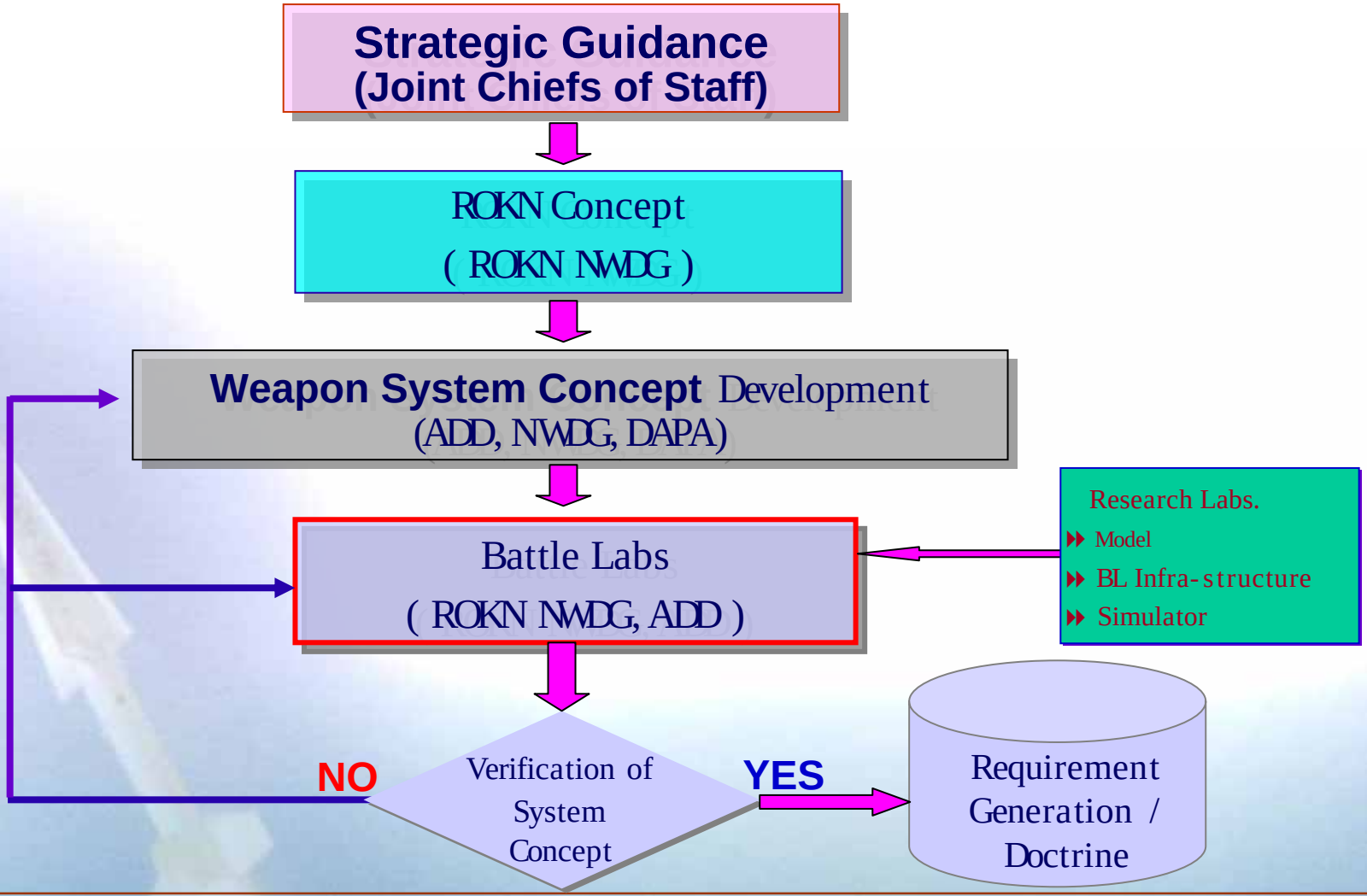
# The Role of Battle Lab. (1/3)

## What is Battle Lab?

- A mechanism for assessing New Ideas & Capabilities provided by advanced technologies
- An innovative mechanism for scientific requirement generation based on the operation concepts of future battlefield
- A core verification tool in Top-down/Born-Joint weapon development flow
- Battle Lab needs to be designed to meet diverse requirements as engineering test beds for R&D Program Managers and as simulation tools for field commanders, tactical planners, and war gamers.

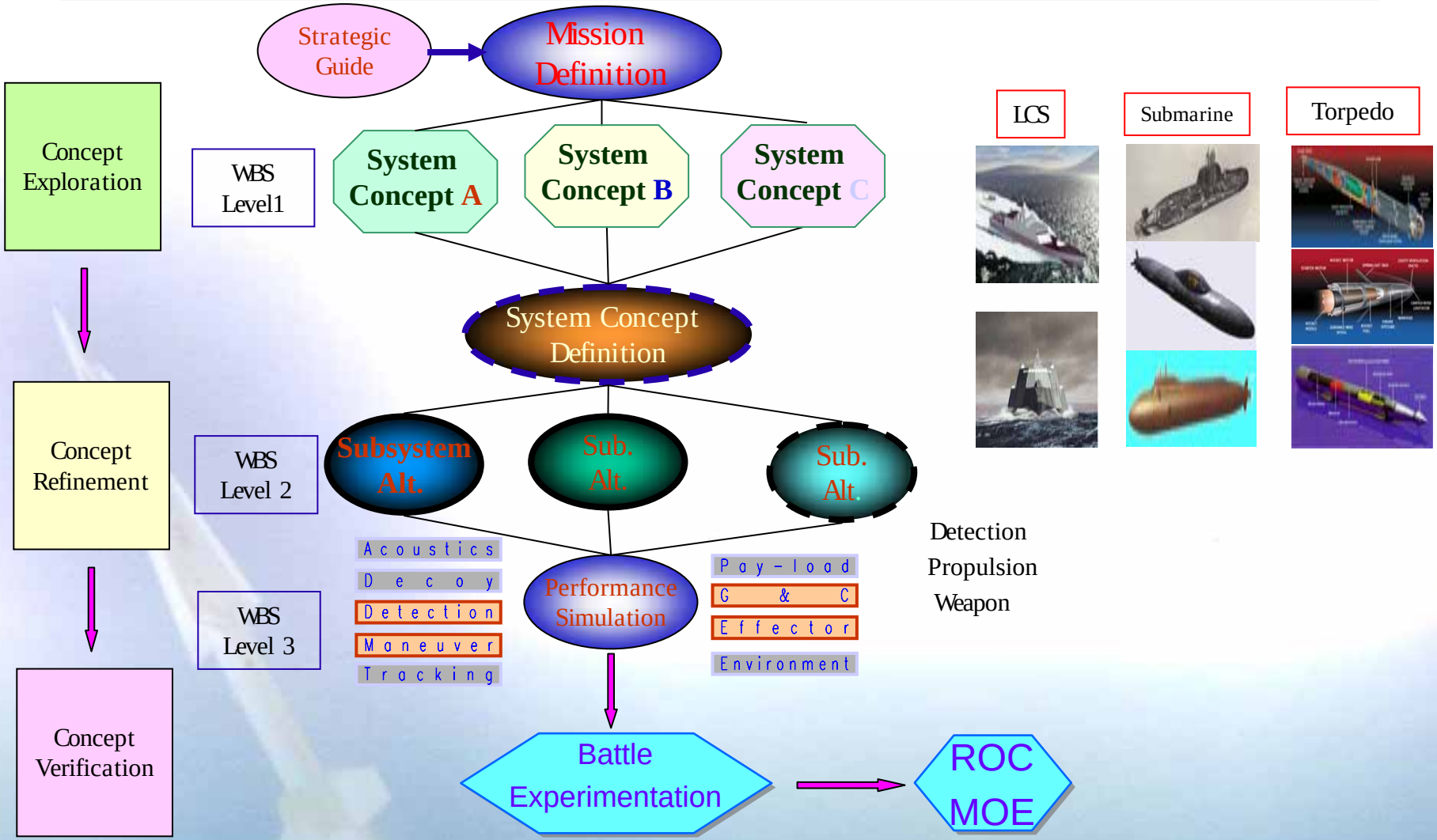
# The Role of Battle Lab. (2/3)

## ROKN New Weapon System Development Flow



# The Role of Battle Lab. (3/3)

## ROK Navy: Top-down Weapon Requirement Generation



# ROKN BL and ADD BL for SBA (1/3)

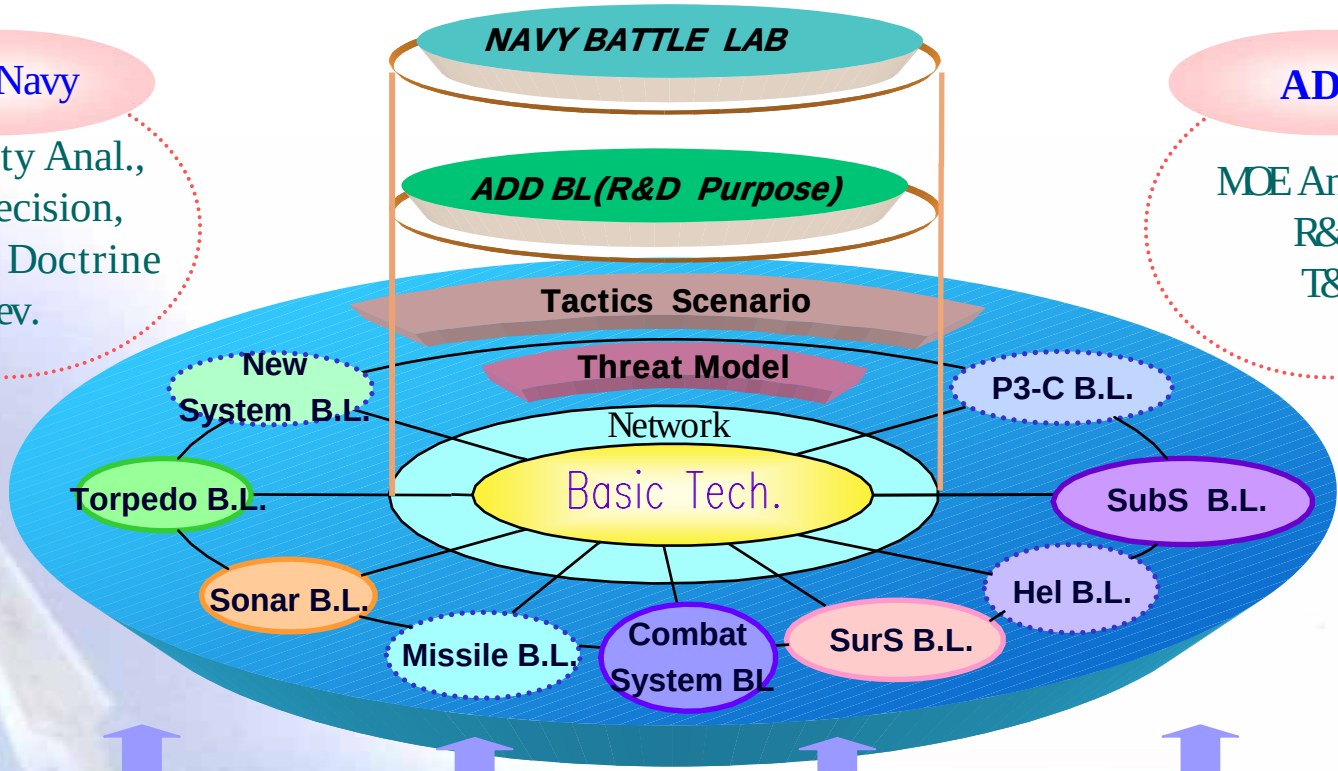
## Simulator-based ADD BL and ROKN BL Building

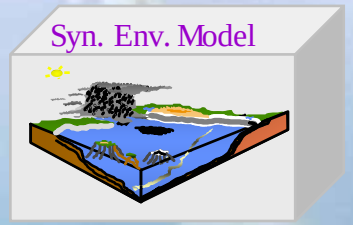
ROK Navy

Capability Anal., Req. Decision, Training, Doctrine Dev.

ADD

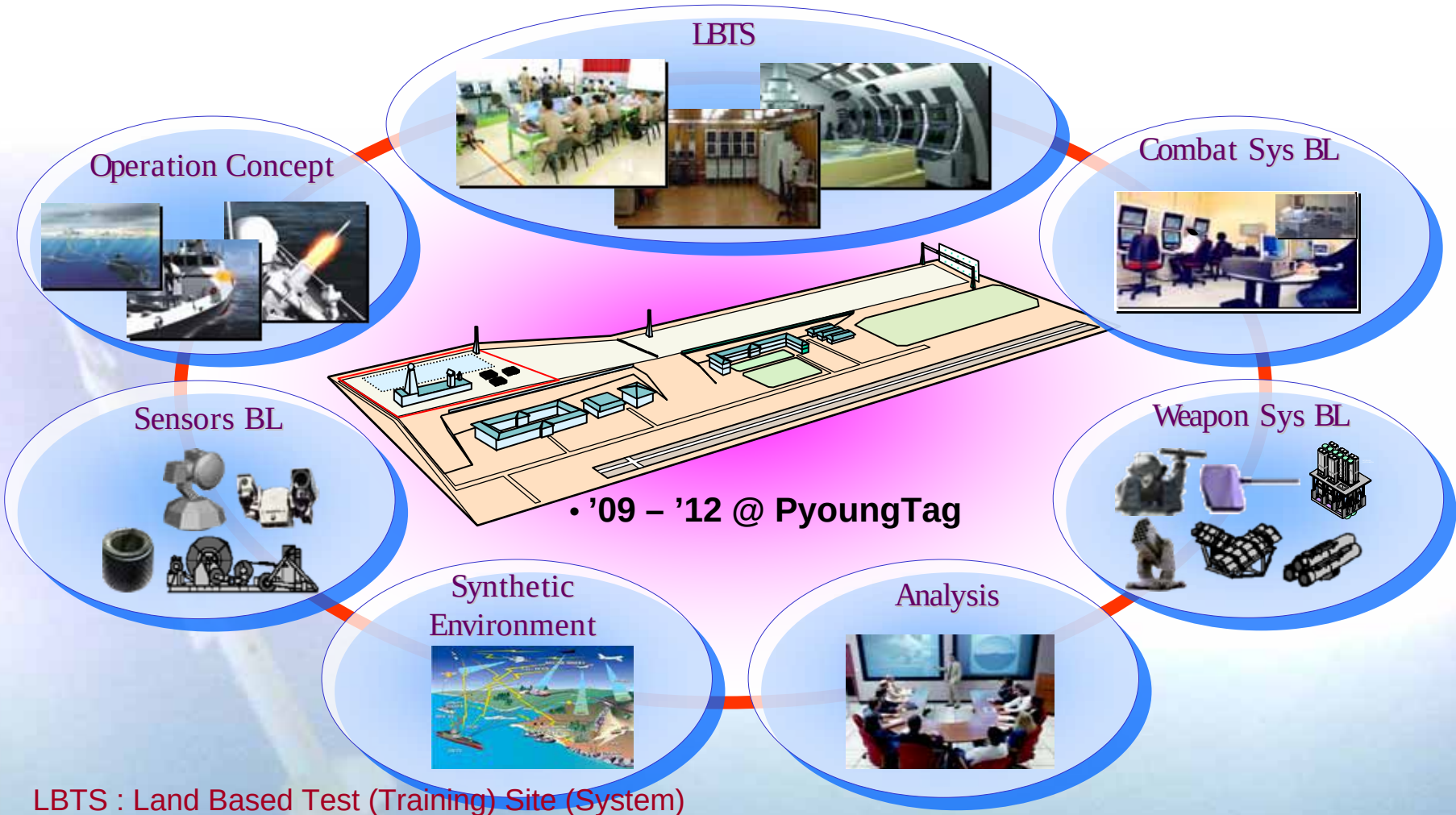
MOE Analysis, R&D, T&E



# ROKN BL and ADD BL for SBA (2/3)

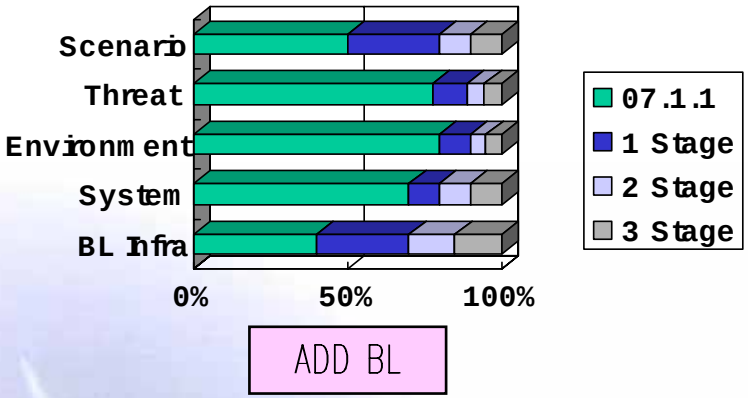
## ADD Battle Lab Development Center based on LBTS



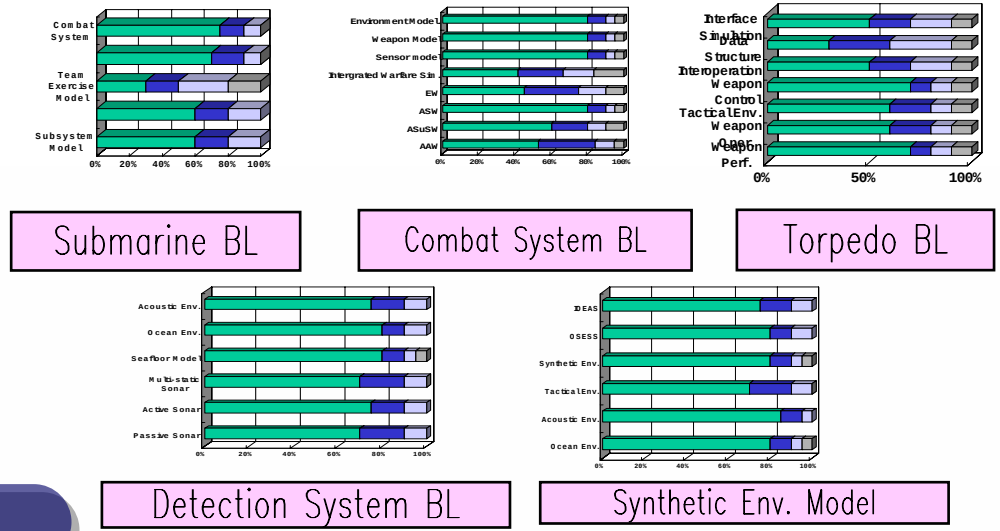

LBTS : Land Based Test (Training) Site (System)

# Status and Roadmap for ROKN BL and ADD BL (3/3)

## ADD BL Status




## Weapon System BL Status




## Roadmap of Battle Lab Development

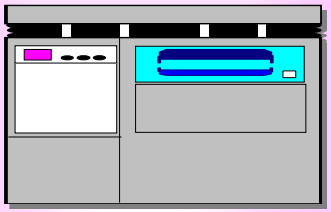
| Year | 2006 ~ 2008 | 2009 ~ 2011 | 2012 ~ 2014 |
|---|---|---|---|
| Stage | Infra Build-up | NBL BL Development | LVC based BL Development |
| ROKN | Mission Model<br>ROKN Wargame for Analysis<br>Battle Exp. for Future Program | ROKN Wargame PIP<br>ROKN BL Build-up | LVC based ROKN BL |
| ADD | Weapon System B.L.<br>ADD BL R. G. | Battle Lab Development Center<br>ADD BL Development | Battle Lab Dev. Center PIP<br>LVC based ADD BL Build-up |

# Synthetic Battle Environment Model

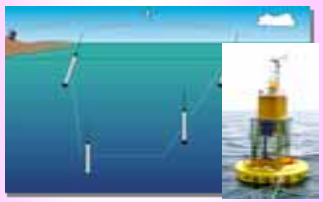
Real Ocean Data System

SATELLITE

DBMS

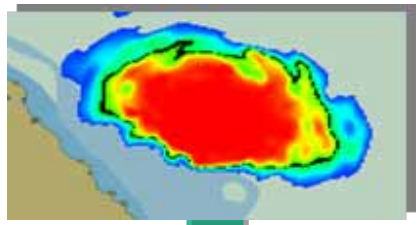


Ocean Buoy

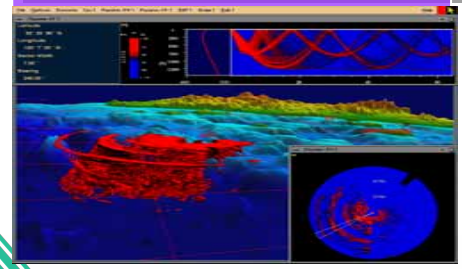


National Data Link

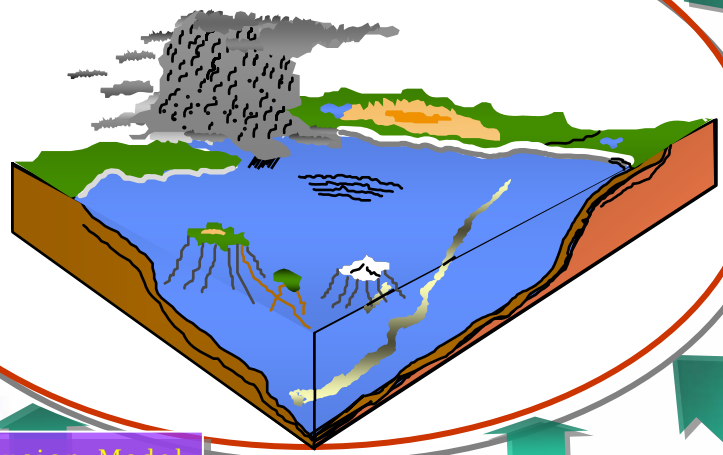
Wave Propagation Model



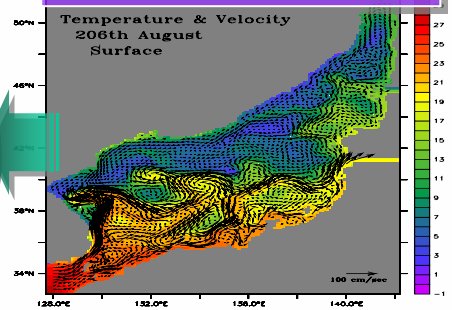
Tactical Simulation Model



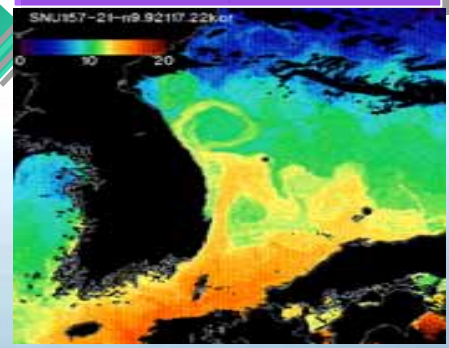
**Synthetic Battle Environment**



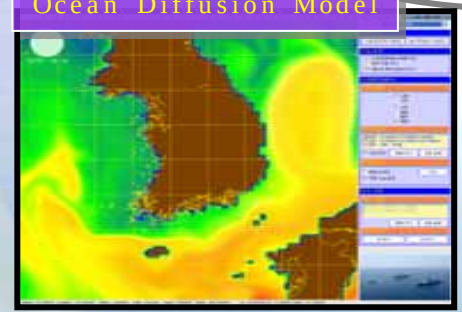
Ocean Circulation Model



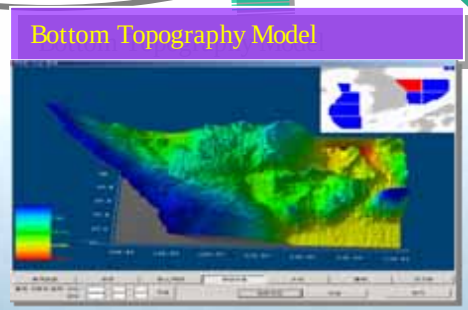

Sea Surface Temperature



Ocean Diffusion Model

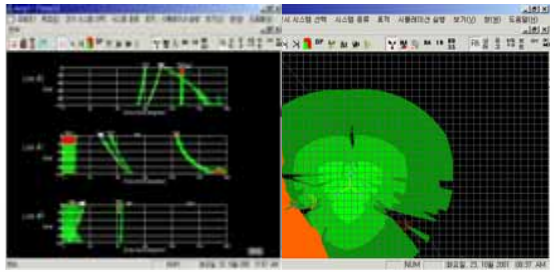


Bottom Topography Model

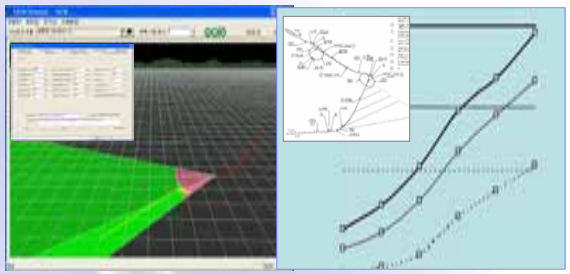


# Detection System BL

## M&S Resources for Underwater Detection System BL

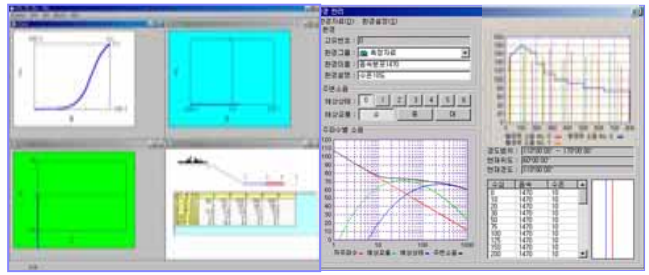


**Detection Effectiveness Analysis for Harbor Underwater Surveillance System**

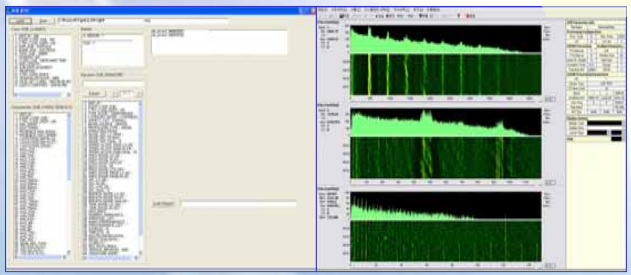


**Operational Effectiveness Analysis for Torpedo Acoustic Countermeasure System**

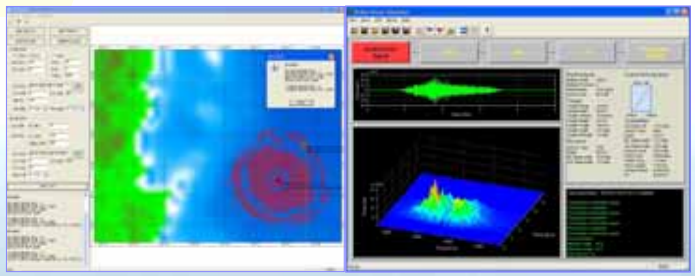
M&S Resources for DSBL-ADD



**Detection Performance Analysis for Towed Line Array Sonar System**



**Signal Classification Algorithm Analysis for Navy Acoustic Information Management System**

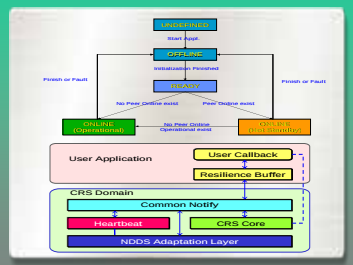


**Detection Probability Estimation for Hull Mounted Sonar System**

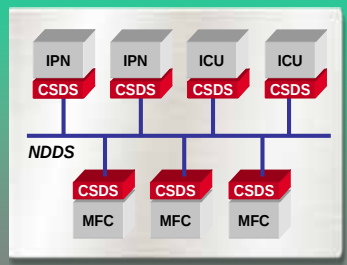
# Naval Combat System BL

## Combat System BL Status

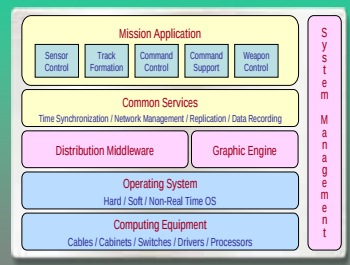
**System Monitoring / Analysis Model**



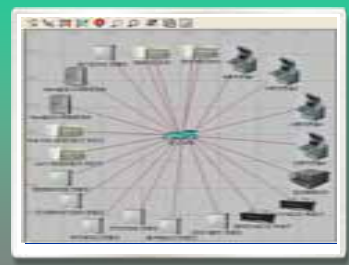

**Common Infra (Middleware) Model**




**System Software Architecture Model**

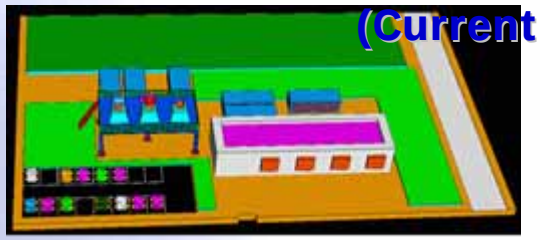



**Network Architecture Model**

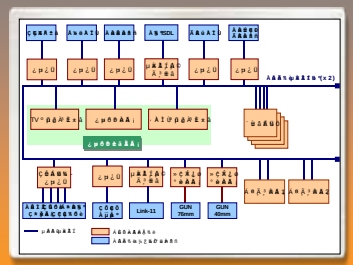


*SYSTEM INFRA STRUCTURE MODELING & ANALYSIS*

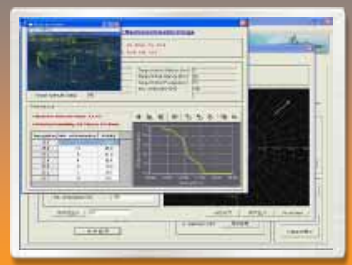
**COMBAT SYSTEM LAND BASED TEST SYSTEM**
**(Current Project, LPX & PKX)**



*SYSTEM & TACTICAL WARFARE PERFORMANCE MODELING & ANALYSIS*



**System Construction Model**



**Sensor System Model**

**Self Defense Model**

**Naval Gunfire Control Model**

# 2007 US-ROK NBE Symposium

- Date: October 25-26, 2007
- Place: JINHAE NAVY CLUB
- Objective of Symposium
  - Technical Information Exchange regarding Battle Lab. & Naval Battle Experimentation
  - Cooperative relation build-up between BL–related organizations of US & ROK
- Major Topics
  - Requirement Generation via Battle Experimentation for Naval Weapon Systems
  - SBA Strategy for US & ROK Naval Systems.
  - Synthetic Ocean Environment Modeling for NBE
  - Threat Modeling for Air/Surface/Undersea Warfare
  - Methodology for Fleet Battle Experimentation
  - Design and Analysis of Naval Battle Experimentation

* NBE: Naval Battle Experimentation

# RoK/US S&T Cooperation

# Evolution of Strategic Alliance

**Dependency on Conventional Forces**

**Combination of US and ROK technologies enabled ROK self reliant defense**

**Deterrence on the Korean Peninsula and within the Asian Pacific Region**

**Defense/Economic/democratic growth**

**Enabling U.S. Strategic Flexibility – 3rd largest in OIF**

**Direct Support**

**Less Soldiers/FMS**

**Cooperate Self-reliant Defense**

**Cooperation**

# Cooperation in Defense R&D

Some examples of mutually beneficial exchanges include:

- Engineer and Scientist Exchange Program (ESEP)
- Data Exchange Agreements (DEA)
- Project Agreements (PA)
- S&T co-development: LOGIR
- Look forward to participating in PACOM's JCTD
  : Medusa, AWSS

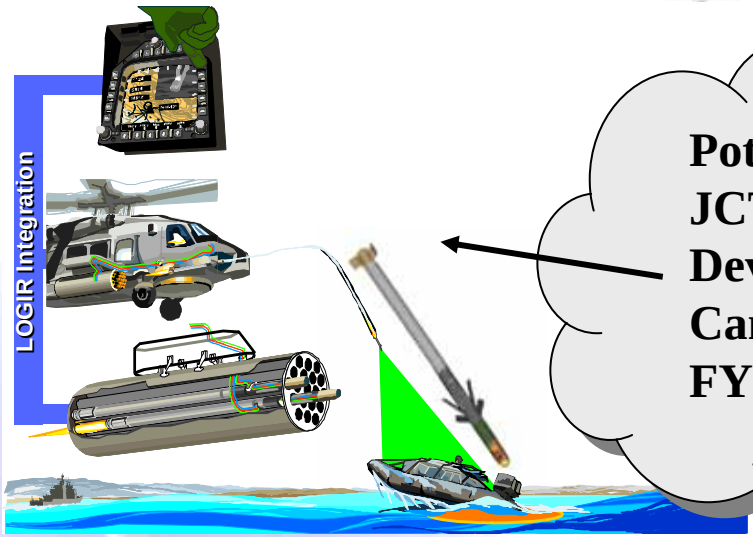
  * Medusa: JCTD version of LOGIR
  * AWSS=Airborne Weapons Surveillance System.

# Technology Cooperation Sub-Committee (TCSC)

**An-Heung PG/Feb. 2007**

# Ongoing/Upcoming Joint Efforts

## LOGIR

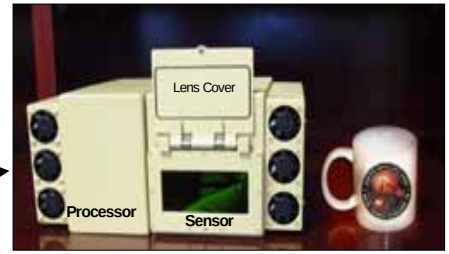



**Potential JCTD Developments Candidates for FY 08-10**

FOR OFFICIAL USE ONLY

## Miniaturized Processor

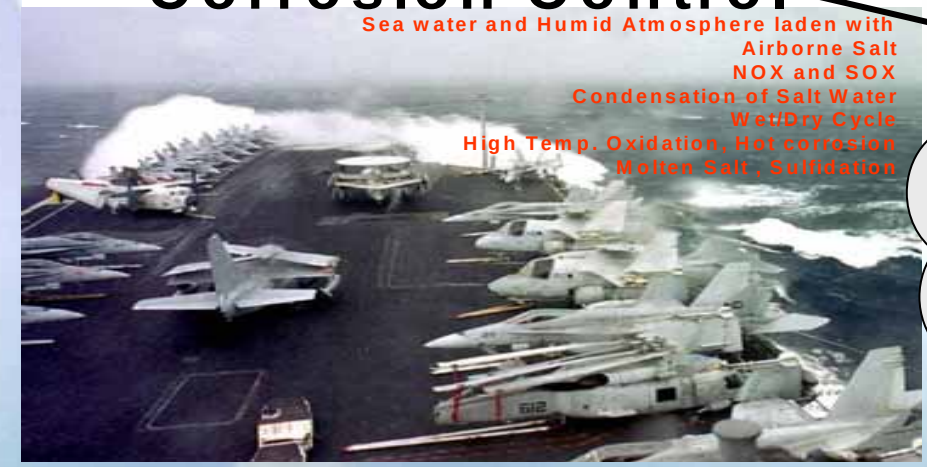
## AWSS



Form Fit & Function

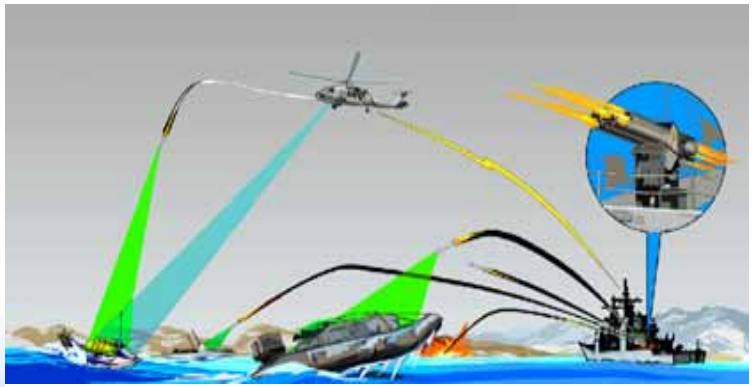
FOR OFFICIAL USE ONLY RT0804.0137b 9

## Corrosion Control

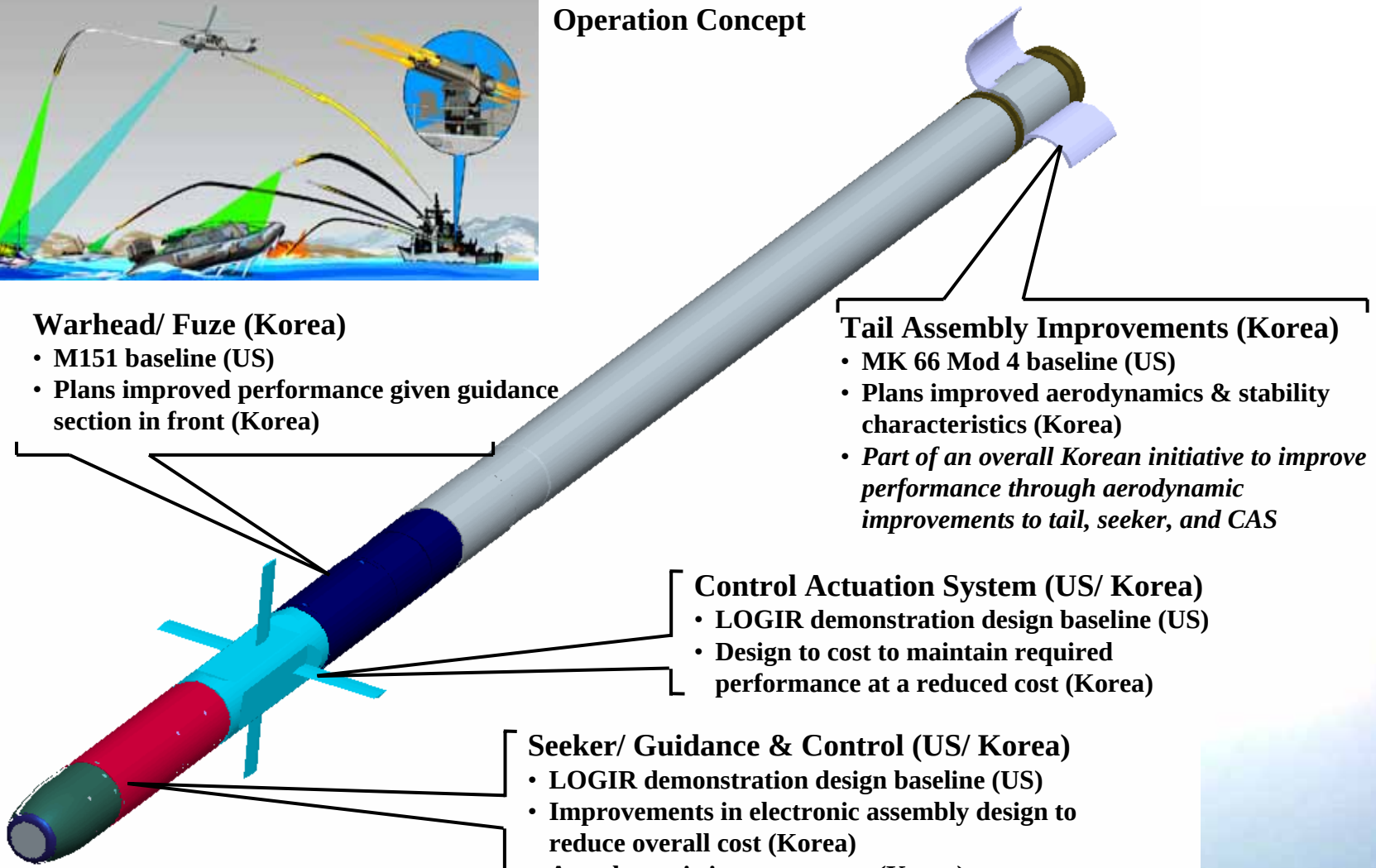



**Cooperative Program US Government/ ROK Industry with anticipated Savings to US in $ Billions**

# LOGIR Collaboration



**Operation Concept**



**Warhead/ Fuze (Korea)**
- **M151 baseline (US)**
- **Plans improved performance given guidance section in front (Korea)**

**Tail Assembly Improvements (Korea)**
- **MK 66 Mod 4 baseline (US)**
- **Plans improved aerodynamics & stability characteristics (Korea)**
- ***Part of an overall Korean initiative to improve performance through aerodynamic improvements to tail, seeker, and CAS***

**Control Actuation System (US/ Korea)**
- **LOGIR demonstration design baseline (US)**
- **Design to cost to maintain required performance at a reduced cost (Korea)**

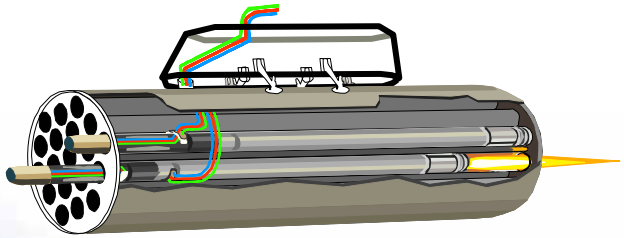
**Seeker/ Guidance & Control (US/ Korea)**
- **LOGIR demonstration design baseline (US)**
- **Improvements in electronic assembly design to reduce overall cost (Korea)**
- **Aerodynamic improvements (Korea)**

# LOGIR Status

- LOGIR
  - Currently S&T MOU for '07 ~ '09
    between ADD and NAWC/China Lake
  - To complement LOGIR technology in the areas of aero, structure, G&C, actuator, signal processing, and fuze.
  - Unique Opportunities for T&E:
    IR Data on Korea's Harsh Terrain/Weather
  - Hope to continue on with SDD

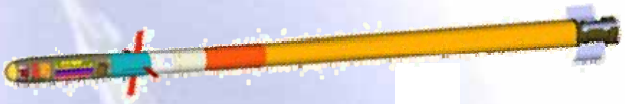
- JCTD: Medusa
  - April 4 workshop for details

# Medusa JCTD



DRL

MH-60R

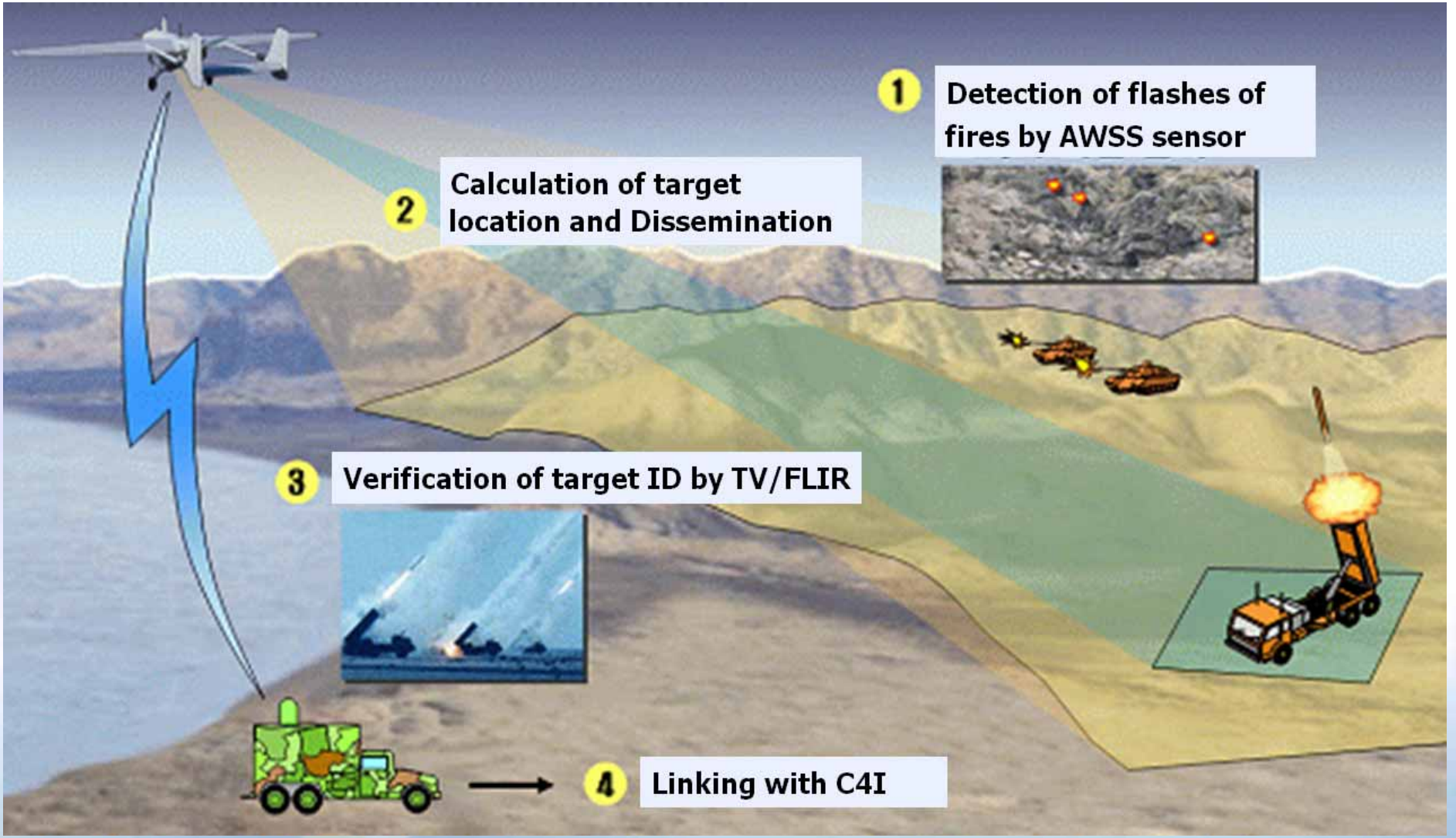


LOGIR

KO-1

- Develop core capability of LOGIR/DRL for MH-60R and KO-1 to address FAC/FIAC scenarios
- Demonstrate capability of LOGIR-enhanced platforms to engage and destroy multiple moving maritime targets

# AWSS JCID


1 Detection of flashes of fires by AWSS sensor
2 Calculation of target location and Dissemination
3 Verification of target ID by TV/FLIR
4 Linking with C4I

# Airborne Weapon Surveillance System (AWSS)

- Offers target locations and classification information in near real-time by detecting, classifying, and locating flashes from target NK fires

- To combine AWSS sensor with UAV System (Falcon)

Talks are under way between ADD and US Army.

# AWSS Components

Falcon Vehicle (Modification)

LCS (Development)

TV/FLIR

**Replacement**

**AWSS sensor**

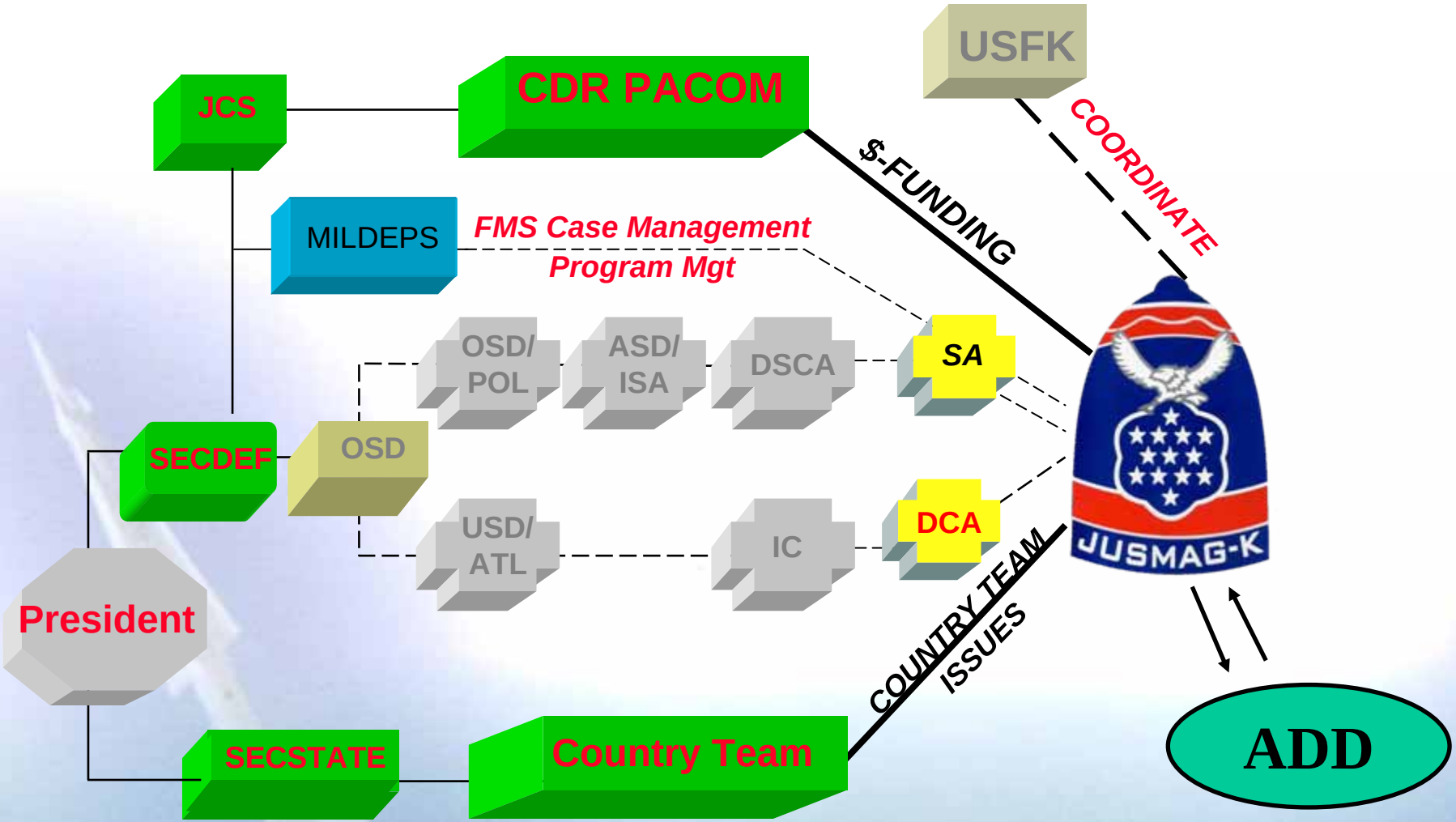
Mini Camera

* LCS : Launch & Recovery Control Station

# Positive **Signs for Cooperation**

- Has taken a long time to come to present status
- Shift from DEA to PA, PA to Co-Development takes place
- The seeds we have sown for 50 years start to sprout

# JUSMAG-K was behind the Scenes



# Conclusions

- RoK Battle Lab program introduced
- Current cooperation status briefly reviewed

  ADD is looking for more opportunities:

  e.g. LOGIR, M&S, GPS, C3**...**
- International cooperation is viewed as a means of delivering capability faster and cheaper to the warfighter

# Nuclear, Chemical and Biological Defense Research and Development

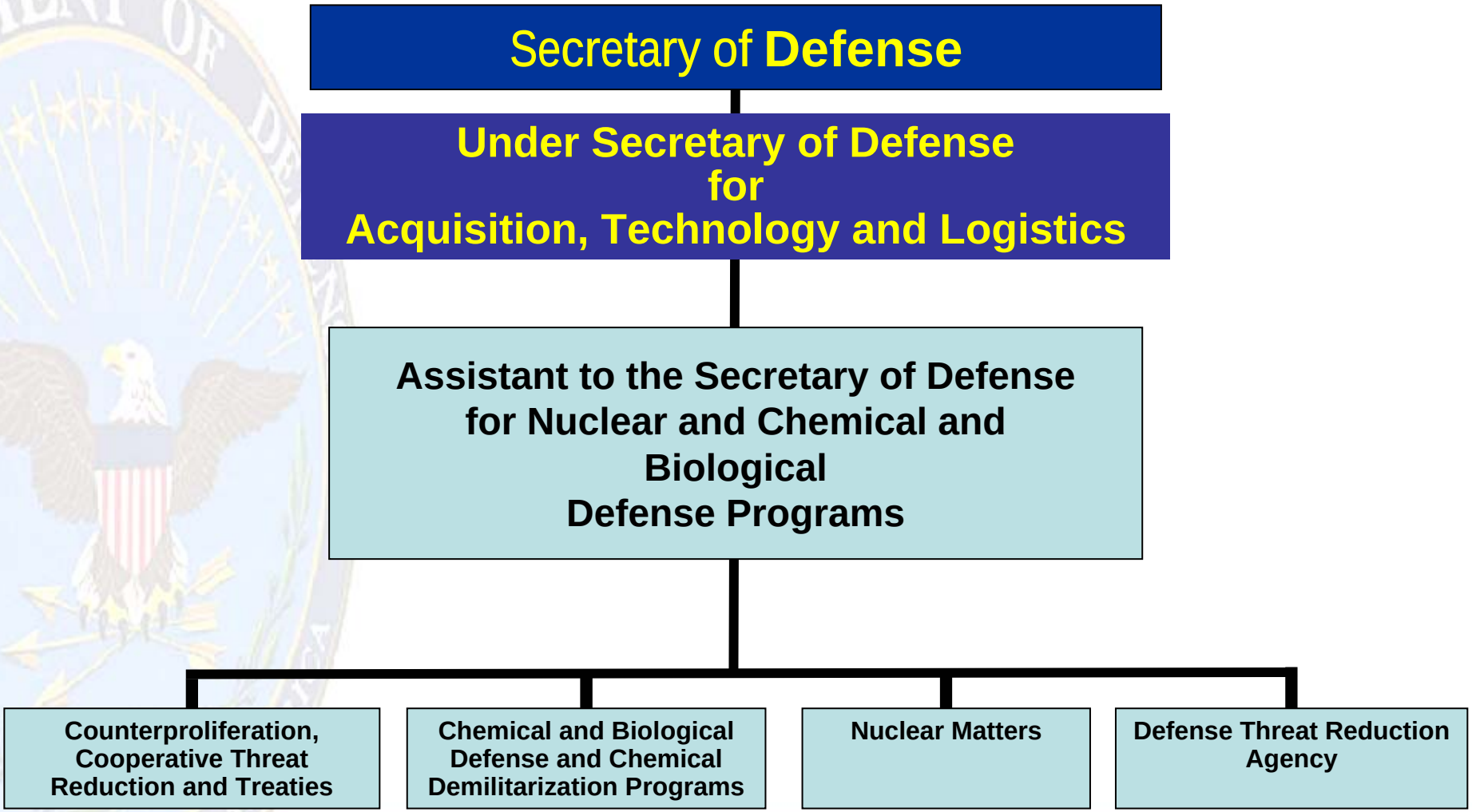
*Pacific Operational Science & Technology Conference*

*4 April 2007*

***Dr. Tom Hopkins***
***A/ATSD(NCB)***

# *Outline*

- ATSD(NCB)
- Strategic Guidance
- Oversight Framework
- R&D Portfolio
- Current Capability Needs
- Emerging Threats

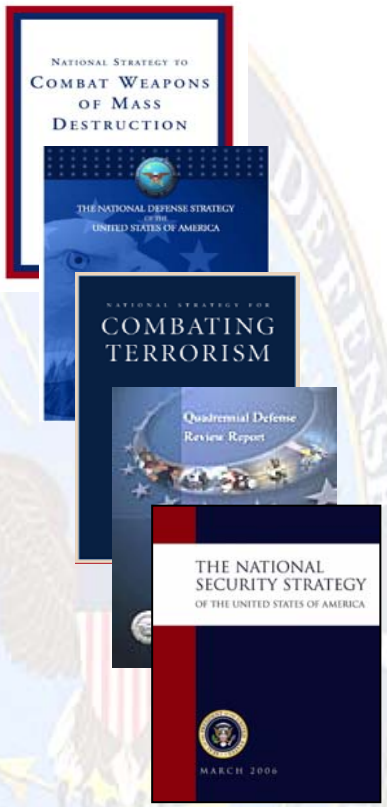

Secretary of Defense
Under Secretary of Defense for Acquisition, Technology and Logistics
Assistant to the Secretary of Defense for Nuclear and Chemical and Biological Defense Programs
Counterproliferation, Cooperative Threat Reduction and Treaties
Chemical and Biological Defense and Chemical Demilitarization Programs
Nuclear Matters
Defense Threat Reduction Agency

# *ATSD(NCB)*

- **Principal Staff Assistant**
- **Direction and Oversight**
- **Resource Alignment**
- **Integration**

- **Advise the Secretary, Deputy Secretary, and USD(AT&L) on nuclear matters and chemical and biological defense programs.**
- **Provide strategic direction and oversee DoD WMD threat reduction activities, combating WMD.**
- **Assess resource alignment with high level guidance to prevent, defeat, and protect against current and emerging WMD threats.**
- **Ensure research and development, multilateral cooperation, tailored threat reduction strategies and deterrence concepts are applied as integrating functions.**

# *Strategic Guidance*




- **High-level guidance includes three goals related to WMD proliferation:**
  - Prevent WMD proliferation
  - Deter, Defend and Defeat WMD use
  - Mitigate Consequences of WMD use
- **Military framework establishes eight operational missions to accomplish goals**
  - Interdiction, Cooperative Threat Reduction, Security Cooperation
  - Elimination, Offensive Operations, Active Defense
  - Passive Defense, Consequence Management
- **ATSD(NCB) focuses on DoD capabilities to achieve these goals**

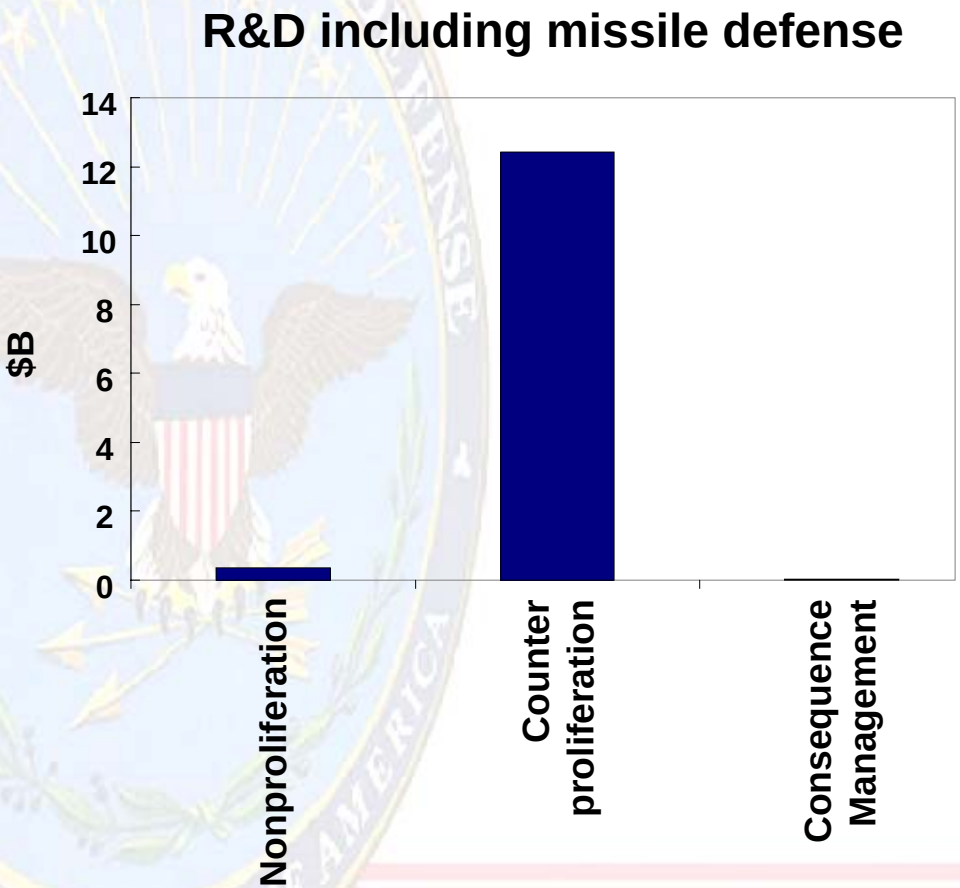
# *Oversight Framework*

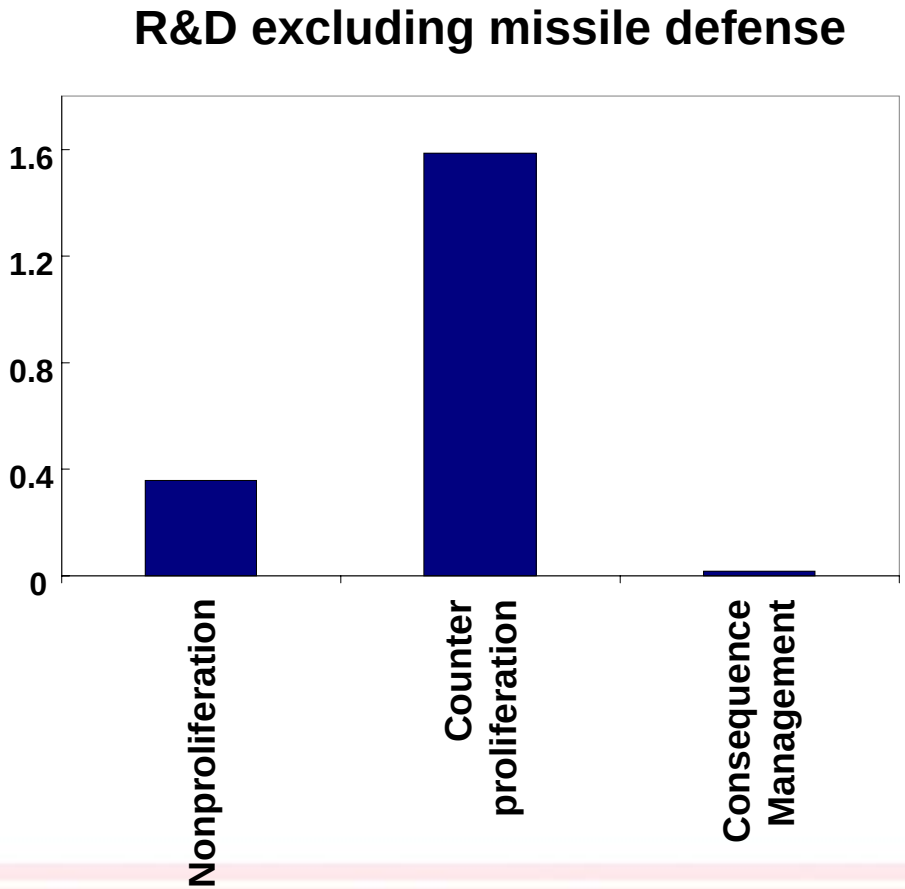
- **WMD threats include potential adversaries who:**
  - Want WMD: Nonproliferation
  - Have WMD: Counterproliferation
  - Use WMD: Consequence Management
- **U.S. needs a spectrum of capabilities:**
  - *Nonproliferation to prevent* WMD spread
    - Threat reduction cooperation
    - Security cooperation and partnership activities
  - *Counterproliferation to defeat* WMD
    - Interdiction
    - Elimination
    - Active defense
    - Offensive operations
    - Passive defense
  - *Consequence Management to protect* against WMD use
    - Consequence management

# *R&D Portfolio*

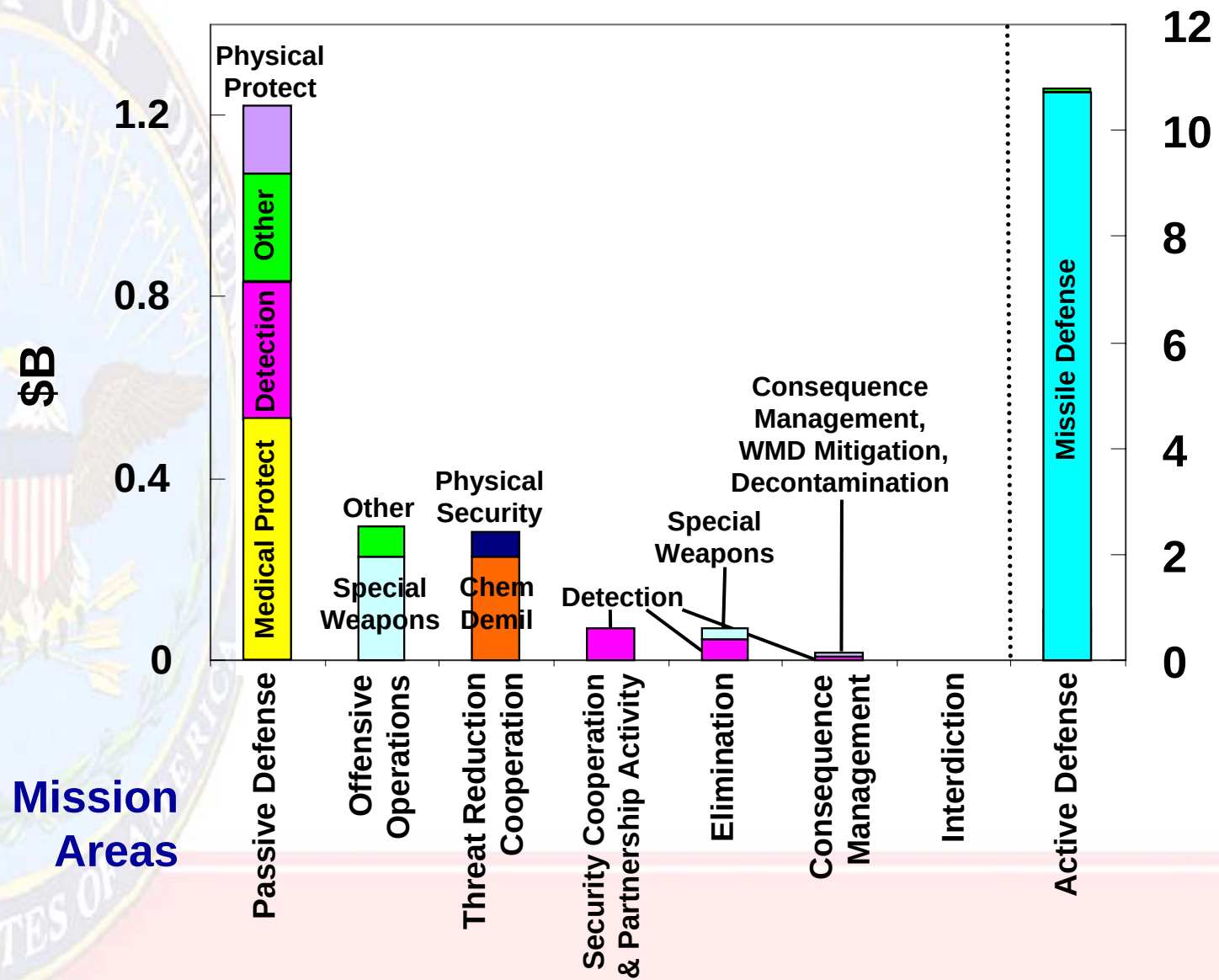
- Correlated Combating WMD R&D programs with the three pillars and eight mission areas
- Identified mission-unique and cross-cutting technology areas
- Assessed the investment portfolio

# FY2007 DoD R&D Investments

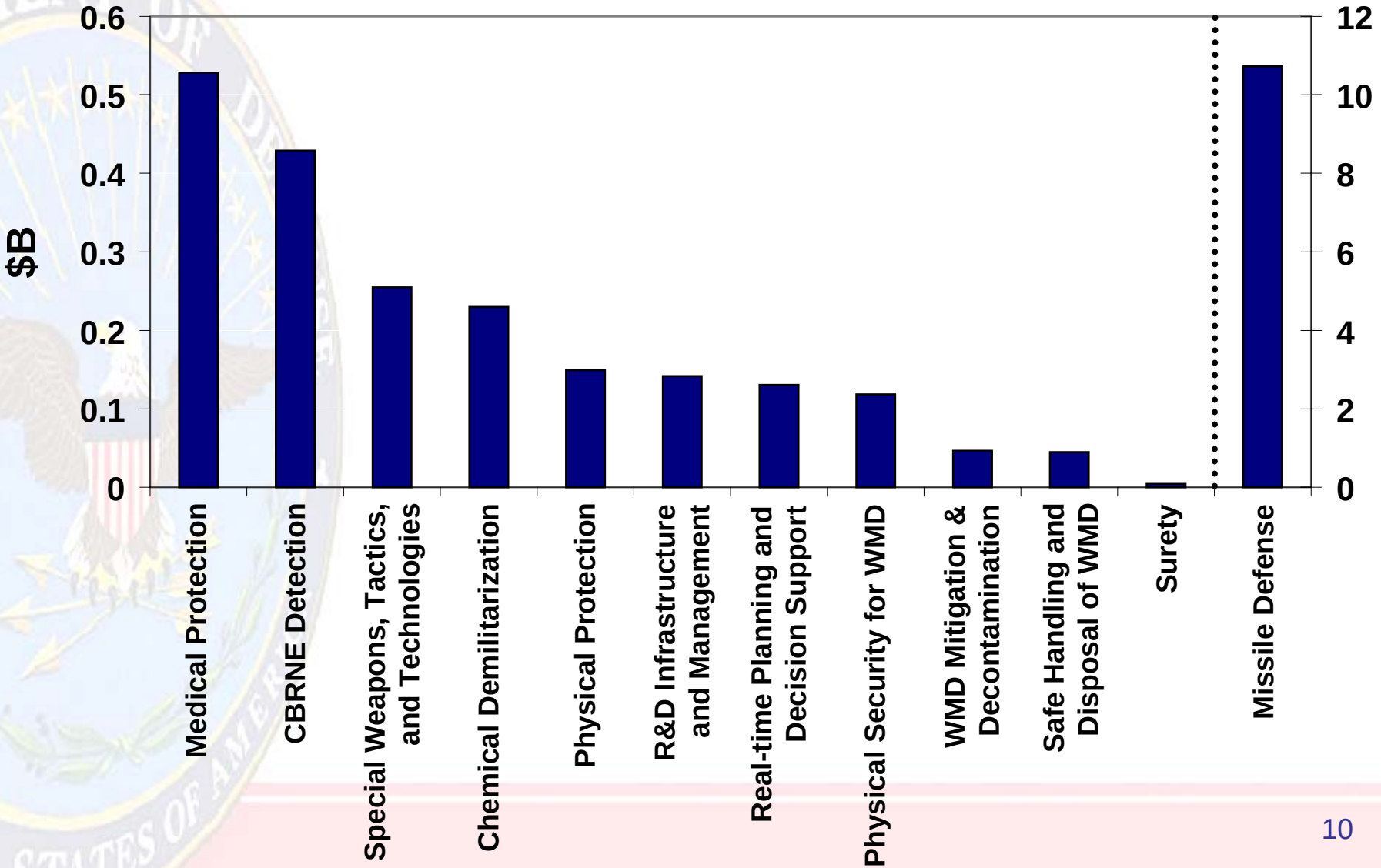


# FY2007 DoD R&D Investments



# Technology Areas



# Crosscutting Technologies

## Mission Areas

Technology Areas

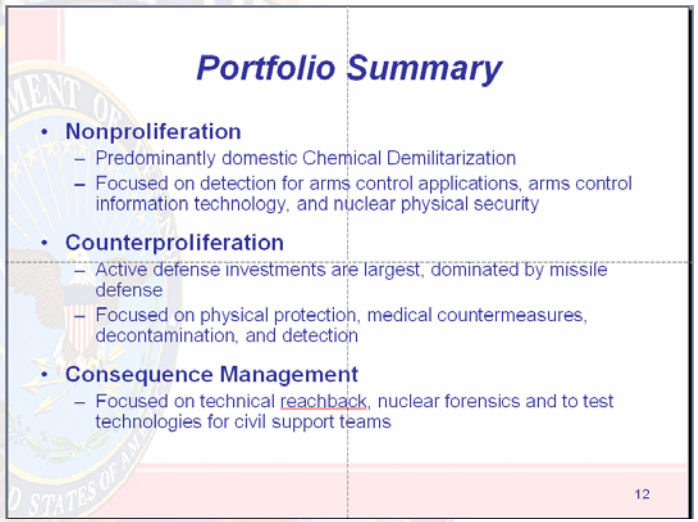
| | Security Cooperation | Threat Reduction Cooperation | Interdict-ion | Offensive Operations | Elimination | Active Defense | Passive Defense | Consequence Management |
|---|---|---|---|---|---|---|---|---|
| CBRNE detection | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Physical methods for protection | | | | ✓ | | | ✓ | ✓ |
| Medical protection | | | | | | | ✓ | ✓ |
| Specialized weapons, tactics, and technologies | ✓ | | | ✓ | ✓ | ✓ | | |
| Consequence management and WMD effects mitigation/ decontamination | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Real-time planning and decision support | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Physical security for WMDs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| RDA infrastructure and management | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| International cooperation activities and WMD demilitarization | ✓ | ✓ | | | | | | ✓ |
| Safely handle and dispose of WMD (and explosives) | | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| Tailored Strategies | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

**All technology areas support more than one mission**

# *Portfolio Summary*

- **Nonproliferation**
  - Predominantly domestic Chemical Demilitarization
  - Focused on detection for arms control applications, arms control information technology, and nuclear physical security
- **Counterproliferation**
  - Active defense investments are largest, dominated by missile defense
  - Focused on physical protection, offensive operations medical countermeasures, decontamination, and detection
- **Consequence Management**
  - Focused on technical reachback, nuclear forensics and technologies for civil support teams

# R&D Addresses Command Needs



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12

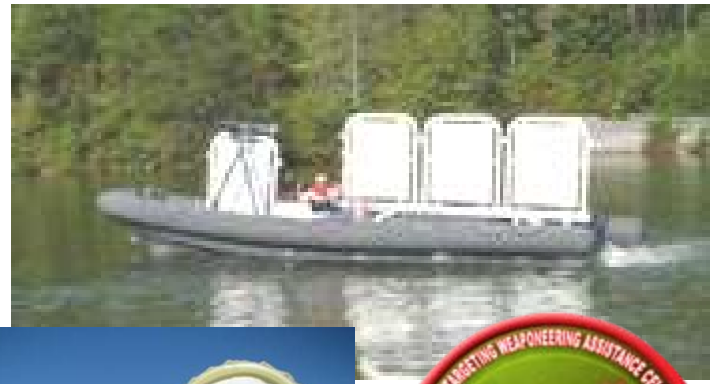
**Command Priorities**

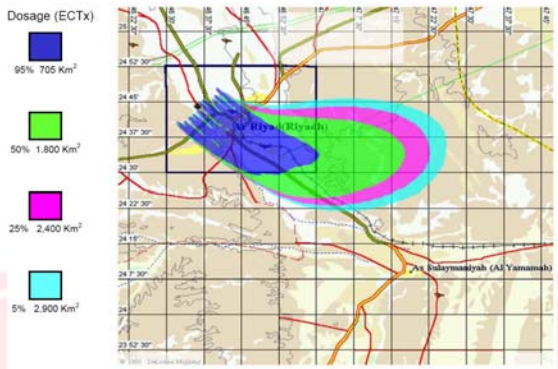
- Persistent surveillance
- Adversarial intent
- Missile defense
- Overcoming integrated air defense systems
- Fast transportation and fast ships
- International military education and training
- Foreign consequence management
- Preferred munitions
- Prompt, hard target defeat capability
- Pandemic preparation

# Current Capability Needs

## Detection, Identification, and Characterization of CBRN Threats

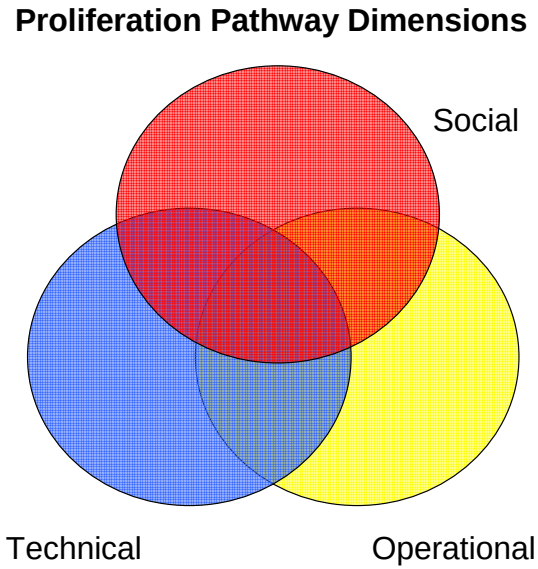
- Detect WMD at operationally relevant distances
- Track WMD and related materials
- Real-time reachback for technical support for detect, identify and characterize
- Application to targeting, weaponeering, bomb damage assessment, treaty compliance, border security, decontamination, demilitarization, force protection, and other operational applications



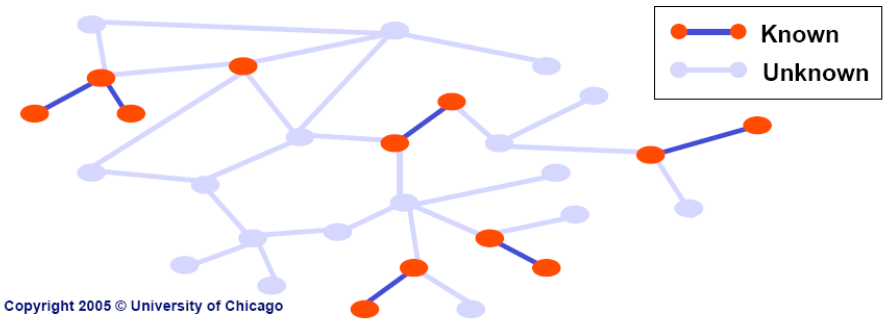


# *Current Capability Needs*
## Decision Support and Planning

- Indicators and understanding of adversarial intent
- Rapid processing of intelligence and dissemination to appropriate decision points allowing rapid action
- Information exploitation



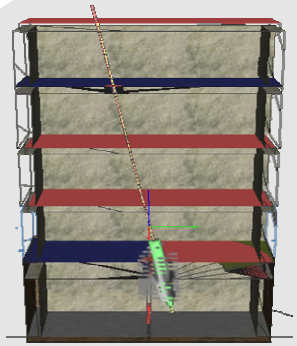

JTAC the joint threat anticipation center



# Current Capability Needs

## Offensive Operations

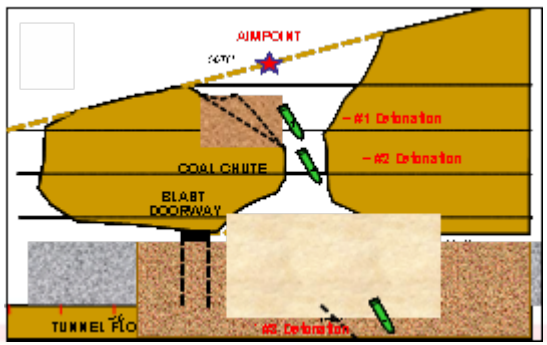
- Defeat WMD targets
  - Hard and deeply buried targets
    - Tunnels
    - Bunkers
  - Agent defeat technologies
- Secure, neutralize, store, and destroy or dispose of WMD



Deep Bunker Targets

Tunnel Targets

Tunnel defeat tests

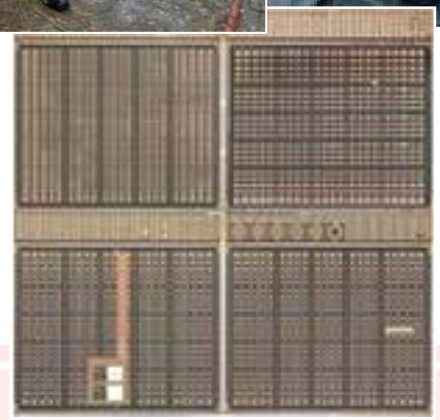



Hard Target Defeat

Tunnel Tests

# *Current Capability Needs*
## *Protection*

- Medical countermeasures
  - Vaccines and broad spectrum therapies
  - Medical prophylaxis
- Medical response, especially active syndromic surveillance coupled to mass treatment and quarantine
  - Bio-surveillance capabilities
- People, facilities, and mission protection



# Current Capability Needs

## Security Cooperation

- Interagency and international data exchange, coordination, and training
- New partnerships, agreements, and initiatives

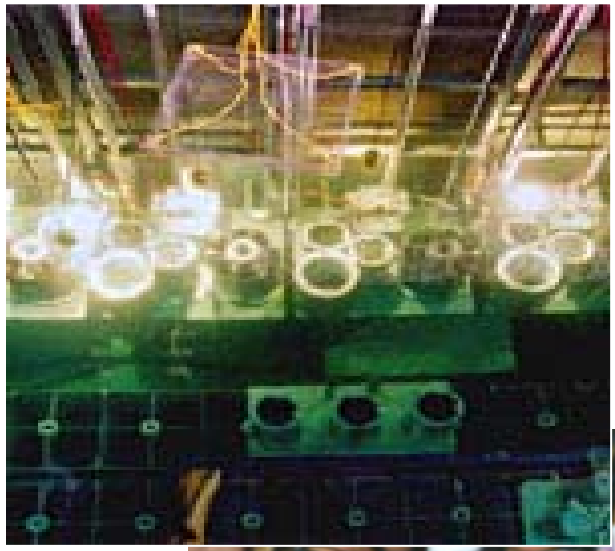
# *Observations*

- CBRN detection investment is significant
  - Challenges: Stand-off detection, identification and characterization
- Decision support tools are embedded in larger systems
  - Challenges:  Real-time situational awareness and threat anticipation
- Offensive operations R&D investments are dominated by hard and deeply buried target and agent defeat
- Protection is single largest technology area
  - Medical protection dominates and remains the biggest challenge
- Security cooperation R&D…future requirements?

# Emerging Threats

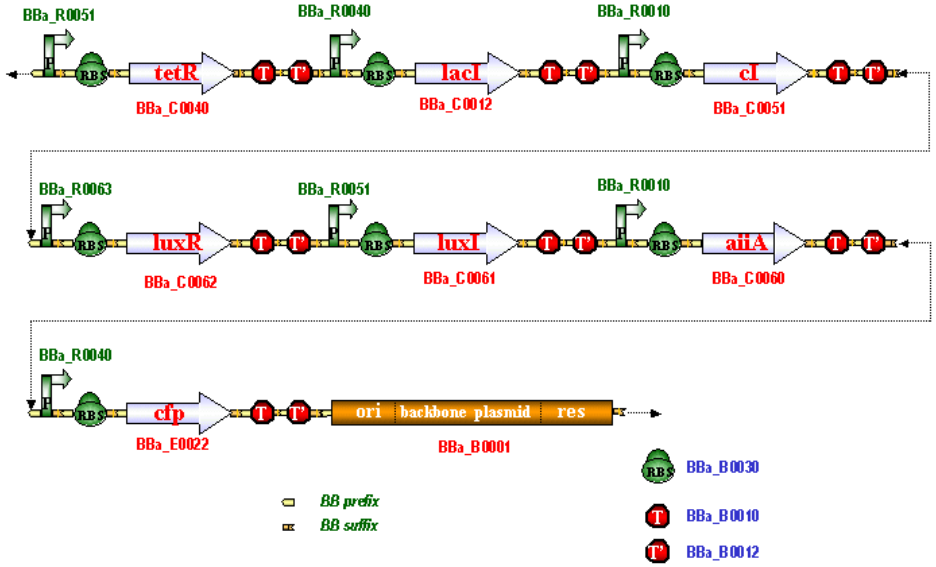
# *Emerging Threats*

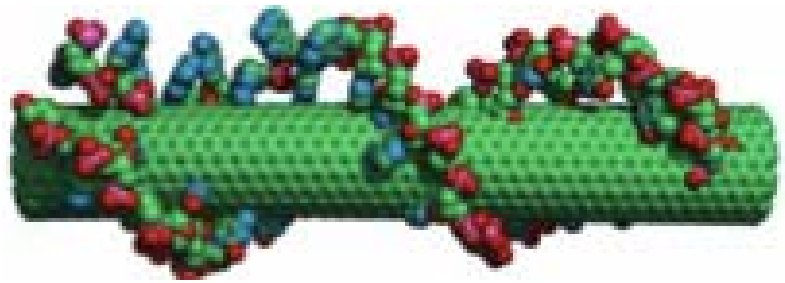
- Nuclear Proliferation
  - New nuclear weapons states
  - Acquisition of nuclear weapons by non-state or sub-state actors
- Natural Pandemics
  - Global connectivity and modern transportation are accelerating vectors for transmission
  - Security and social aspects
  - Emerging public health threats can also become BW threats



# Emerging Threats

- Biotechnology
  - Dual-use technology
  - Genetic engineering
  - Synthetic biology
- Nanotechnology
  - Nano-enabled biochemical agents and energetic materials
  - Circumventing vaccines and evasion of medical countermeasures
  - Anti-material agents



# *Emerging Responses*

Responses to emerging threats will require the full spectrum of R&D, operational, intelligence, political measures and international partnerships

# *ATSD(NCB) Challenges*

- Assess and improve the Combating WMD R&D investment strategy
  - Guidance
  - Current needs
  - Emerging threats
- Ensure that R&D communities communicate and collaborate with stakeholders

# Army Science & Technology Overview

U.S. Pacific Command

4 Apr 2007

Dr. Thomas H. Killion
*Deputy Assistant Secretary for Research and Technology/ Chief Scientist*

# Outline

- ***Science and Technology (S&T) Strategy***
- ***Warfighter Guidance and Drivers***
- ***Technology Area Investments***

# Science & Technology for a Campaign Quality Army with Joint & Expeditionary Capabilities

## Current Force

~100 lb. load

Limited network

> 70 tons

< 10 mph

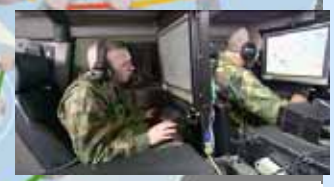
Enabling the Future Force

**Science and Technology—develop and mature technology to enable transformational capabilities for the Future Force while seeking opportunities to accelerate technology directly into the Current Force**

Enhancing the Current Force

## Future Force

< 40 lb. load



Fully networked

< 30 tons

> 40 mph

# From Science to Technologies…Systems

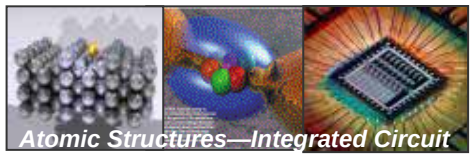
## 3 Different Types of S&T Investments

**S&T PB08 $1.7B**

**Development** → **Acquisition**

### 6.1: Basic Research 18% of S&T

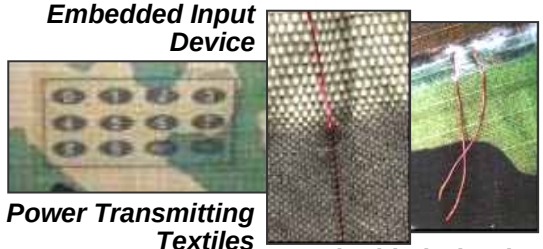
**Nanoscience**




- Understanding to solve Army-unique problems
- Knowledge for an uncertain future

### 6.2: Applied Research 40% of S&T

**Integrated Textile Conductors**




- Applications research for specific military problems
- Components, subsystems, models, new concepts

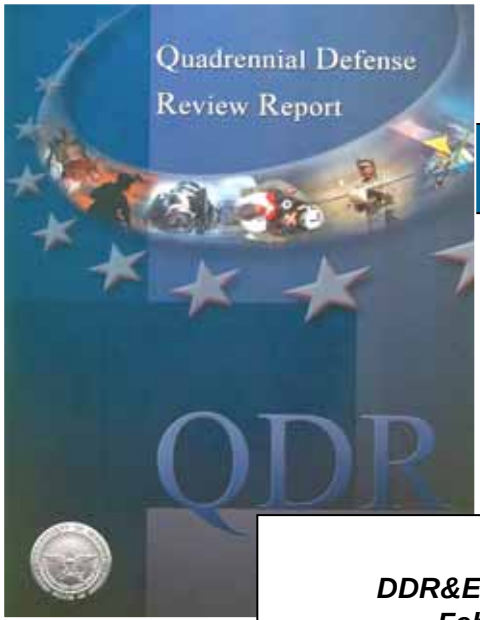
### 6.3: Advanced Technology Development 42% of S&T

**Precision Air Drop—50 meters**

- Demonstrate technical feasibility at system and subsystem level
- Assess military utility
- Path for technology spirals to acquisition—rapid insertion of new technology

**Far Term** | **Mid Term** | **Near Term**

# OSD Planning Framework

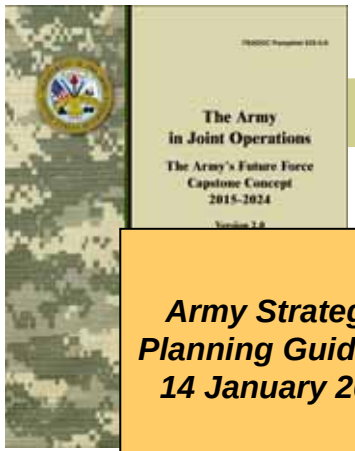



***Enhance our expeditionary combat power and shape the Services to be lighter, yet more lethal, more sustainable and more agile***

***DDR&E Guidance***
***Feb 2006***

***Protection, Battlespace Awareness, Force Application, Focused Logistics—implementing QDR guidance***

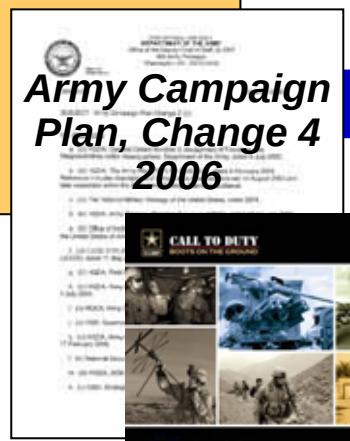
# Army Level Guidance



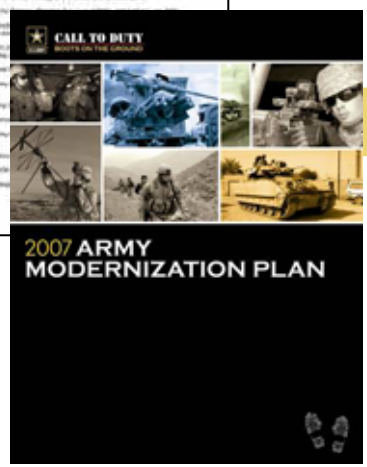

***"The FCS further encompasses a set of technologies and capabilities that will spiral into the entire Army as they mature. Networked C4ISR, precision munitions, and advanced fire control will also be key enablers."***

***Army Strategic Planning Guidance 14 January 2005***

***"…provide relevant and ready land power capability to the Combatant Commander as part of the Joint Team"***




***"… provide relevant and ready land power to combatant commanders and the Joint Force..."***




***"The Army's investment strategy pursues technologies to achieve the goal to field forces that are "lighter yet more lethal, more sustainable and more agile" while achieving entirely new capabilities..."***

# TRADOC Capability Gaps—Shaping S&T Programs

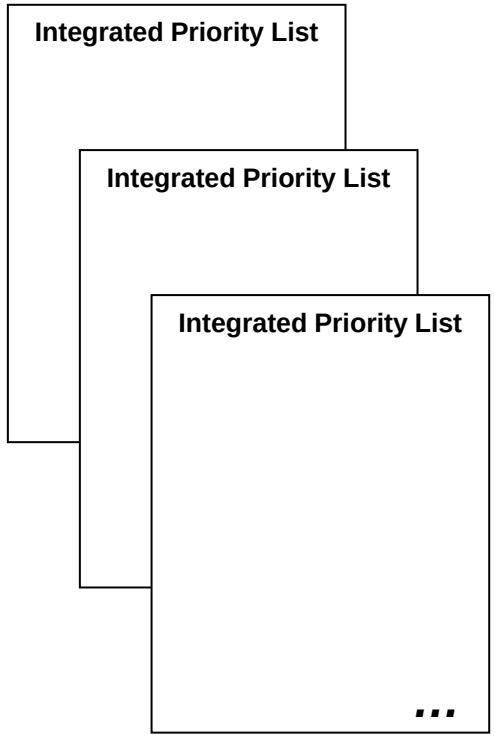
## Emerging Top Challenges for Current Force 2006

- Networked Enabled Battle Command
- Protect Force in Counterinsurgency Operations
- Soldier Protection in Counterinsurgency Environme
- Logistics and Medical in Counterinsurgency Operati non contiguous battlespace
- Train the Force How and As it Fights
- Tactical Communications
- Ability to Conduct Joint Urban Operations
- Joint Interoperability, Coalition and Interagency Ope
- Enhanced ISR Capabilities
- Timeliness of Analysis, and Information Disseminati

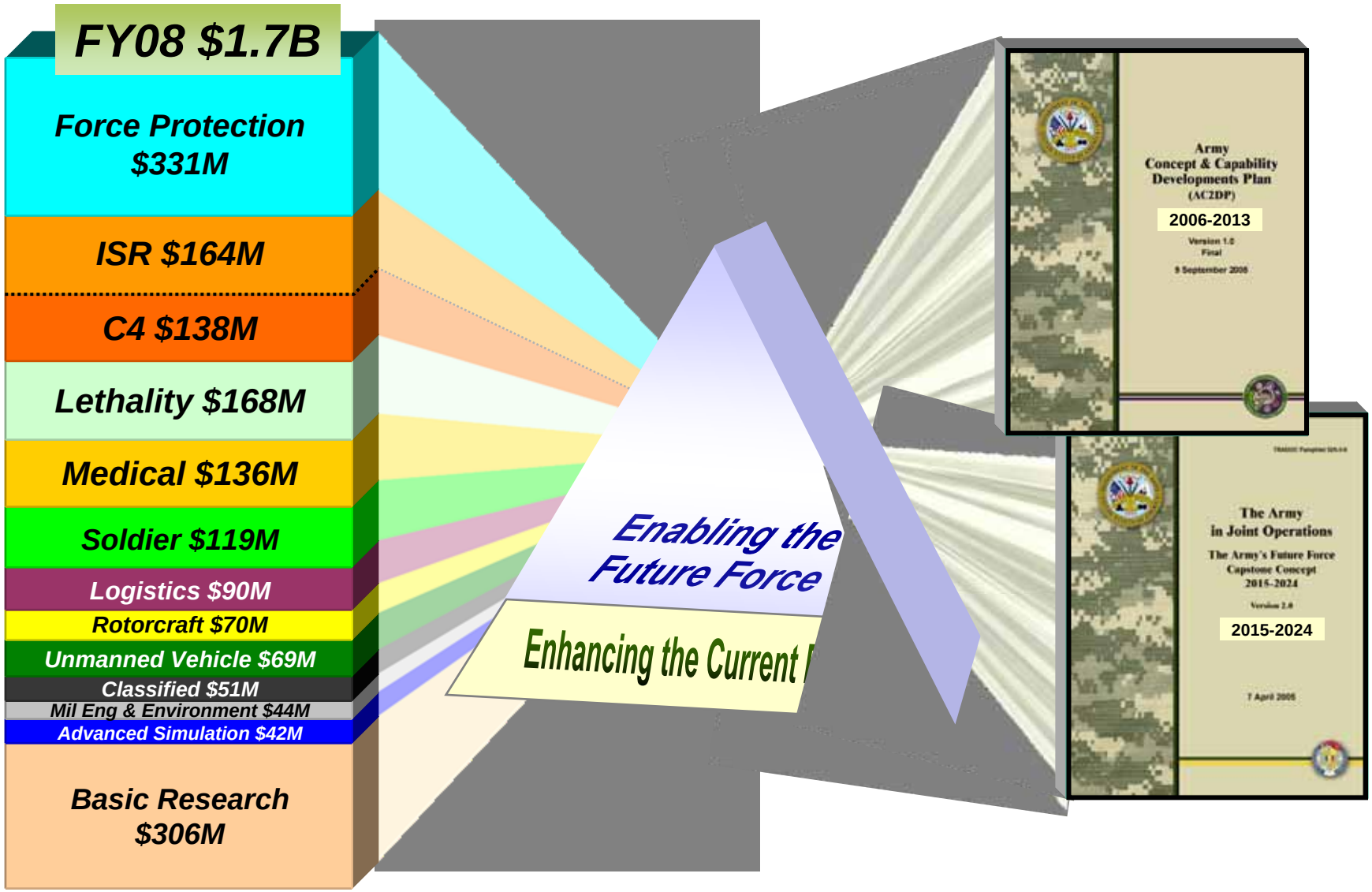
## Future Force Capability Gap Areas

- Enhanced Soldier Protection
- Modular, Scalable and Tailorable Battle Command and Control
- Enhance Platform/Group Protection
- Dynamic, Uninterrupted Communications Network
- Sustainment of Modular Forces
- Enhanced Collection, Exploitation and Dissemination
- Strategic Force Projection/Intratheater Operational Maneuver and Sustainment
- Modular, Tailorable Forces
- Capability for Lethal/Non-lethal Overmatch
- Ability to Train the Force How and As it Fights

# Responding to Joint Needs



# Technology Area Investments to Satisfy Gaps—New Capabilities

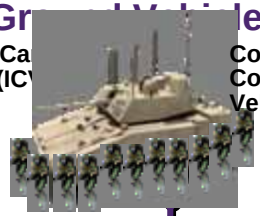


# FCS Brigade Combat Team

PROGRAM MANAGER FCS BRIGADE COMBAT TEAM
One Team-The Army/Defense Industry

## Manned Gr[illegible]les (MGV

Infantry Ca[illegible]
Vehicle (ICV



Command an[illegible]
Control
Vehicle (C2V)

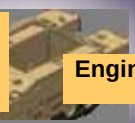
Mounted Combat

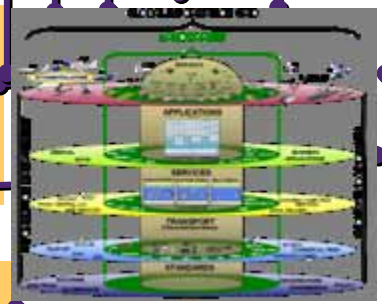
Reconnaiss[illegible]
And Survei[illegible]
Vehicle (RS[illegible]

Common Chassis

Advanced Lightweight Armor

Engine





Non-Line of Sight Mortar
(NL[illegible]

## Unmanned Aerial Systems (UAS)

Class I UAV

Class IV UAV

## Unattended Ground Systems (UGS)

T-UGS

U-UGS

Tactical and Urban Unattended Ground Sensors

Non-Line of Sight Launch System (NLOS-LS)

## Unmanned Ground Vehicles (UGV)

Multifunction Utility/ Logistics and Equipment Countermine and Transport

Armed Robotic Vehicle – Assault (Light) (ARV-A-L)

Small UGV (SUGV)

FCS Recovery and Maintenance Vehicle (FRMV)

Medical Vehicle
Trea[illegible]

[illegible]icle
(MV-E)

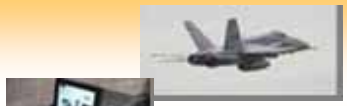
# Support to Current Operations

## Demonstrations, Prototypes, or Limited Fieldings

**Countermine/ Counter Boobytrap**

*WARLOCK Jammers*

*Explosive Detection*

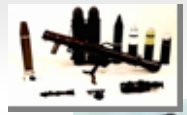


*Change Detection Workstation*

**Enhanced Lethality**

*Acoustic Gunfire Detection System*

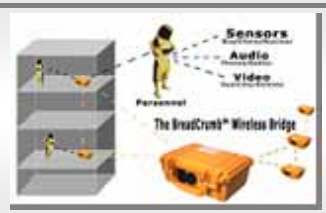
*SWORDS*



*Special Purpose Munitions*

**Network**

*Well Camera*




*Secure Wireless Relays*

*Satellite Nodes*

**Power & Energy**

*Zinc-Air Battery Family*

*"AA" Battery Solar Charger*

*SATCOM & Javelin Hybrid Power Sources*

**Survivability**

*Integrated Rocket, Artillery, Mortar (RAM) Detection*

*Backstop*

# Current Force—Force Protection

## Platform Protection

Stryker w/Bar Armor

Expedient HMMWV Armor Kit

Tactical Vehicle Add-on Armor

Tear-off Windshields

Deltoid Axillary Protection

SAPI Plates

Interceptor Body Armor

Vehicle Class Body Armor Support System

## Counter Rocket Artillery Mortar

Unattended Transient Acoustic MASINT System (UTAMS)

Backstop

Lightweight Counter Mortar Radar

## Countermine/Counter Boobytrap

Detection, Surveillance, Neutralization and Defeat

Airborne Detection

Neutralization

Robotic Detection/Neutralization

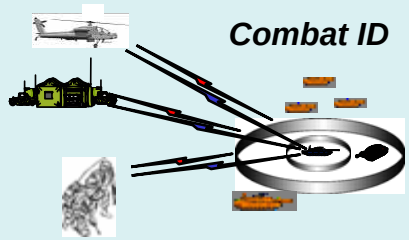
# Future Force—Force Protection

## Platform Protection

Structural Armor

Active Protection

Laser Vision Protection



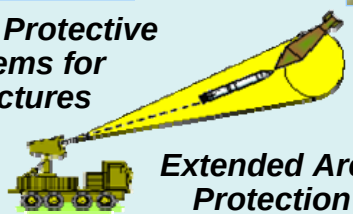
Combat ID

Integrated Rotorcraft Protection

## Counter Rocket Artillery Mortar

Modular Protective Systems for structures

Solid State Laser (SSL) Weapon System Concept



Extended Area Protection

## Countermine/Counter Boobytrap

Detection, Surveillance, Neutralizatio and Defeat

Networked Electronic Warfare

Packbot w/ sensor

Concealed Explosives Detection

# Current Force—ISR and C4

## Command & Control

Urban Tactical Planner (UTP)

Agile Commander

## Networked Comms

Airborne Network Extension

Tele-engineering

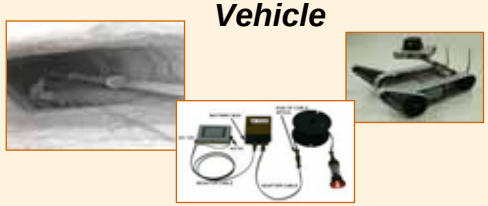
Integrated Meteorological System

Extended Range Communications (Breadcrumb)

## Surveillance & Sensors

Overwatch—Detection & Classification of Hostile Fire

Well Camera & Remote Robotic Vehicle



Mobile Stabilized Panoramic Sight

IR Sensors for Small Raven & Pointer

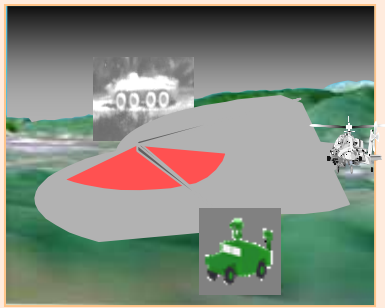
Wide Field of View Night Vision Goggle

Pilar Gunfire Detection System

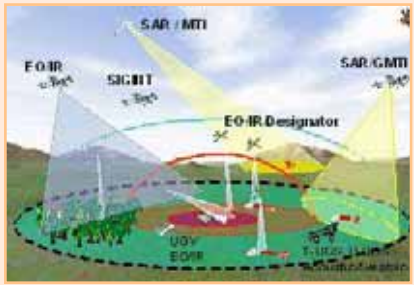
# Future Force—ISR and C4

ISR
C4

## Persistent Sensor Coverage



3rd Gen Infrared Sensors




Layered Networked Sensors

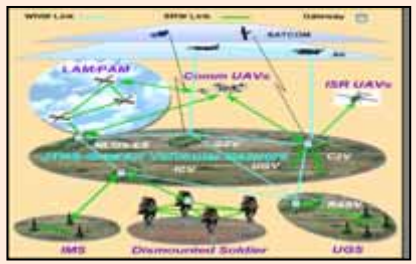
## Command & Control

Knowledge Fusion

Flexible Displays

## Tactical Mobile Networks

- Find the Enemy
- Assured Comms
- Battle Command



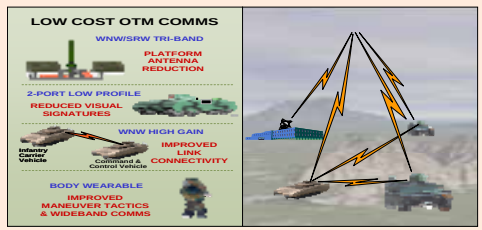

## MOUT/Situational Awareness

Through Wall Sensing

C2 in Urban Terrain

Pos/Nav Network Assisted and Improved MEMS IMUs

## Advanced Antennas




Tactical Network & Communications Antennas

Directional Antennas

# Future Force—Medical

Medical

## Combat Casualty Care

Improved Treatment for Head Injuries

Regenerative Therapies

Far-Forward Resuscitation & Hemorrhage Control

Semi-Autonomous Intensive Care & Transport System

## Infectious Diseases

Malaria Treatment Drugs

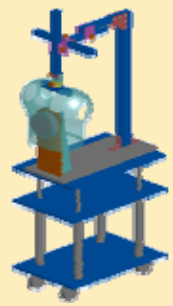
Malaria Prevention Vaccines

Malaria Rapid Diagnostic Device

Dengue Prevention Vaccines

## Operational Medicine

Remote Monitoring of Warfighter Health and Performance



Performance Test for Future Lightweight Body Armor Systems

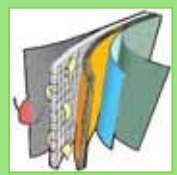
# Future Force—Soldier Systems

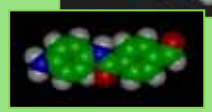
**Soldier**

## Survivability

*Modeling & Simulation*

*Nanomaterials for Ballistic, Laser, Environmental Protection*





*Novel Fibers for Ballistic Protection*

## Future Force Warrior

## Rations

*First Strike Compact Ration*

*Biosensor for Food Safety*

*Joint Combat Feeding*

## Power

*Fuel Cell Battery Hybrid*

*Photovoltaics*

*Stirling Engine*

*Electro-textiles*

## Personnel Technologies

*Accessing, Retaining & Training Adaptive Soldiers & Leaders*

*Realistic, Effective Training*

## Sensors

*Physiological Status Monitoring*

*Uncooled IR Sensors for UAVs*

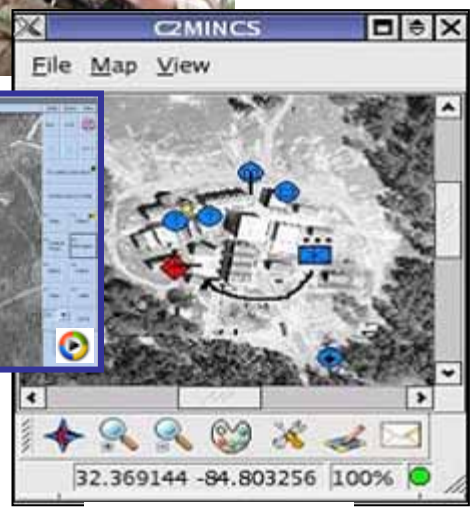
*Pointer*

# Future Force Warrior (FFW)—2006

- *FFW Increment 1 at C4ISR OTM Jun-Aug 06:*
  - *Integration into Future Force network via Soldier Radio Waveform*
  - *Current force integration via FBCB2*
  - *Integrated combat ensemble with stand-off body armor/load carriage/electronics and signature management*
  - *Squad level NLOS cooperative engagement*
  - *Headgear with integrated fused thermal and I2*
  - *System voice control*
- *FFW Early Increment 2 improvements at OTM 06 and AAEF/Spiral C:*
  - *Beyond squad level NLOS cooperative engagement*
  - *Digital target hand-off to joint platforms (F-16, A-10)*
  - *Class I UAV imagery feed*
  - *Goggle mounted "look down" display*
  - *Physiological status monitoring*
- *FFW at C4ISR OTM and AAEF/D in 2007*
  - *Precise positioning system*
  - *Low power flexible display demo*
  - *Headgear sensor fusion*
  - *Wireless Personal Area Network and weapons interface*
  - *UGV, UGS integration to FFW platform*
  - *Compact computer (Falcon computer from AFRL)*
  - *Apache digital target hand-off*

DARPA

*Leader Display*




*Soldier Display*

***FFW transitions to PEO Soldier in 1QFY08 for Ground Soldier System (next generation Land Warrior)***

# Future Force—Logistics

Logistics

## Power & Energy

Hybrid Electric Drive

Heavy Fuel Engine

Fuel ormation

Fuel Cell Development

UNITED STATES ARMY NAC NATIONAL AUTOMOTIVE CENTER

Utility Variant

Sustainment Variant

Future Tactical Truck System Concepts

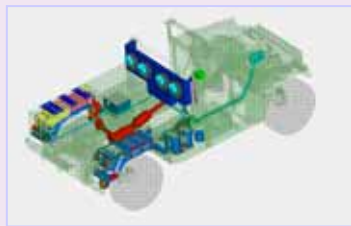
## Deployability

Lightweight Band Track

Precision Air Drop 30k lbs

## Sustainment

Water Generation & Recovery



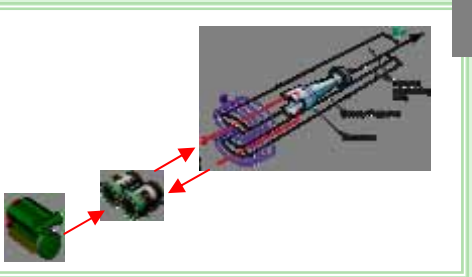
EM Gun Munitions

Prognostics/ Diagnostics

# Future Force—Lethality

## Guns and Munitions

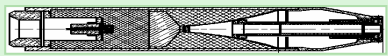
**Electromagnetic Gun… paradigm shift in propulsion**



Electronically Controlled Variable Effects Warheads

Wall Breaching Munitions

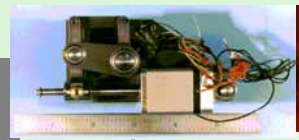
Small Arms Deployable Sensor Network



Urban Assault Munitions

## Missiles

GPS Receiver



Control Actuators

IMU

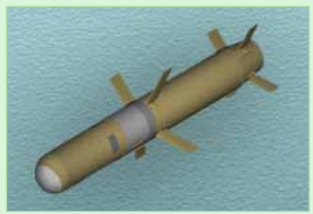
Guidance & Control

**Future Missile Technology**

Non-Line of Sight Launch System (NLOS-LS)

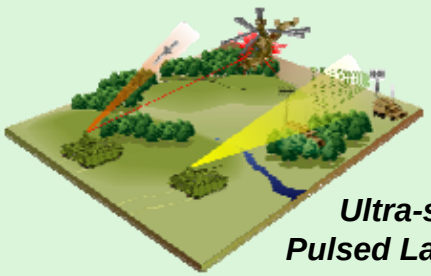
**NLOS-LS and C3**

Precision Attack Missile (>40km)



## Non-lethal

**Multi-Mission High Power Microwave**

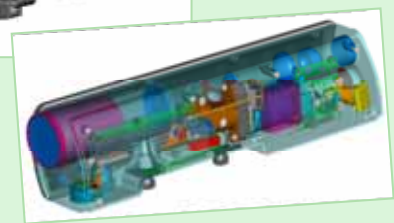


Ultra-short Pulsed Lasers

## Joint Small Arms

Lightweight Weapon Component Technologies

Lightweight Caseless Ammo



Target Acquisition Fire Control Sub-system

# Future Force—Rotorcraft

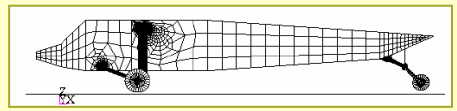
Rotorcraft

## Reduced Operations and Support Costs

### Propulsion and Drive Trains

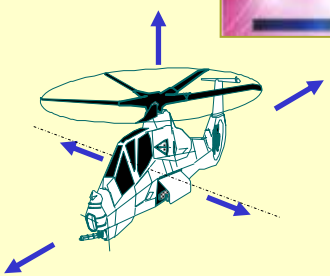
- Increased Fuel Efficiency
- Lighter Weight Components
- Small Heavy Fuel Engine

- Reduced Weight/Vibration
- Improved Reliability and Durability



## Rotors and Flight Controls

- Intelligent & Active Rotors and Controls
- Embedded Actuators



## Platform Technology

- Advanced Rotary Wing Concept Designs
- Aviation Weapons Integration
- Directed Energy/ Non-lethal Weapons Integration

# Current Force—Advanced Simulation

## Advanced Simulation

Cultural Awareness Simulation

Psychological Evaluation and Treatment

Adaptive Learning Environment

# Joint Fires and Effects Trainer System

## Urban Terrain
- Application of indirect effects in urban battlespace
- Cognitive proficiency for better decision-making

## Fires & Effects Command (FEC)
- Testbed for system and human/machine interface requirements for Networked Fires Command node

## Open Terrain
- Skill and cognitive trainer
- Mounted and dismounted
- Range of “individual” to “collective” tasks

## Close Air Support (CAS)
- Movable flats for mixed reality environments
- 300-degree perimeter field-of-view
- 360-degree overhead field-of-view
- All rear projection

# Future Force—Training Simulation

Adv Simulation

## Training Strategies & Simulation

Next Generation Training Systems

Army Excellence in Leadership

Learning with Adaptive Simulation & Training

# Progress in Autonomy & Cognition for Operational Capability

Million Instructions/ second

**Key Challenges**

- High speed mobility
  - Improved perception
  - Reliable data fusion
- Safe operations
  - Detect & classify stationary people & objects
  - Collision avoidance
- Design for tactical behavior flexibility
  - Understand environments
  - Decision processing
  - React appropriately to contact
- Collaboration
  - Conduct collaborative missions with mixed manned/unmanned force
  - Collaborative air-ground operations

1B

10M

100K

1K

Demo IIIa

True follower—follows in tracks of manned leader

On-road convoy operations

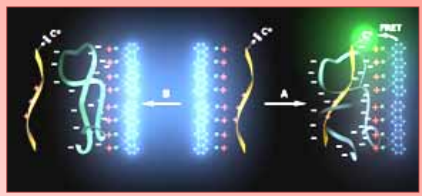
Armed Reconnaissance Vehicle—RSTA

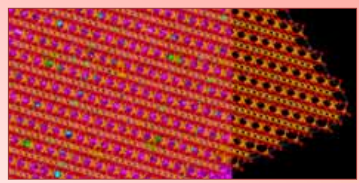
Near autonomous team members

2000 2005 2008 2011 2015…

# Shortening Cycle Time—Research to Products

*Immersive simulation for training, cultural awareness and mission rehearsal*

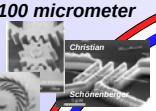




*Bio-inspired materials designs for energy, sensors, and networks*

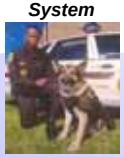
**Transforming knowledge into Technology**

*Microtechnology 1-100 micrometer*



*Macrotechnology Millimeter Kilometer*

*Functional System*



*Soldier ~2 meters*

*Nanotechnology 1-100 nanometer*

*Nanotechnologies for Soldier survivability*

*Develop high performance, commercially-viable, conformal and flexible displays*

# Army S&T…
## Engine of Transformation

*The Overall Classification of this Briefing is*
**UNCLASSIFIED**

# *Game Changing Technologies*

## Computational Imaging Systems

**Timothy M. Persons, Ph.D.**
**Technical Director and Chief Scientist**
**Disruptive Technology Office**
**Office of the Director of National Intelligence**

**April 4, 2007**

**UNCLASSIFIED**

*The Overall Classification of this Briefing is*
**UNCLASSIFIED**

# *How the Disruptive Technology Office is Working to Subvert Pre-21st Century Intelligence Business Paradigms*

## Case Study: Computational Imaging Systems

**Timothy M. Persons, Ph.D.**
**Technical Director and Chief Scientist**
**Disruptive Technology Office**
**Office of the Director of National Intelligence**

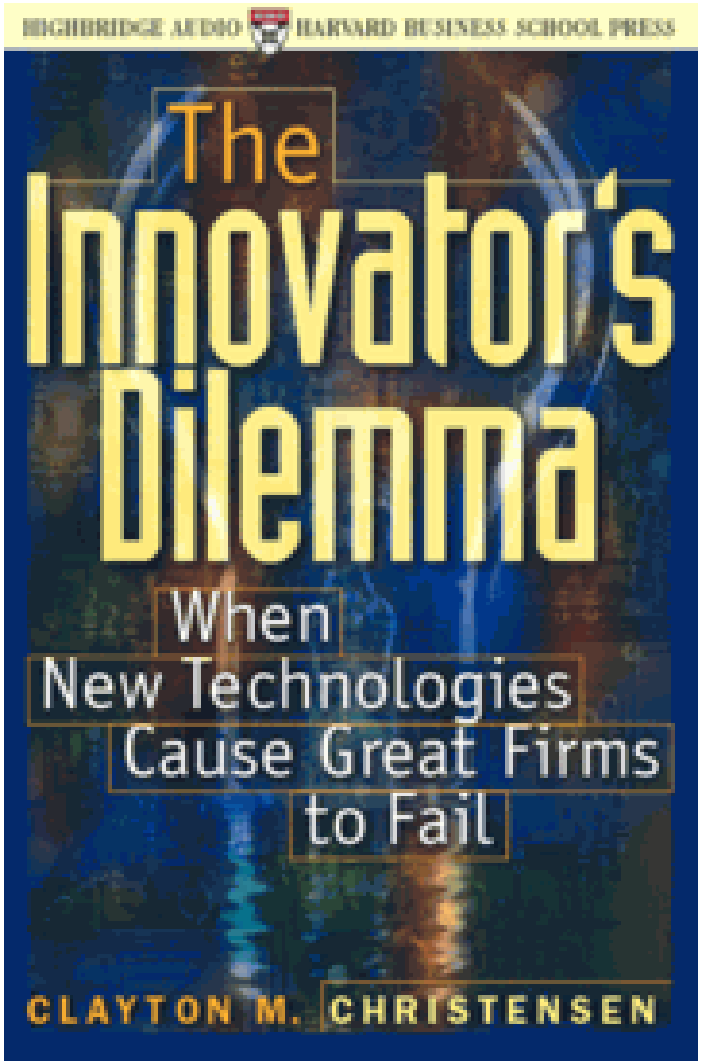
**April 4, 2007**

**UNCLASSIFIED**

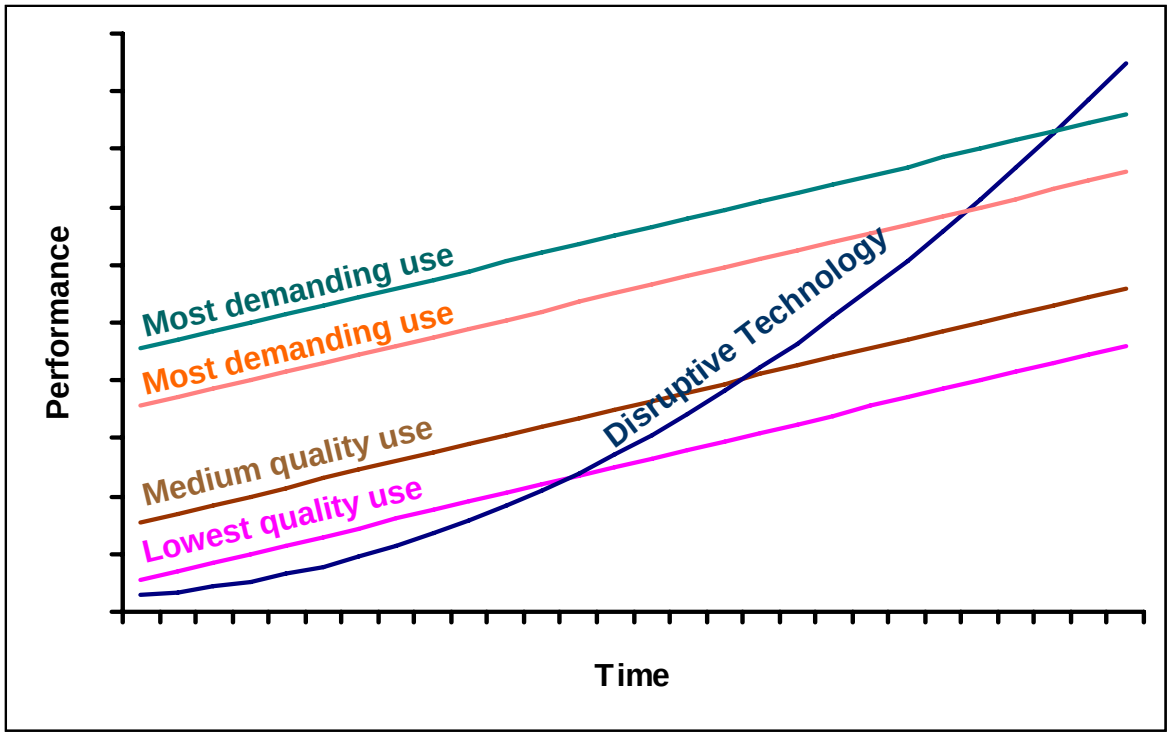
DTO

# The Nation's Intelligence Community

# The Innovator's Dilemma

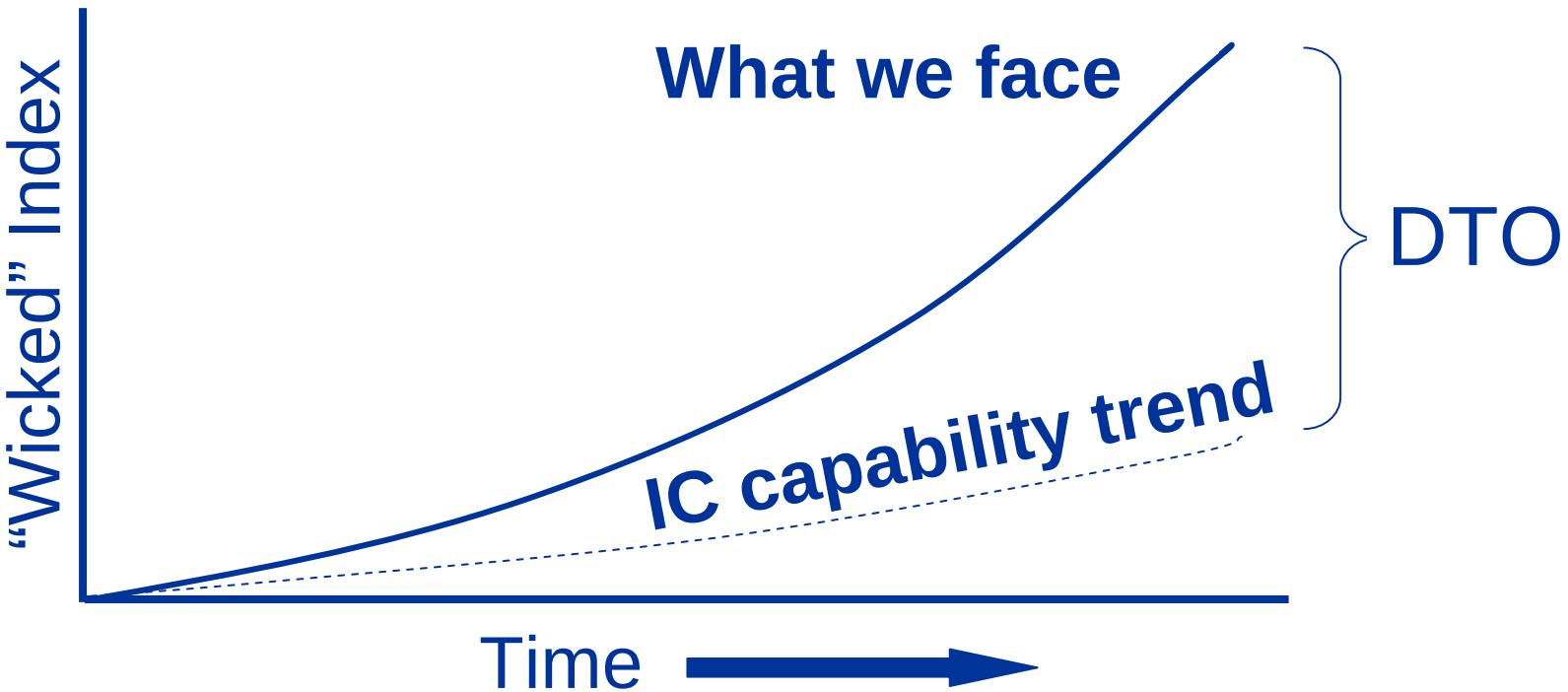



Christensen, Clayton M. *The Innovator's Dilemma*, Harper Business, 1997, 286 pages



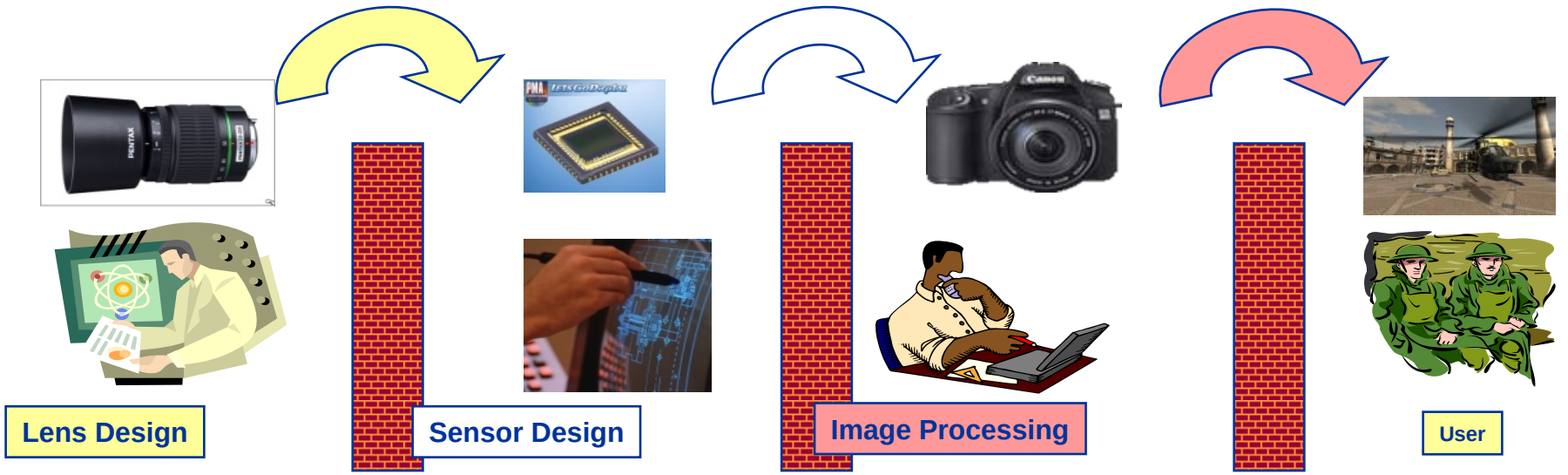

| Established Technology | Disruptive Technology |
|---|---|
| Silver halide photo film | Digital photography |
| Wireline telephony | Mobile telephony |
| Manned fighter & bomber aircraft | Unmanned aircraft |

# *DTO Addresses "Wicked" Problems*



# Conventional Approach to Designing Imaging Sensors

- **Current imaging sensor design strategy:**
  - Separately designed and optimized subsystems/components bolted together
  - Fixed allocation of resources at design time
  - Feed-forward information flow only




**Case Study for a Hypothetical Sensor:**

**Data generated = 1024 x 1024 (spatial) x 200 (spectral) x 8 bits = 200 MB / frame**

**Information extracted from a typical tactical scene = 100 objects of interest x 4 B/object = 400 B**

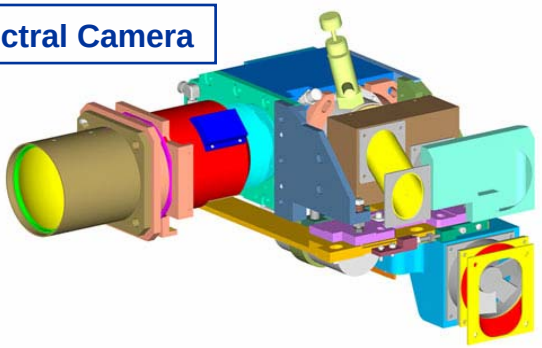
**(Information / Data) = $10^{-6}$ …VERY POOR EFFICIENCY**

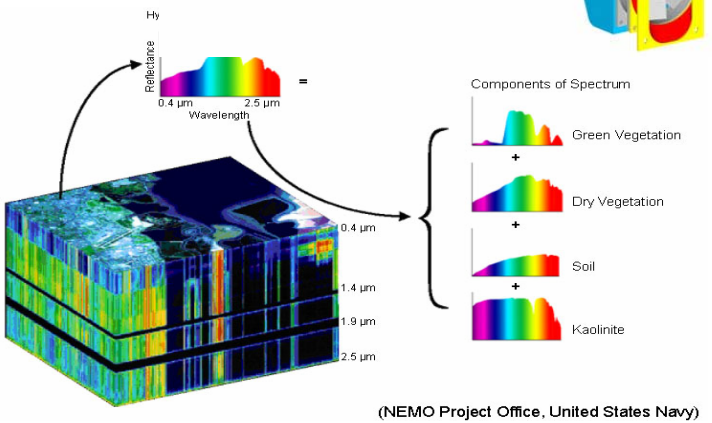
# Current High Performance Imaging Sensors

Predator Camera

Predator Ladar

Hyperspectral Camera






(NEMO Project Office, United States Navy)

39 Megapixel Hasselblad

*Technology Scaling Driven by "Moore's Law"*

- 3D, hyperspectral, polarimetric, Doppler Ladar….
- More detector pixels, more spectral bands, higher frame rates….
- Governing philosophy: *"More data is better data"*

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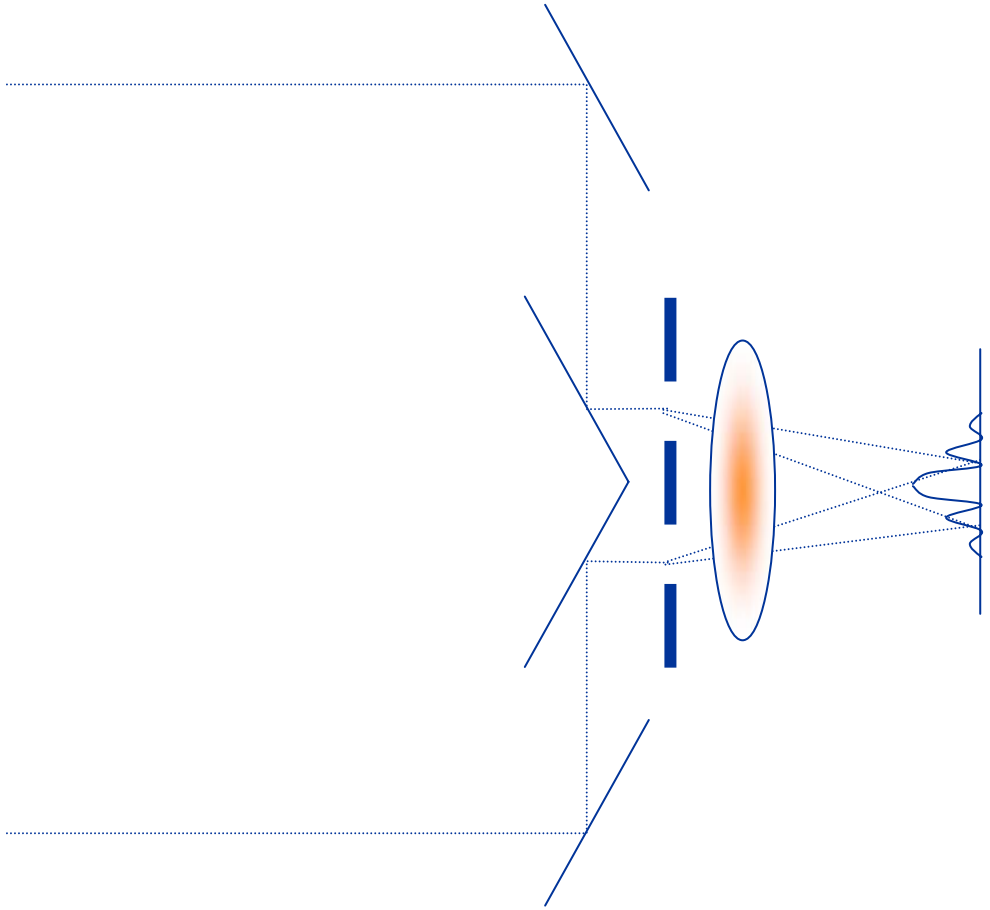
# *Definition of Computational Imaging Systems*

- Sensing systems that exhibit jointly optimized optics, transduction, algorithmic, form factor, power, and information factors which together are tunable and exhibit semi to fully autonomous, purposeful[1] sensing.
- Such systems have experimentally exhibited the following features:
  - Digital super-resolution
  - Depth of field extension
  - Logarithmic dynamic range adjustment
  - Multispectral
  - Low aspect ratio (slim form factors)
  - Polarimetric
  - Wide FOV

[1]*Purposeful sensing:* application-specific sampling with optimal allocation between space, intensity, spectrum…

# Oldest Computational Imaging Sensor: Michelson Stellar Interferometer

**A. A. Michelson, "Visibility of Interference-Fringes in the Focus of a Telescope," Phil. Mag. 31, 256-259 (March 1891).**





VISIBILITY OF INTERFERENCE-FRINGES IN THE FOCUS OF A TELESCOPE.*

By Albert A. Michelson.

When the angle subtended by an object viewed through a telescope is less than that subtended by a light-wave at a distance equal to the diameter of the objective, the form of the object can no longer be inferred from that of the image. Thus, if the object be a disk, a triangle, a point, or a double star, the appearance in the telescope is nearly the same.

If, however. the objective is limited by a rectangular slit, or, better, by two such, equal and parallel, then, as has been shown in a former paper,† the visibility of the interference-fringes is, in general, a periodic function of the ratio of $\alpha$, the angular magnitude of the source in the direction perpendicular to the length of the slits, and $\alpha_0$, the "limit of resolution." The period of this function, and thence $\frac{\alpha}{\alpha_0}$, may be found with great accuracy; so that by annulling the greater portion of the objective the accuracy of measurement of the angular magnitude of a small or distant source may be increased from ten to fifty times. As ordinarily understood, this increase of "accuracy" would be at the cost of "definition" (which, in this sense, is practically zero); but if by "definition" we mean, not the closeness of the resemblance of the image to the object, but the accurracy with which the form may be inferred, then definition and accuracy are increased in about the same proportion.

In almost every case likely to arise in practice, the form of the source is a circular disk; and if the illumination over its surface were uniform, the only problem to be solved would be the measurement of its diameter. But in many cases the distribution is anything but uniform. If the curve representing the distribution along the radius be $i = \psi(r)$, then the element of intensity of a strip $y_1 dx$ will be

$$\int_{-y_1}^{y_1} \psi(r)\, dy = \phi(x),$$

* Reprinted, by request, from the *Philosophical Magazine*.

† "On the Application of Interference Methods to Astronomical Measurements" (Phil. Mag., July, 1890).

© Astronomical Society of the Pacific • Provided by the NASA Astrophysics Data System

# Automotive Analogy for Imaging Sensors

Horse-drawn Carriage

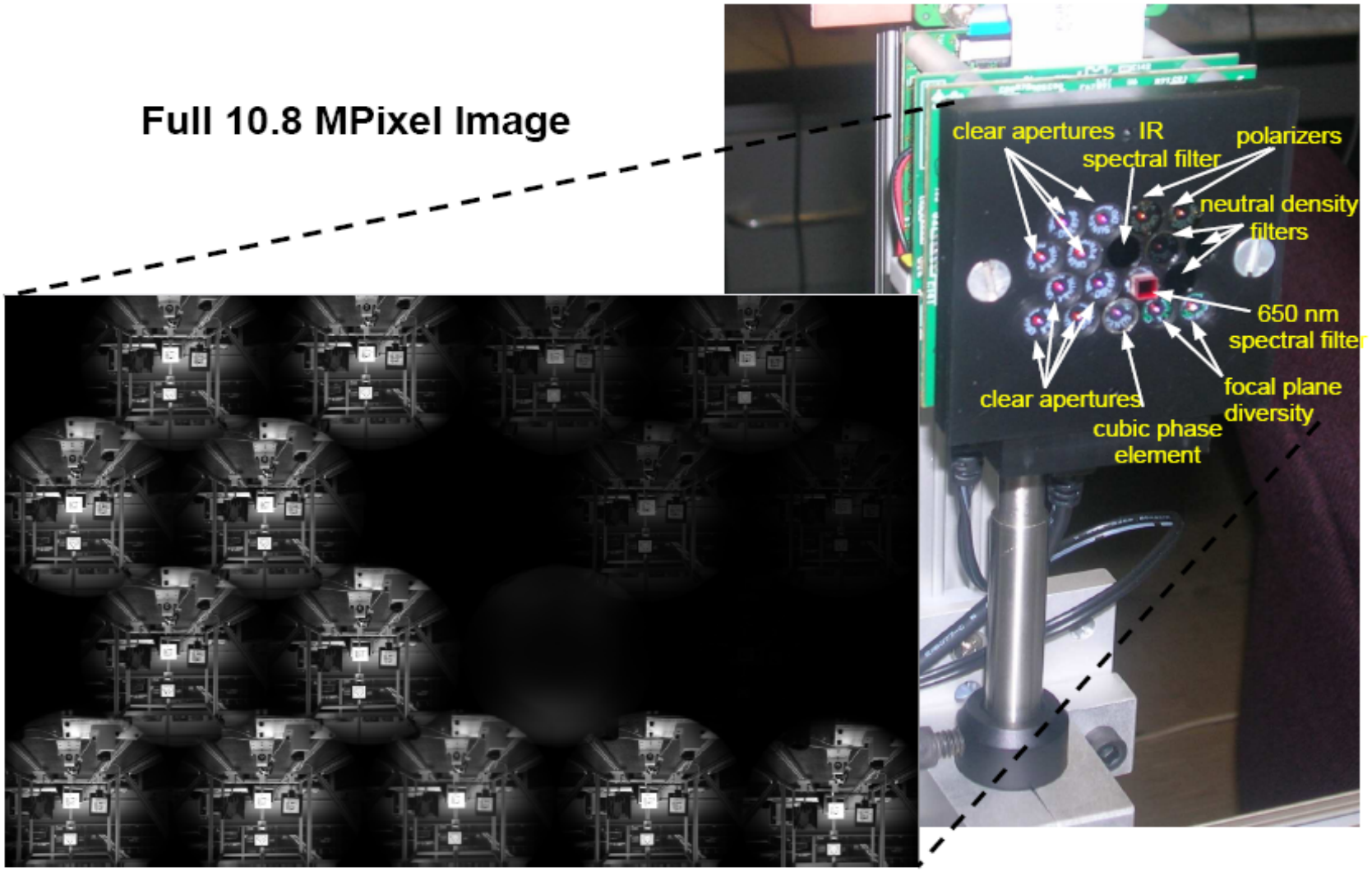
Horse-*less* Carriage

Film Cameras

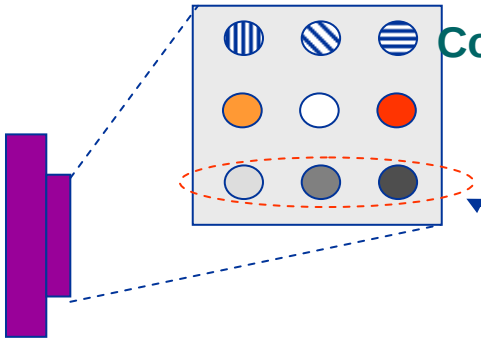
Film-*less* Cameras

**Specialization?**
**Autonomy?**

# Multi-Aperture, Multi-Diversity Compact Imager: PERIODIC Seedling

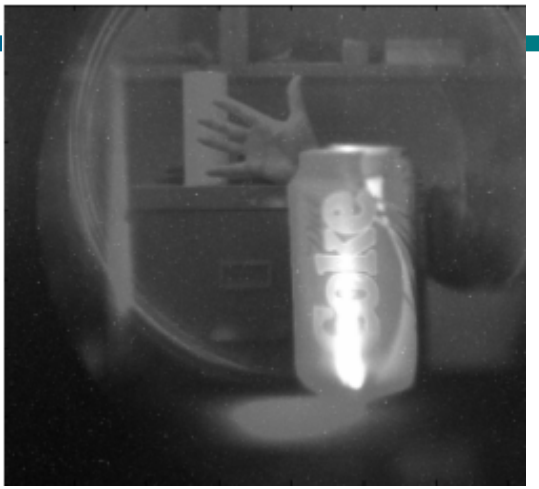


# PERIODIC Demonstration

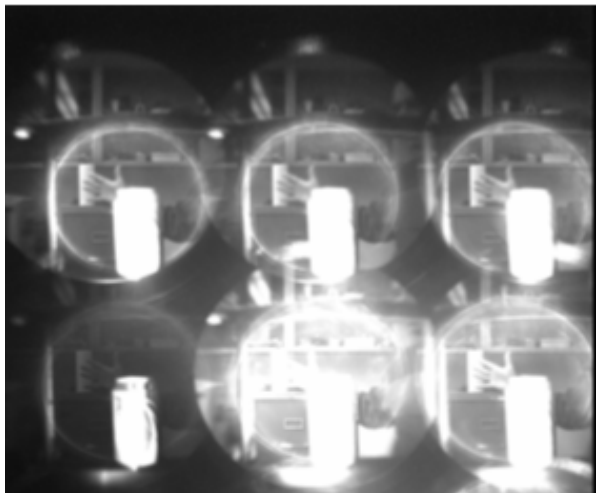


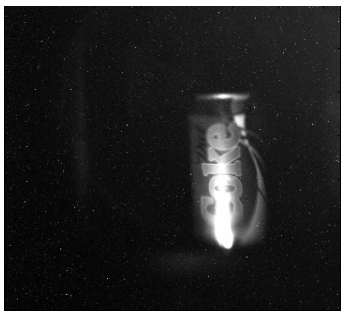
Compound Eye Camera

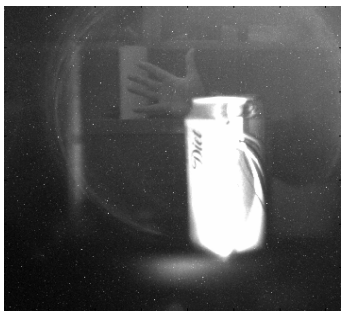
Three neutral density filters.

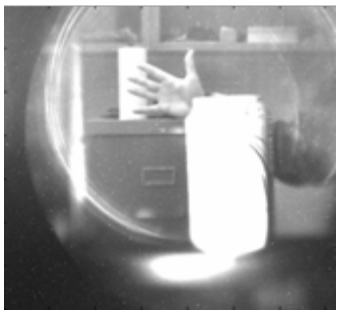


Combining subimages using three different neutral density filters can be used to improve dynamic range



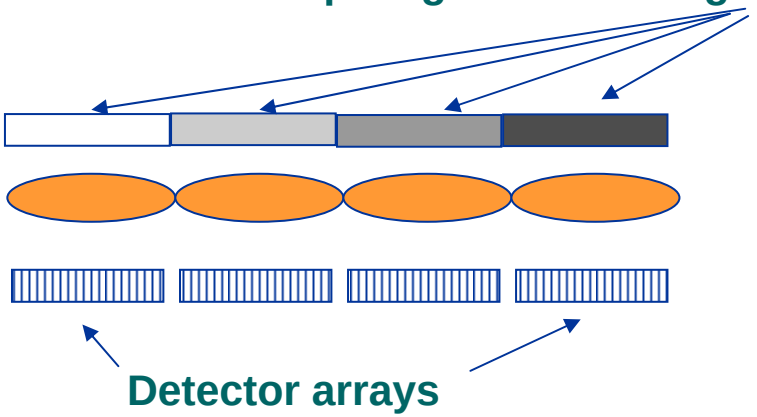






# Imaging of High Dynamic Range Scenes – Conventional vs. PERIODIC

## Simple light attenuating filters




- Place different neutral density filters in different ‘subimagers.’
- Capture image
- Perform image computation

Moderate exposure time needed to see details in mid-range

Long exposure time needed to see details in shadow regions

Some portions of scene underexposed

Rest of scene overexposed

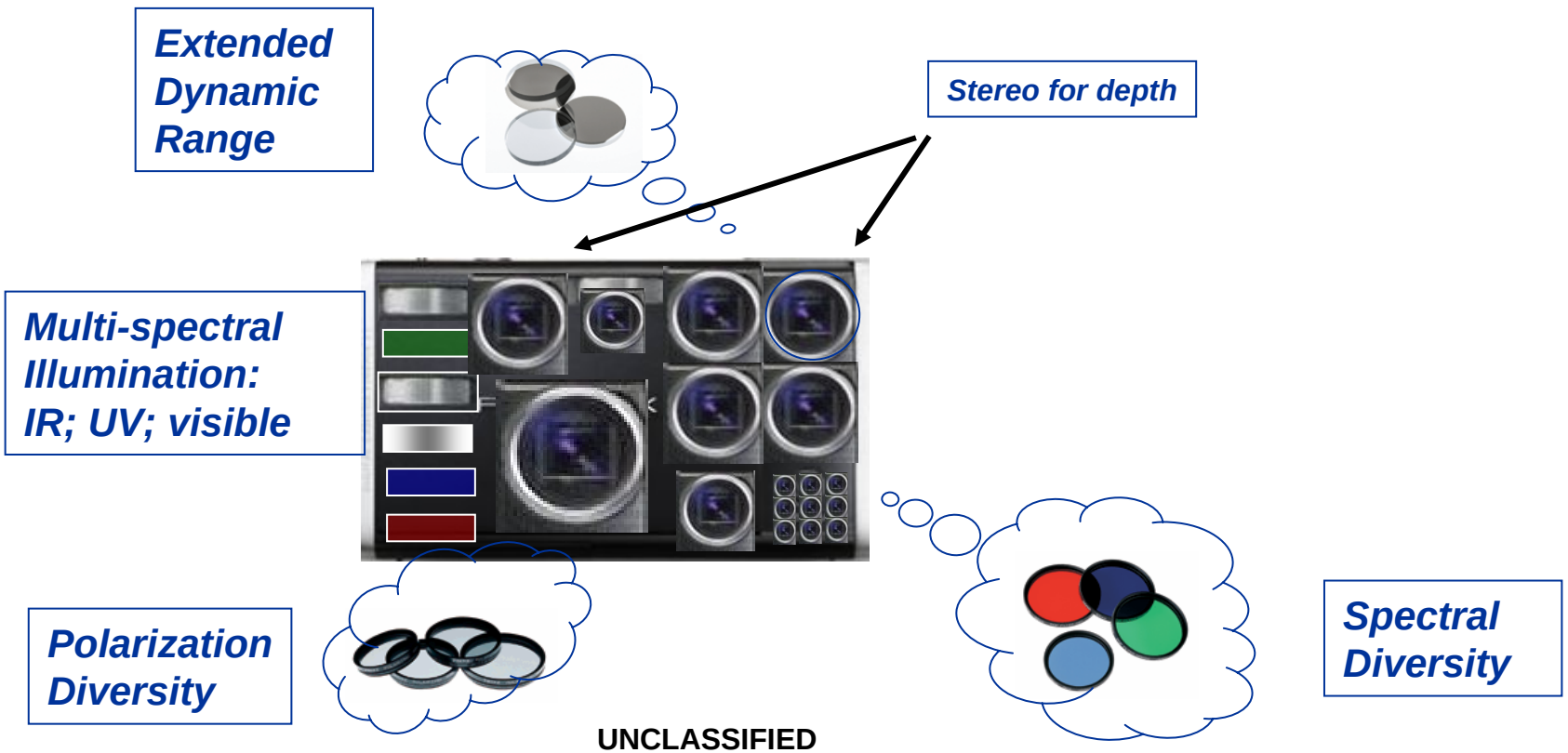
Short exposure time needed to see details in bright regions

Some portions of scene overexposed

Rest of scene underexposed

# Next Generation System CONOPS
# The "Swiss Army" Imaging System

- Multi-aperture architecture with *dynamic* diversity elements
- Multi-spectral, broad-band sensing (visible-LWIR)
- Multi-band illumination for chem-bio sensing
- Optimized Integration with post-processing and display
- Ultra-thin aspect ratio



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## *Bottom Line*

**Computational Imaging Systems =**

**Nanophotonics + Megapixels + Gigaflops + Form Factor + Power**

***Jointly designed and optimized***

**Mission Goal:**

**Purposeful, Semi to Fully Autonomous Sensing**

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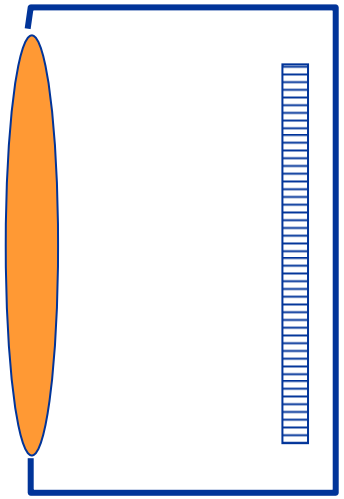
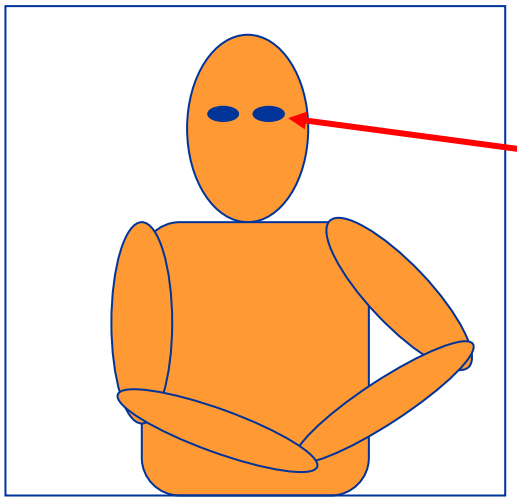
# *Thank you*

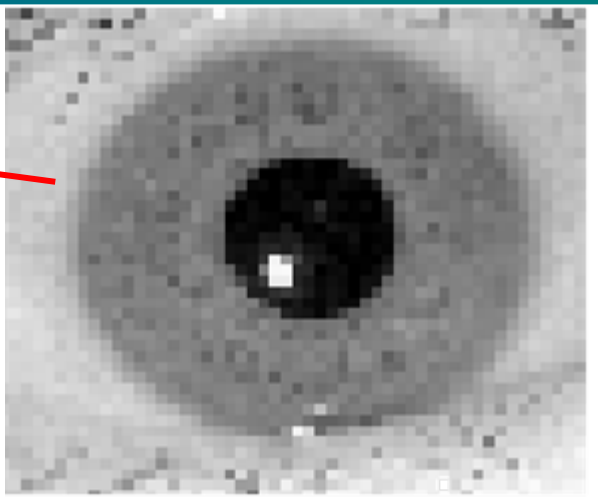
# BACKUP

# Form Factor Reduction

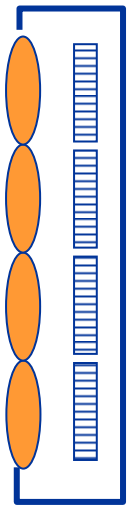
Standard system

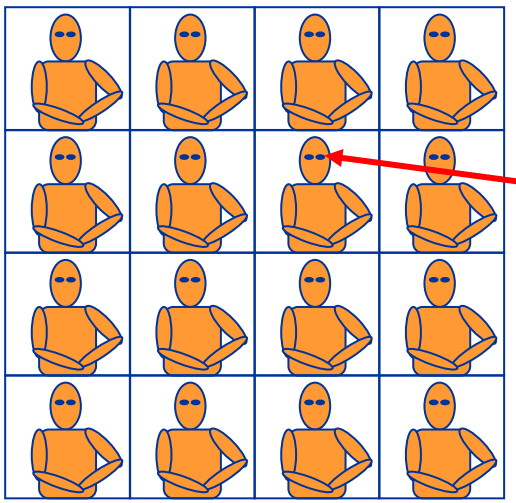


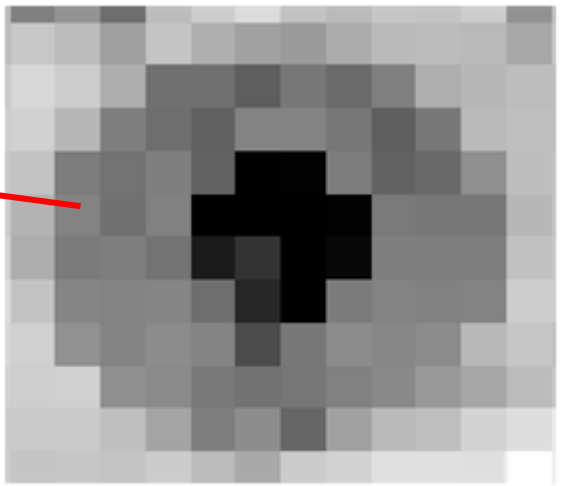




PERIODIC system







If the images are acquired such that they are shifted with respect to each other by subpixel amounts, the full resolution image can be restored subject to noise and other uncertainties.

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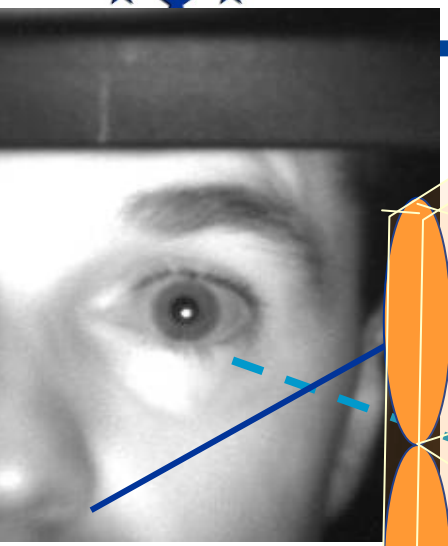
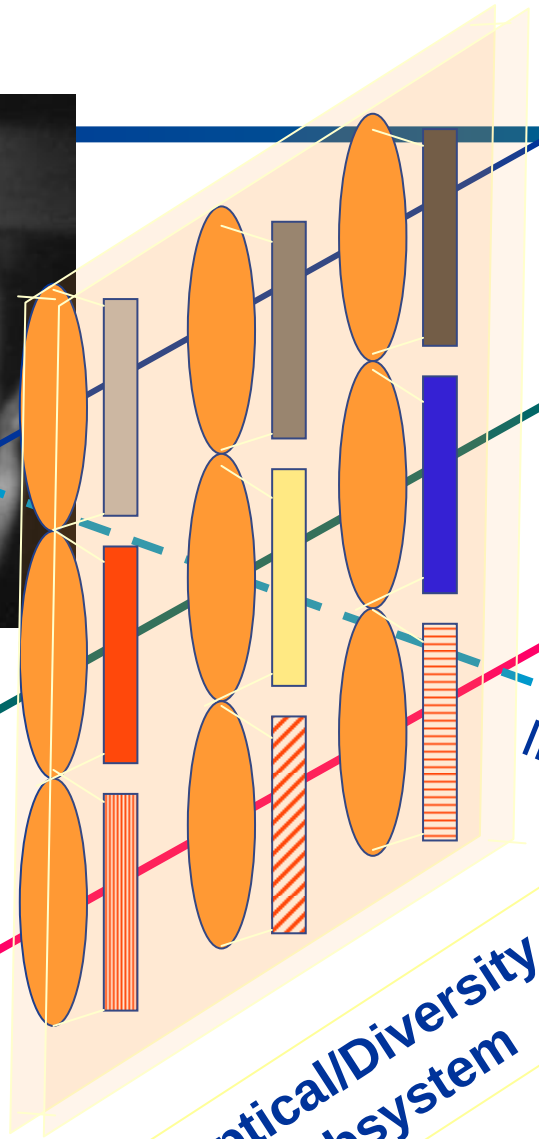
# Example of a 3 x 3 Array





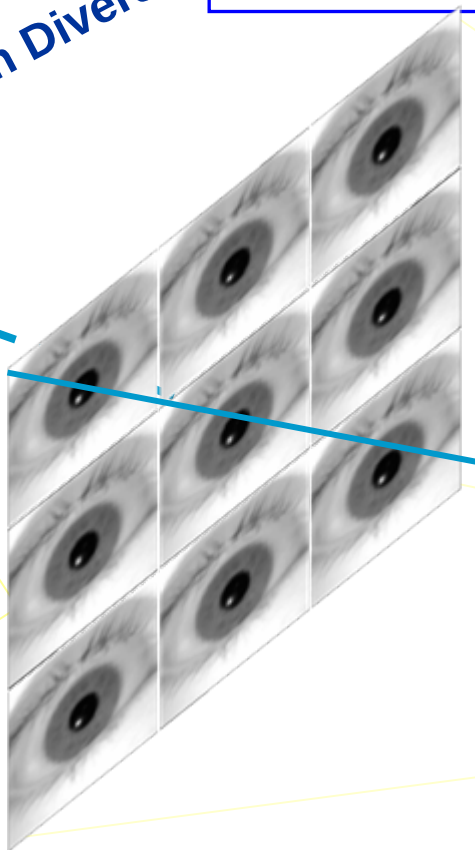
Dynamic Range Diversity

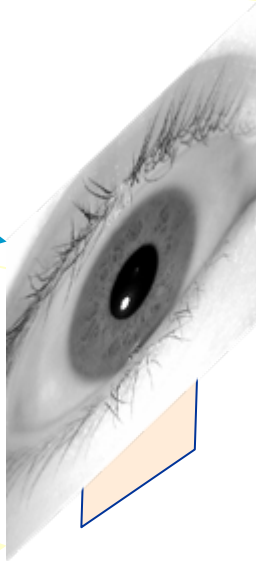
Wavelength Diversity

Polarization Diversity

Imaging Axis

3 x 3 LOW-DEF images post-processed into one or more HIGH-DEF image



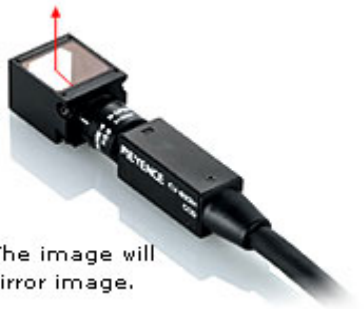


Optical/Diversity Subsystem

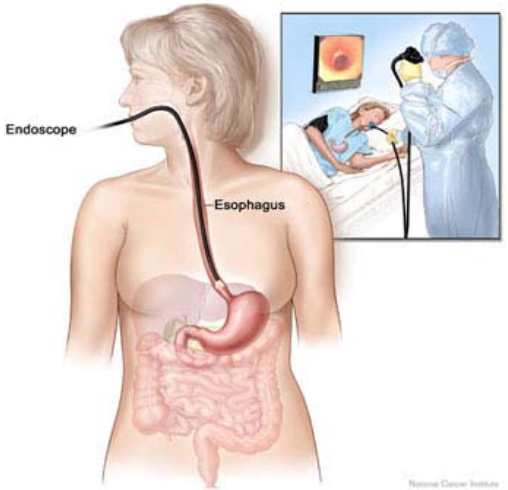
Sensor Array

# Digital Cameras….all shapes and forms!

## But they all operate the same way



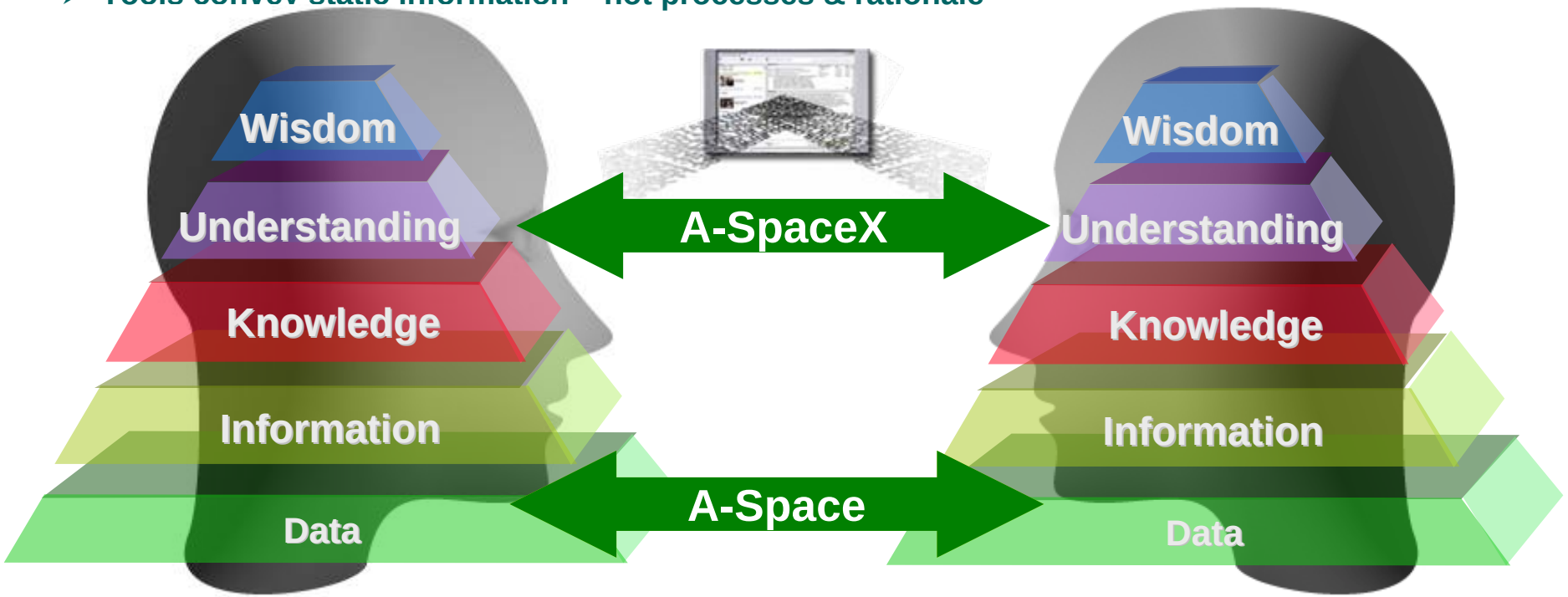
Note: The image will be a mirror image.



# MMP Collaborative, Multi-INT Systems

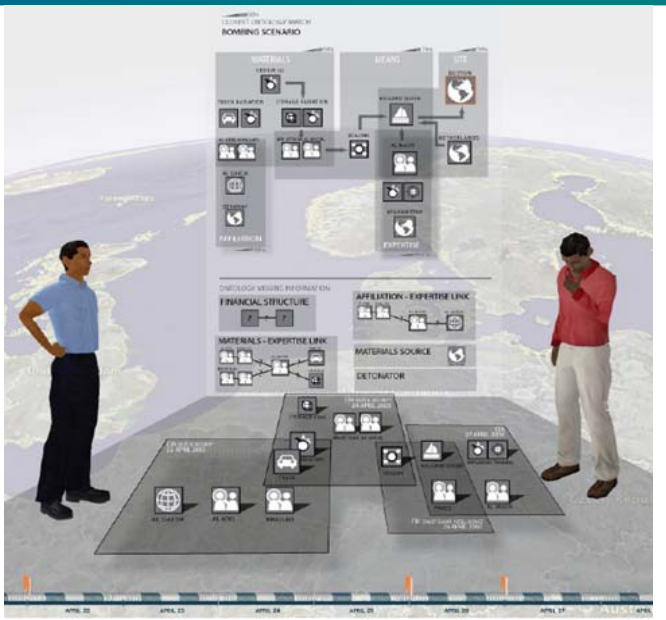
# Operational Problems

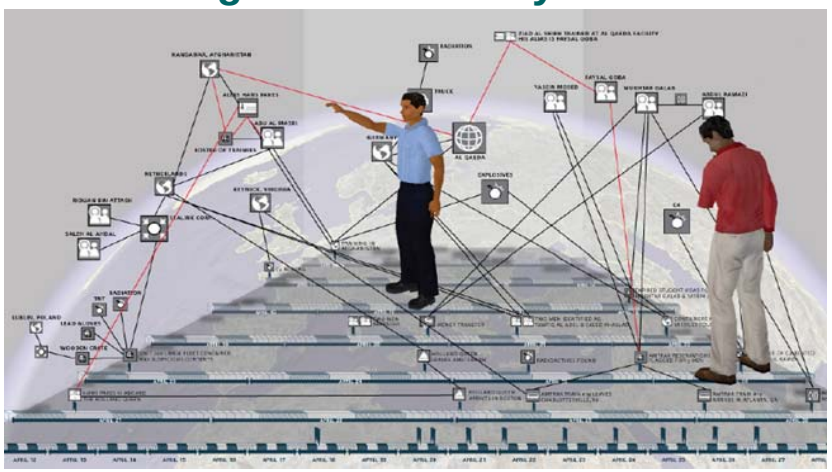
- Too much data – not enough information!
  - Multiple, poorly defined threats make it make it hard to know what is salient.
- Conventional visualizations do not readily support analytic processes
  - Decision making highly branched & iterative characteristic of analytic processes
  - Hypotheses abandoned today may be salient tomorrow
  - Context is key to framing and understanding the problem –
- Sharing is hard – Understanding is collective!
  - Sharing uncertainty is at odds with IC culture
  - Tools convev static information – not processes & rationale



# Opportunities

- Web-enabled Technologies
  - Modern & next generation browsers support advanced visualizations
  - Web technologies consistent with Services Oriented Architecture (SOA)
  - Multiple Visualizations readily derived from shared data sources
- MMRPG technology viable
  - Readily available
  - Next-generation analysts are comfortable





- Models maturing
  - Models as games,
  - Models as processes
  - Products inter-operable
- Agent Technologies & Automation
- IC is making major commitments to upgrade infrastructure. (A-Space)

***A-SpaceX has a unique opportunity to impact the future of the IC!***

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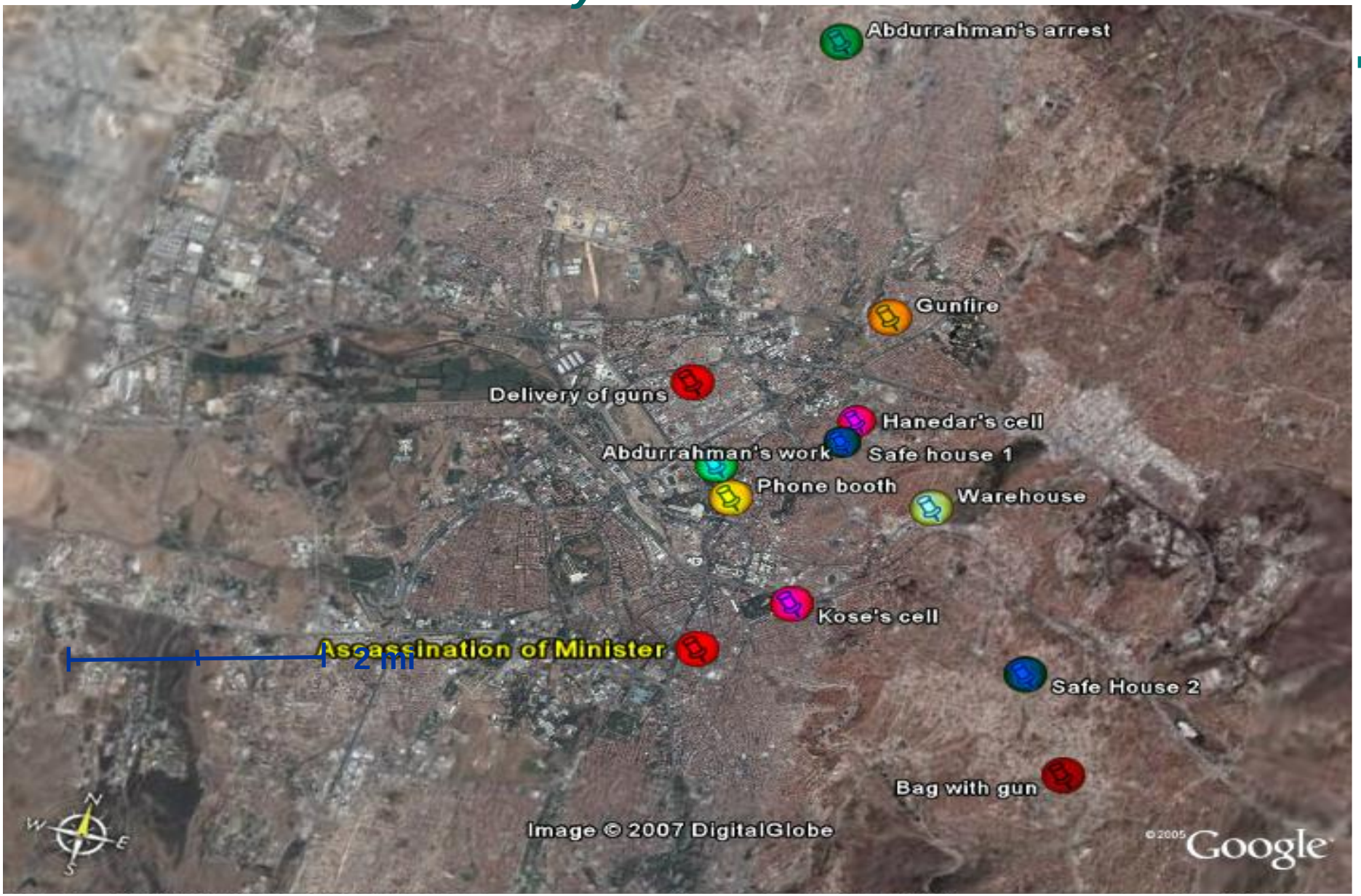
# *Example Environment*

# Geospatial Profiling for Counter-Terrorism

# Geospatial Profiling for Counter-Terrorism
## Case Study: Assassination of Turkish Minister



# Proactive Intelligence Analysis

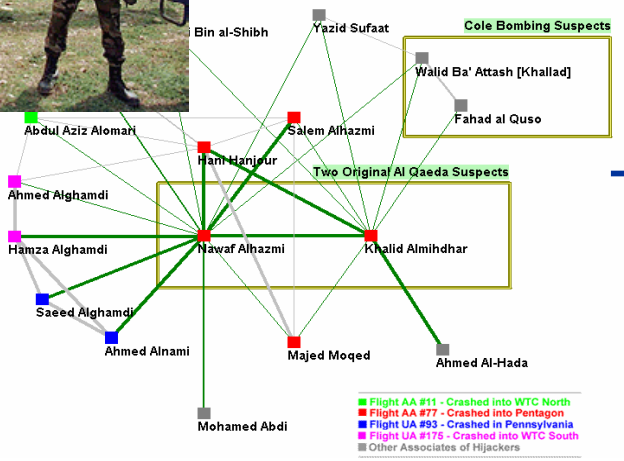
# *Why Proactive Intelligence (PAINT)?*

Cyber attack

Weeks to recover

Bioterrorism

Pandemic in days




Terrorism Attack

Disruptive Change

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# *Proactive is Essential*

## Smallpox attack exercise without proactive warning or plans has dire consequences

- Rotterdam port, world's 2nd largest, closes
- Polish citizens stream to Germany for scarce vaccine
- Debate on closing borders, quarantining cities, and limiting the movement of people
- World Health Organization lacks authority

ATLANTIC STORM

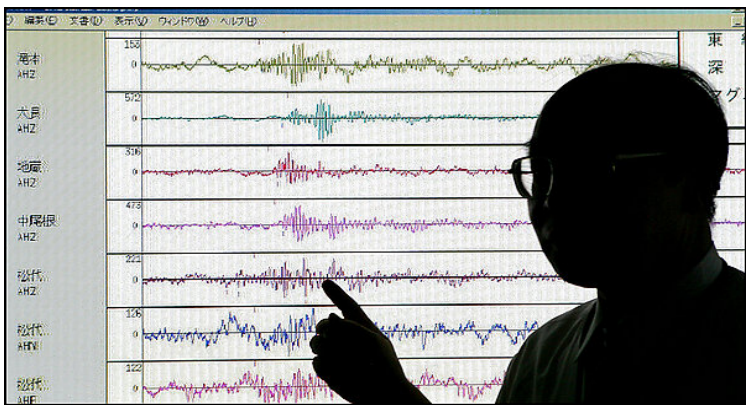
# PAINT's Approach

## ❑ Project Forward

Doomsday Clock moves closer to midnight by two minutes due to nuclear weapons programs in Iran and North Korea.

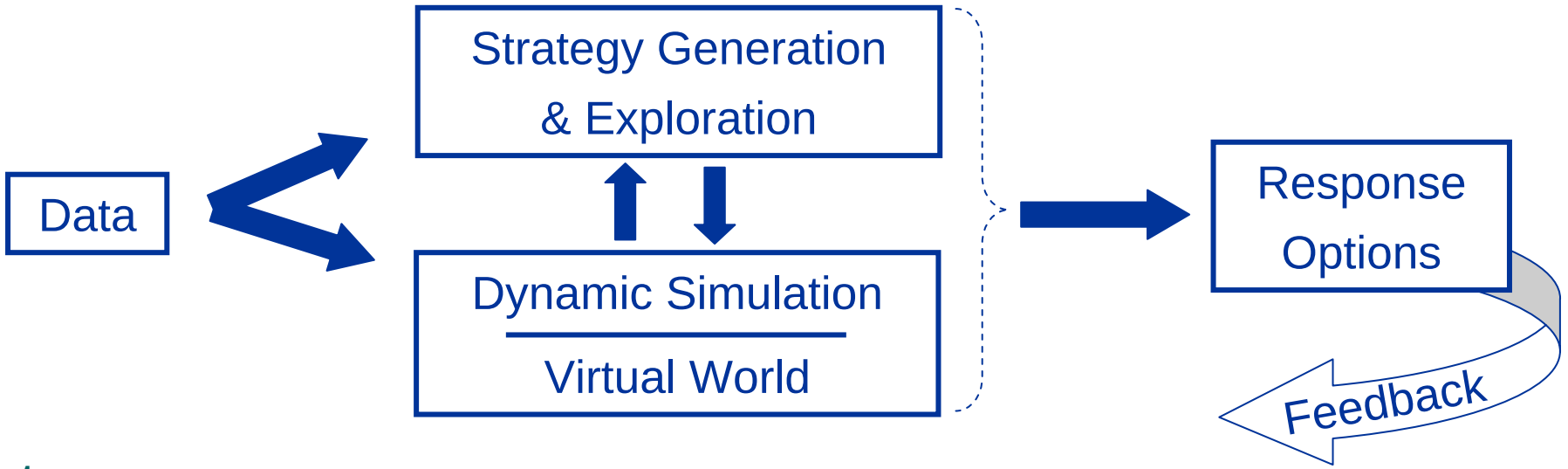
-February 25, 2007, Board of Directors of the *Bulletin of the Atomic Scientists*

- Explore strategies & identify response points



- Monitor test areas
- Disrupt supply chain
- UN trade ban re uranium enrichment
- UN diplomatic & economic incentives
- US financial sanctions

# What's New in PAINT's Approach?




**Near-term**

**Timely: Rapid ID of causal relationships in diverse data sets**

**Mid-term**

**Adaptive: Construct models to handle sparse & ambiguous data**

**Semi-autonomous: cultural, environmental & threat models formulated with "light touch"**

**Integrated: Strategy tests with dynamic simulations & virtual worlds**

**Goal**

***Project future threat developments and identify response options***

# Strategic Challenges in the Asia-Pacific Region

## *Three Waves of Five…&*

## *Some Trends Ahead*

LTG (Ret) Ed Smith
Director, APCSS

# With us now:

1.The attraction of terrorism to those disadvantaged and with little hope.

- An opportunity for identity; a means to act
- Enablers:
  - Socio-economic gaps
  - Transnational crime
  - Globalization (seamless internet effectiveness)

# With us now:

2. The limiting effect of corruption, particularly within governments, throughout the region and the world.

- Pervasive
- Enervating
- Tolerated, too often by many

# With us now:

3. Political polarization leading to extremist views…AND diminishing shared values.

- Interest→Identity→Values clashes
- Strategic alignments—major actors
  - PRC-Russian security cooperation
  - PRC-South Asian nations
  - Entire region positioning, given PRC economy
  - US presence, a security ctr-weight

# With us now:

4. Disrespect due to a lack of appreciation for cultural/racial/ethnic diversity.

- Rooted in intellectual, ethnic, racial, social, & psychological arrogance
- Fundamental to collaborative progress
- Ldr-to-ldr relationships “decide the day”

# With us now:

5. Extremes in educational opportunities.

- Deeds, not words
  - Availability
  - Quality
  - Access
- Why not main effort collaborative prioritization?

# With us now, or …on the horizon:

1. Extremes in human security due to the growing have and have-not gaps the world over.

- Demographic profiles identify possible security threats
- Socio-economic trends are key

# With us now, or …on the horizon:

2. Interruptions in information-technology networks that impact global security.

- Info-age absolute dependence on IT, especially in the economic and military dimensions.
- Are “degraded-mode” operations still an alternative?
  - F-22s
  - World financial systems

# With us now, or …on the horizon:

3. Environmental effects physically impacting large portions of the region/world due to unchecked global warming.

- Fact: global economic competition driving adverse environmental impacts
- Energy security gained using less environmentally threatening energy sources

# With us now, or …on the horizon:

4. Over-extension of multinational and multilateral forums intended to foster collaboration on security-cooperation opportunities.

- UN simultaneously in crisis & demand
- Many international orgs face calls for reform (UN, WTO,IMF)
- Shaping potential of Asia-Pacific forums...impacts?

# With us now, or …on the horizon:

5. Uncontrolled means of mass destruction and/or mass chaos.

- Unraveling global nonproliferation
- Nuclear wpns: security asset or liability?
- Shock event→Chaos, in info age
  - Dirty bomb, or atk on nuclear reactor
  - Low-tech tactics also show potential

# With us now, or on the horizon, … but translucent

1. Conflict over scarce and valuable resources and/or disputed territory believed to contain such resources.

- For example, potable water in South Asia…or anywhere else

# With us now, or on the horizon, … but translucent

2. Balancing country X's demand for increased power and influence and the willingness of other major actors to accommodate this.

- PRC
- India
- Smaller countries on the rise (Vietnam)

# With us now, or on the horizon, … but translucent

3. Mutating pandemic disease among humans.

- "One in ten chance of human-to-human transmission in next ten yrs."
- World health orgs not as confident
  - Not "if" but "when"
- What type, where, by whom, & how much prep is enough?

# With us now, or on the horizon, … but translucent

4. Understanding, and managing, reactions to the perceived threat of information globalization to cultural identity.

- Pursued “inside out”
- Grounded in promise, not fear
- Transforming from power to coerce to power to aid

# With us now, or on the horizon, … but translucent

5. Leaders without a vision that serves the common good…the harder right.

- How do we develop ldrs with such vision?

# So What?

- If these are trends, how do we influence and shape them, to advantage?  Or, mitigate those we cannot shape?

A couple final thoughts…

# Final Thoughts

- Security challenges have always been complex, but perhaps the nature of the complexity today is shifting
- Ways (problem analysis), toward solutions, require “centering” highly dynamic, diverse knowledge/people relationships and their impacts on organizational potential
- Means must be adapted to applications in very different social & cultural frameworks
- Ends sought → conditions v. endstates

# KNOWLEDGE DISCOVERY

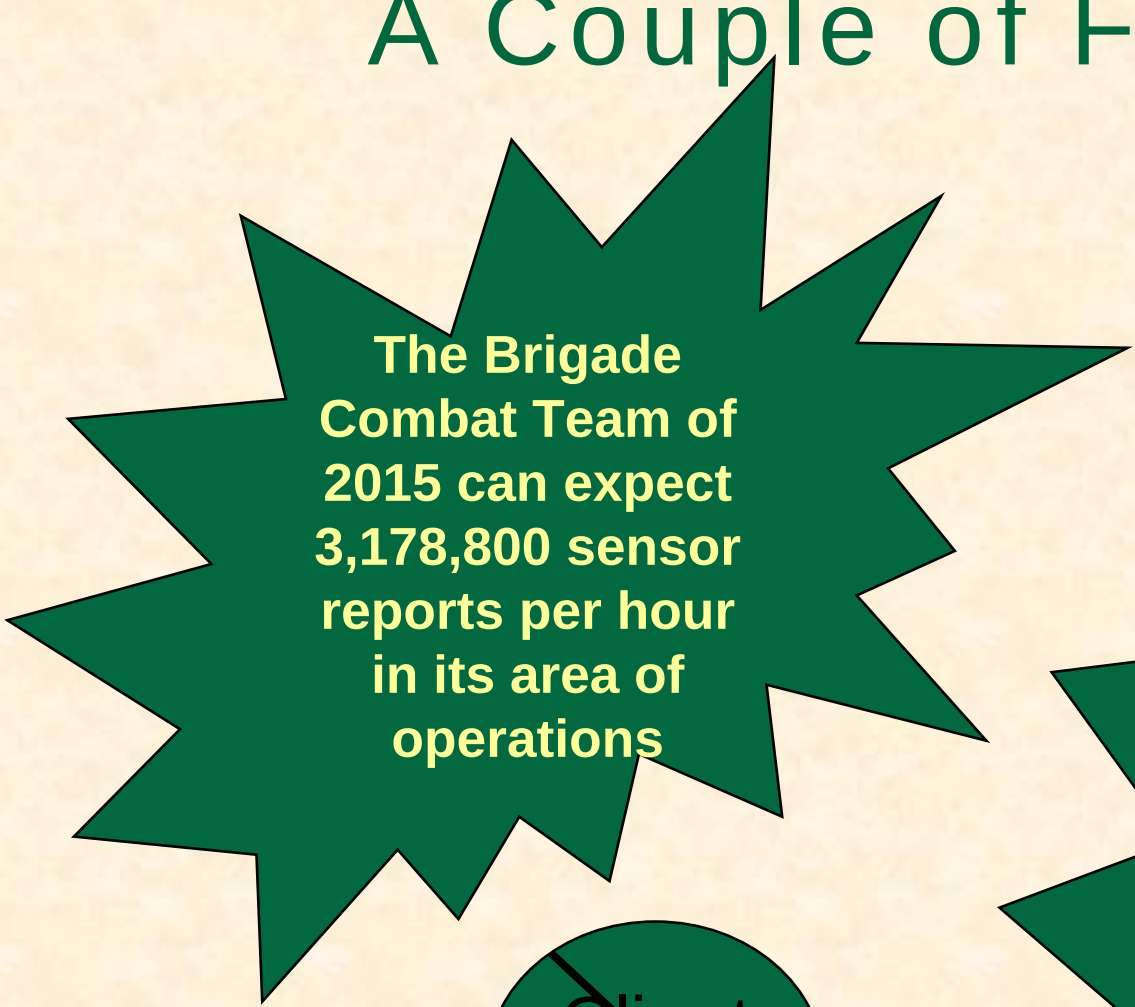
## From Situational Awareness to Bomb Damage Assessment

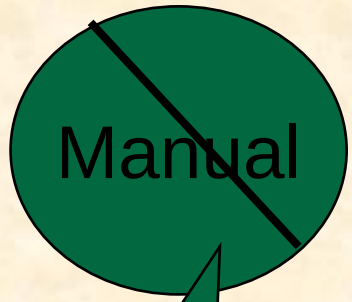
LTG (Ret) George A. Fisher
Oak Ridge National Laboratory

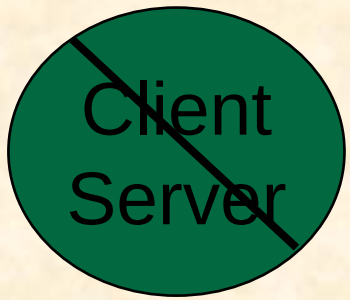
**“Connecting the Dots”**

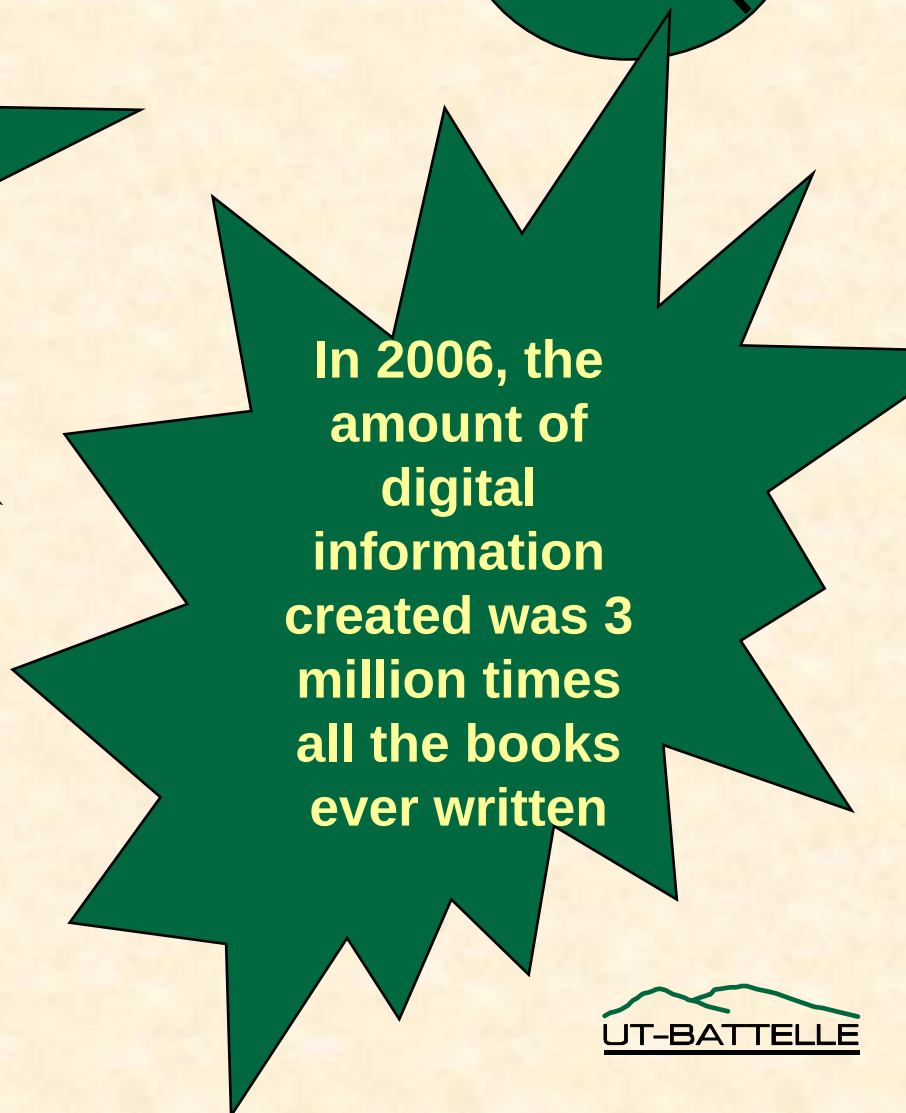
**“All I’m saying is, now is the time to develop the technology to deflect an asteroid.”**

# A Couple of Facts

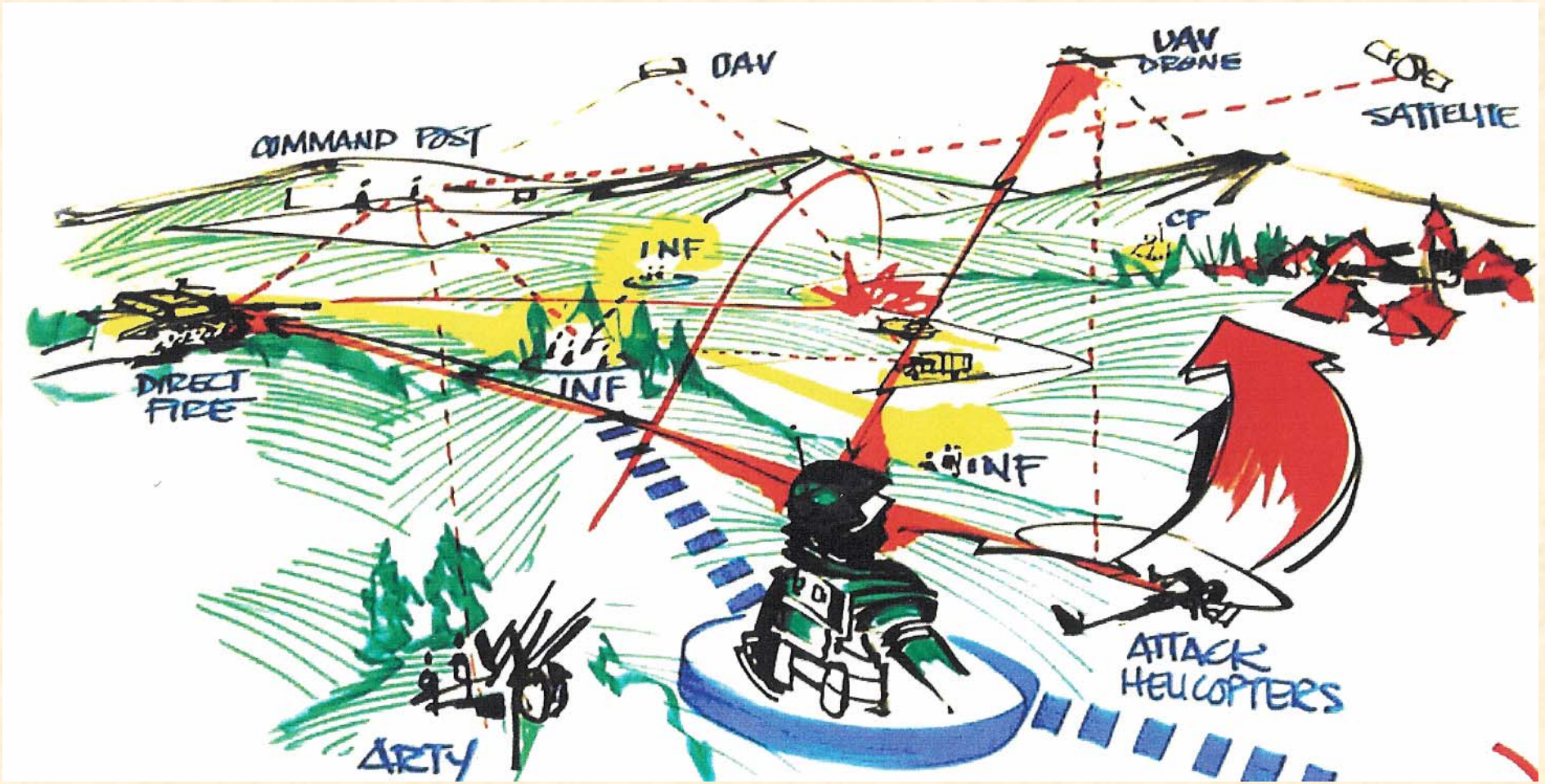


# THE 2020 War Fighter




**"Know what the Network Knows"**

# Challenge – What to do with this?

- **What is in there?**
- **Are there any threats?**
- **What am I missing?**

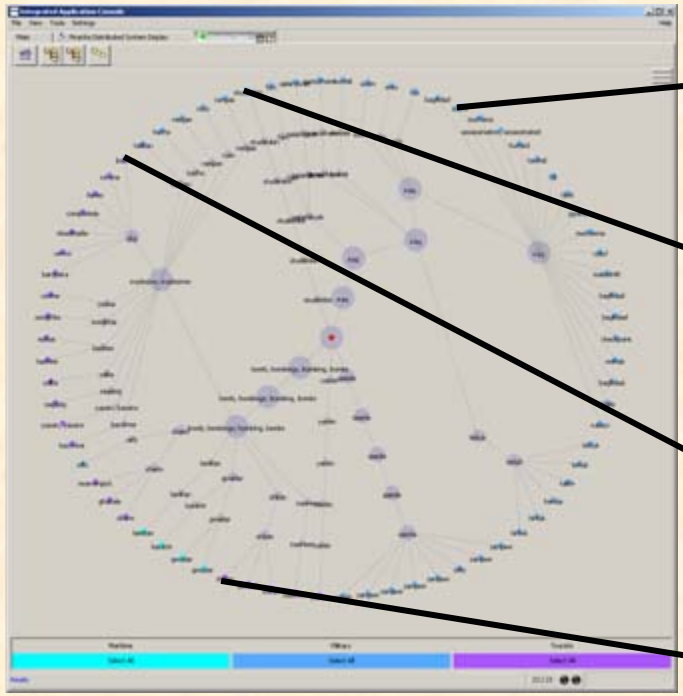
# Connecting the Dots

**Raw Documents**

**Organize the Information**

- Iraq
- Nuclear materials
- Chemical Weapons
- Threats
- Potential Targets
- Money Laundering
- Training Camps

**Connect the Information**



**Find the Threats**

**Take Action**

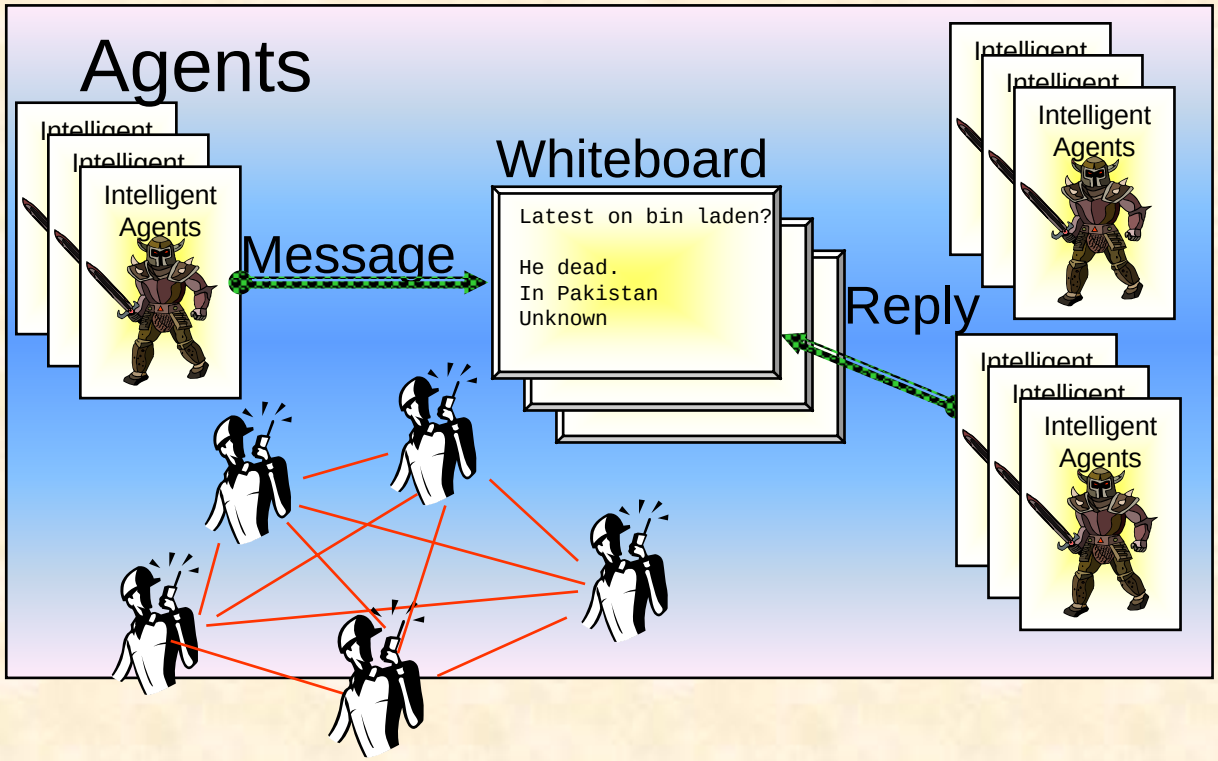
**What do we have?**

**What are the connections?**

**What are they planning?**

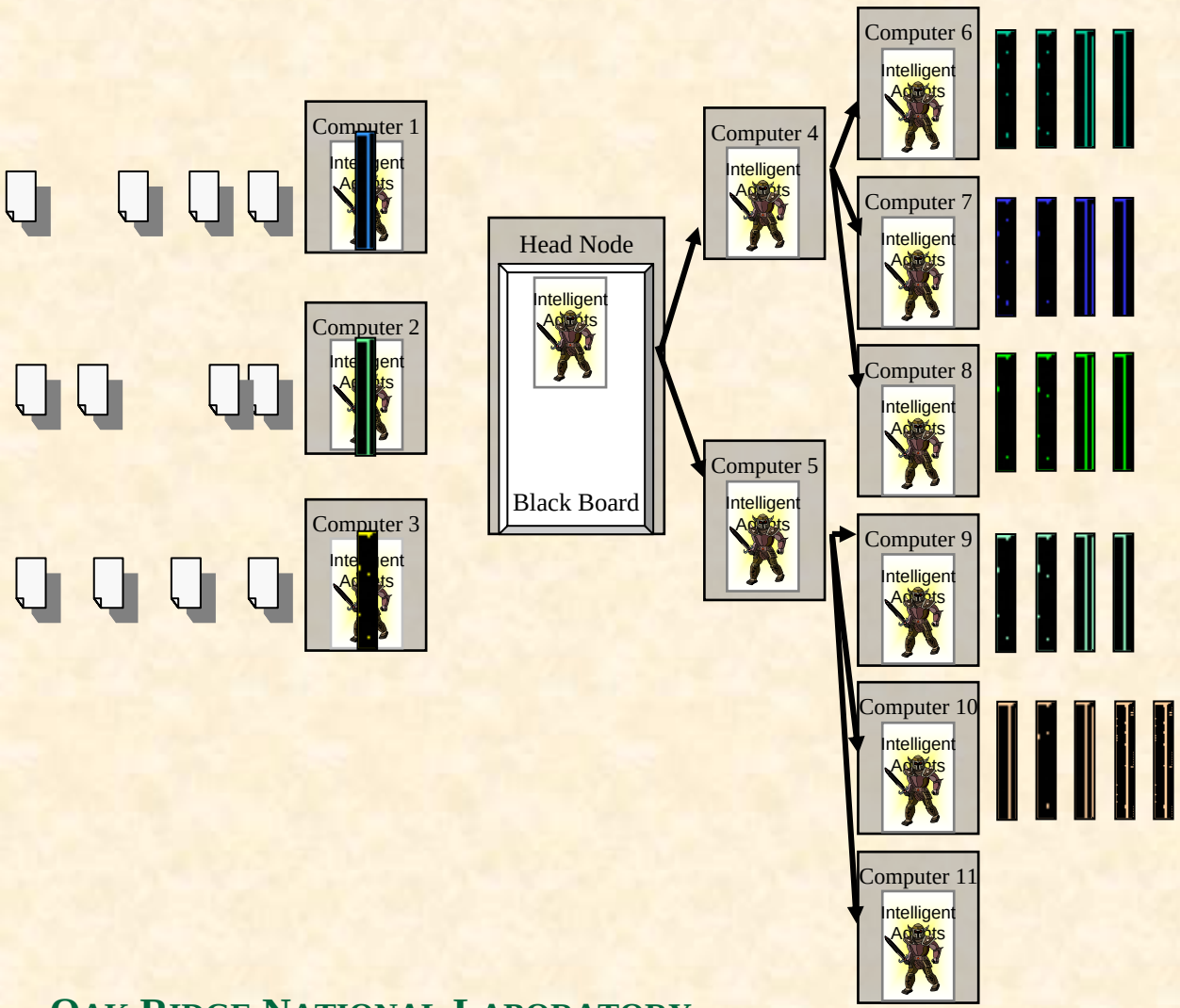
**How credible is the threat?**

# Intelligent Software




- **Intelligent Agents**
  - **Software processes**
  - **Can communicate in unstable environments**
  - **Form teams to solve problems**
  - **Live, die, and reproduce to solve problems**

# Agent Approach




- **Standard Approach**

  **11.5 Days**

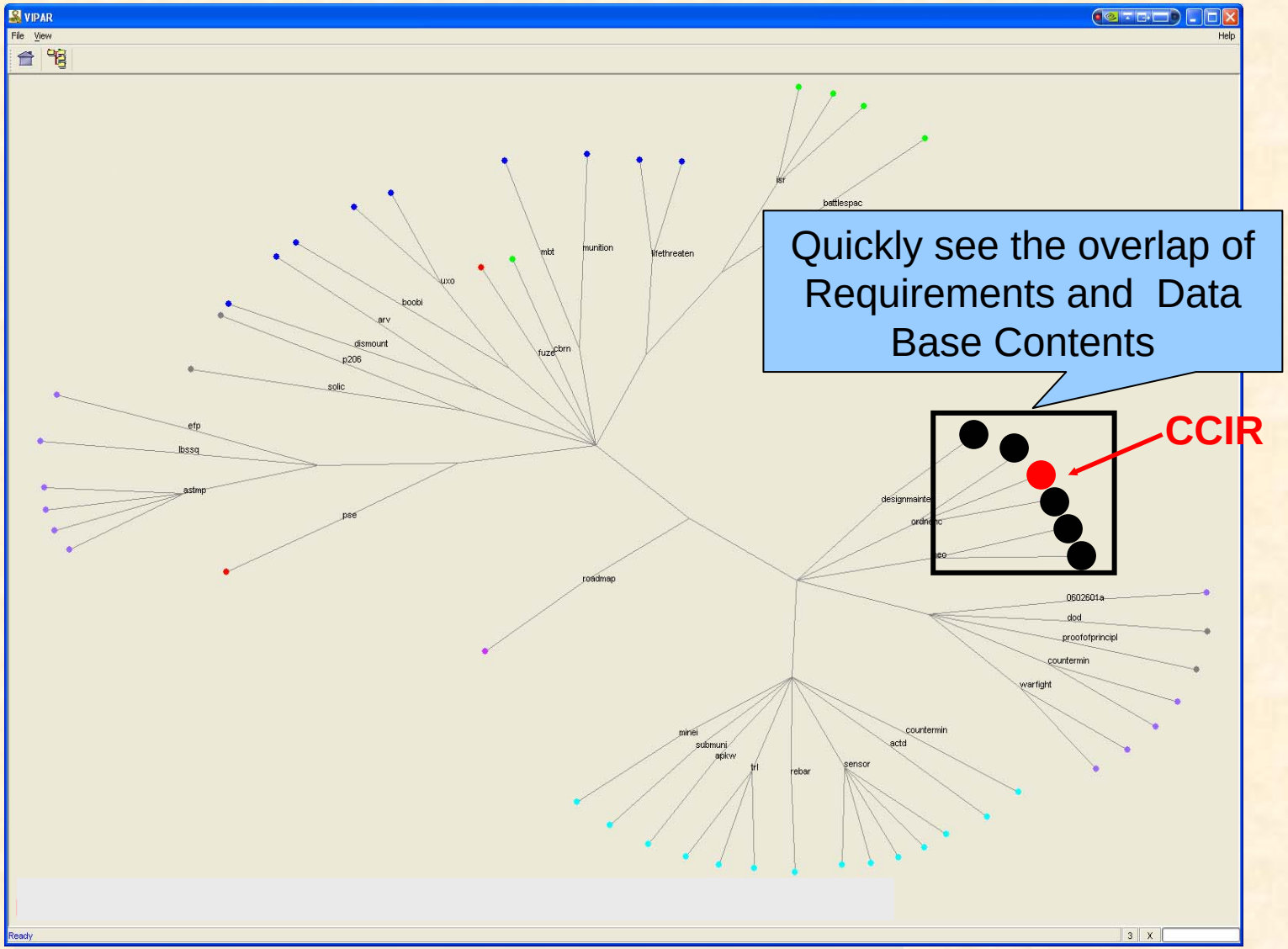
- **Agent approach**

  **8 minutes 24 Seconds!**

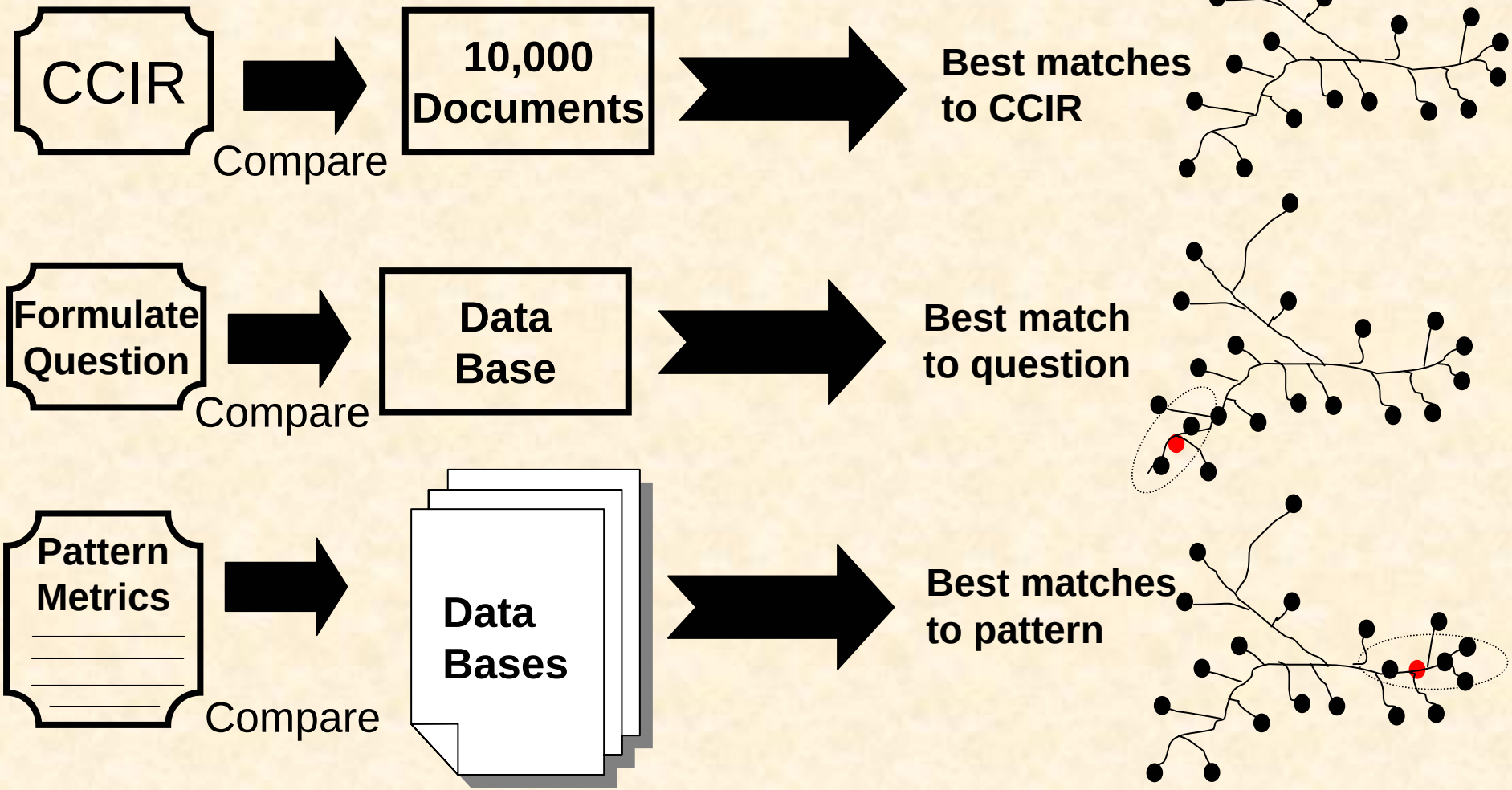
  **2000 times faster**

  **With no loss of accuracy**

# Results

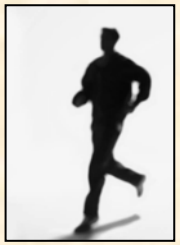

VIPAR
File View
Help
isr
battlespac
mbt
munition
lifethreaten
uxo
boobi
arv
dismount
p206
solic
cbrn
fuze
efp
lbssq
astmp
pse
roadmap
designmainte
ordnanc
eo
0602601a
dod
proofofprincipl
countermin
warfight
countermin
actd
sensor
rebar
trl
apkw
submuni
minei
Ready
Quickly see the overlap of Requirements and Data Base Contents
CCIR

# Software Agent Applications



# Next Step: Adding DNA to Agents

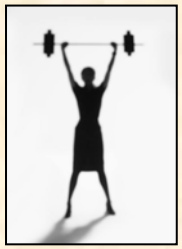
Endurance



Speed

Agility

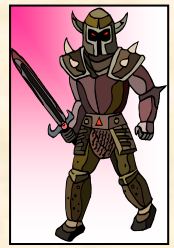
Strength



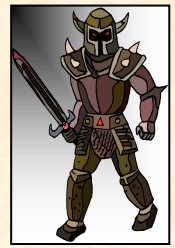
Group

Method

Target



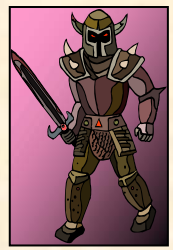
Location



Speed/Strength

Group/Method

Target/Location



Group/Method/Target/Location

# Connecting the Dots

**Threats**

**6 Indonesians Barred From U.S.**
Current and Former Military Officers Pl
*By* *Slevin*
Wa ters
Fri
The
dozen current
officers, includ
on a watch list
barring them from entering the United States, according to U.S. government officials.

**US naturalized citizen indicted for hiding**

**Cold war leaves a deadly anthrax legacy**

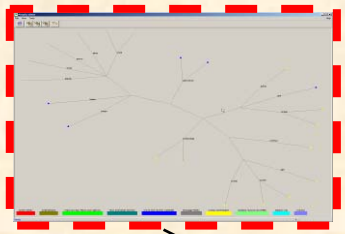
**Miller**

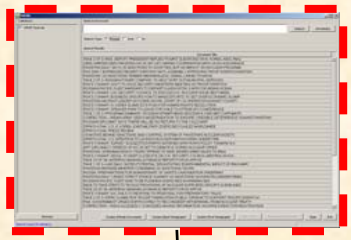
VOZROZHDENIYA ISLAND, Uzbekistan -- In the spring of 1988, germ scientists 850 miles east of Moscow were ordered to undertake their most critical mission.

**Agents**

**OSCAR High Performance Computer Cluster**

**Analysis**





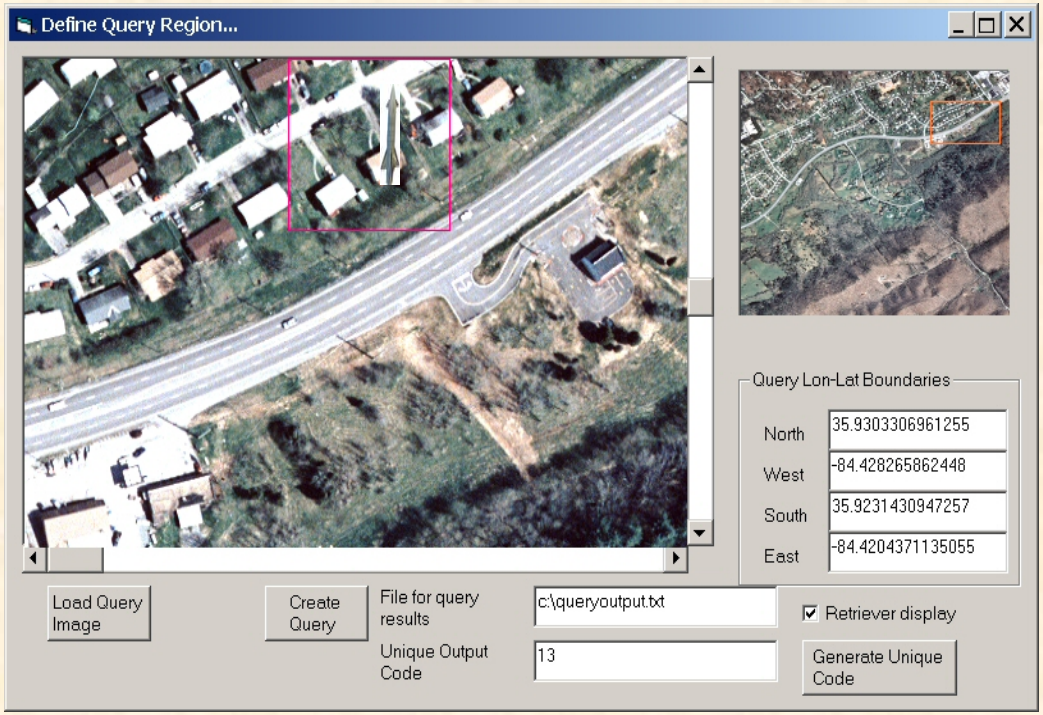
**Decision**

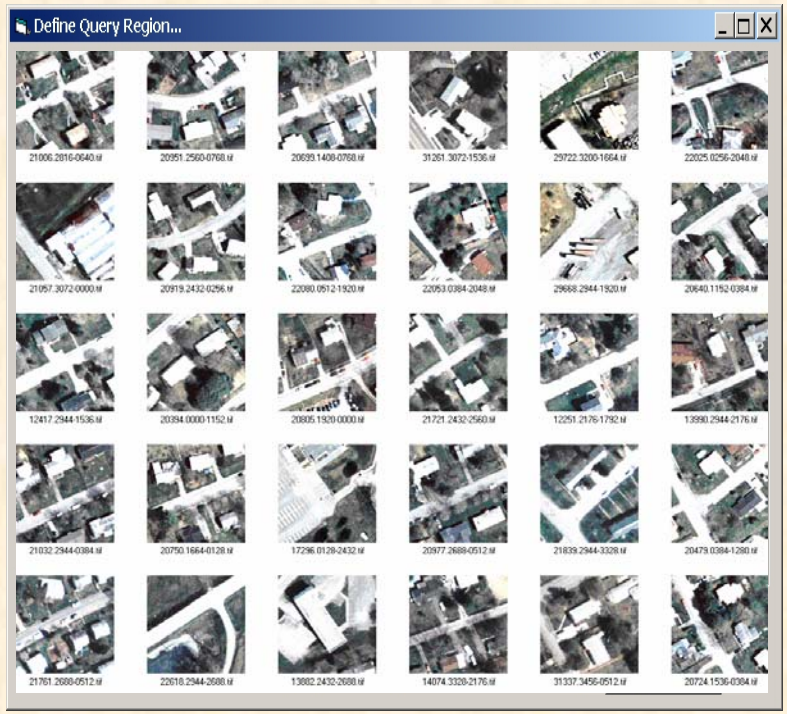
**Synthesizing and Disseminating Information**

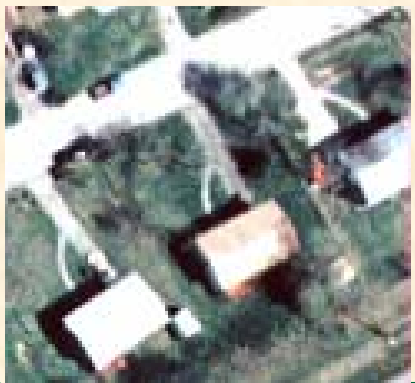
# Screen Satellite Photos at Machine Speed

- **Is your image repository up-to-date and accurate?**
- **How can you search through thousands of images in seconds?**
- **How can you comprehensively search based on:**
  - **Longitude and Latitude**
  - **Box on a map**
  - **Time**
  - **"Just like this one"**

# Find “Just like this one…”



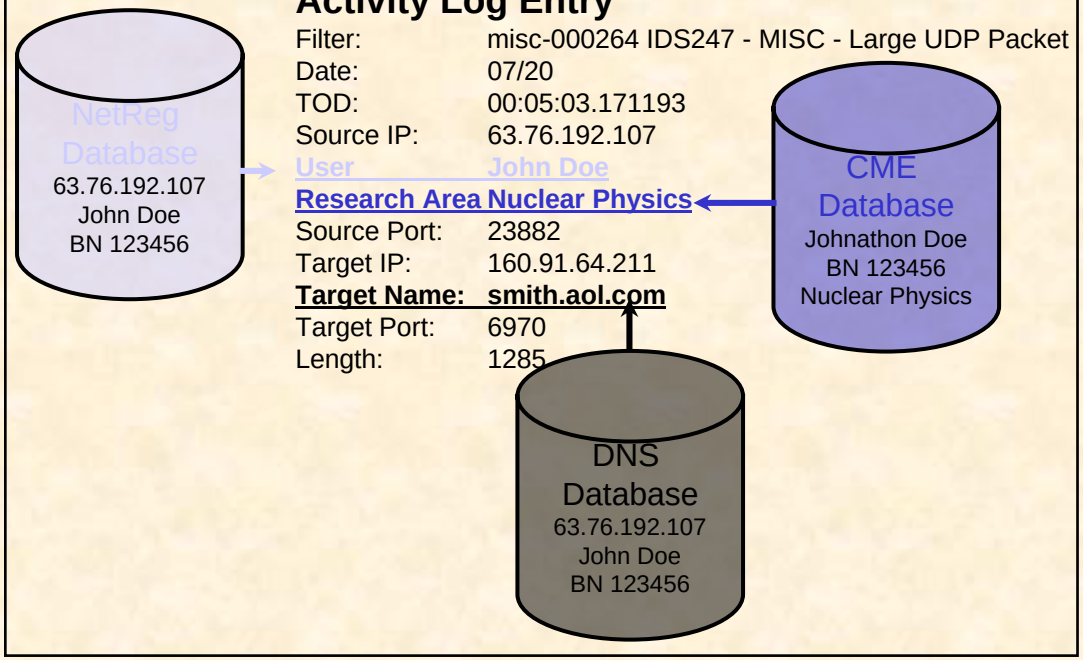



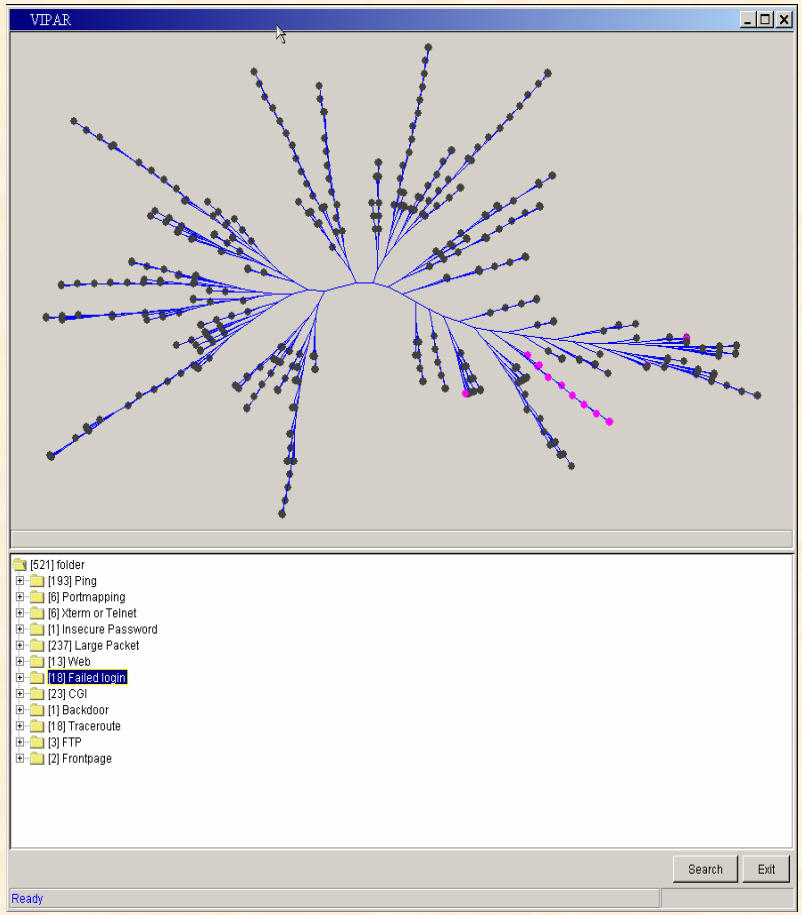
Where is the missile ?

# Cyber Security

## Relate Sensitive Research to IP addresses

- **1,000,000 suspicious records daily**
- **Critical Decisions**
  - **Is someone trying to hack into the system?**
  - **Are attack from "script kiddies" or state sponsored?**
  - **What are they going after and why?**

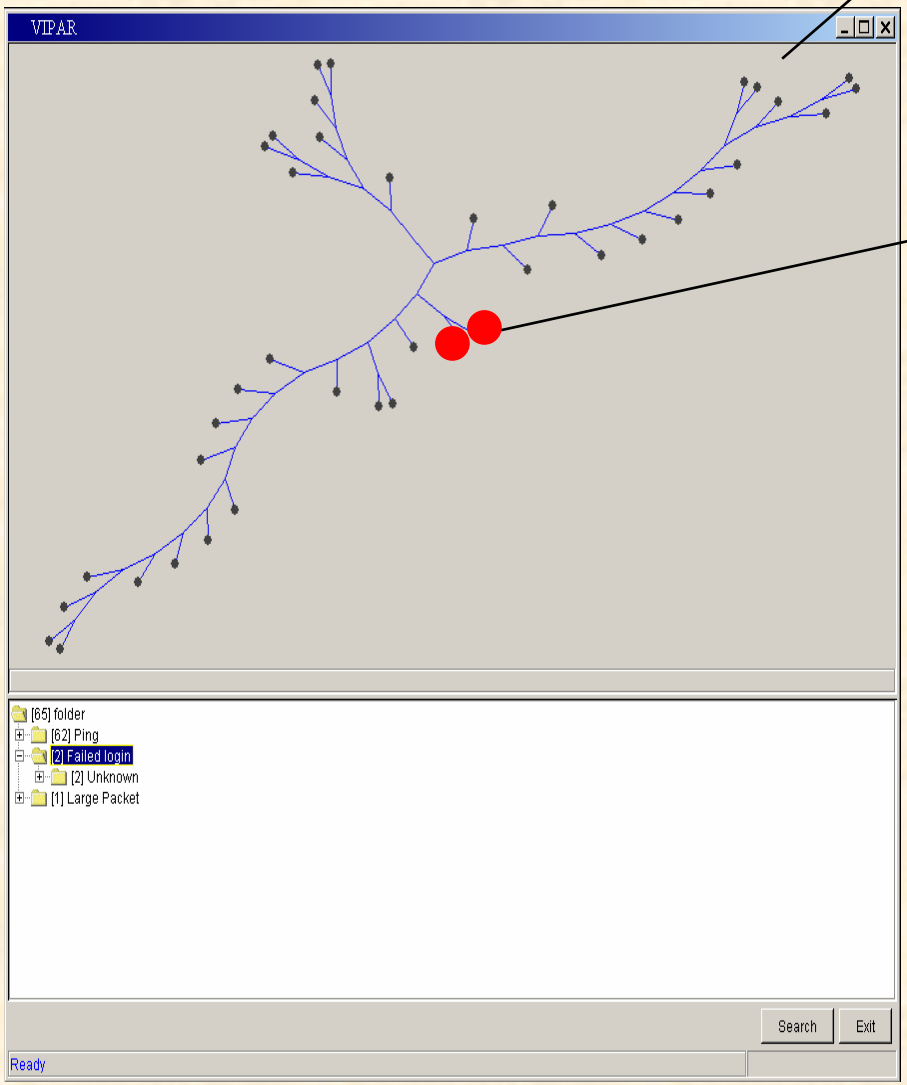


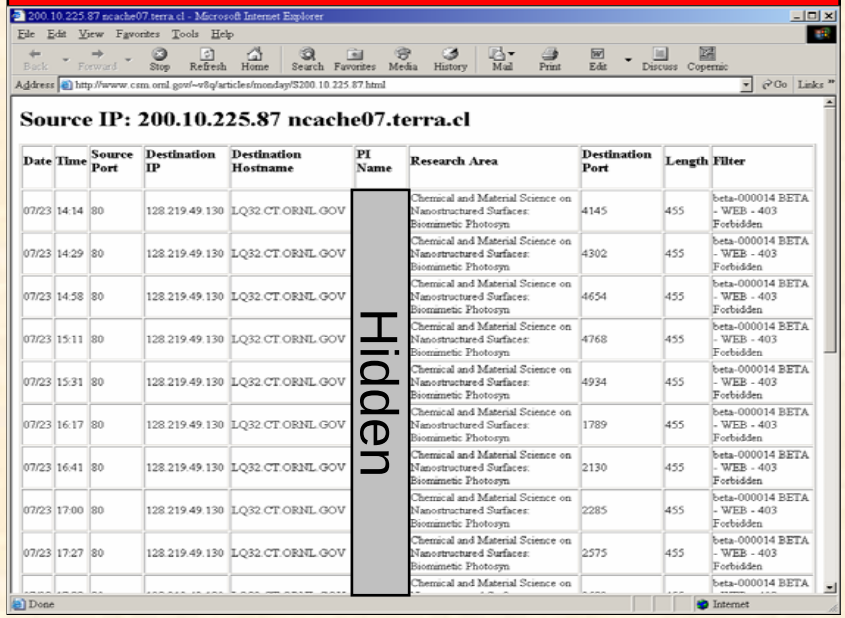
# Caught in 30 Minutes!

**45 "low and slow" pings from:**

- **Country X**
- **Country Y**
- **Country Z**




**2 attacks on nanotechnology scientists**

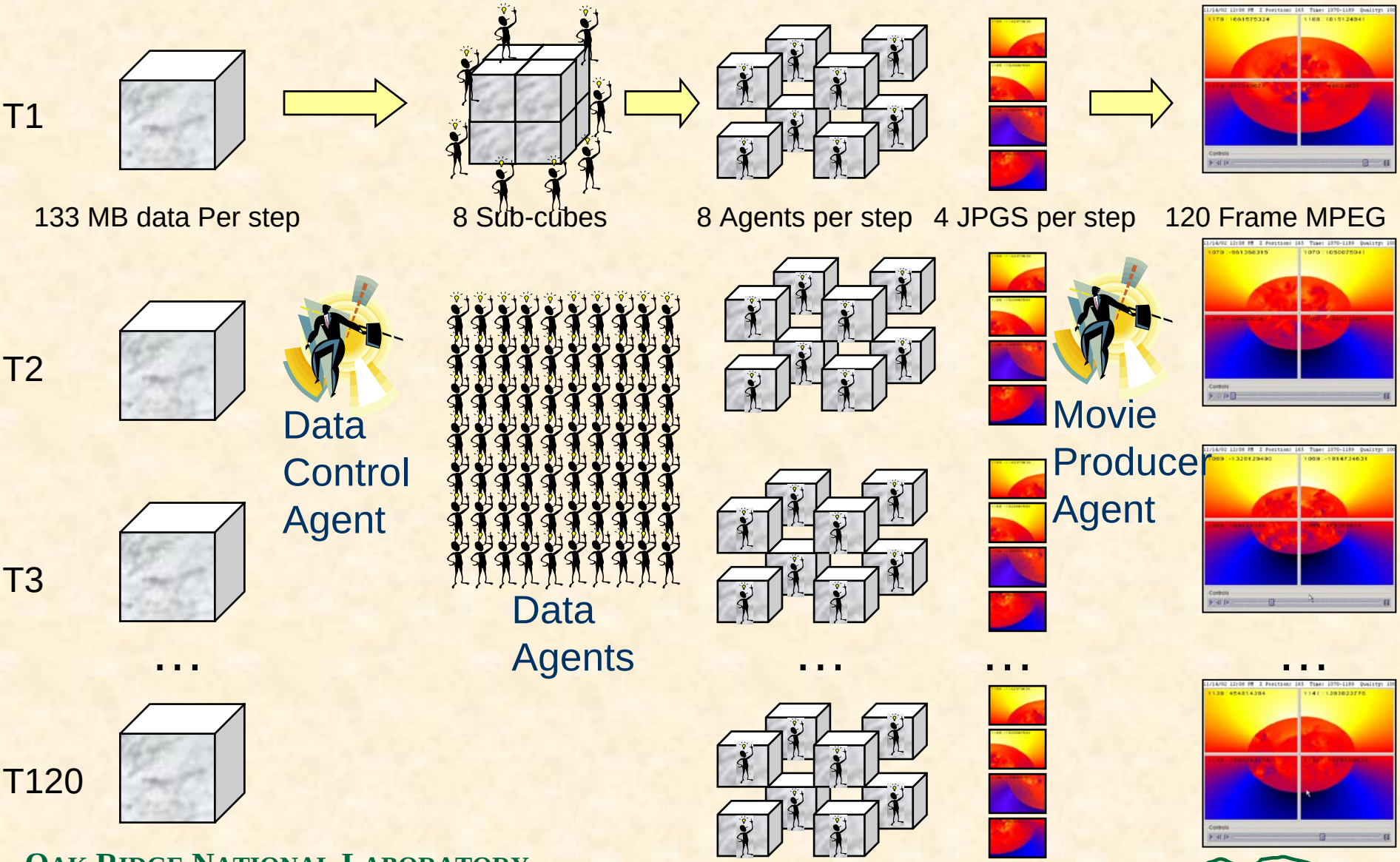



Patent Pending

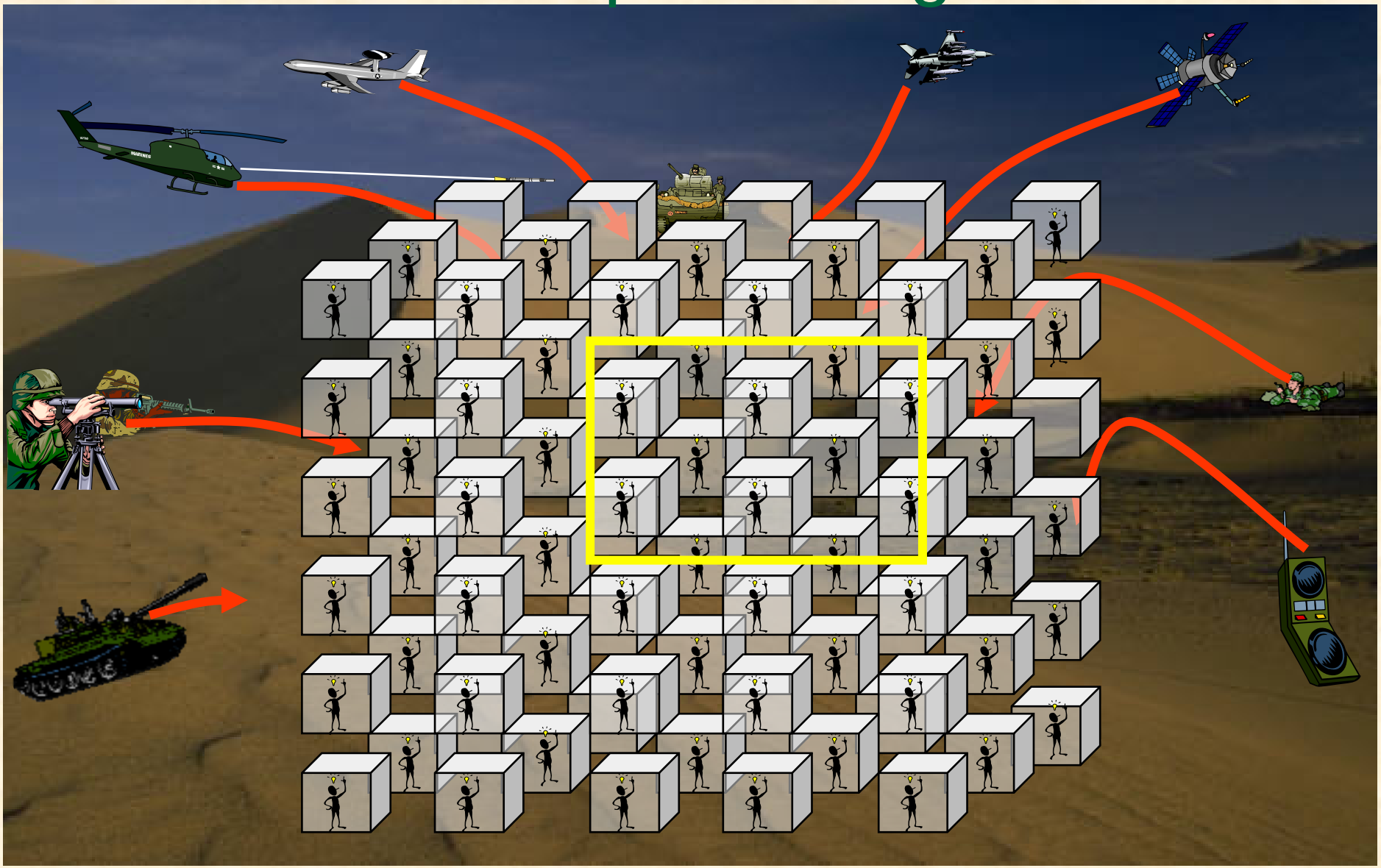
# Agent Example "Pictures from Data"

- 1 Terabyte of streaming astrophysics data
- 1000 agents analyzing
  - 120 time steps of 300x300x300 matrix for 5 variables
  - 33 million units density in 194 files
- Each time step governed by an oversight agent which redraws picture with most recent information

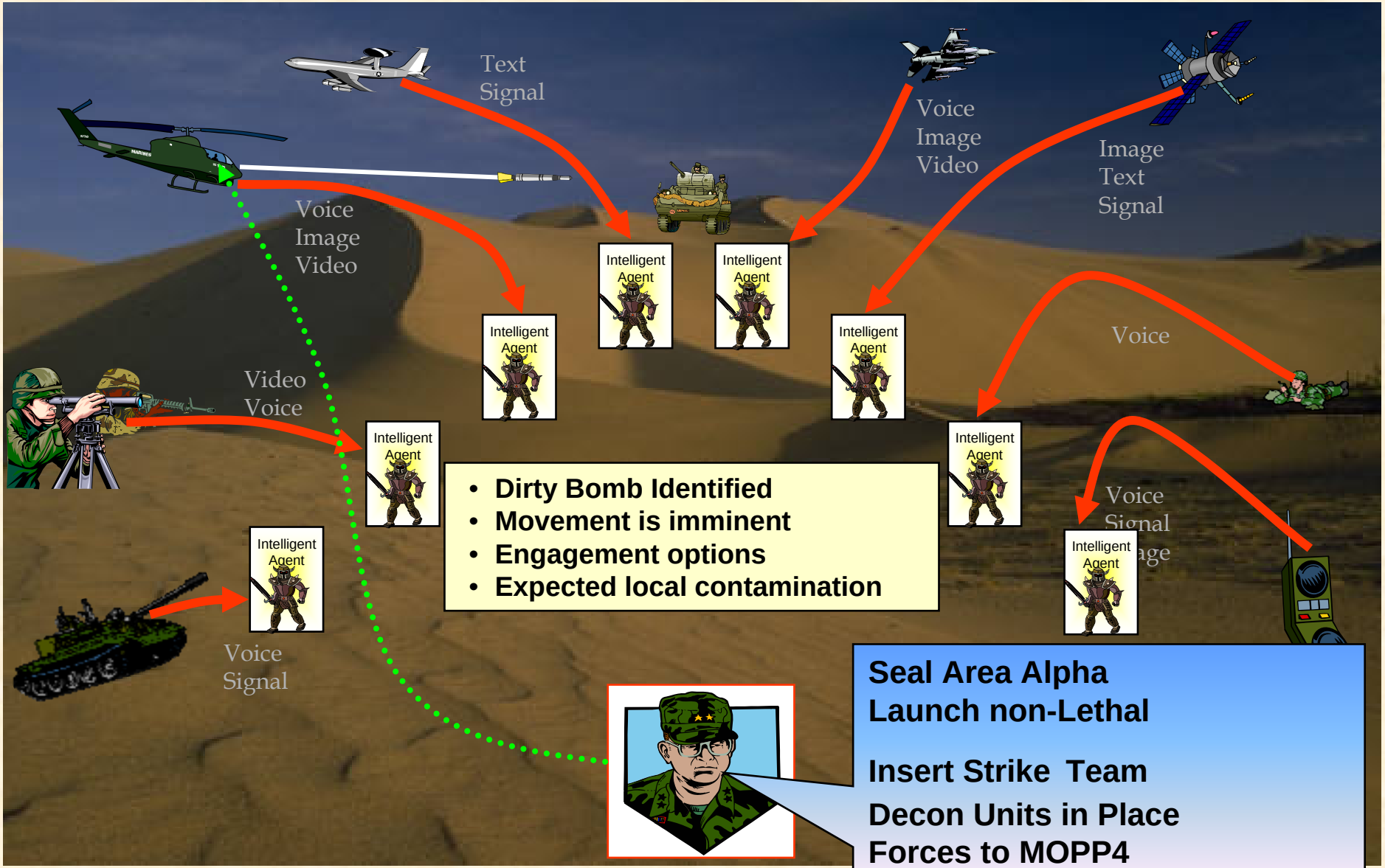
# Astrophysics Common Operational Picture



# Common Operating Picture



# Future Battlespace – Forward Analysis

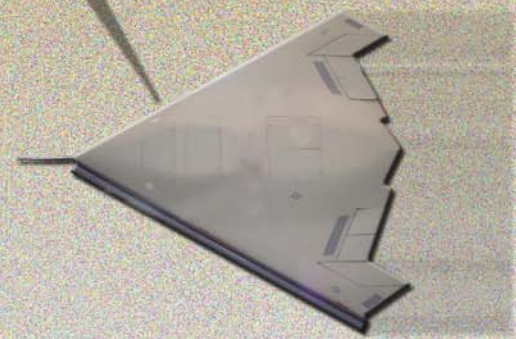


# Knowledge Discovery

## "The Art of the Possible"

**Info Transmitted**

- Engine (MTBF)
- Transmission (MTBF)
- Weapon System (MTBF)
- Ammo
- Fuel

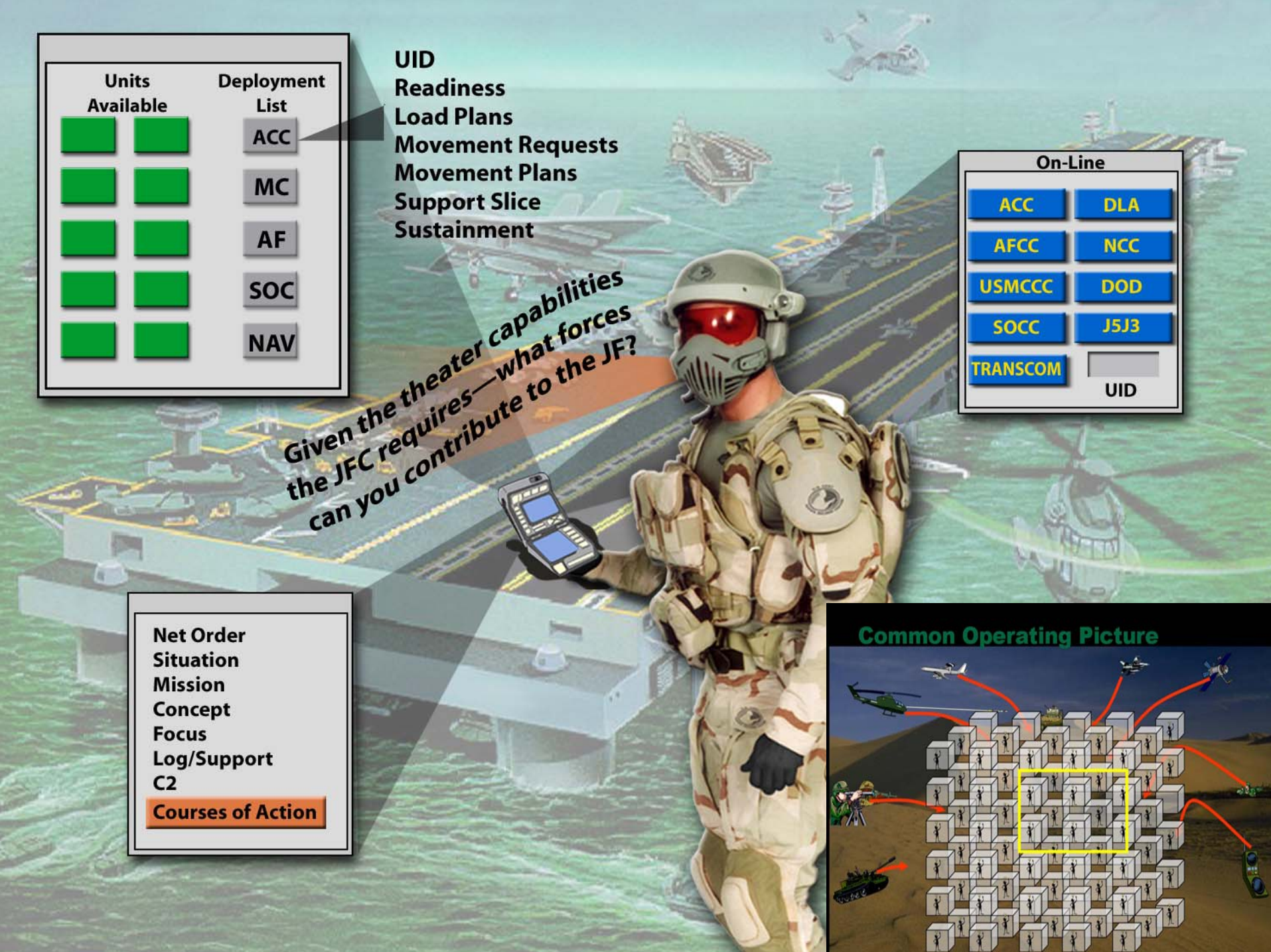


**END ITEMS**

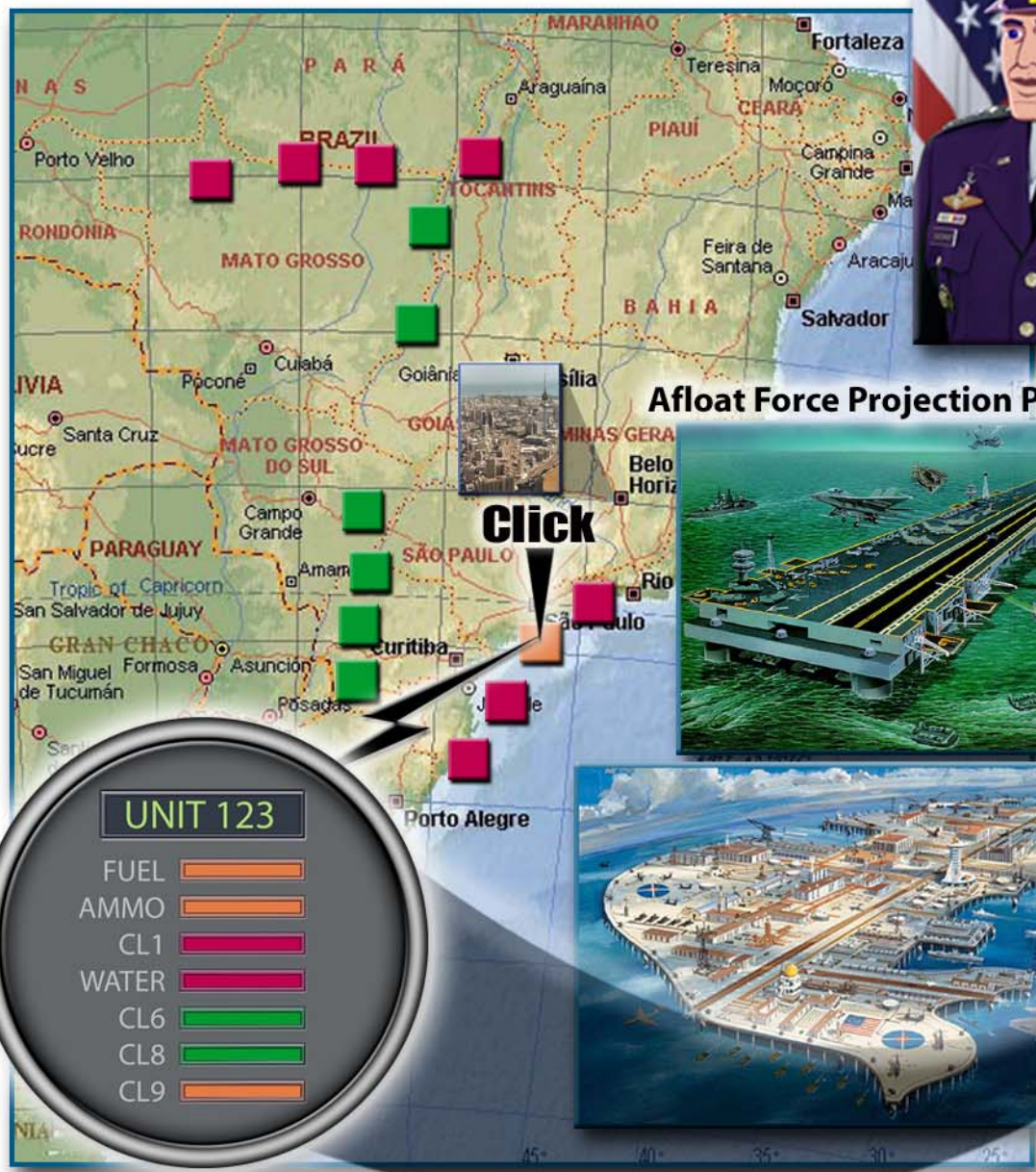
Fixed Wing Attack
Fixed Wing Non-Attack
UAV (Attack)
UAV (Intel)
Ground Support Equipment

**Sqdn Cdr**

Warning Order at 1200 Z
UNITED STATES TRANSPORTATION COMMAND
U.S. AIR FORCE
On-Line
DEPARTMENT OF THE NAVY
UNITED STATES MARINE CORPS
DEFENSE LOGISTICS AGENCY
UNITED STATES COAST GUARD 1790
UNITED STATES MARINE CORPS
AIR FORCE SPECIAL OPERATIONS COMMAND
DEPARTMENT OF THE ARMY
1775
UNITED STATES OF AMERICA
DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA
JFC J3


Units Available
Deployment List
ACC
MC
AF
SOC
NAV
UID
Readiness
Load Plans
Movement Requests
Movement Plans
Support Slice
Sustainment
On-Line
ACC
DLA
AFCC
NCC
USMCCC
DOD
SOCC
J5J3
TRANSCOM
UID
Given the theater capabilities the JFC requires—what forces can you contribute to the JF?
Net Order
Situation
Mission
Concept
Focus
Log/Support
C2
Courses of Action
Common Operating Picture

# Day 5: Combat Power



# Path to Success

- **Vision the Capability**
- **Articulate the Development Path and Priority**
- **Leverage the niche Centers of Excellence**

Knowledge Discovery 2020
Know all that can be known
Apply the Power of the Force
“The Force Is Always With You”

# Solutions to Current Challenges: FY07-FY09

Major General Ted Bowlds

4 April 2007

# AFRL Vision

## Air Force S&T Vision

**Anticipate, Find, Fix, Track, Target, Engage, Assess, Anything, Anywhere, Anytime**

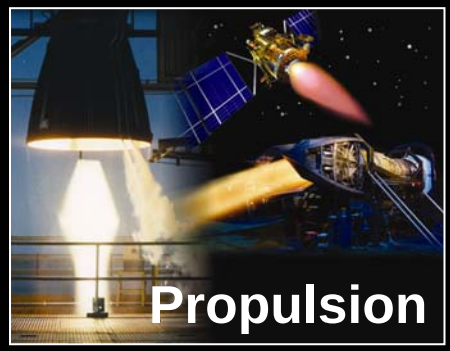
## AFMC Vision

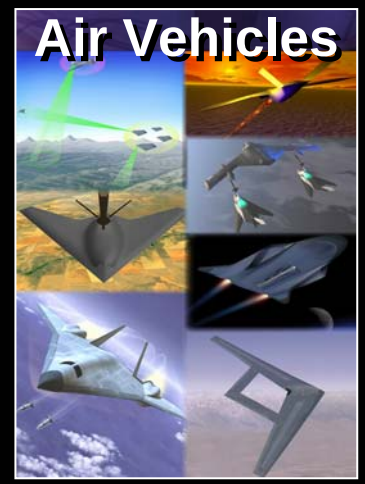
**War-winning Capabilities… On Time, On Cost**

## AFRL Vision

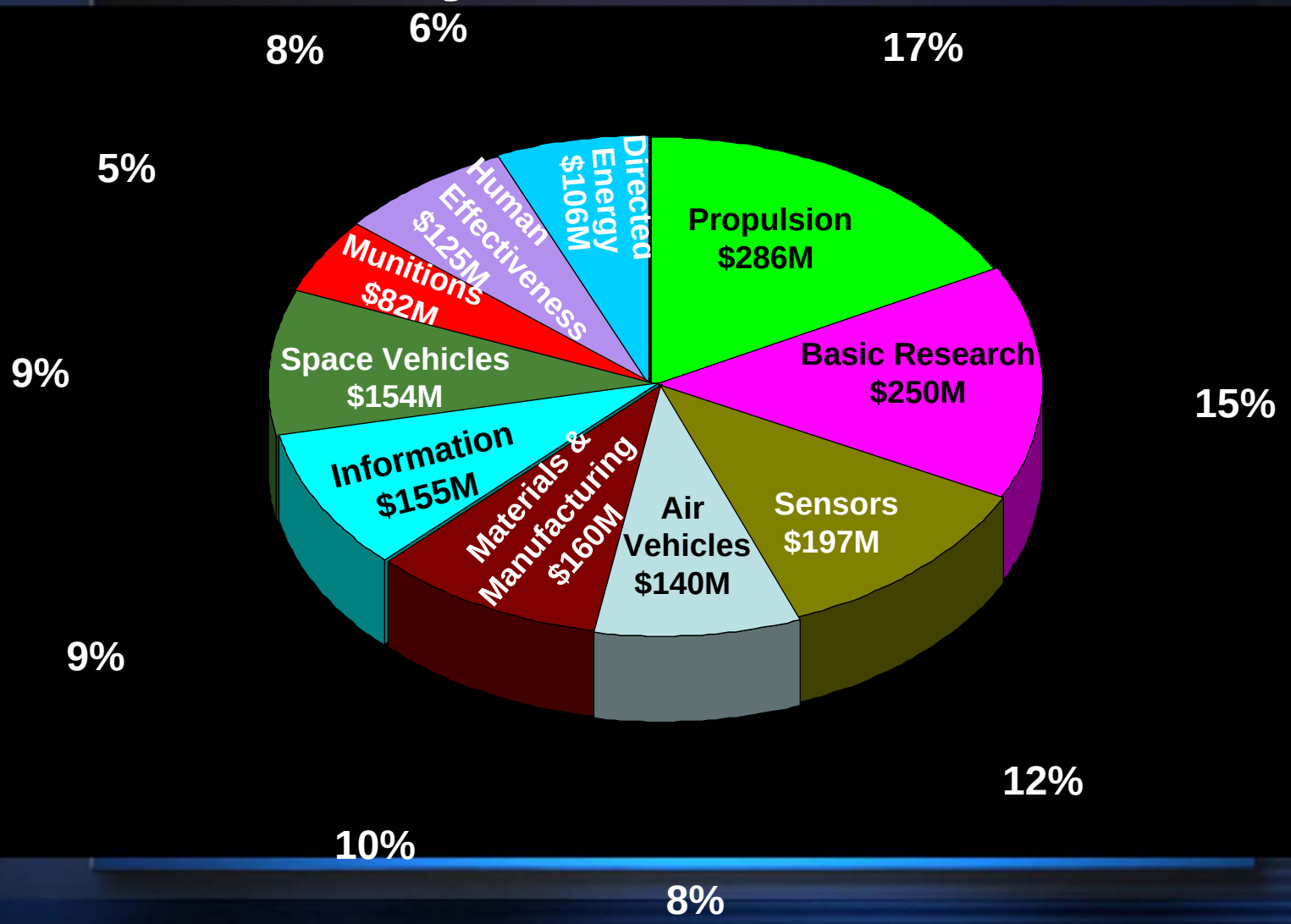
**We defend America by unleashing the power of innovative science and technology**

# Core Work Areas





# AF Budget Investment By Tech Area




FY07 Presidential Budget
Values May Not Add Due to Rounding

# AFRL Customers

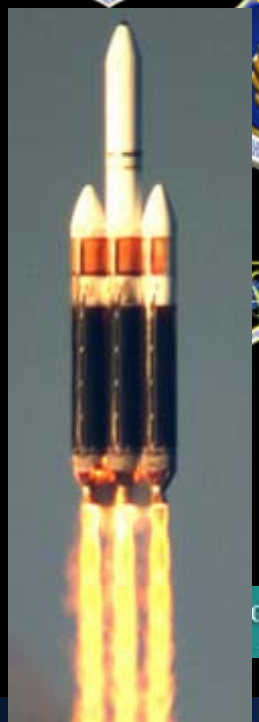
## AF Senior Leadership

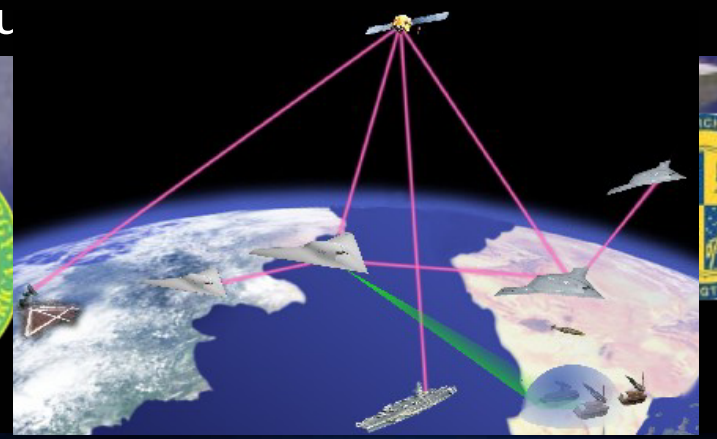
- Top-level guidance and strategy

## Program Managers (Capability Developers)

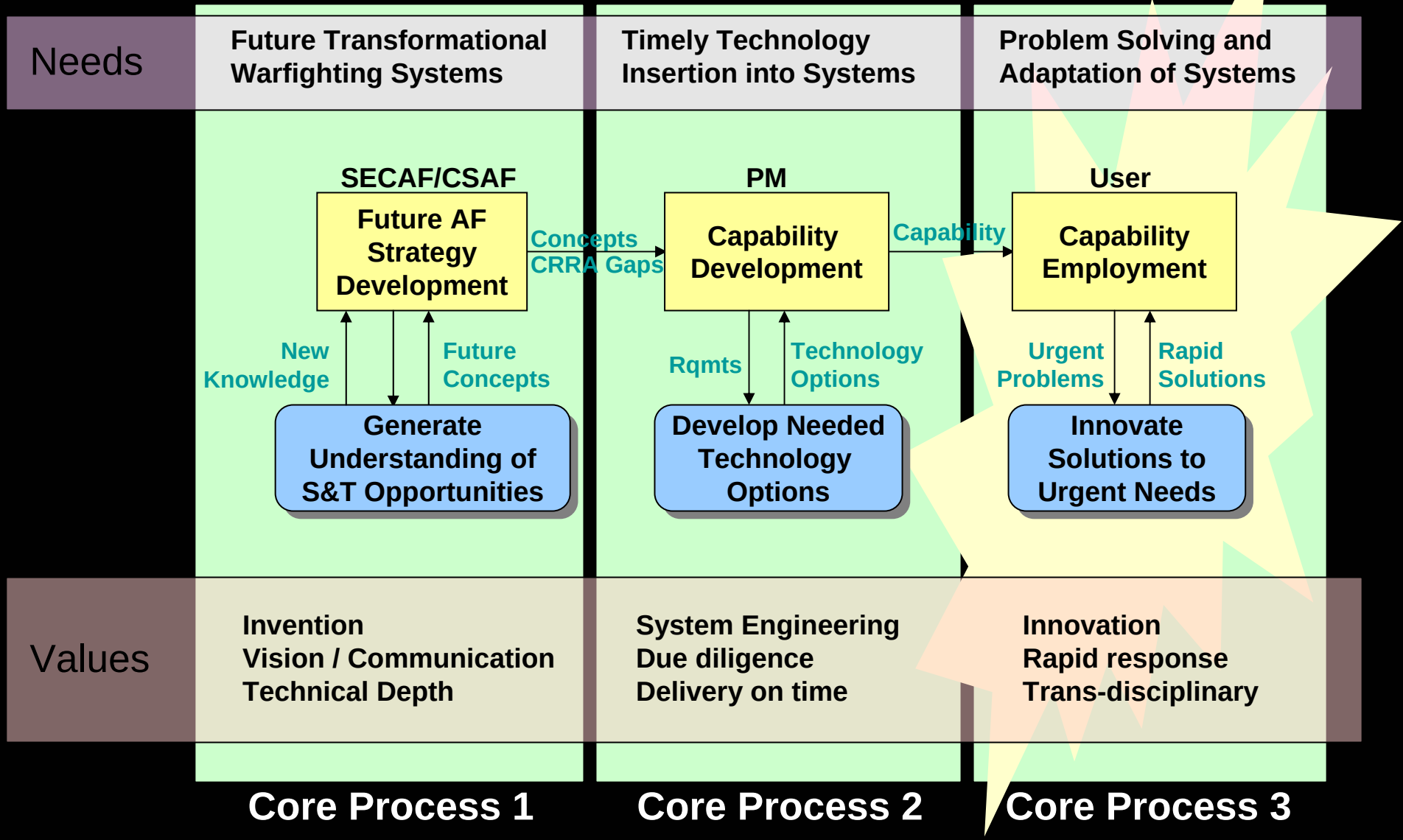
- Anticipate, Find, Fix, Track, Target, Engage, s[illegible] thi[illegible] An[illegible]re [illegible] time
- Core S&T con[illegible]ed [illegible]per[illegible]al [illegible]needs
- Solve capability gaps and shape future concepts
- AFRL pushes to show operators what's possible

## Warfighter



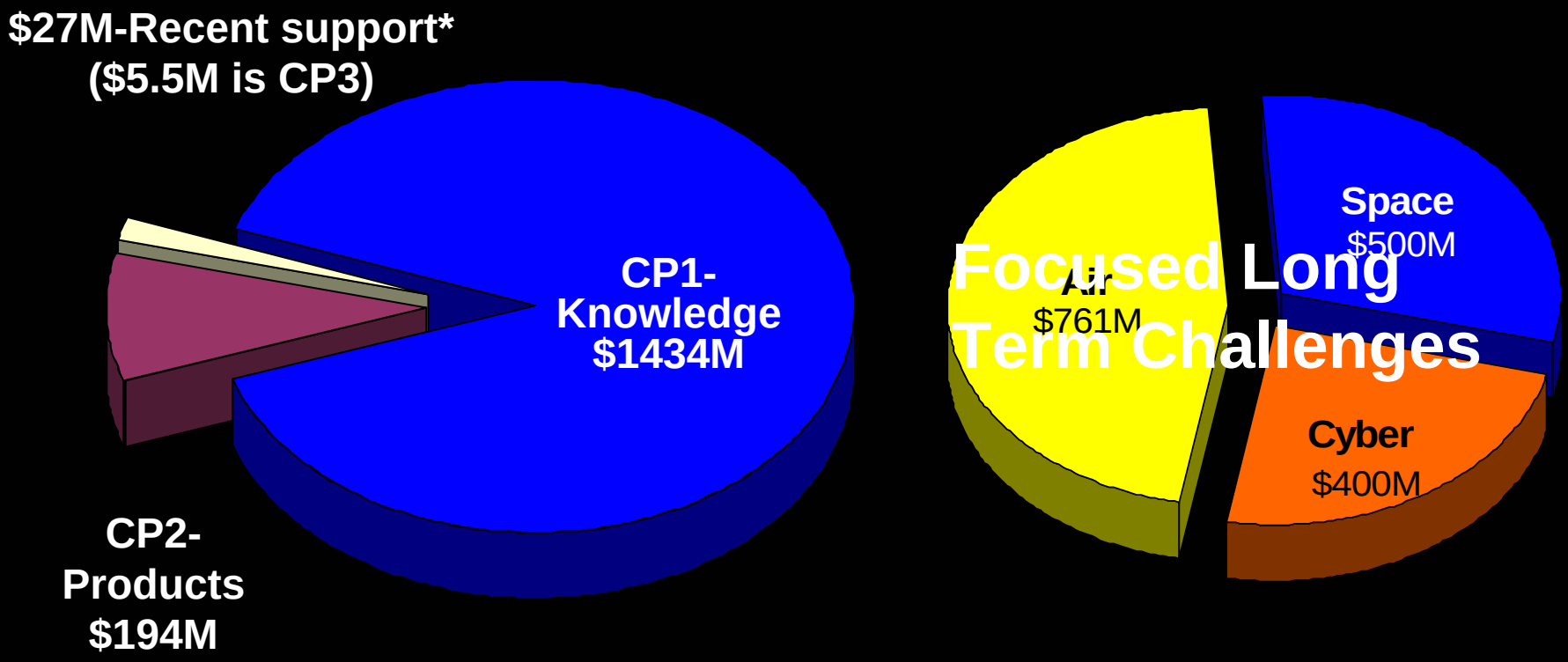


# AFRL's Core Processes Aligned with Customer Needs



# FY07 $ in FY07 PB

## By Area




**TOTAL: $1.655 Billion**

AIR SPACE CYBERSPACE

* Delivered to supporting current on-going combat operations

# Core Process 1
# Focused Long Term Challenges

## USAF S&T Vision

**Focused Long Term Challenges (FLTCs) to address each problem**

- Define the problem statements
- Apply Enhanced OPTICNAV Force

Anticipate, Find, Fix, Track, Target, Engage, Assess Anything, Anywhere, Anytime

**AF²T²EA⁴**

FLTC #1
FLTC #2
FLTC #3
FLTC #4
FLTC #5
FLTC #6
FLTC #7
FLTC #8

Problem #1
Problem #2
Problem #3
Problem #4

AIR FORCE RESEARCH LABORATORY

Program
Program
Program

**Many AFRL programs tied directly to the user's problems**

# FLTCs – Examined

# FLTCs – Examined

FLTC #2

## Unprecedented Proactive Intelligence, Surveillance, and Reconnaissance (ISR)

Problem Statement #2

**2.2 Deliver On-demand Fused Multi-Source ISR for Total Battlespace Awareness**

**Mid-Term Attribute 2.2.1**

**Survivable, High-altitude, Long Endurance, Multi-INT Sensing for Battlespace Awareness**

**Product 2.2.1.1** Improved Light Aircraft Structures (VA)

**Product 2.2.1.2** Structurally Integrated Aircraft Antennas (VA)

**Prod** Persistent ISR Sen

**Produ** Al ra ar

**Internally Funded Program** — TRL MRL

**Partially or Un-Funded Program** — TRL MRL

**Jointly Funded Program** — TRL MRL

**Externally Funded Program** — TRL MRL

TRL Technology Readiness Level

MRL Manufacture Readiness Level

# Socialization Process to Date

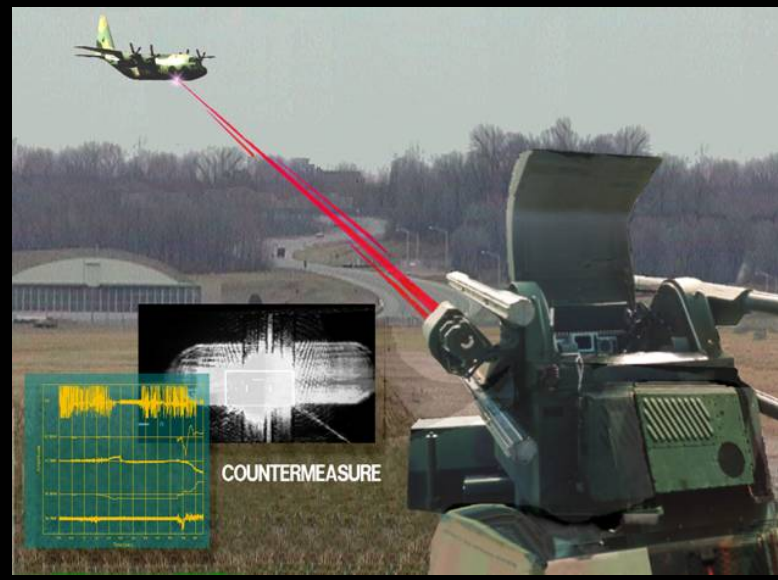
- 20 Jun 06 — ACC/A8 and ACC Staff
- 21 Jun 06 — AFSPC/A3 and AFSPC Staff
- 26 Jun 06 — AFSOC/A8/A5 and AFSOC Staff
- 27 Jun 06 — AFFTC Staff
- 28 Jun 06 — AETC/A5/A8 and AETC Staff
- 14 Jul 06 — SMC/CC
- 20 Jul 06 — AFC2ISRC/A8 and AFC2ISRC Staff
- 25 Jul 06 — ESC
- 28 Jul 06 — AMC/A5 and AMC Staff
- 3 Aug 06 — DTRA
- 7 Aug 06 — Air Staff – A3, A8, AQR
- 30 Aug 06 — NSSO S&T IPT
- 30 Agu 06 — Air War College
- 31 Aug 06 — AFSPC/CC
- 1 Sep 06 — AF SAB
- 5 Sep 06 — PACOM
- 7 Sep 06 — ONR
- 11 Sep 06 — N-81 Study Team
- 21 Sep 06 — AFSPC

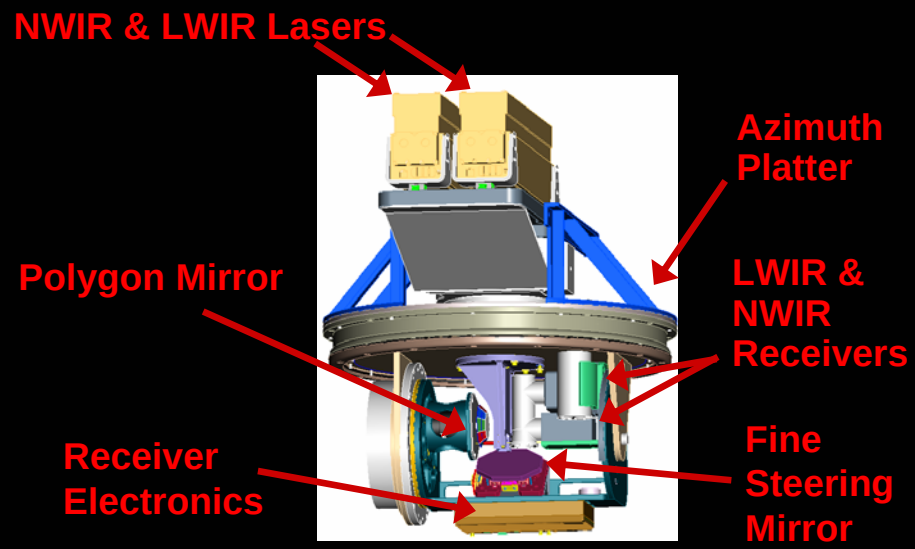
# Socialization Process to Date

- 25 Sep 06 NAVAIR Process Council
- 28 Sep 06 AFSOC
- 5 Oct 06 Dir NASA Dryden
- 5 Oct 06 AFRL-AFIT Summit
- 6 Oct 06 AFSPC/CV Brief
- 19 Oct 06 DTRA
- 14 Nov 06 USSOCOM
- 30 Nov 06 ACC/AFC2ISRC
- 8 Dec 06 NASA HQs
- 19 Dec 06 ASC/XR
- 3 Jan 07 SAF/AQ
- 3 Jan 07 DDR&E
- 9 – 11 Jan 07 Deep Dive Workshop #1 – DC
- 17 Jan 07 Cyber Command
- 31 Jan 07 Dr Erbsloe, AMC/ST
- 5 Feb 07 ASC Aeronautical Enterprise IPT
- 7 – 8 Mar 07 Oak Ridge National Lab
- 8 Mar 07 Idaho National Lab
- 14 Mar 07 NGA

# Technology Insertion
# Day/Night EO/IR Tracker CM

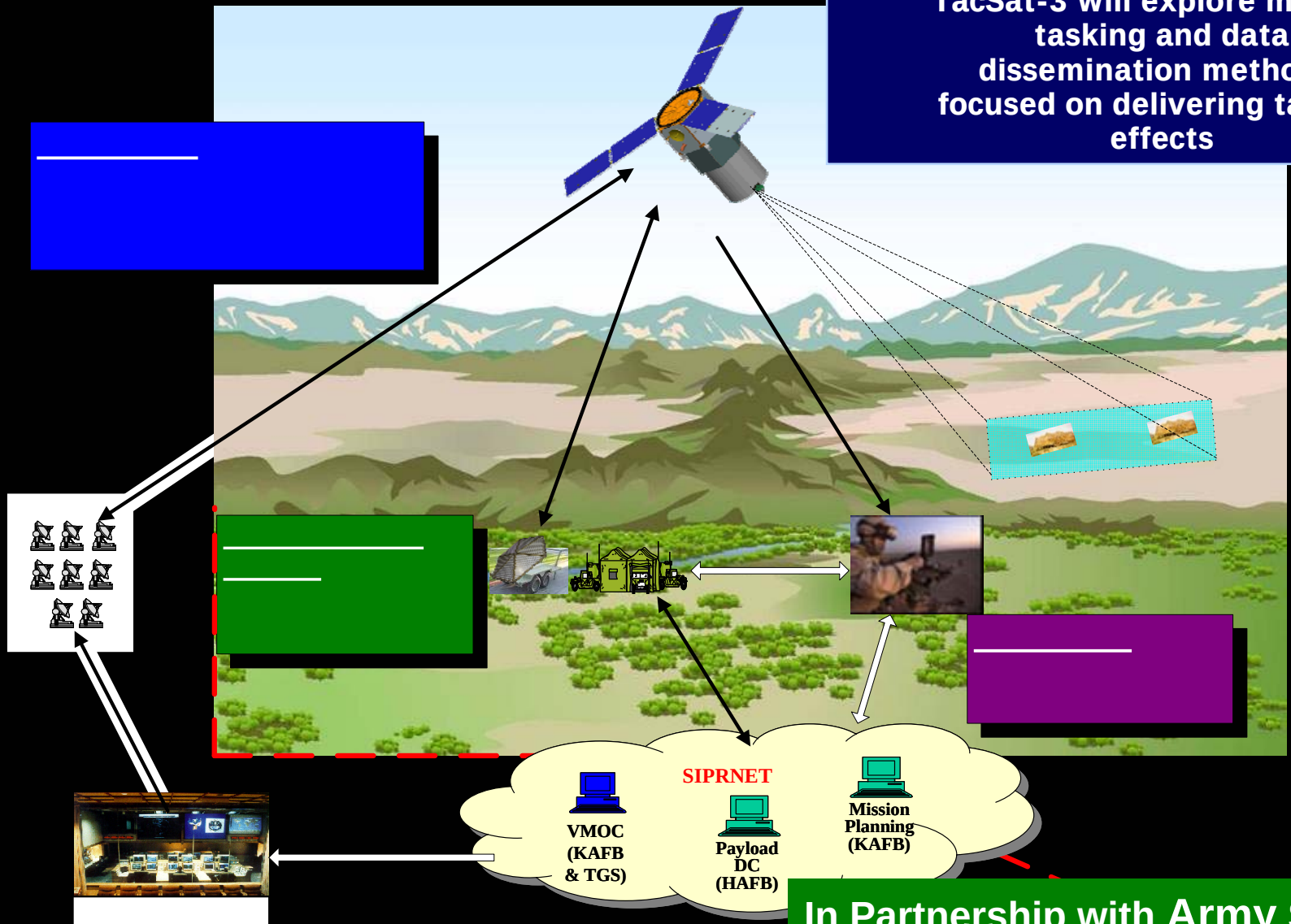
- Locates and defeats / denies use of passive infrared fire control systems and active laser trackers on man-portable and mobile SAM systems
  - Compatible with AFSOC/SOCOM platforms using DIRCM IR CM systems
- Detects threat IR sensors before weapon launch
- Provides threat location and possible threat classification
- Provides option to avoid, deny or counter the threat beyond missile launch range
- Denies enemy the ability to operate passively (forces RF use) and increases survivability
- Negates AAA and laser beam rider tracking



# Technology Insertion
## TacSat-3 Real Time Downlink & C2

TacSat-3 will explore multiple tasking and data dissemination methods; focused on delivering tactical effects




In Partnership with Army SMDC

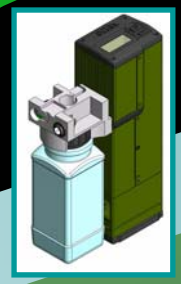
# BAO BRITES ATD SPIRAL 2

(PM – Lt. Josh Johnson, AFRL/PR)

Methanol Fuel Cells
~500 W·hr/kg

Solid Oxide Fuel Cell
~600 W·hr/kg

Zinc Air
~350 W·hr/kg



High Energy

Rechargeable
Li Metal
~300 W·hr/kg

Optimized Li Ion
~200 W·hr/kg

High Power

Lithium Ion
~200 W·hr/kg

Power
Management

Spiral 3
50%

Spiral 2
33% Wgt Savings

Spiral 1
25%

# Technology Insertion

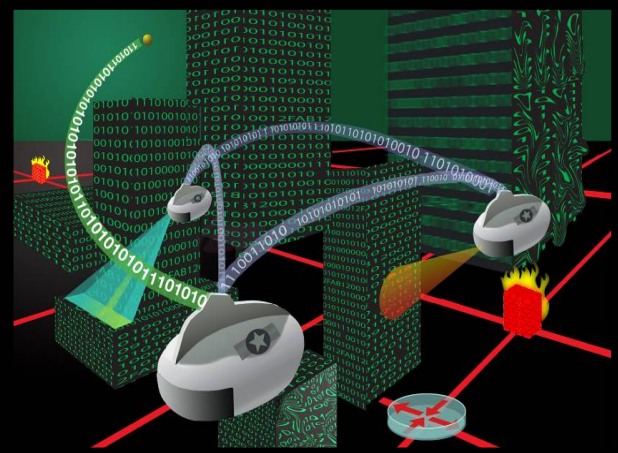
## Trusted Tactical Weaponeering for Cyberspace

(PM – Rick Metzger, AFRL/IF)

- **Program objectives**
  - Combines disparate cyber programs throughout the AF and Intelligence community
  - Enhance C2 with remote cyberspace attack capabilities
    - Third leg of "C2 Triad"

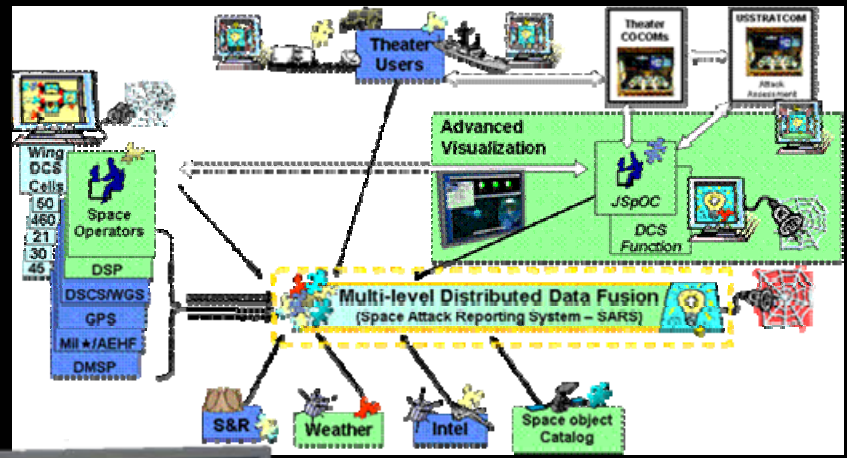
- **Benefits to the Warfighter**
  - Enables warfighter to dominate the cyberspace: strike anytime, anywhere
  - Global reach: unprecedented access beyond physical and geo-political boundaries.
  - Gathers intelligence for IPB
  - Acts as non-traditional ISR asset: supports BDA

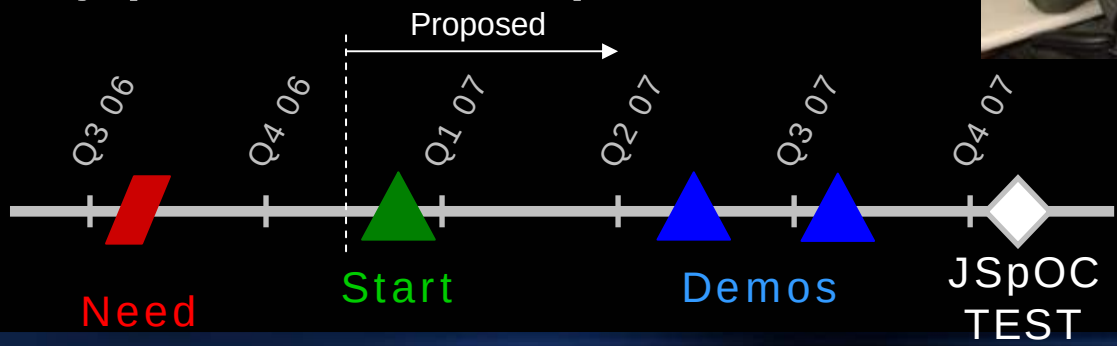
- **Schedule**
  - Contract (Jan 06)
  - Demo (Sep 09)



# AFRL Rapid Reaction Project
# Space Situation Awareness

- Commander Joint Space Operations Urgent Need
  - Rapid ability to assess space situation using existing information
- 70% Quick-to-Field Solution Identified
  - Data fusion and intuitive display of telemetry, ephemeris, and space weather data
  - Plan to validate in Joint Space Operations Center (JSpOC)
- Coordinating plan with broader community (AFSPC, SMC, etc)



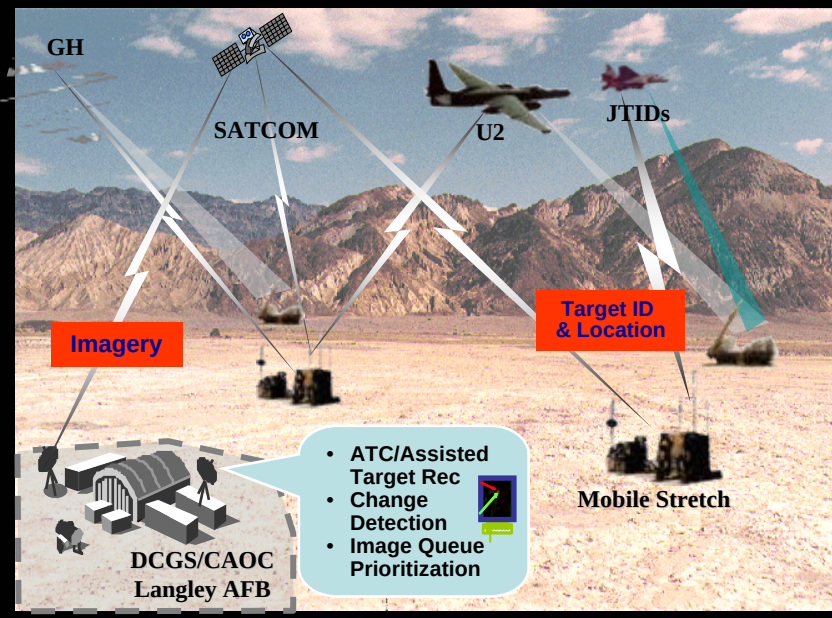


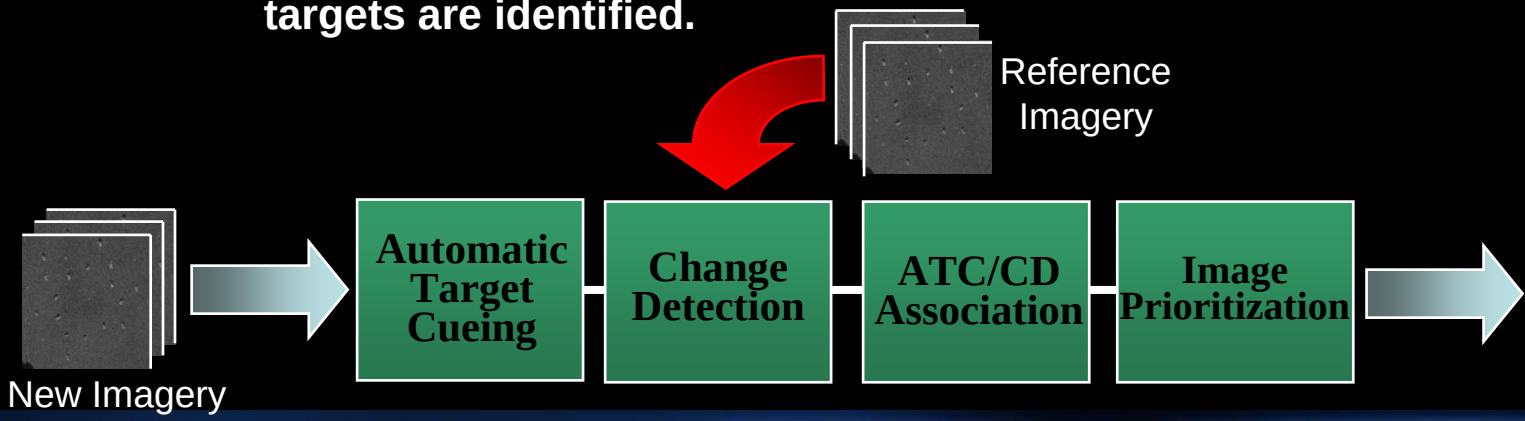

**Rapid Response**

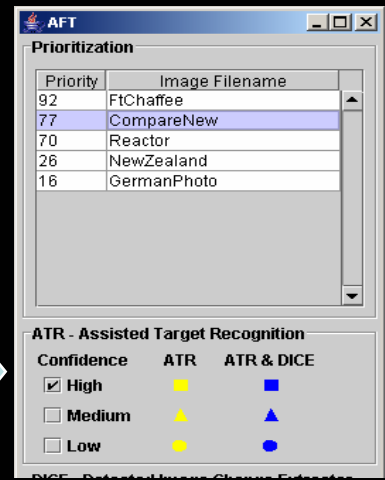
# Assisted Target Recognition for Time Critical Targeting

(PM – Lt. Amanda Martin, AFRL/SN)

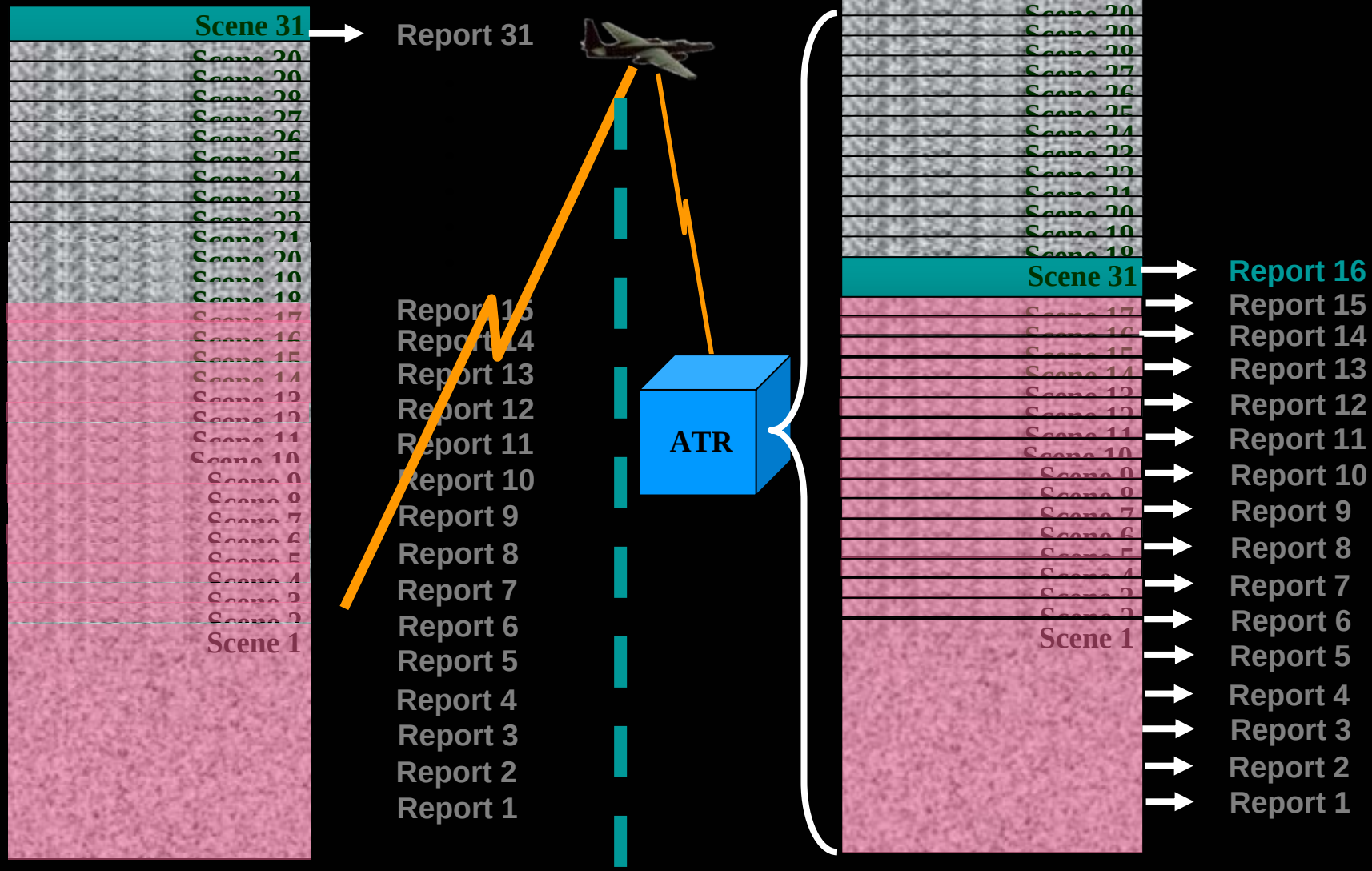
- Dynamic high value targets are only vulnerable for short periods of time
- Image Analysts are responsible for ever increasing, large volumes of data
- Solution
  - Automatic Target Cueing (ATC)
    - Automatic Target Detection
    - Assisted Target Recognition
  - Change Detection (CD)
    - Compares images collected at different times to identify change.
  - Image Prioritization.
    - Sources of information are correlated and images are most likely to contain targets are identified.



# Potential ATR Uses – Shorten Timelines



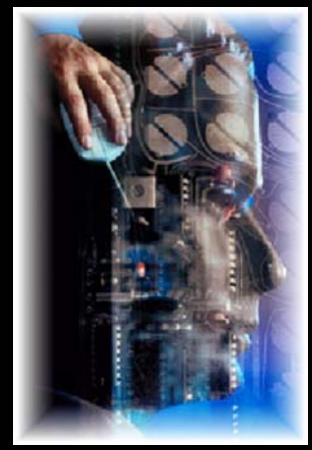
# Key Observations

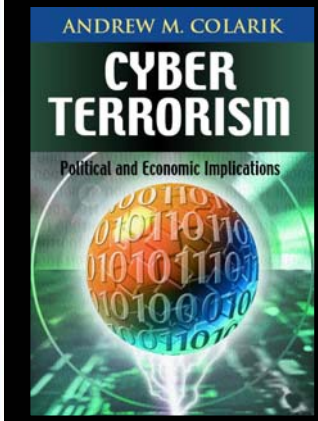
- Collaboration a must
- Direct warfighter-scientist interaction essential
- Put high risk efforts in lab, not in programs

AFRL
THE AIR FORCE RESEARCH LABORATORY
LEAD | DISCOVER | DEVELOP | DELIVER

# AFRL Rapid Reaction Project Cyberspace

- Addressing urgent needs for MAJCOMs (PACOM) and soon to be:
  - Cyber Command
  - ISR Command
- Understanding the urgency for rapid action within the cyber arena
  - Access, stealth and persistence
  - Cyber tracking technology
  - BDA/IPB
  - PSYOPS
  - Cybercraft
  - Anticipatory modeling of human behavior
- Identified CP3 projects
  - Information Support Server Environment Guard
  - Web Enabled Timeline Analysis
  - DODIIS Trusted Workstation
  - Joint Targeting Toolkit





# Core Process Alignment with Customer Timelines and Needs

SECAF, Chief – long view, strategic planning

PM, Industry/Product Center – next generation, acquisition timelines

Warfighter – day-to-day, employing capabilities

| 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

rapidly deliver technical innovation, driven by warfighter emergencies –*reshape today's battles*

Core Process 3 — CP3

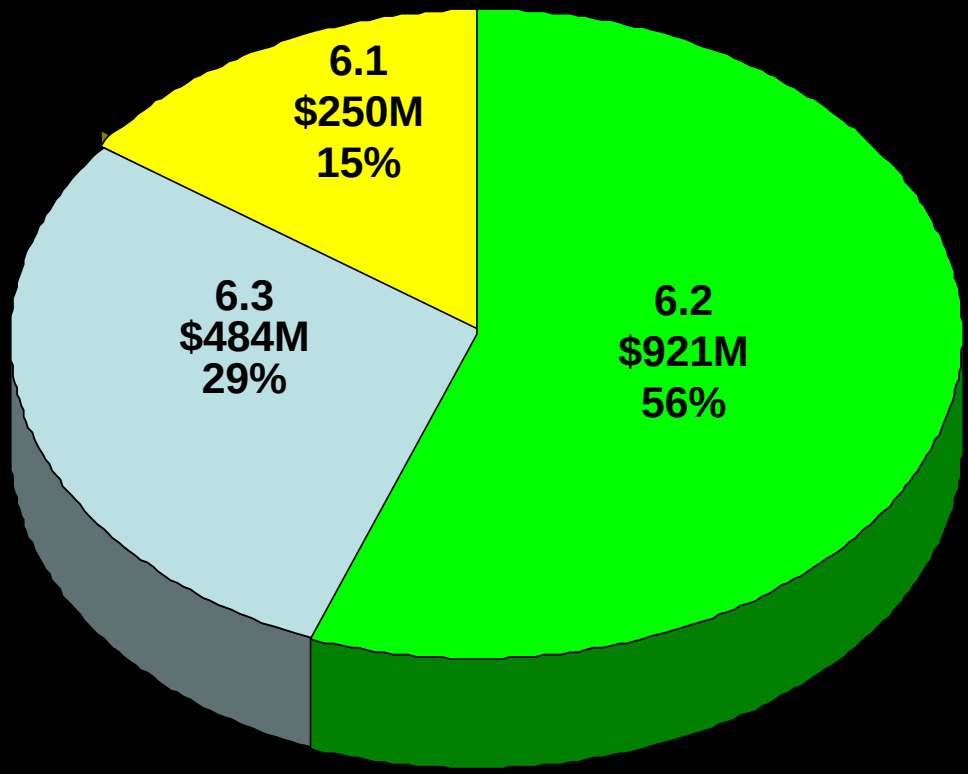
develop technology options that meet the needs of capability developers – *shape today's Air Force*

Core Process 2 — CP2

conduct long-term research, driven by a bold technology goal – *shape the future Air Force*

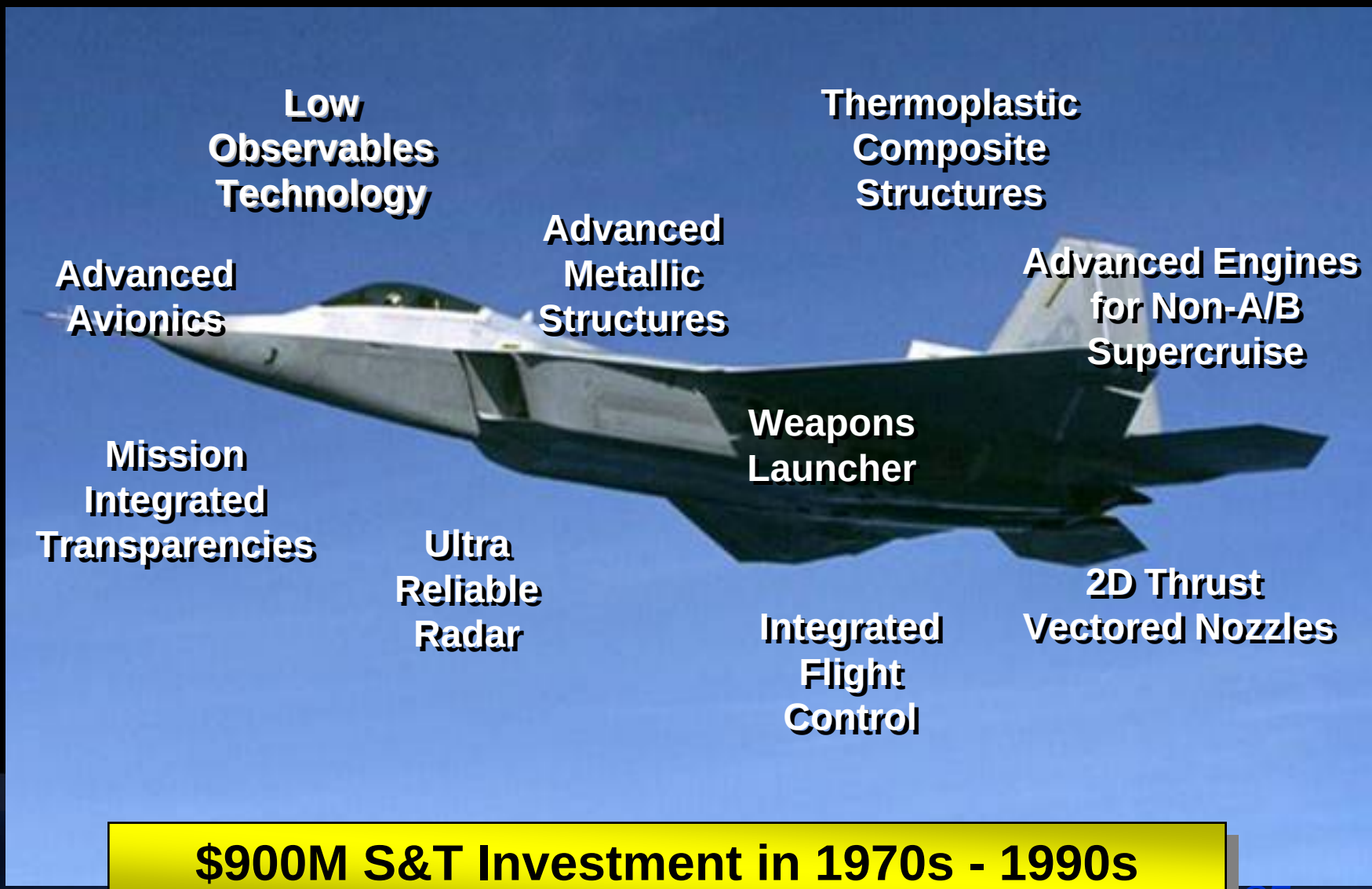
Core Process 1 — CP1

# AF Budget Investment By Budget Activity




**TOTAL: $1.655 Billion**

# AFRL Technology Transitions to F/A-22

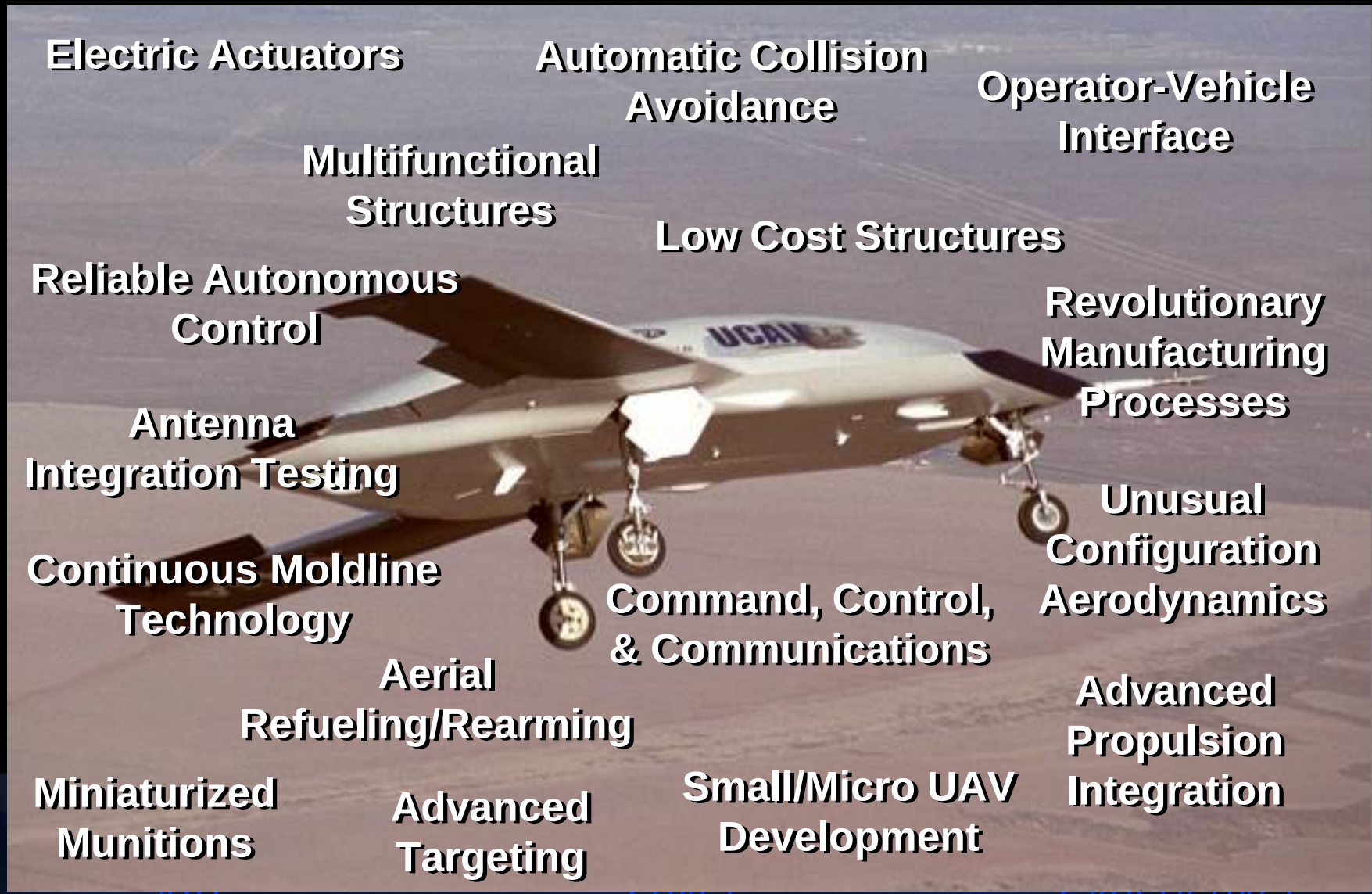



**$900M S&T Investment in 1970s - 1990s**

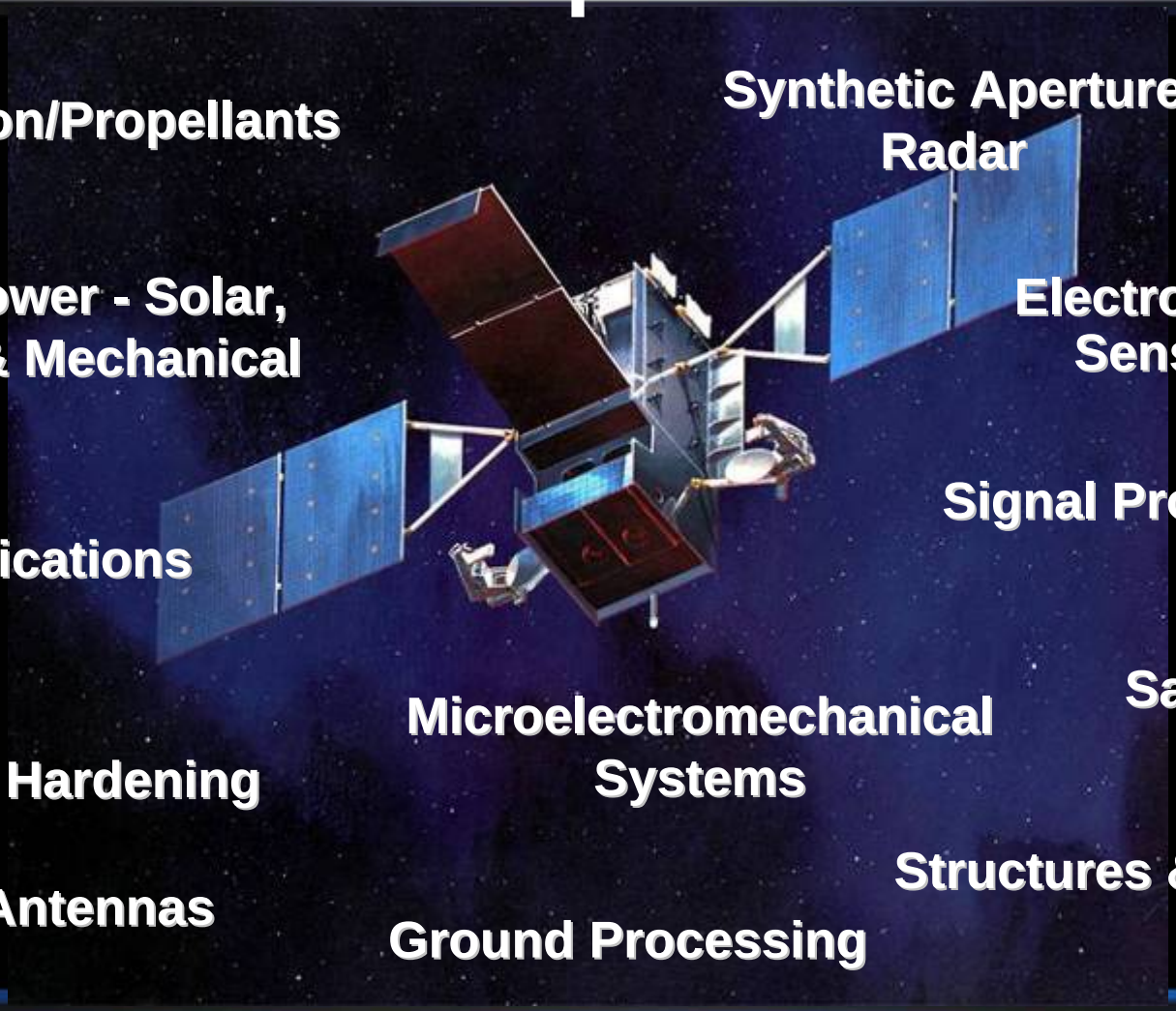
# AFRL Technology Transitions to F-35

AIR SPACE CYBERSPACE

# AFRL Technology Transitions to UAVs



# AFRL Technology Transitions to Space



Propulsion/Propellants

Synthetic Aperture Radar

Electric Power - Solar, Chemical & Mechanical

Electro-Optic Sensors

Signal Processors

Communications

Satellites

Microelectromechanical Systems

Radiation Hardening

Structures & Materials

Antennas

Ground Processing

# AFRL Information Technology Transitions

AIR SPACE CYBERSPACE

# AFRL Technology Transitions to Munitions

GPS/INS Guidance Solutions

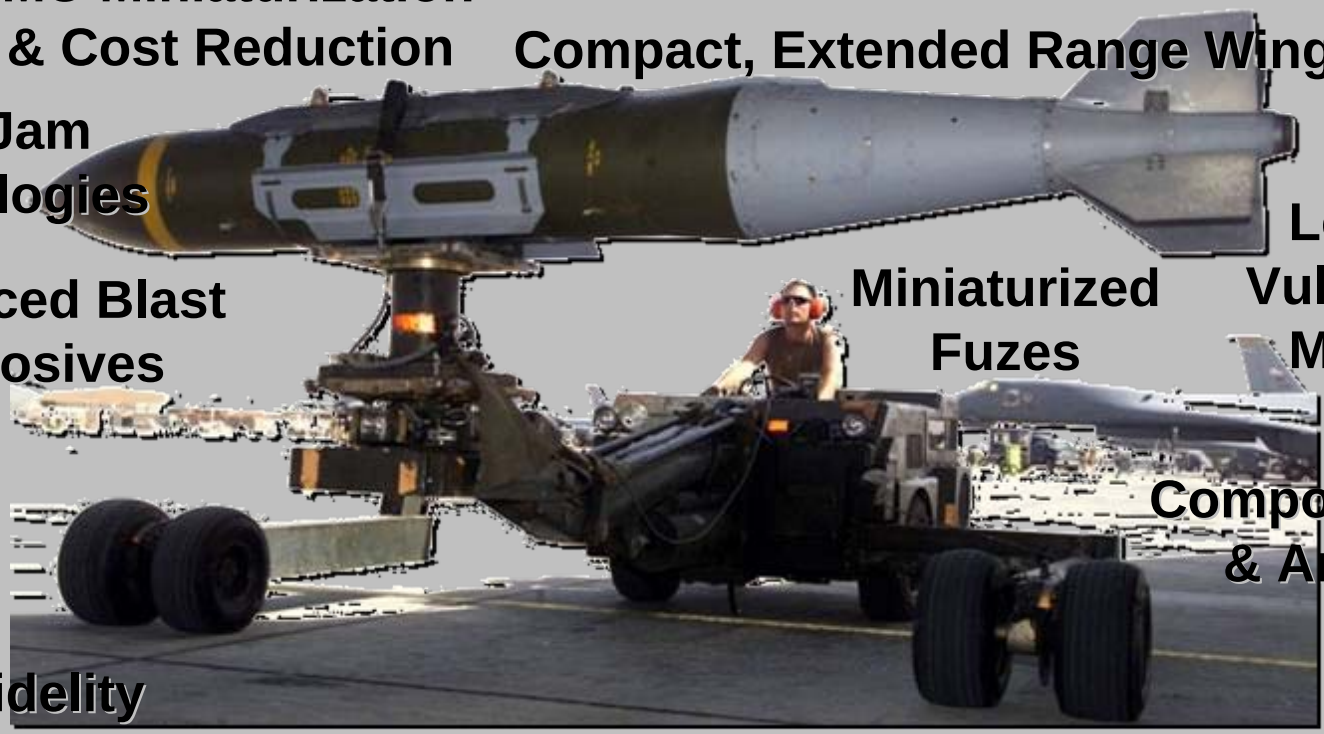
IMU Miniaturization & Cost Reduction

Smart & Survivable Fuzes

Compressed Tail Kits

Compact, Extended Range Wing Kits

Anti-Jam Technologies



Enhanced Blast Explosives

Miniaturized Fuzes

Lethality/ Vulnerability Modeling

Component Test & Analysis

High Fidelity Design Tools

Optimized W/H Geometry for Penetration

System Demonstrations

Insensitive Munitions

High Strength Warhead Cases

AIR SPACE CYBERSPACE

# AFRL Technologies Support Operation Iraqi Freedom

- Battlefield Air Operations Kit
- Anti-Jam GPS
- Massive Ordnance Air Burst
- Panoramic Night Vision Goggles
- CRASH Prompt Agent Defeat
- Surface Target Ordnance Package
- Laser Eye Protection

# AFRL Human Effectiveness Technology Transitions

AIR SPACE CYBERSPACE

# AF Office of Scientific Research

- Physics & Electronics
- Mathematics & Space Sciences
- Aerospace & Materials Sciences
- Chemistry & Life Sciences

# Air Vehicles Directorate

- Sustaining Today's Fleet
- Unmanned Air Vehicles
- Space Access & Future Strike Technologies

# Directed Energy Directorate

- Lasers
- High Power Microwaves
- Advanced Optics & Imaging

# Human Effectiveness Directorate

- Warfighter Training
- Crew System Interface
- Bioeffects & Protection
- Deployment & Sustainment

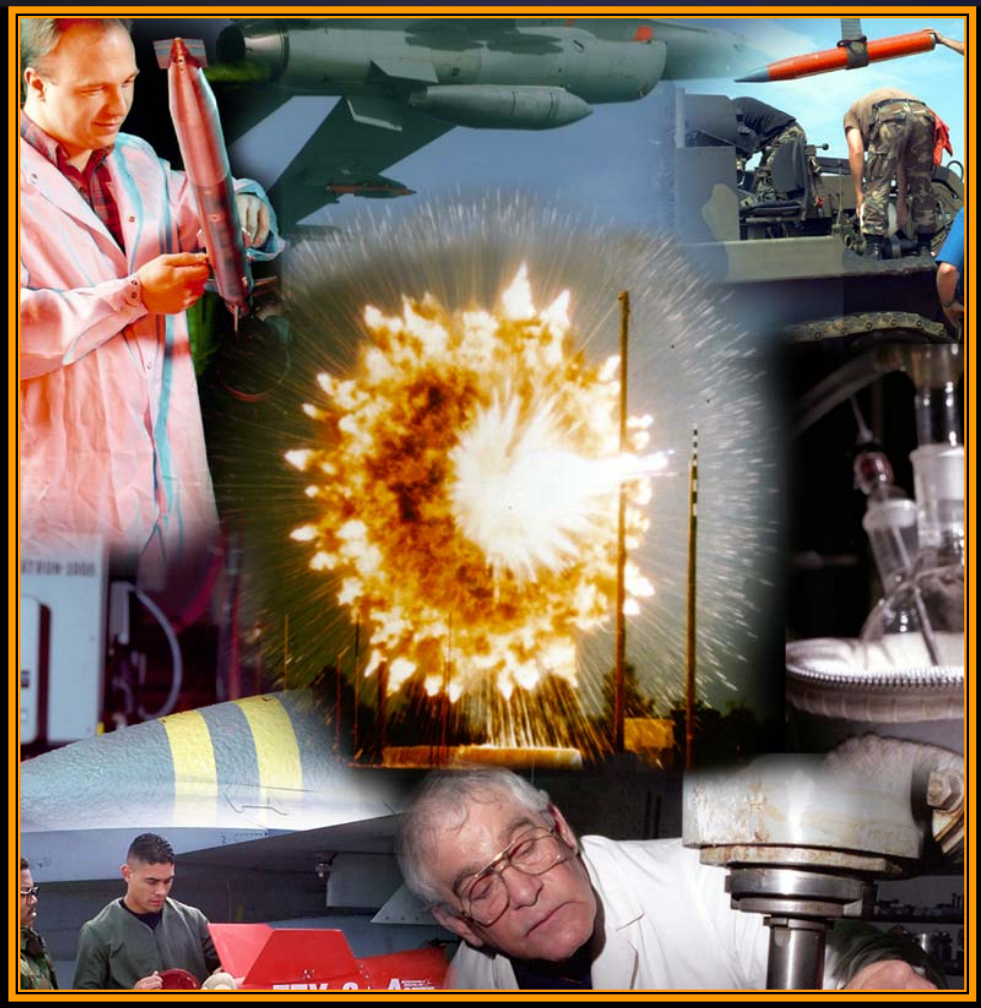
# Information Directorate

- Dynamic Planning & Execution
- Global Awareness
- Global Information Enterprise

# Materials & Manufacturing Directorate

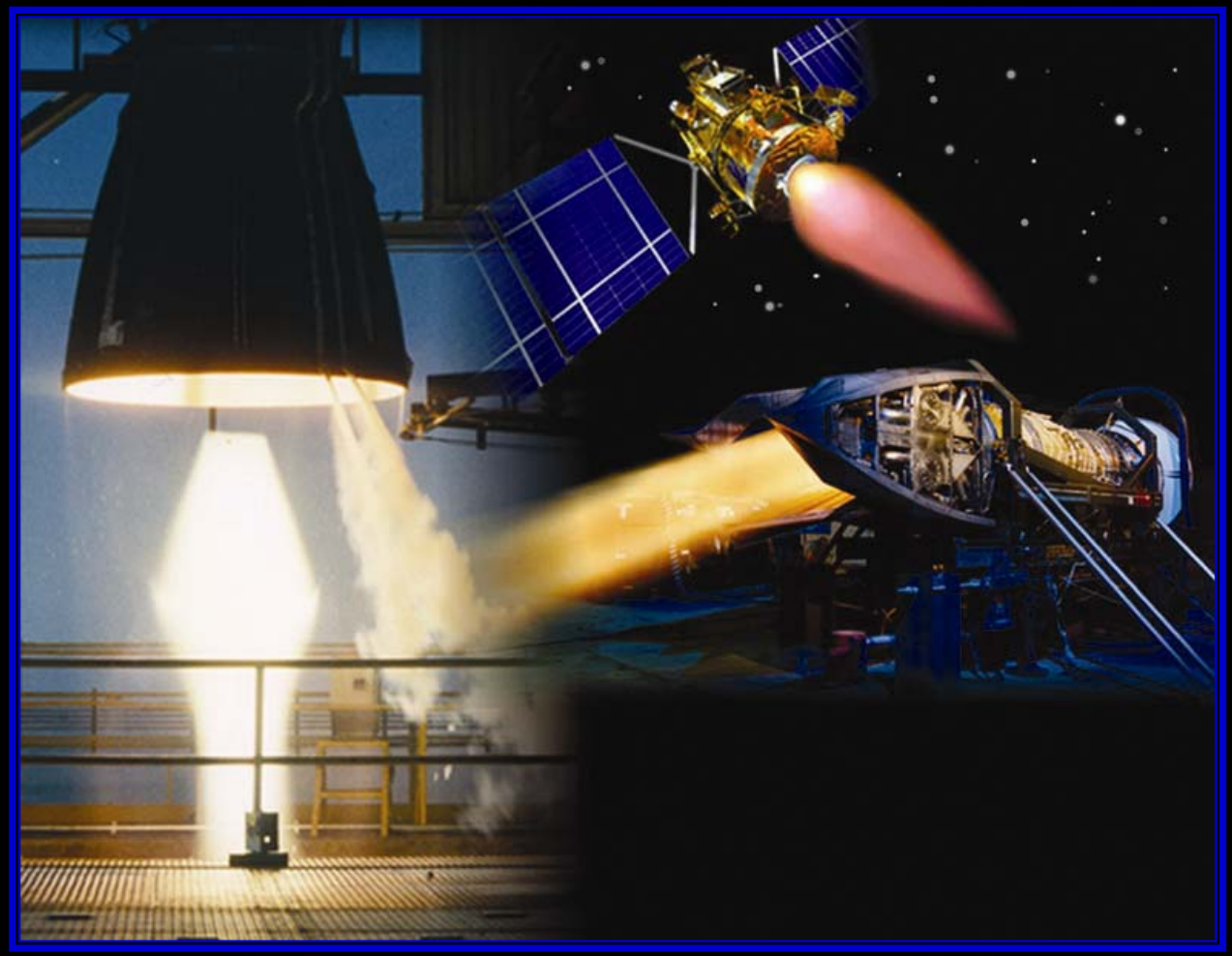
- Metals, Ceramics
- Polymers, Composites, & Coatings
- Laser-Hardened & Sensor Materials
- Manufacturing Technology
- Non-Destructive Evaluation
- System Support

# Munitions Directorate (MN)



- Precision Munitions
- Counterproliferation
- Alternative Effects Weaponry

# Propulsion Directorate (PR)



- Turbine Engines
- Fuels & Lubricants
- Liquid & Solid Rocket Power

# Sensors Directorate (SN)

- Radio Frequency Sensors & Countermeasures
- Electro-Optical Sensors & Countermeasures
- Automatic Target Recognition & Sensor Fusion

# Space Vehicles Directorate

- Space-Based Surveillance
- Space Capability Protection
- •Counterspace
- •Space Access

# The ATLAS Powered Rope Ascender

## Student Technology Transition

-Fall 2004: Team ATLAS Enters *MIT-ISN Soldier Design Competition*
-Spring 2005: Working Prototype wins 3rd Place
*Atlas Devices, LLC* Incorporates, files patent
-Summer 2005: Demo at Infantry Center at Ft. Benning
-Since then: 3 more patents, Partnerships, further iterations, and contract with US Army Rapid Equipping Force

nate.ball@atlasdevices.com

# The Device

Original Challenge: 50 ft in 5 seconds with 250 lbs
- -Device Weight: <25 lbs!
- -5 kW Mechanical Output in 25 lb package

Team ATLAS Original Design:
- -Similar to Cordless Power Tool
- -High Output DC Powertrain
- -Innovative Capstan Mechanism
- -Achieved 50 ft in 7 seconds with 250 lbs

Current Model: SRA03-1
- -17 lbs total weight
- -350 lbs at 5 ft/sec
- -600 ft vertical per charge

$$T_1 = T_2 e^{(\mu\theta)}$$

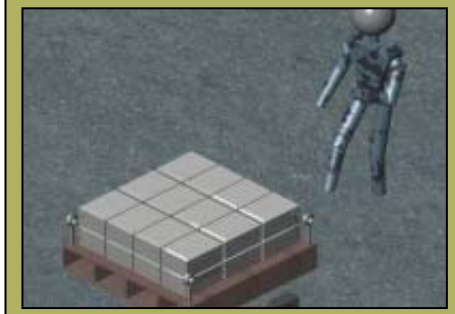
# Multiple Iterations, Multiple Uses

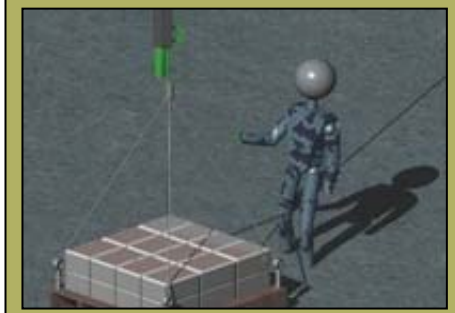
ATLAS DEVICES

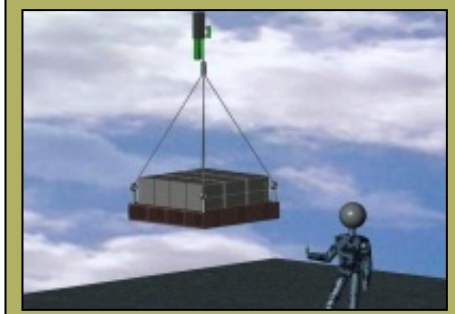
## Powered Ascent

## Rescue, Towing

## Equipment Hauling







## …and More

…

- Ship Boarding
- Maritime Rescue
- Obstacle creation & removal
- Gate/door breaching
- Cave exploration
- Maintenance access
- Industrial load positioning
- Helicopter rescue
- Portable winching
- Minefield Raking
- IED Removal

…

# Current Focus

- US Army Rapid Equipping Force Delivery
- Development of further iterations for Specialized Applications
- Upgrading capabilities: Lighter-Weight, Smaller, Faster
- Graduation
- *Further sales:* Small-batch orders of the SRA03-1 for testing, evaluation & refinement

## ATLAS DEVICES is:

Tim Fofonoff
- Ph.D. Candidate, S.M. Mech. Eng. MIT
- Member of MIT ISN and BioInstrumentation Lab
- Winner of 2006 $50K MIT Hatsopoulos prize

Bryan Schmid
- S.M., S.B. Mech. Eng. MIT
- Serial Entrepreneur
- Padmakar P. Lele undergraduate teaching award

Nathan Ball
- S.M. Student, S.B. Mech. Eng. MIT
- All American pole-vaulter
- Winner of 2007 $30K Lemelson-MIT Student Prize

Daniel Walker
- S.M. Student, S.B. Mech. Eng. MIT
- Experienced climber and rescue instructor
- Former MIT outing club president

# Emerging Technologies from the Army-Funded Institute for Soldier Nanotechnologies (ISN)


***by MAJ Rex Blair***
***Harvard Applied Physics Graduate Student and Uniformed Army Scientist at ISN***


Harvard
School of Engineering and Applied Sciences

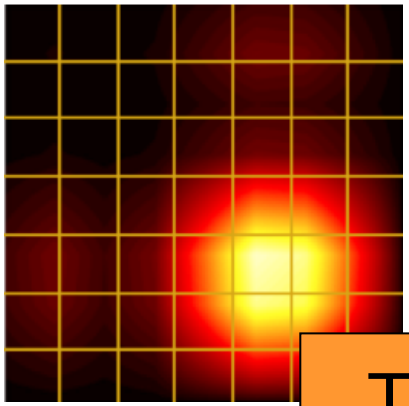
Massachusetts Institute of Technology

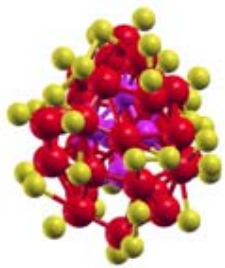
INSTITUTE FOR SOLDIER NANOTECHNOLOGIES
Enhancing Soldier Survivability

## ***Boots to Benchtop… and Back…***

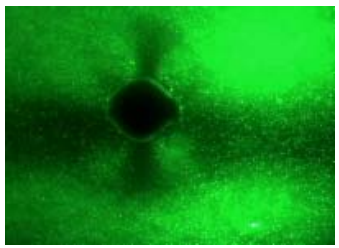

Rex.Blair@us.army.mil

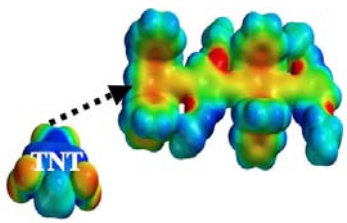
# Institute for Soldier Nanotechnologies
# MISSION





To dramatically improve the survivability of the Soldier by working at & extending the frontiers of Nanotechnology *through fundamental research*





# ISN Research to Enable Key Soldier Capabilities

## *ISN Dedicated Facility*

***State of the art instrumentation***

***Multidisciplinary***

***40 Faculty (8 Departments)***

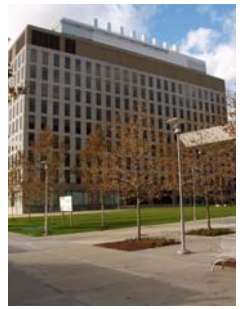
***80 Grad students***

***30 Post-docs***

***2 Uniformed Army Scientists***

***4 Civilian Army Scientists***

***8 Industry Visiting Scientists***



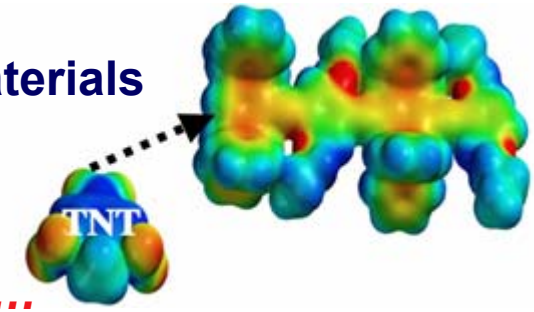
***Industry Consortium***

***Army S&T Labs***

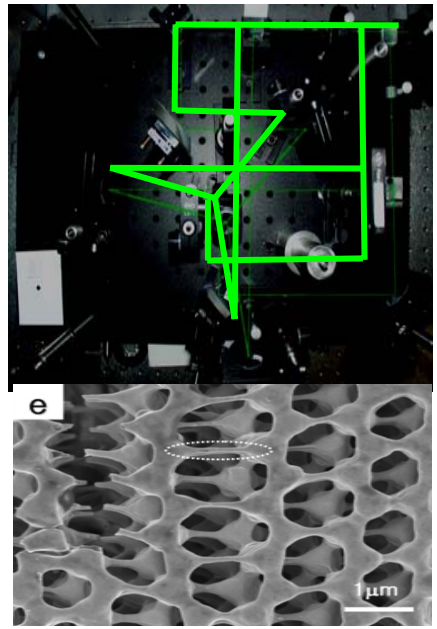
Rex.Blair@us.army.mil

# ISN Research to Enable Key Soldier Capabilities

- ***Protect:***
  - *Lightweight,* **strong structural materials**
  - ***Ballistic + blast protection***
- ***Detect unseen threats:***
  - ***Explosives, chemicals, biotoxins…***




- ***Enhance:***
  - **Adaptive,** ***multifunctional materials***
  - **Soldier** ***performance monitoring*** **(medical status)**
  - **Injury triage and** ***treatment for survivability***
- ***Improve Performance:***
  - **Mechanical actuators:** ***"exo-muscle"***
  - **Situational** ***awareness***
  - **Give individual Soldiers** ***small-unit*** **capabilities: chem-bio, awareness, far forward medical care**

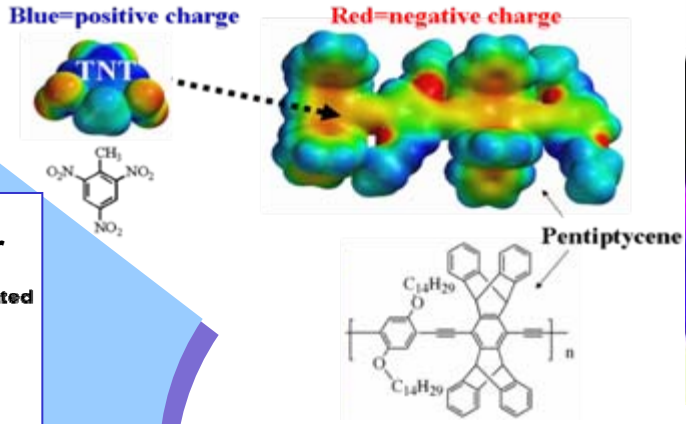



*Microtrusses via 3D photolithography*

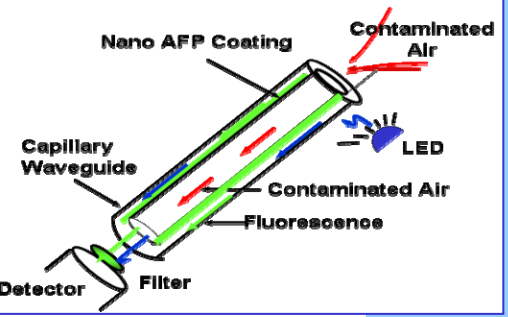
***Soldiers are FIRST customers for improved protection***

# Science Making a Difference for Soldiers: FIDO Explosives Detector

**MOLECULAR ENGINEERING:**
designed molecules

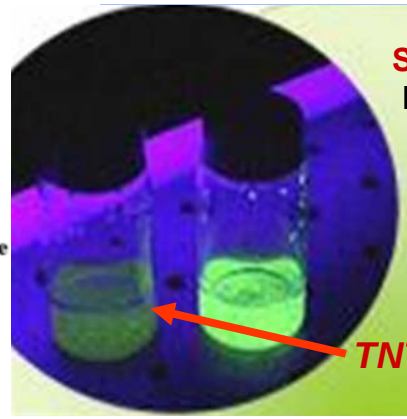



**OPTICAL ENGINEERING:**
integrated Detector/Sampler




**REPACKAGING:**
from DARPA Dog Nose concept to real Warfighter Device

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



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

*TNT Detected*

***Assessments:***
***USMC in Iraq (2004), ATEC in Iraq (2005)***
***Procurements:***
***SOCOM (2005),***
***PMs (2006) for handheld + robot-integrated***

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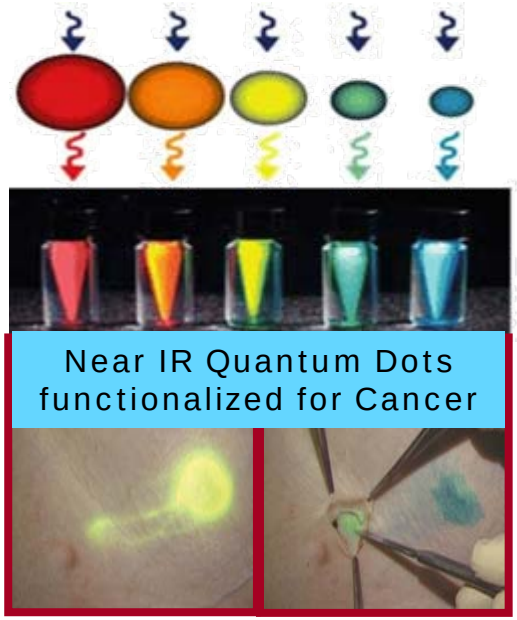
Mar 2007

# Projects with Medical and Other Military Benefit Can Speed Technology *Adoption* (more than "*Availability*")

- **Near IR Quantum dots are functionalized for cancer, injected into patient; migrate to cancer cells (Bawendi)**
  - **Surgeon assesses Near IR image before a single cut**
  - **Cluster == much cancer, few dots == less surgery**
- **MEMS Microchip addresses Hemorrhagic shock (Cima)**
  - **Enables rapid drug delivery**
  - **Military is "lead user," leverages FDA approval process**



Near IR Quantum Dots functionalized for Cancer

Rapid drug delivery via MEMS device: prevent hemorrhagic shock

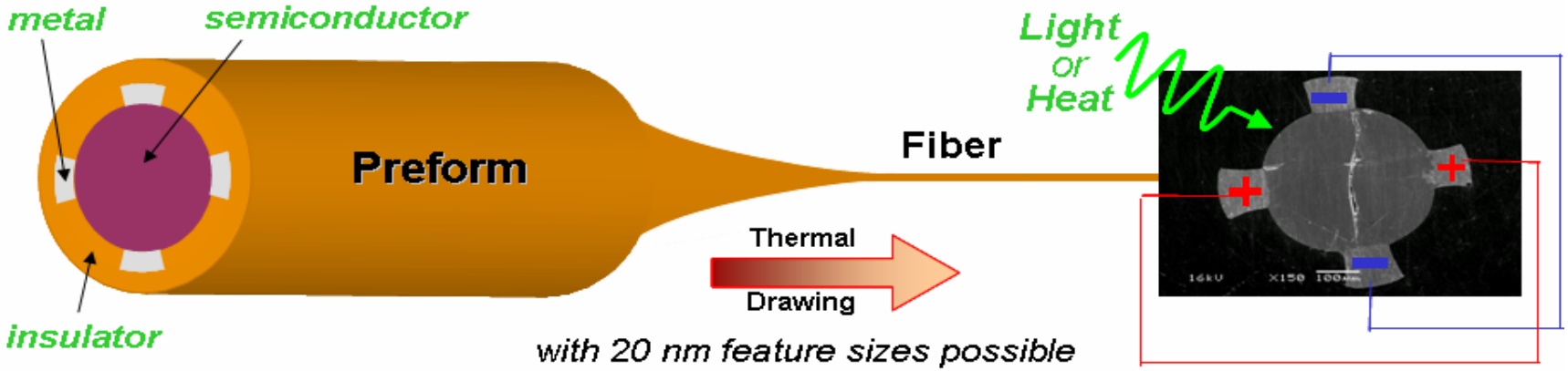
**Explore implant (long term) and "Epi-Pen" (short term) types of delivery**

*Leveraging med research & partners:*
*Saves lives + grows market + accelerates tech adoption*
*== reduces costs + risks for Soldier applications*

# Fiber Web Linear Sensors

**Optoelectronic fiber-devices for light, heat, & acoustic sensing:**

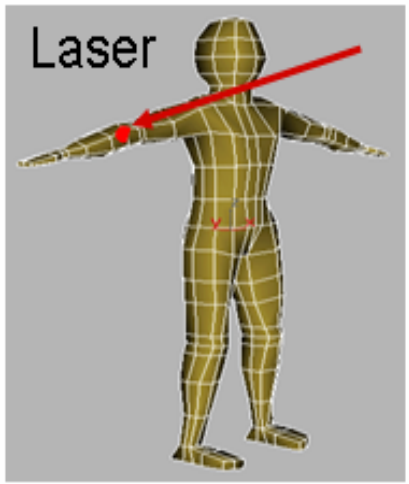
***Full-body sensing (Photonic Band-gap Fibers)– new paradigm fibers & fabrics that can see, feel, hear…***



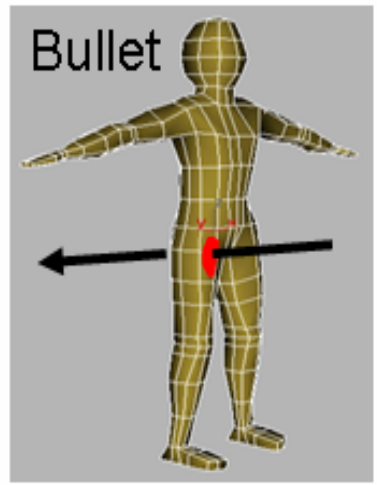

Full Body ID;

Laser-to-Uniform Non-RF Communications;

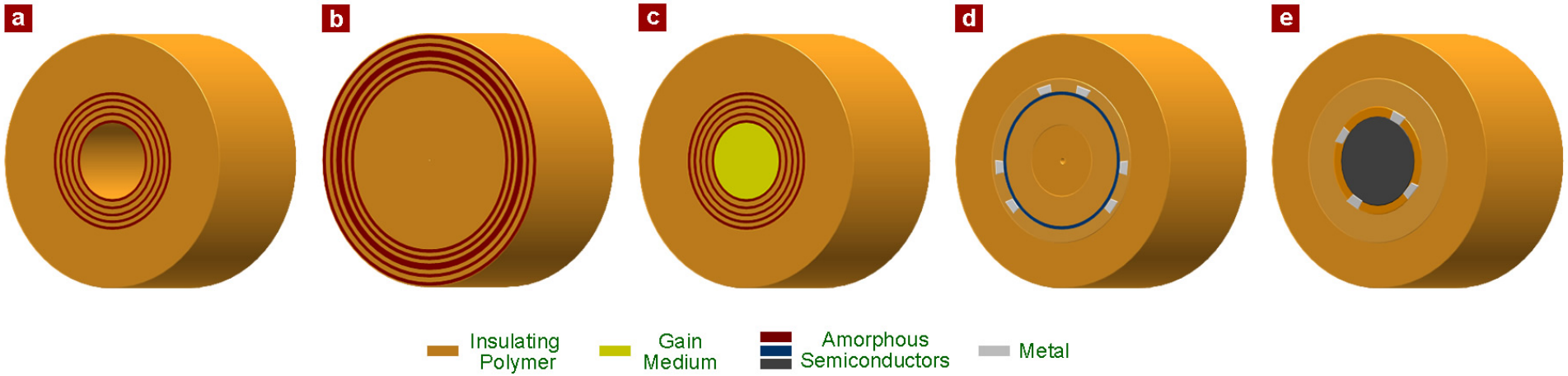
Improved MILES

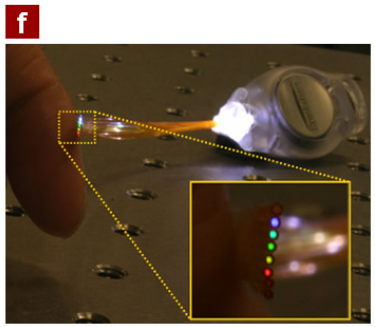



Full Body Thermal Sensing *Remote Triage*

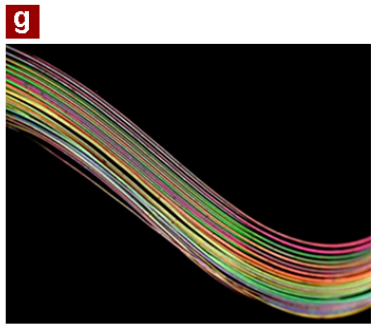


# Fiber Web Linear Sensors:
# Tunable Metal-Insulator-Semiconductor Fiber Devices



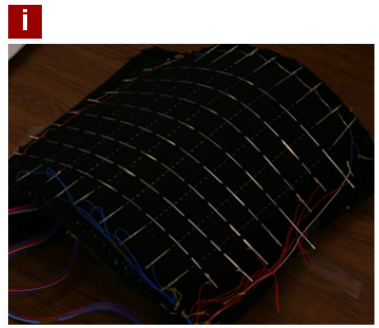




Hollow transmission fibers




Optical cavity fibers

Surface emitting fiber lasers




Thermal detector fibers

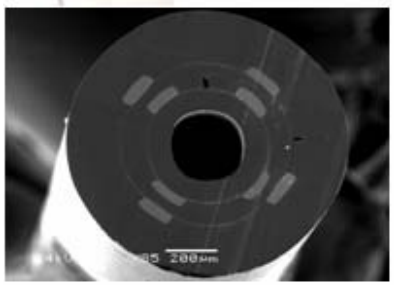
Optical detector fibers

# ICOM-H Identification & Communication Helmet Prototype

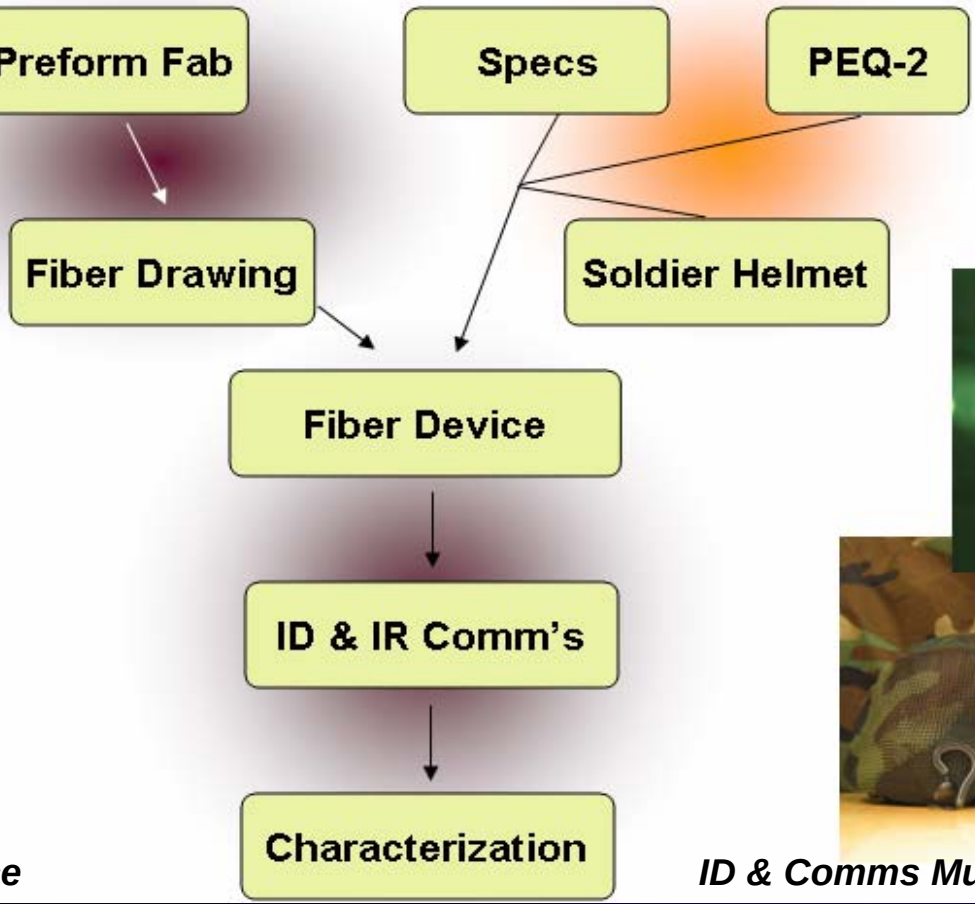
**Design, fabricate, and implement an optoelectronic fiber-device covering for combat ID and line-of-sight IR communication**


*Prof. Y. Fink*
*Prof. J. Joannopoulos*
*MAJ R. Blair*


*NSC –*
*PM SOF Warrior*
*R. Elder*



*Optoelectronic Fiber-Device*



*ID & Comms Multifunctional Helmet*

# ICOM-H Identification & Communication Helmet Prototype

# Be Alert for Opportunities:
# MIT ISN Soldier Design Competition

COL Terry Clemons, QM DCD & COL Ernest Forrest, TSM-Soldier, look on as Team TXI demo their novel parachute canopy release mechanism

Judging the SDC

CSM Michael Kelso & COL Forrest examine TacShot's rocket-based photography system

Team Surreptiles, with COL Ted Johnson (center), show off their check for placing 2nd in the SDC finals

# ISN Soldier Design Competition: Dealing with Success….

RALLYPOINT

**Directional Gesture Communication System**

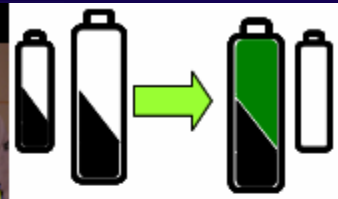
**SDC-1: Digitized Hand-Arm Signals with Personal Direction Reference: Incorporated as RallyPoint, Inc., won 2 Army SBIRs ($750K) for Future Force Warrior (FFW) Handwear Computer Input Device**

*Army & Marine Challenges Ensure relevance*

ATLAS Powered Rope Ascender

TLASmini.gif

USMA Team Supercharged



MIT Team Xitome: Kailas Narendran, CEO

**SDC2: Battery Power Scavengers:**

**PEO Soldier – 2 designs (MIT + USMA) for Soldier field testing by Fall 2005 ($250K); FY07 contract for Iraq**

## Goal: Involve undergrads in ISN

- ➔**Solve real problems, to help Warfighters**
- ➔**Involve military: USMA, mentors, judges**
- ➔*Innovate to make a difference sooner:*

*technology for Warfighters*

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Mar 2007

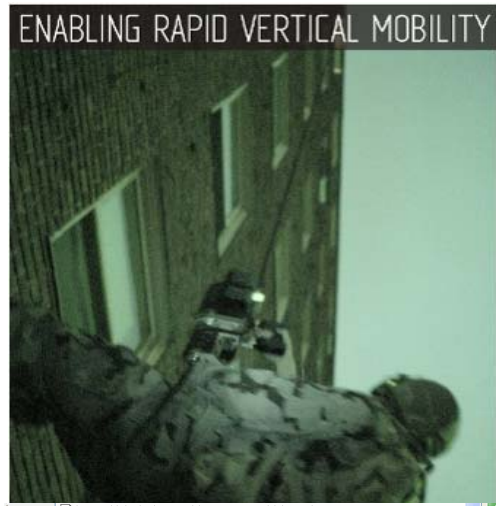
# Broader Impact & Media Coverage

POPULAR science best of what's new 2004

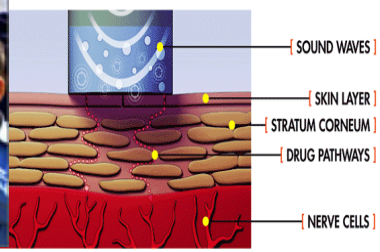
SonoPrep Skin Permeation Device
Injecting drugs with acoustics—not needles

SBIR: SonoPrep
Needle-less drug
delivery for vaccines
-- future battlesuit

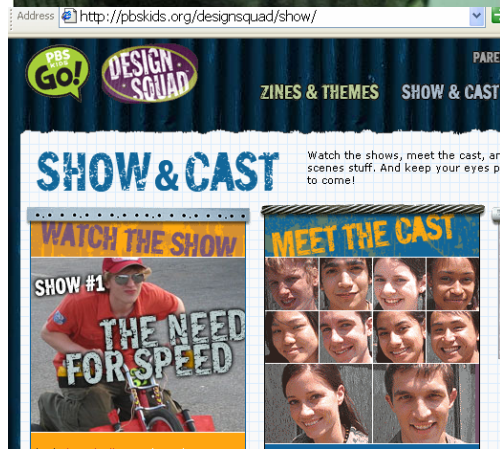
www.atlasdevices.com




ATLAS / Nate Ball:
MIT-Lemelson $30K
Inventiveness Award;
PBS Design Squad;
Army Rapid Equip Force
$120K Procurement of
ISN SDC-award winning
ATLAS Powered
Rope Ascenders
-- current needs



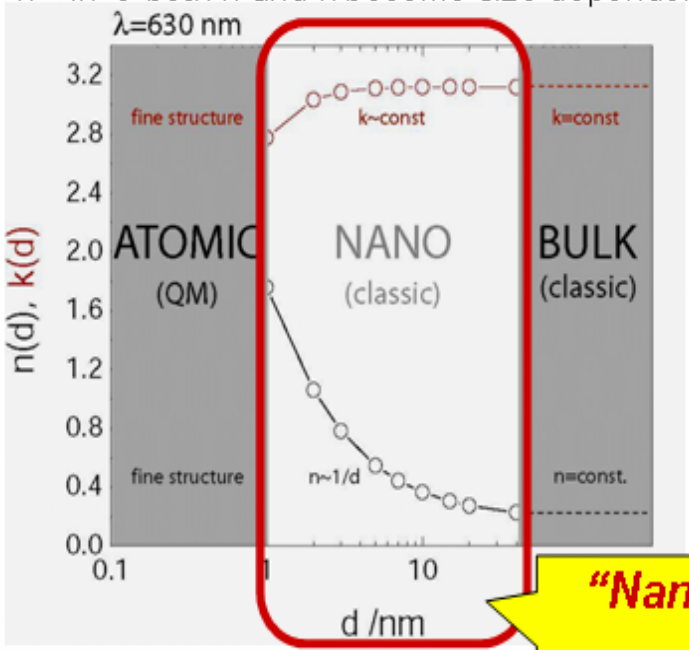

http://wbztv.com/video/?id=29313@wbz.dayport.com



# ISN: Building Understanding of a New Class of Materials with a Human Customer in Mind

## *Size Effects on the Optical Properties of Gold:*

Plotting the Index of Refraction of Gold shows
n + ik → both n and k become size dependent



*The color of Gold varies by Size*

***"Nano" == Where things change***

Opportunities:
Understand the physics better

*– new design space, new tradeoffs….*

## Characterize properties and Explore MANY uses of these new materials

***Define Parameter Space of new nanotechnologies – Don't target a single specific application***

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# Soldier Capabilities Enhancement: Technology from the ISN This Decade

## Improved Performance:
- 'Exomuscle' actuators
- Situational Awareness (SA) from Quantum Dot thermal detectors & conformal computing displays

## Improved Development Tools:
- Advanced Modeling & Simulation
- New Materials Characterization, Design and Test Tools
- Nano manufacturing

## Improved Protection:
- Sense unseen threats: chem/bio
- Nano-enhanced protective Materials (Transparent Armor, flexible protective materials)
- Smart coatings
- Smart materials with dynamic, switchable surfaces

## Broader Enhancements:
- Nanoscientists work for Soldiers
- Nano-systems engineering know-how
- Commercial Apps for Soldiers, First Responders (via Industry Partners, Small Businesses, Soldier Design Competition)
- Unexpected advances

## Improved Soldier Capability:
- Soldier bio-med: far forward triage & treatment (Needle-less drug delivery, dynamic splints…)
- Give individual Soldiers *small-unit* capabilities: Ubiquitous sensors, SA…

## Improved Military Capabilities:
- Improved Armor Materials
- Lightweight materials for Army systems (Vehicles, weapons, etc.)
- Advanced Materials + Optical Properties
- Laser Detection Sensors

*** Army Collaboration*

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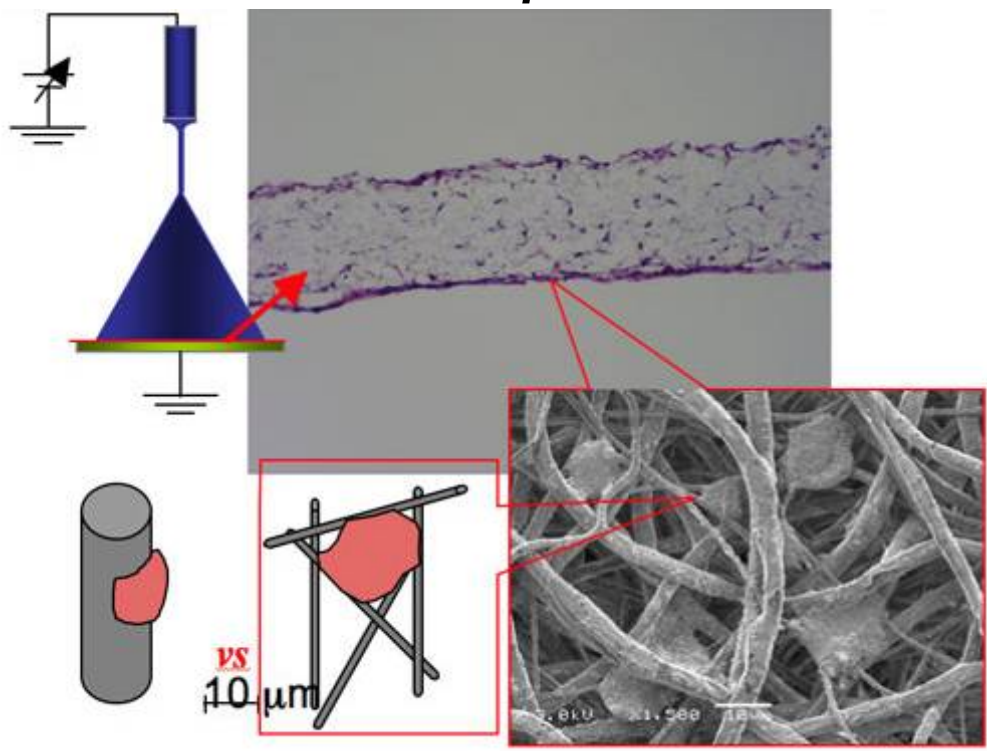
- **Project 4.4 partners Prof. Gregory Rutledge's team with Dr. Sonya Shortkroff (BWH and CIMIT)**
  - **Exploring electrospun PCL scaffolds to grow new biological tissues such as chondrocytes**

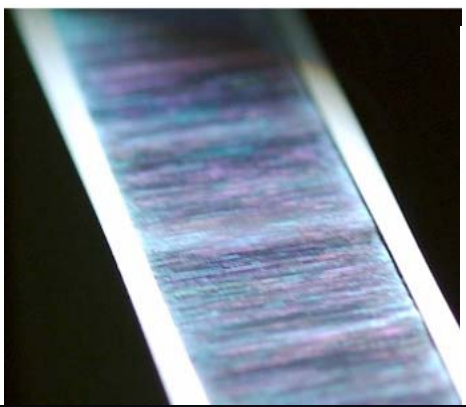
Electrospinning & Polymer Nanofibers

(L. Chen, J.L. Lowery, M. Ma, M. Wang, KK.Gleason, RM.Hill /DCC, D.Kaplan, S. Shortkroff)

*Superhydrophobicity*

*Electrospun scaffolds exhibit unconventional cell/fiber interactions*



With R. Hill, DCC Visiting Scientist @ ISN, Rutledge group co-invented monodispersed color-shifting nanofibers

# Collaboration between ISN researchers and Army Scientists: On-Site Army Research Lab (ARL-WMRD) Scientist

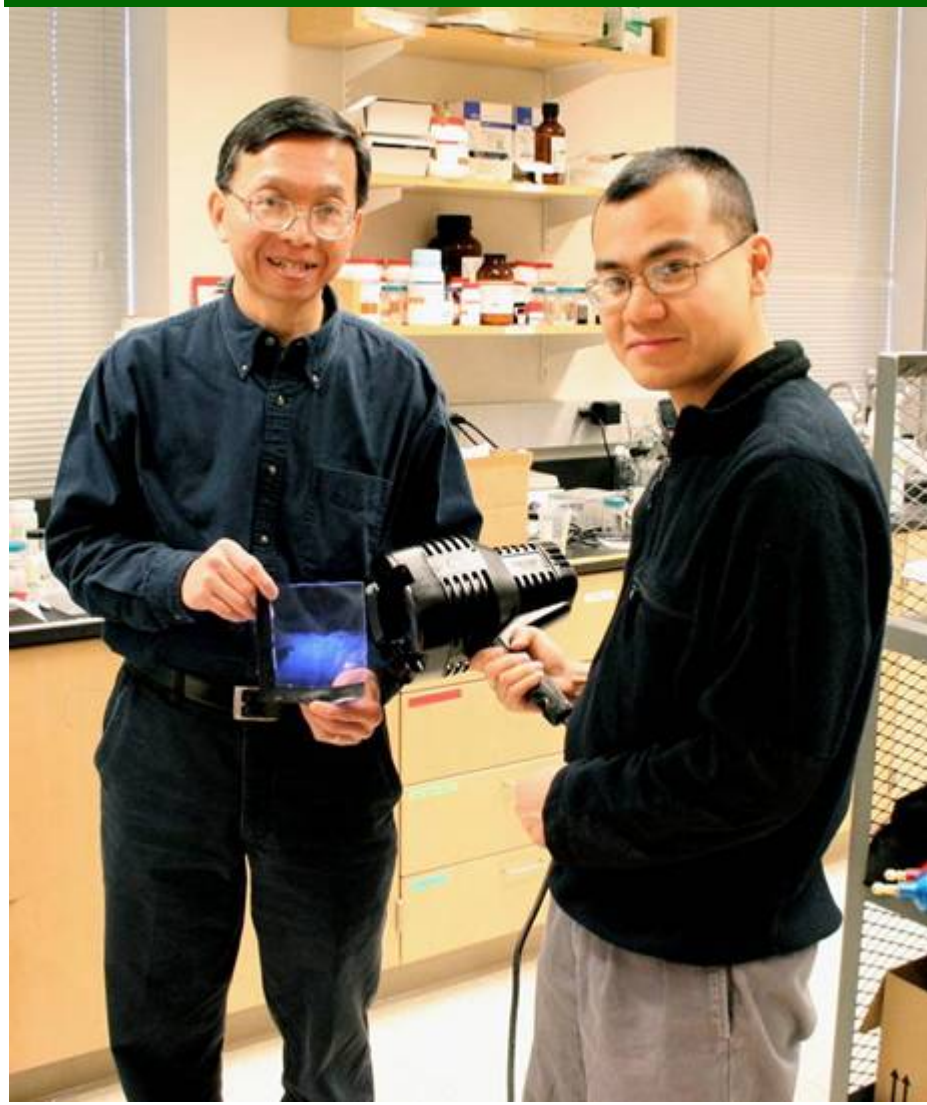
- Interesting material system developed at ISN
  - ➔ ***Army Scientist Alex Hsieh*** **creates transparent armor, understands Army context**
  - ➔ ***ISN researcher Jian Yu*** **created a polymer system with embedded nanofibers**
- Initial goal leads to transition opportunities:
  - ➔ **Initially: reinforce eyewear**
  - ➔ **Discovered *interesting optical properties in UV***
  - ➔ **Many potential applications *(optical tagging):***

*lead users for feedback / testing....*

Optically transparent in visible light

Pattern detectable under UV

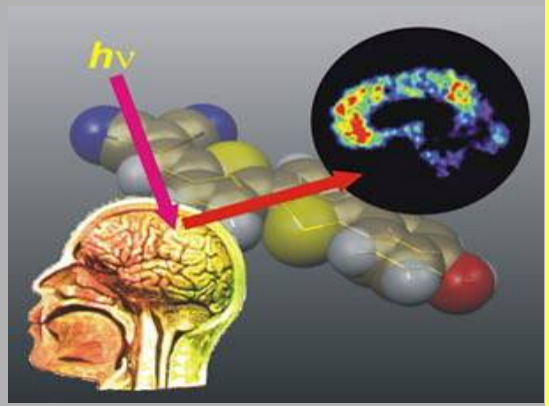
Army Scientist Alex Hsieh + ISN researcher Jian Yu



# ISN Tech Insertion: Army-funded 6.1 & 6.2 Science continues to improve explosives detection, leading to other capabilities

## Extending chromophore use:

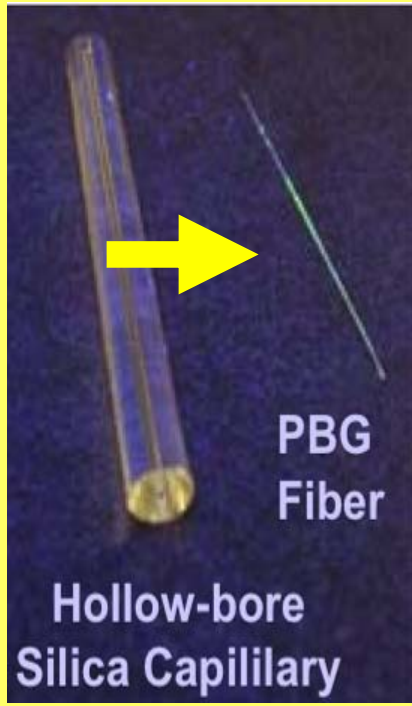
**from finding explosives (FIDO) to finding Alzheimer's: Swager's group designed new dye (NIAD-4) to bind with brain plaques (TBI?)**




## Changing chem platform:

Swager / Bulovic / Fink

*Nature Materials* **5,** 532–536 (2006)




***Hollow Photonic Band Gap (PBG) Fiber: Smaller Size & Better Signal***

*Nomadics FIDO == PLATFORM technology to insert new capabilities*

# Future Developments…
# Information-bearing Protective Materials?

- **Possible structural materials:**
  - + **Next-gen Light-transmitting polymer (fiber optics inside polymer matrix)**
    - ➔**CNT-reinforced polymer matrix**
    - ➔**Embedded FiberWeb fiber sensors**

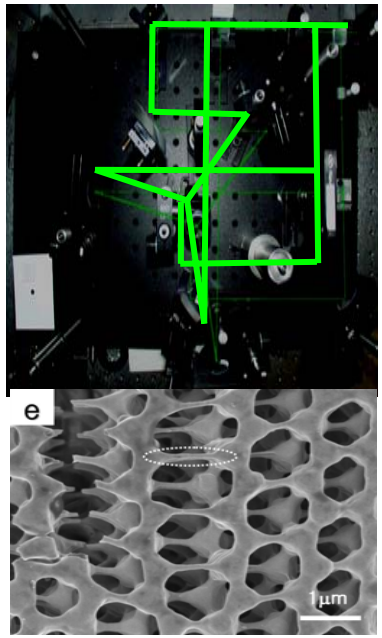
- **Possible protective materials:**
  - + **3D Microtruss system**
  - + **Holographic Data Storage**
    - **DCC subsidiary Aprilis**

- **Micropumps + FiberWeb == lightweight laser warning systems, systems (OPTICAL SOUND) etc…**

- **Lens-less Imaging with FiberWeb**

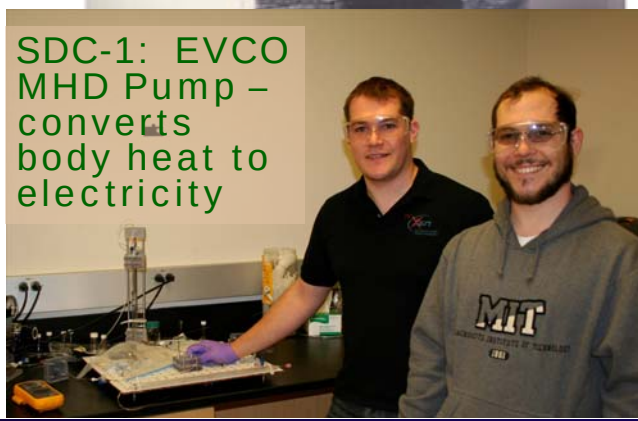
- **Flexible EMI Shielding with iCVD**

- **New computer interfaces: logistics ops**




*Microtrusses via2D & 3D photolithography*

LitraCon light-transmitting concrete invented by Hungarian architect Áron Losonczi – Structural material embeds optical fibers <*www.litracon.hu*>



SDC-1: EVCO MHD Pump – converts body heat to electricity

# Army Expectations of Industrial Partners

## *Focus:* Nanotechnologies to improve Soldier protection

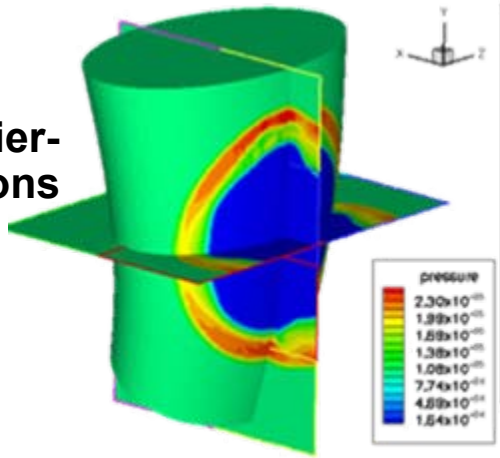
- **Industry Partners should support Soldiers as valued customer**
  - **Collaboration with Army/DoD S&T encouraged**
- **6.2 Research should be scientifically compelling, AND should lead to commercial applications for nanotechnologies, leveraging 6.1 basic research**
  - **Two major paths:**
    - ***Commercialize*** **for open market; Army / other Gov't == Customers**
    - **With Army programs,** ***customize*** **for applications for the Soldier**
  - **Seek ways to** ***expedite*** **transition into products**
    - **Early products may be incremental improvements over current tech**

**➔Soldiers = *Lead Users*, giving feedback on future directions**

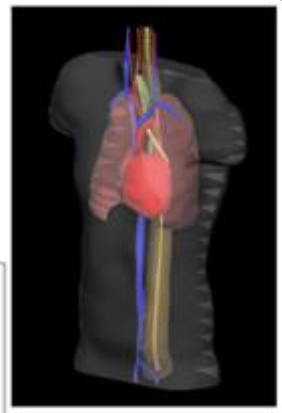
# Army-funded University Affiliated Research Centers work with Army Scientists to address challenges

## Energy Absorption:
**Modeling Soldier-Blast Interactions**

***Radovitzky***




*Simulation of lung injury due to blast overpressure (BOP)*



*Target human organ models*

**Army ARL-WMRD @ISN: Scientist Alex Hsieh**

Multi-Hit Resistant System

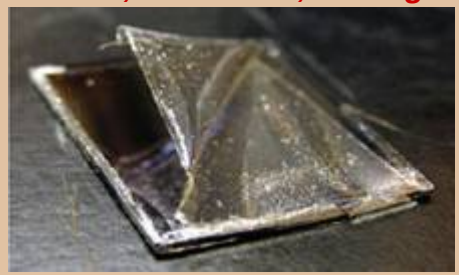
**IP: 4.5 Energy Absorbing Responsive Fluids**

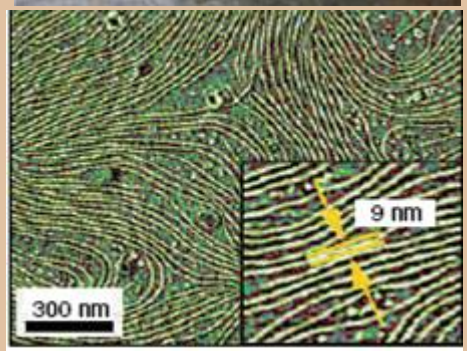
**ISN Researcher Giorgia Bettin**

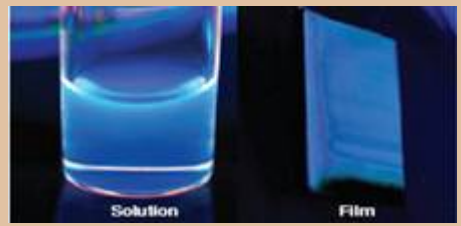
## Transparent Protection:
**Shear Thickening Foam system, tested at ARL-WMRD**

## Portable Energy:
Virus-based Self-assembly of flexible Lithium batteries

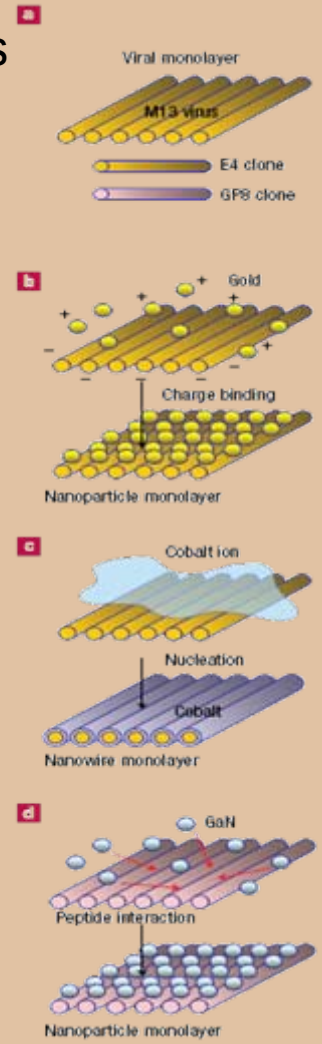
***Belcher, Hammond, Chiang***






***Nature Materials, Vol 5, Mar 2006***



# SDC Transition: Ancile Warning System

Cadets 1st Class Brian Lebiednik and Greg Isham (front center and right) smile as Ancile system picks up another mortar round at the C-RAM exercise at Yuma Proving Grounds, AZ. Army officials said they hope to issue pagers to Soldiers in Iraq within the next nine months. *U.S. Army Photo*

**Reward Innovation for Soldiers!**

## *"Cadet project could save lives"*

**By MAJ Fernando J. Maymi, D/EE&CS**

**"Pointer View," May 27, 2005**

**http://www.usma.edu/PublicAffairs/PV/050527/project.htm**

**Four senior USMA cadets helping make troops safer.**

**EECS senior project for USMA Cadets 1st Class:**
**Jeffrey Hermanson, Jamie Dayton, Brian Lebiednik, Gregg Isham**
**Cadet team designed and built an Ancile pager to warn Soldiers of incoming artillery/mortar strikes**

**Army tested at Yuma PG: "significant advance notice each time"**

**Project sponsor Paul Manz, technical director for ground combat command and control in Fort Monmouth, NJ, developed a plan to field pagers within 9 months.**

**Their senior project was a great way for them to help Soldiers:**

***"wonderful that we were able to do something that helps keep our fellow Soldiers safe while they are working to keep us here at home safe"***

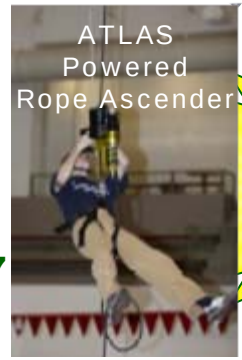
➔ **Florida-based Mahdahcom licensed + is producing Ancile**

# Dealing with Success: Innovation Challenges

***Secretary of the Army joined us for ARO @ ISN Workshop, 11 Apr 2006***

- In innovation, tech **availability ≠ adoption**
  - *Absorptive capacity issues*
    - *Practice for major change (FCS)*
  - *Clockspeed differences*
  - *Impedance mismatch*
- Outsourcing risk == outsourcing process
  - *Other peoples' processes reward differently*
    - MIT TLO → patenting IP, $$$
    - Small business marketing needs vs. OPSEC
- Entrepreneurs need to survive
  - *First customer == favorite customer*
    - *Lead users: **joint**, varied missions*
    - *Champions crucial*
  - *Timelines are very different!!*
    - RallyPoint: Apr 2004 vs. FFW Dec 2007
- Need to help manage risk
  - Army can help! Eg, Safety Certs, operational assessments
  - Need business growth: shared costs / revenues
- Innovation can help the Army & the Army can help innovators!
  - *Need adaptive leaders who train in innovation*
    - *–Science must translate to technology*
      - *– Technology must come to market*
        - *– Customer purchases make a difference*

RALLYPOINT




*Good challenges to have....*

Fido™ Explosives Detector

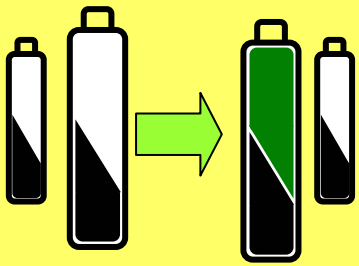
# Support to Current Operations

- Nomadics FIDO explosives detector has been in Iraq since Summer 2004: limited assessments by Soldiers and Marines, and screening with EOD Tech
  - ➔*Detects TNT/TNT-based explosives, usable in several modes: handheld, on robot, underwater, down wells*
  - ➔*Air Force bought systems for cargo screening*
  - ➔*Army Rapid Equipping Force and Joint IED Task Force funding Iraq-based ATEC Warfighter Assessment of integrated FIDO on iRobot PackBot for vehicle inspection*

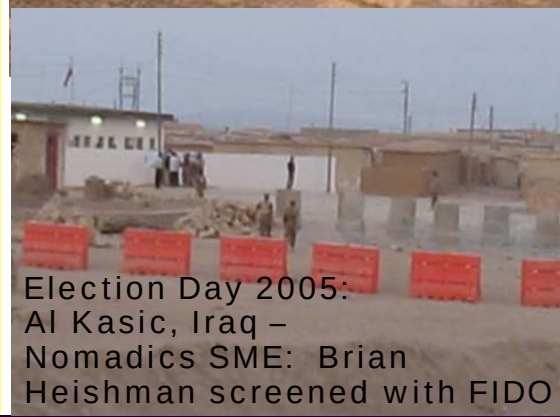
Fido™ Explosives Detector

- PEO Soldier procured ISN Soldier Design Competition award-winning Battery Power Scavenger designs from undergraduate teams for Soldier assessment
  - ➔*Designs from Supercharged (USMA) and Xitome (MIT) help Soldiers by scavenging power from used AA batteries for rechargeable batteries*

**USMA Team Supercharged: Cadets Nick Barry, Jeremy Spruce, Walter Velasquez**



**MIT: Xitome CEO Kailas Narendran shows PowerPlus**

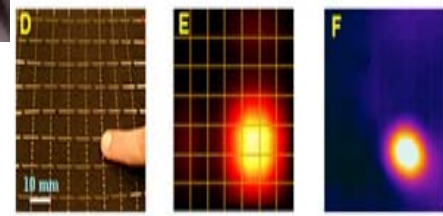


Election Day 2005: Al Kasic, Iraq – Nomadics SME: Brian Heishman screened with FIDO

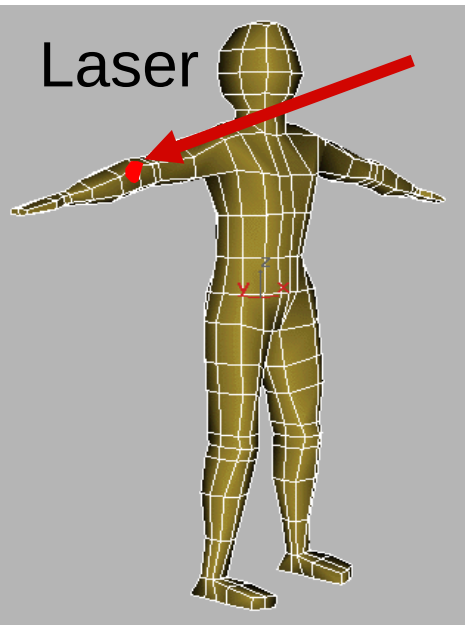
# ISN "Fiber Web" linear sensors (Profs. Fink & Joannopoulos)

*Same Material: FIBER WEB:*
*Senses light from lasing*
*(both ops + embedded training),*
*Temperature for well-being,*

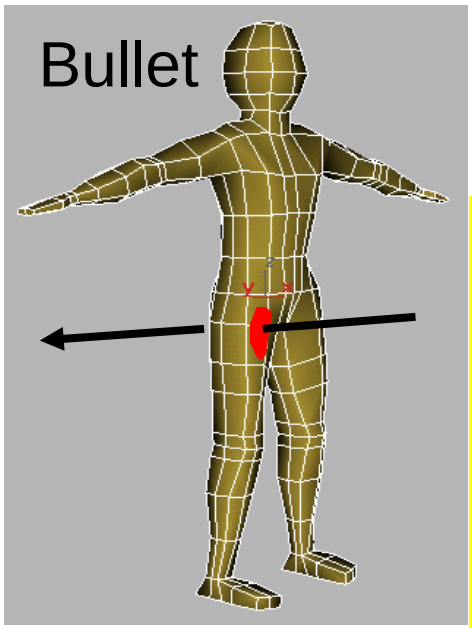
*Lasers for intra-squad comms*
*(when RF not available or desired)*



***Full Body MILES++***
***For Realistic Training***




***Full Body Thermal Sensing***




*-- Rapid helmet prototype for*
*PM SOF Warrior CID user demo*
*27Nov2006*

*-- Based on 20Dec2006 VTC,*
*PM Live Training Systems will assess*
*for potential use in*
*Training devices e.g. MILES, E-Targets*

*Challenge: Tech vs. OPSEC*

- Why ISN good idea:  ISN acts as  hub
  - Multi-dept professors brought together
    - Chem Eng (Gleason) + Chem (Klibanov)
    - Big discoveries at the crossing of academic boundaries
    - Army benefits from interaction of smart people
      - They benefit by meeting / knowing customer
- My role:  Military liaison – people get immediate feedback from me as combat commander on technology uses
- Some ISN projects
  - FIDO
  - Cima Microchips vs. hemorrhagic shock --??
- My special project
  - FiberWeb ICOM-H:  comms over light
- SDC rapid innovation program:  How are we helping the Soldier today

# Breakthroughs, the Product of Innovators

By Burt Rutan

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# Breakthroughs: Why

- Technical accomplishment
  - Defines our species - separates us from other animals
  - Satisfies desire for continuous improvement
  - Provides for ‘well being’
- Without breakthroughs
  - Boredom and mediocrity
  - Low expectation of future
  - Degradation of national security

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# Breakthroughs: When

- When do breakthroughs occur?
  - During or shortly after:
    - Crisis, chaos, “bad” times
  - Not:
    - During tranquil, stable, “good” times
    - When highest priority is equal status of populous
- We are creative when scared

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# Breakthroughs: How

- Breakthroughs cannot be specified by massive funding
  - Example: Low cost space access was the **goal** of the Space Shuttle Program
- Breakthroughs occur due to the working environment
  - Kelly Johnson ‘Skunk Works’

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# Breakthrough Observations

R & D experience has **inverse** relationships

- Value of product….Self-perceived sophistication of customer
- Content of new technologies….Program timeline
- Product's worth….Risk averse role of managers

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# The management of innovators

Manager's only tasks: Set goal and get funding

- Set goal high  (50% should say impossible)
- Reward achievement of goal  (power of a prize)
- Let the innovator decide what risks to take
- Leave them alone and keep others out
- Applaud courage and expect multiple failures
- Allow *fun*

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# Focus for the management of innovators

*"If you want to build a ship, don't drum up people to collect wood and don't assign them tasks and work, but rather teach them to long for the endless immensity of the sea."*

*-**Antoine de Saint-Exupery***

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# Exposure During Childhood Leads to Adult Technical Innovation

- Inspiration begins early – Kids ages 3 to 14

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# Our Responsibility Now - Create Progress to Inspire our Kids

- Our Technology leaders had their inspiration in exciting times
- Periods of extreme technical progress: I will discuss three.
  - Aviation's Renaissance, 1908 to 1912
  - My inspiration, 1946 to 1957, post WWII
  - Gagarin to Skylab, 1961 to 1973

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# Aviation's Renaissance
# 1908 to 1912

- Early 1908, < 12 pilots
  - Then "I can do it"
- By 1912
  - Hundreds of aircraft types in 39 countries
  - Aircraft invented by 'Natural Selection'
  - Airshows with 400,000 attendance

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# Kids Were Inspired by Aviation's Renaissance

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# Which Kids Were Inspired by Aviation's Renaissance?

- **Every one** of those that inspired me.
  - Wernher von Braun
  - Kelly Johnson
  - Charles Lindbergh
  - Jack Northrop
  - Ed Heinemann
  - Howard Hughes
  - Sergei Korolev
  - Alexander Lippisch
  - Bill Lear

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# Aerospace Activity 1946 to 1957
## During my Childhood (age 3 to 14)

The Jet Age starts. The Missile Age starts.

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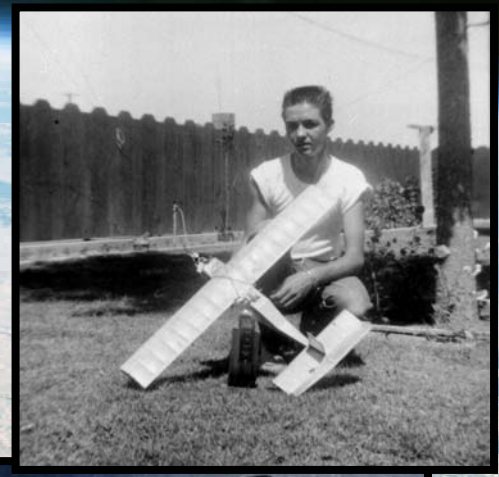
# Childhood Activities Were Driven by Aviation Progress



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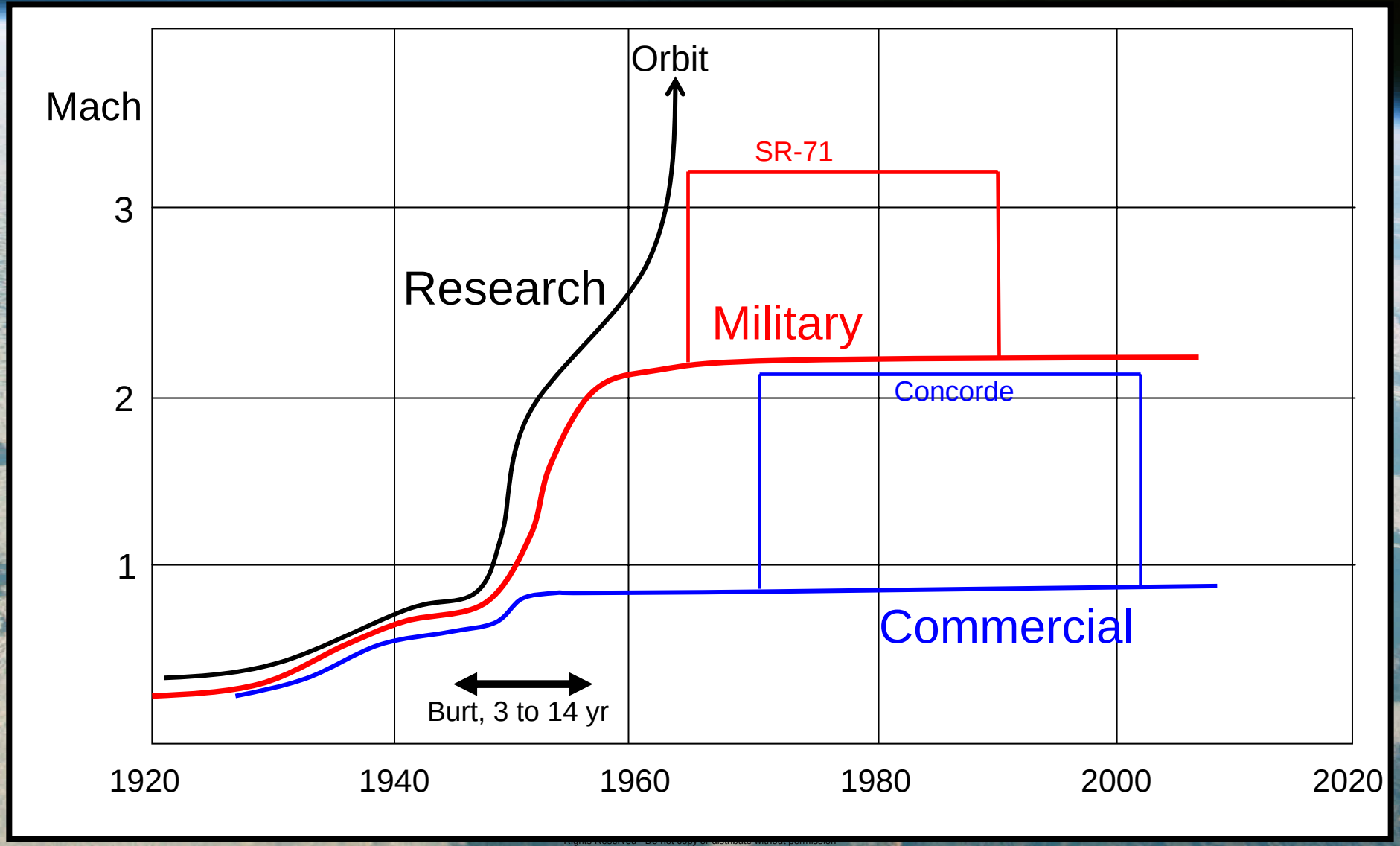
# A Jump in Performance
# Inspired me during childhood



# My Post-College Career Choice: Aviation (unusual for space-crazed 1965)

- Airplanes, not the moon
  - Realist?
  - Burt the conservative?
- General Aviation was the passion, but Air Force Flight Test, was the Compromise.

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# Air Force Flight Test 1965 to 1972

## The “whole-package” experience

## Best training for an aircraft designer

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# Military Flight Test Not Fulfilling

- Great experience, but not creative
- Light aircraft – target rich for innovation
- Light aircraft were the ‘fun hobby’
- The dream of a job as fun as the hobby

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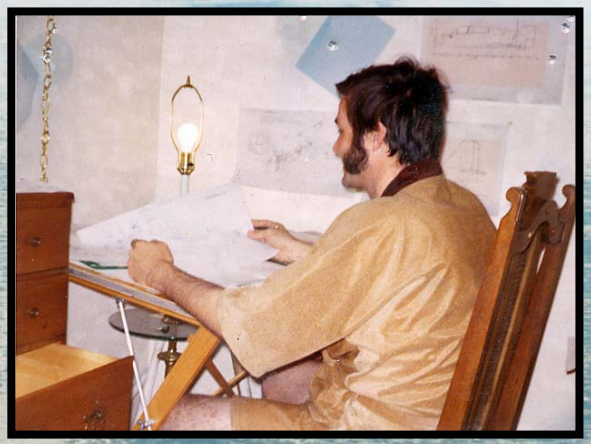
# A Big Jump ‘Down’ 1972

## Rutan Aircraft Factory

## The entrepreneur can control his destiny



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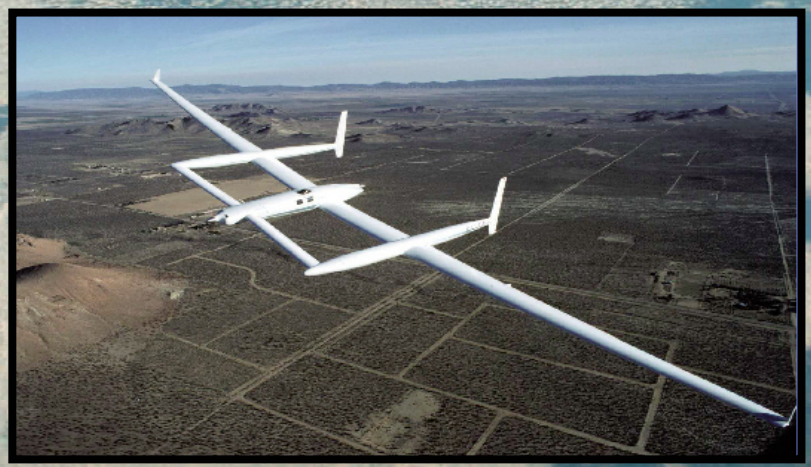
# The Projects of RAF 1972 to 1985

# The Public Interface
# The Thrill of the Milestone



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# Scaled Composites Company
# 1982 - Present

- Composites Structural Technology
- Aggressive projects, big customers
- World-Class Staff – shop and engineering
  - More folk to have fun

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# Scaled's Aircraft

**DC-X**
**1995**

**Roton**
**1999**

**SpaceShipOne**
2003

**Predator**
1984

**Pegasus**
1990

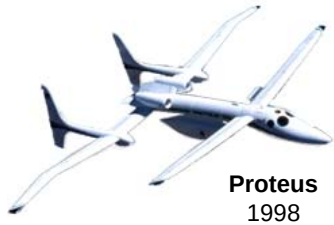
**Raptor D-2**
1994

**X-38**
1997

**ARES**
1990

**Scarab**
1986

**Vantage**
1993



**Proteus**
1998

**White Knight**
2002

**Starship 1**
1983

**Triumph**
1988

**Raptor D-1**
1993

**X-47**
**2001**

**VisionAire**
**Vantage**
1996

**ATTT**
1987

**Lima II**
1991

**Freewing**
1994

**Adam Model 309**
2000

**Global Flyer**
2004

**Microlight**
1983

**CM-44**
1987

**Pond Racer**
1991

**V-Jet II**
1997

**TAA-1 POC**
2002

1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004

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# Why The Perfect Accident Record?

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# The U.S. Manned Space Renaissance 1961 to 1973

- Progress accelerated by Sputnik/Gagarin 'losses' – The need to regain National prestige
- A wild ride to recover prestige
  - Mercury, Gemini, Apollo lunar, Skylab and planetary exploration
- Enormous courage applied to huge risks
  - Five launch systems in seven years
  - Apollo 8/Saturn 5 risk
  - Lunar-orbit-rendezvous decision

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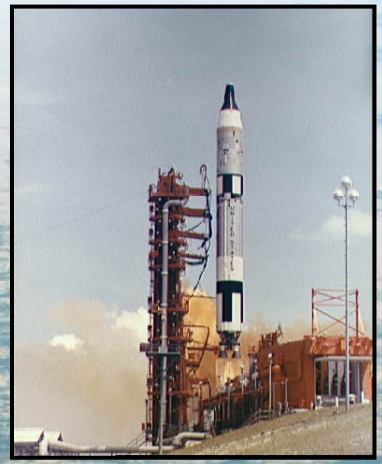
# American Manned Launch Systems

| Redstone | Atlas | Titan | Saturn | Shuttle |
|---|---|---|---|---|
| | |  | | |
| Flights: 2 | 4 | 10 | 15 | 114 |

Each was abandoned when more expensive one became available - not matured for affordability

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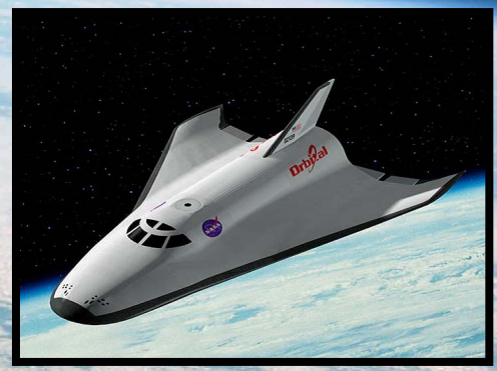
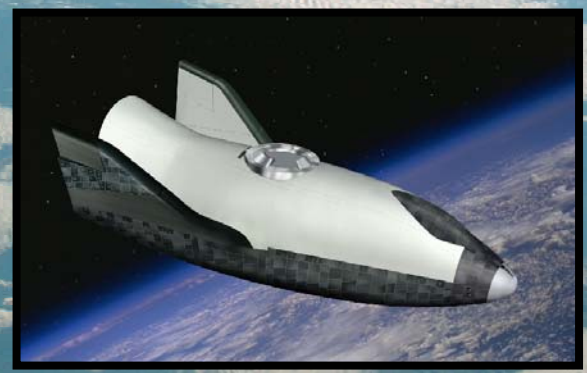
# The Collapse that Followed 1973 to Present

- Abandoned genuine search for safe, efficient orbital manned capability.
- Abandoned lunar capability
- Risk-averse attitude: study it, do not try to fly.
- Lacked the courage to fly new research programs





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# The Most Impressive Aircraft?
# Lockheed SR-71

Designed in 1959, only 14 years after first operational jet.
First flown in 1963.
Abandoned in 1998, retreated to 1956 U-2.

P-80
1945

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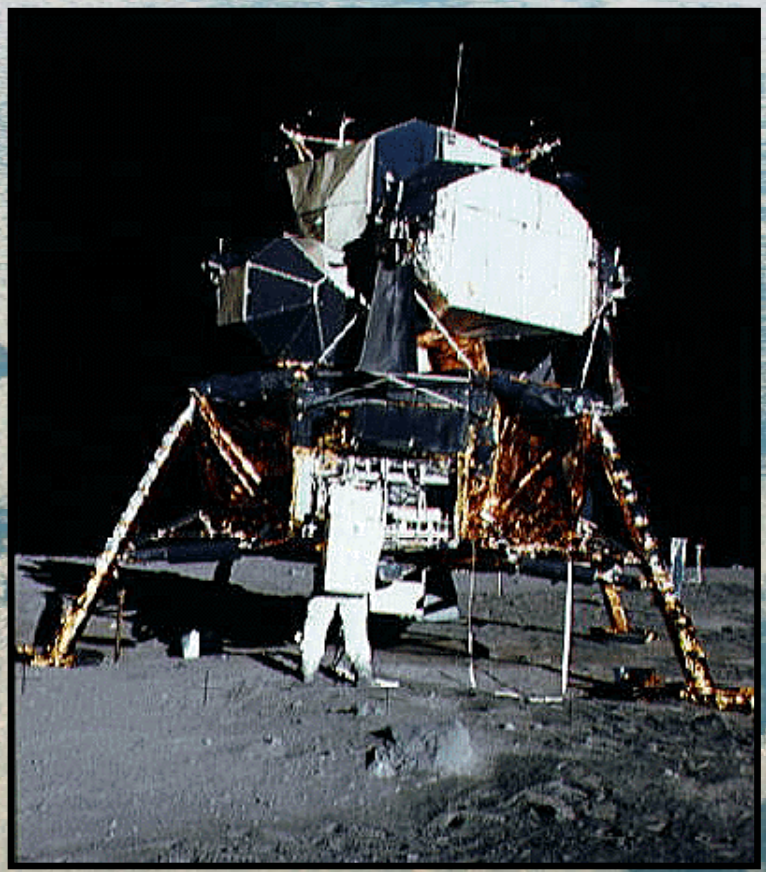
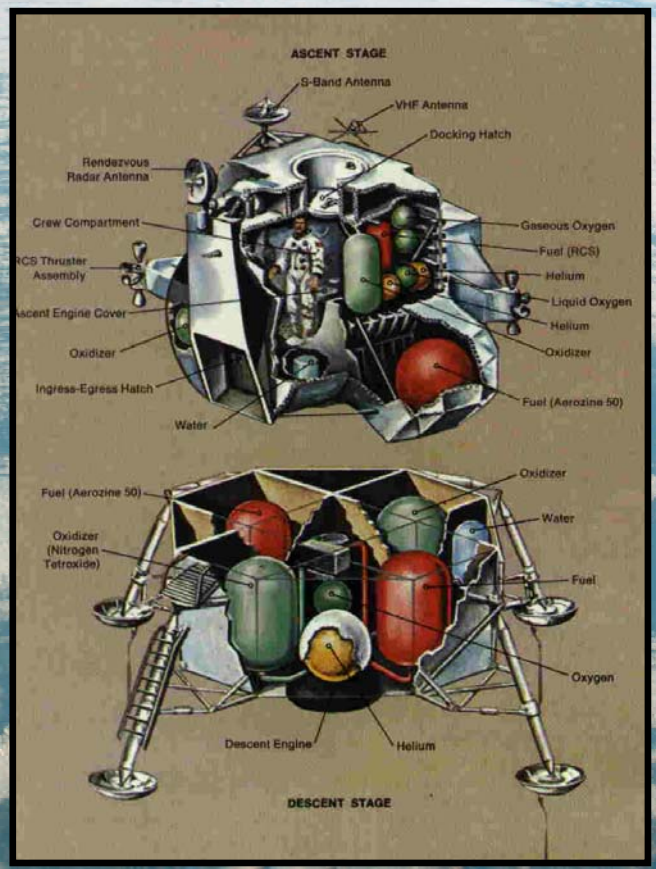
# The Most Impressive Spaceship?

Grumman Lunar Module
Designed in 1964, three years after Gagarin
First flight 1968
Abandoned capability in 1972





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# What is wrong with this picture?

1925 1965 2005

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# F-22 Raptor & F-35 JSF
## The only new USAF fighters for the next 40 years?

- Another 40 years with 1960's performance?
- Requirements based on perceived need, not a desire to find performance breakthroughs.
  - Air superiority in < 2 days, last two decades.
- Requirements direct Development Programs, not Research.
  - Industry employs a new generation of aerospace engineers who think development **is** research.
  - Risk averse requirements breeds risk averse technical progress.

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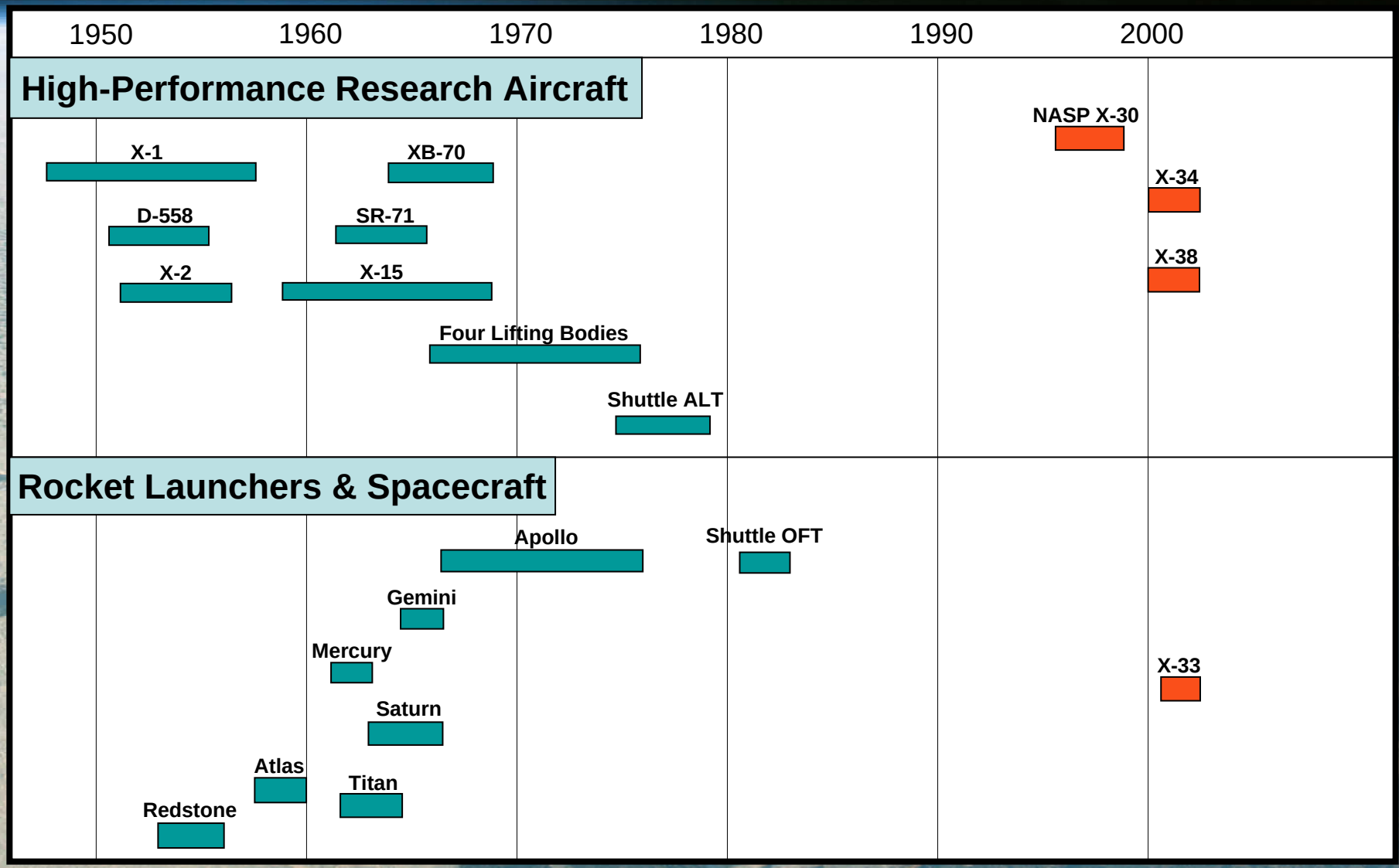
# Historical Perspective

## Manned Research Programs That Expanded the Envelope

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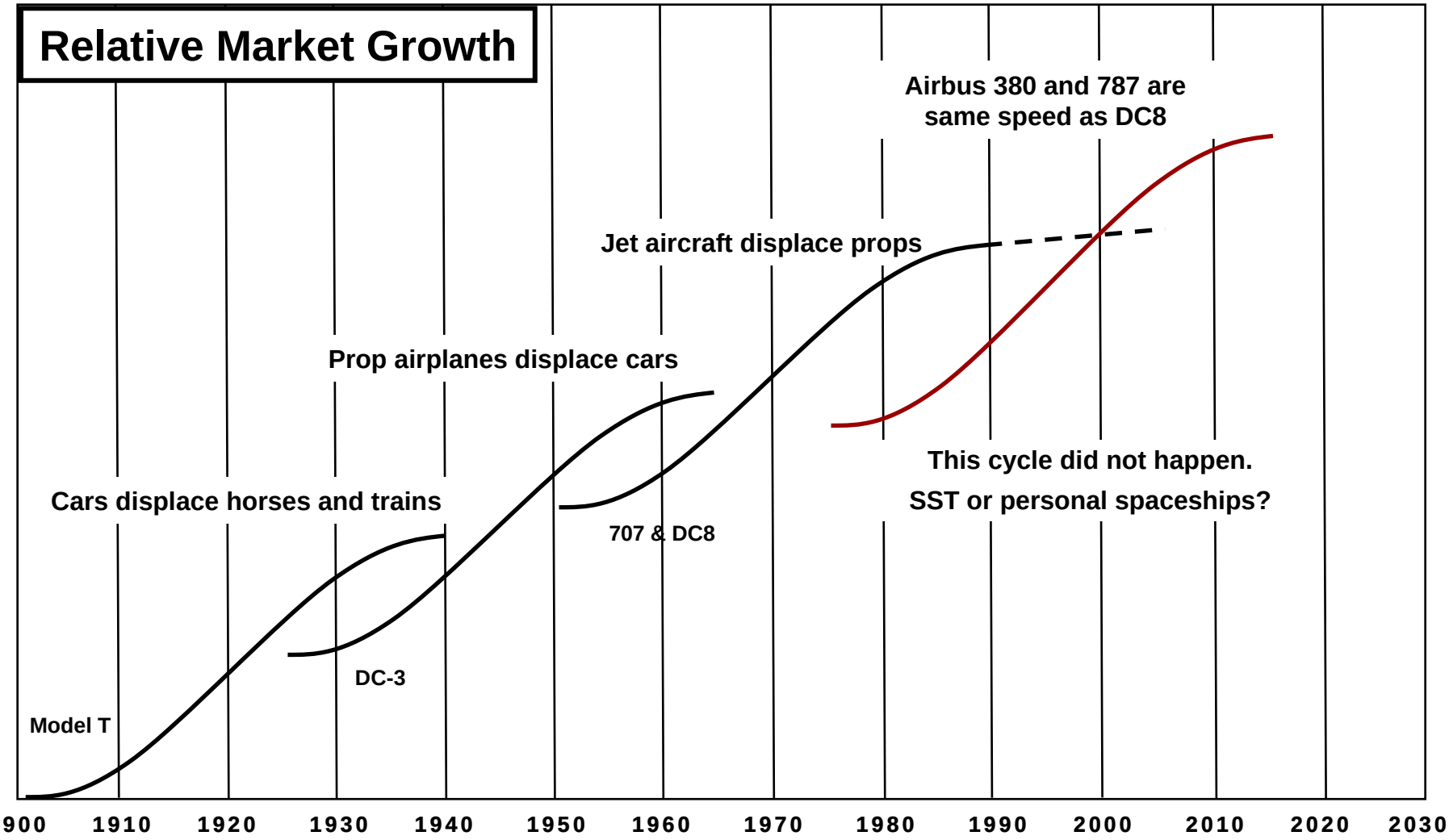
# Higher Speed Travel – Forty Year Cycles
## We are Overdue - Recent Cycle is Missing

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# Orion/Ares, NASA's road ahead

- Retreat to Apollo/Shuttle-era hardware for manned orbital and lunar operations
- No opportunity to discover breakthroughs
- Another 13 years without progress for Personal Spaceflight
- Lack of challenge for another full generation of spacecraft designers.

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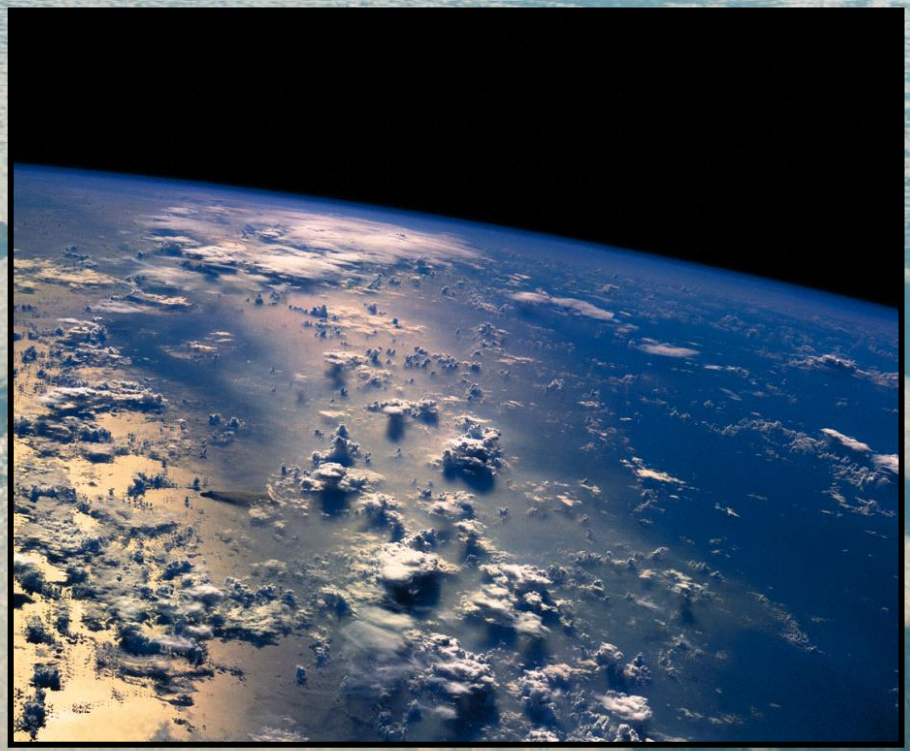
# Our Sub-Orbital Space Program

## The Goal is Fun, To Enjoy This View

To stimulate a Private Spaceflight industry,
so others can enjoy this view



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# Space, for us – Why Now?

- SpaceShipOne was a personal goal, not a customer request
- Inspiration from visionaries' courage
  - Required my exposure **as a child**, not a view of current aerospace practice
- The 'New Space' investors/developers – were, **as children** inspired by Sputnik to Apollo
  - Allen, Musk, Bezos, Branson, Bigelow, Page/Brin & Carmack

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# Our Research Test Pilots

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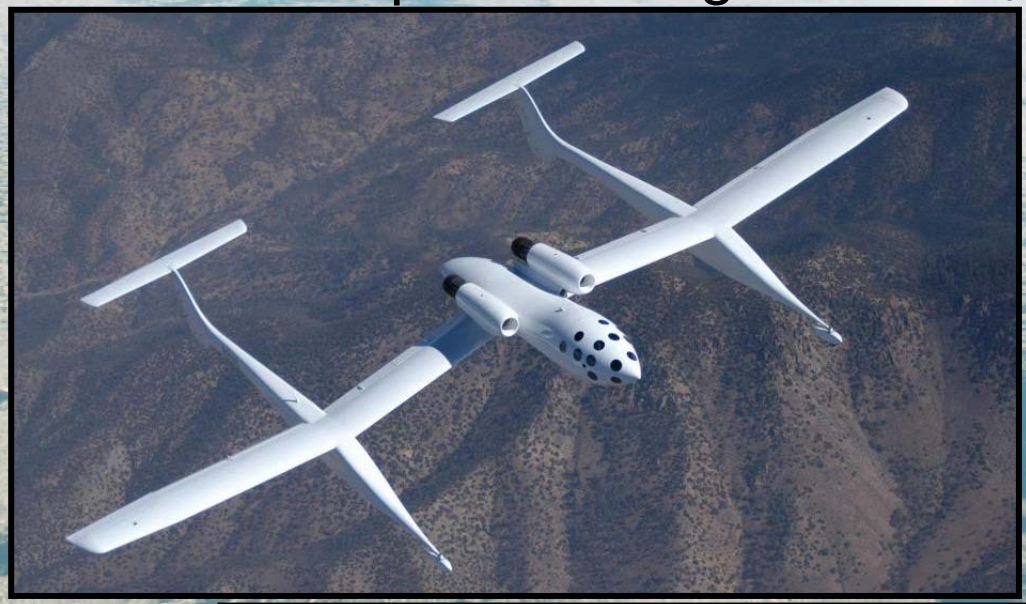
# Launch Aircraft - White Knight

- Identical systems components to Spaceship.
- Provides pilot training for boost, entry & landing.



# SpaceShipOne

Air-launched
Feathered entry
Runway landing

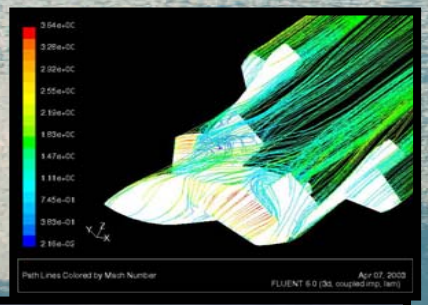
# The Re-entry Feather

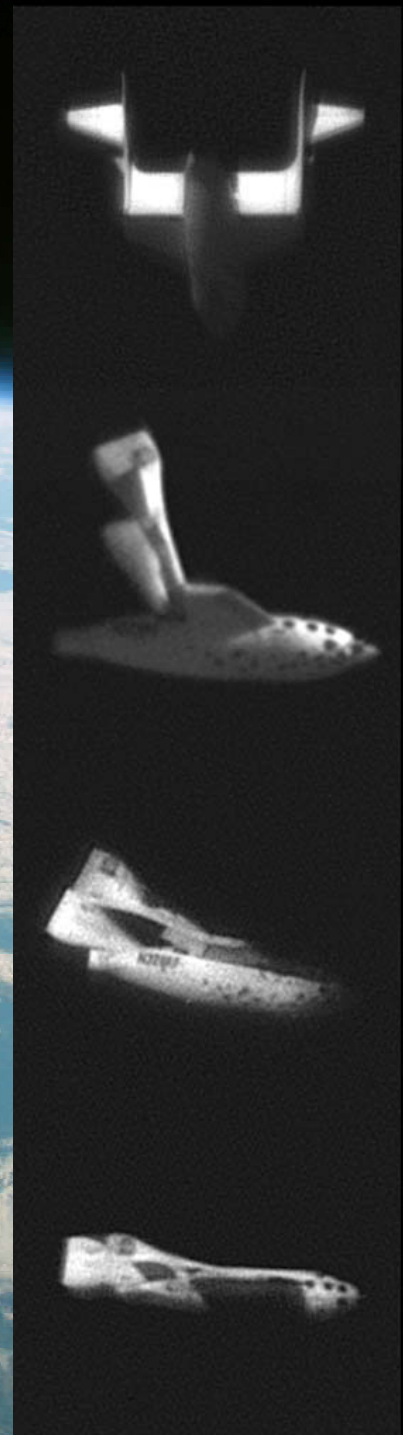
## Immune to accidents caused by entry flight controls

Forces Ship to a Stable High Alpha Condition

Active controls not needed

- High Drag = Lower loads & Lower Heat
- Result: ‘Care-Free’ atmospheric entry





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# An Aggressive Flight Test Program

- White Knight , Pre-Spaceship
  - Performance, Stability & Space Systems Development
  - 56 flights, 10 Months
- Rocket Hot-Fire Ground Tests
  - R & D - nine months, eleven firings
  - Flight qualification - Three Firings

- SpaceShipOne Flight Tests
  - Two captive carry (one manned)
  - Glide tests - 7 glides, 4 months
  - Rocket Powered Envelope Expansion – 4 flights, last one >100km
  - X-Prize – 2 full-performance flights in 5 days

# Space flight really **is** too dangerous
## Airline experience as a model

Risk statistics, fatal risk per flight

- All manned space flight = 1 per 66 flights
- First airliners (1927 & 1928) = 1 per 5500. Same aircraft, but add some maturity (1933 to 1935) = 1 per 31,000
- Modern airlines = 1 per several million

- Logical Public Spaceflight goal:
  - Better than the first airliners
  - < 1% of the historic government space risk
  - Achievable only for sub-orbital

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# Is a New Space Renaissance Possible?
## What Is Needed?

- **Environment that existed for aircraft in 1909**
  - Entrepreneurs in competition for market share
  - Belief that “I can do that”
- **Courage to try risky concepts**
  - Breakthroughs needed for safety
  - Robust solutions needed
- **Research justified by exploration and fun**
  - Not just politics and ‘science’

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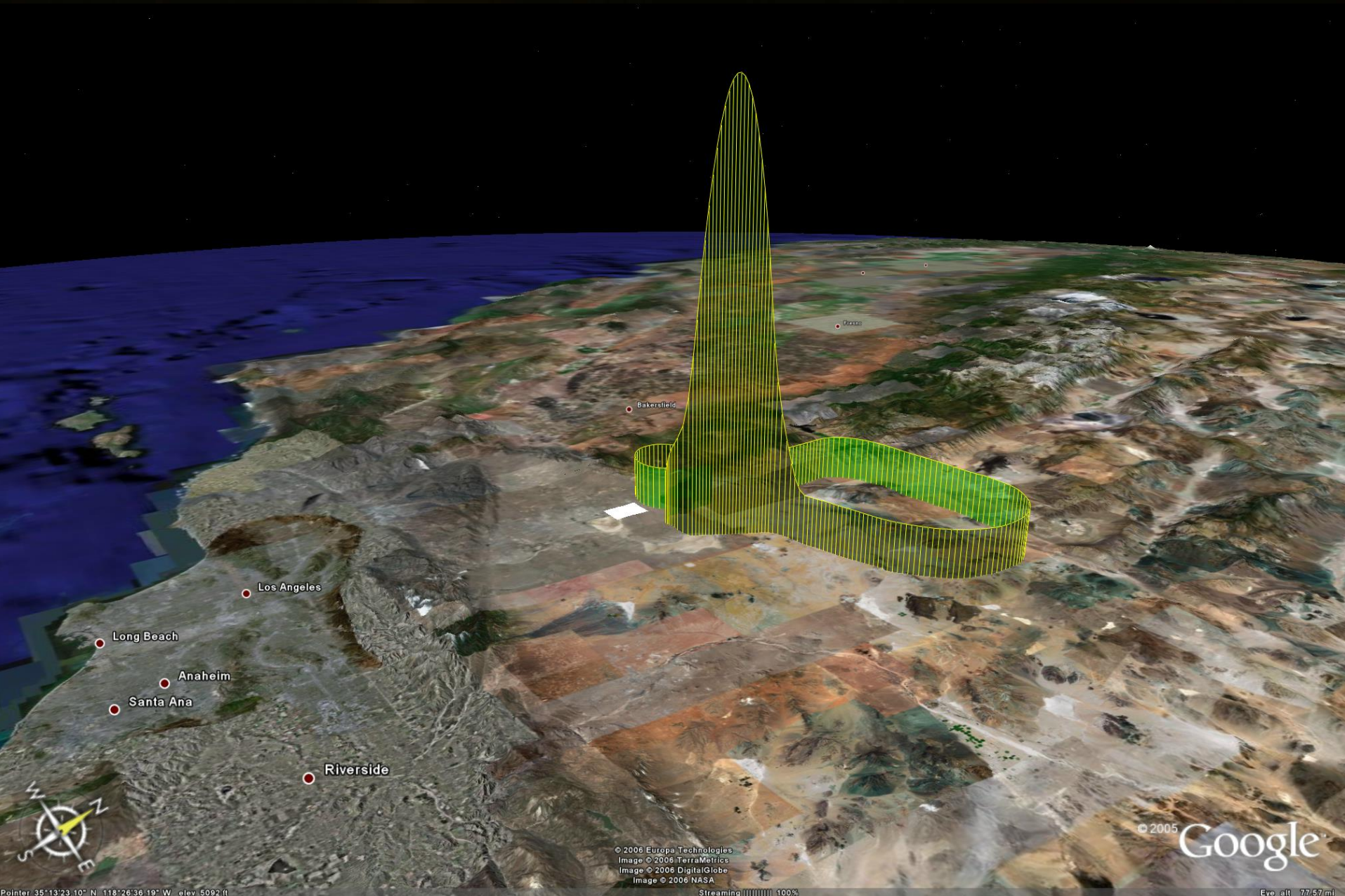
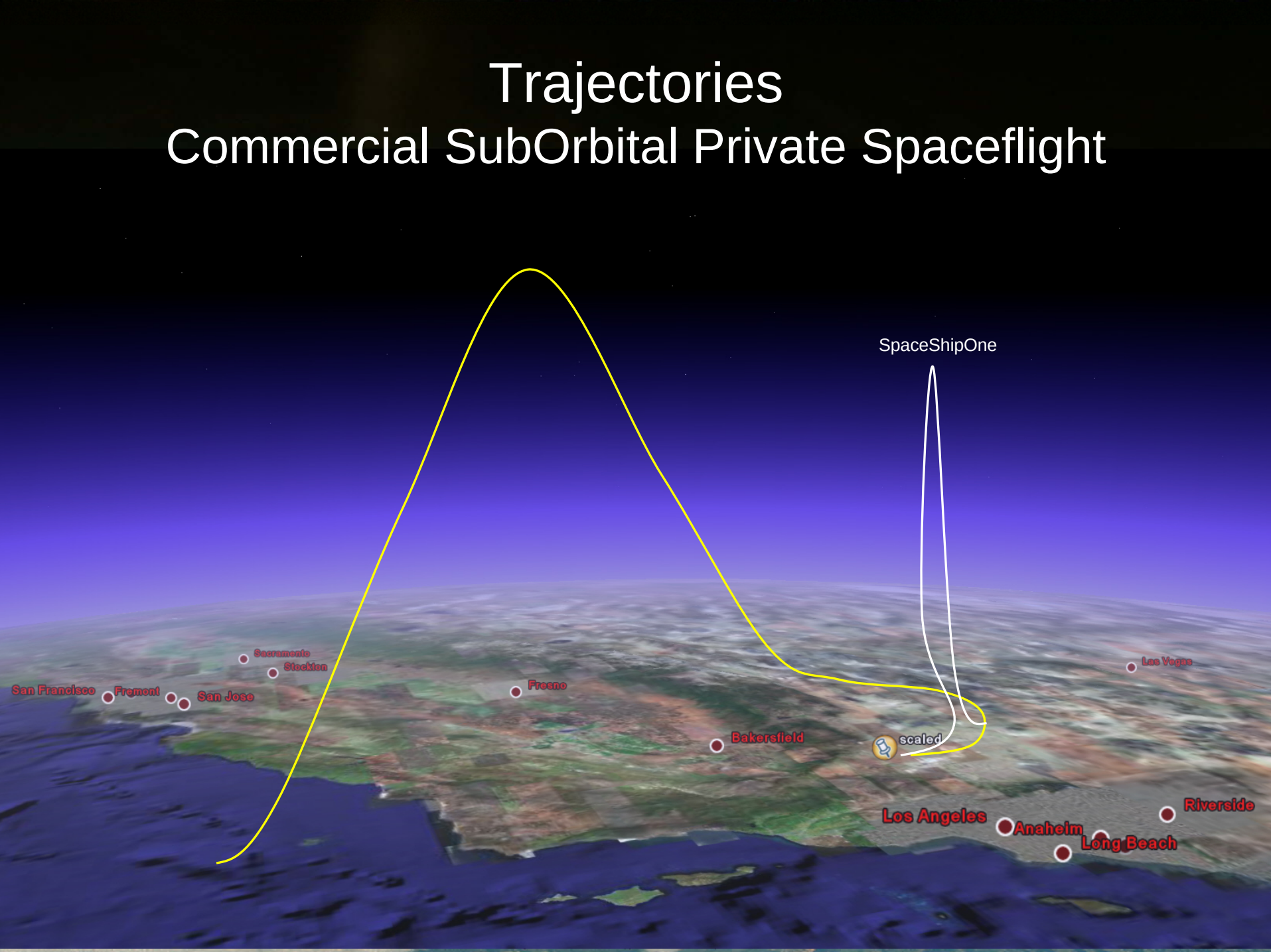
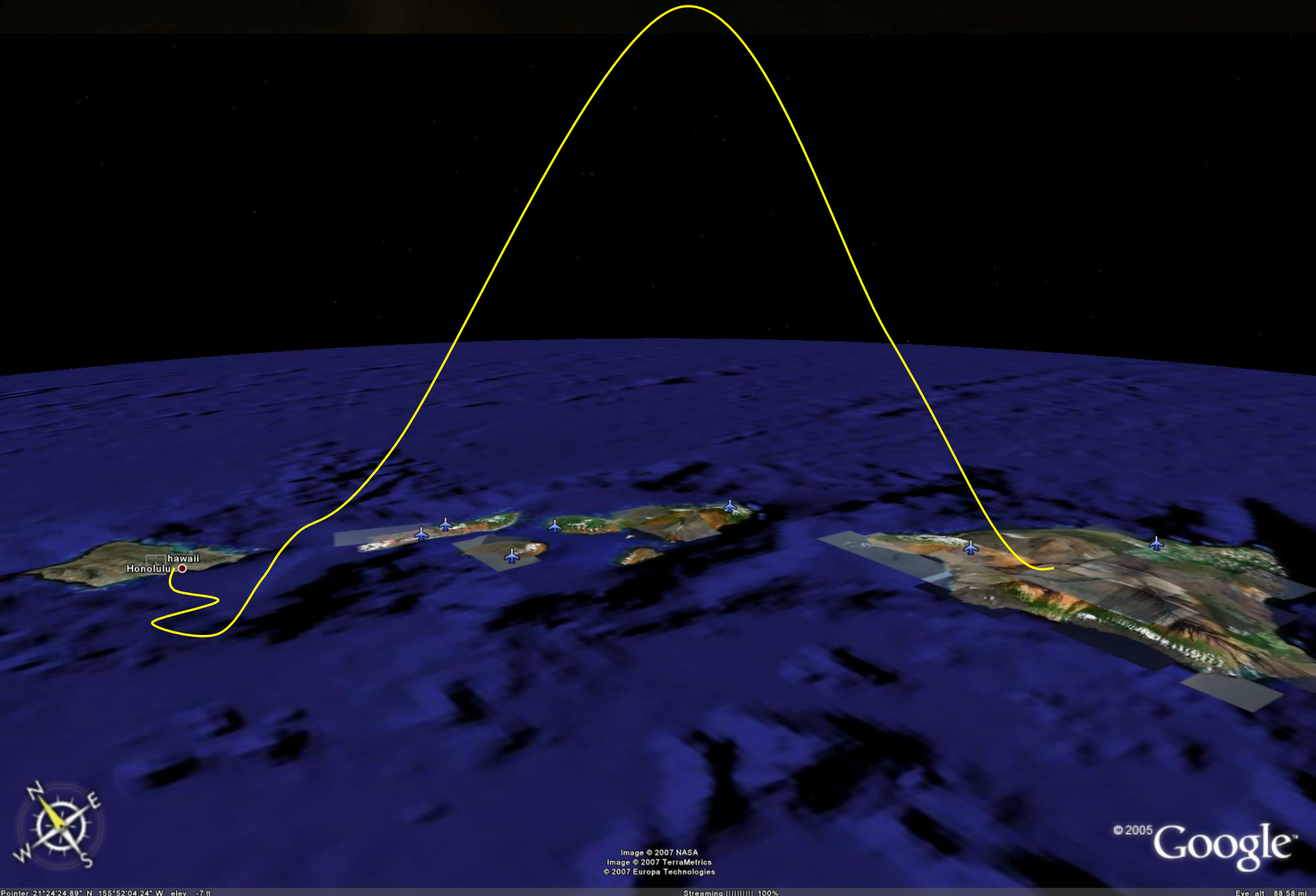
# Your View from 130 Km altitude – Mojave Desert



# Trajectories
## Commercial SubOrbital Private Spaceflight



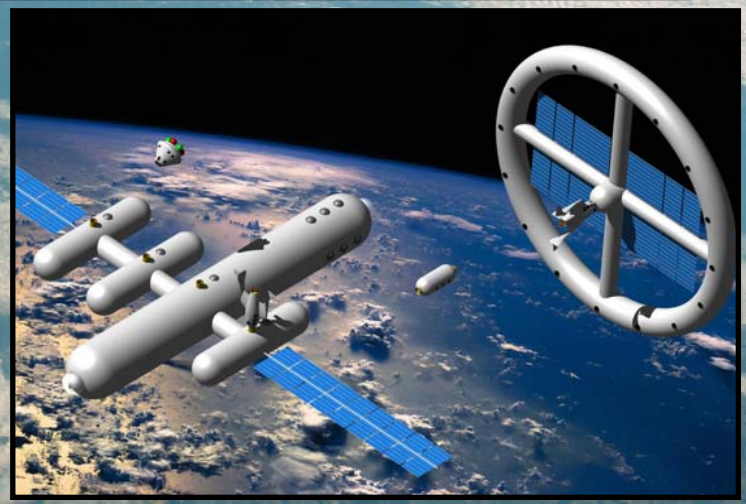
# See the Islands from a different perspective….



# The Next Steps for Private Spaceflight

- First industry - sub-orbital flights
  - Experience – optimized
    - Large cabins, large windows and body weightless float.
- First industry - high-volume
  - Competing spacelines, flights priced to fly 100,000+ people (first 12 years of operations)

Success will accelerate solutions for safe, affordable flights to orbital resort hotels



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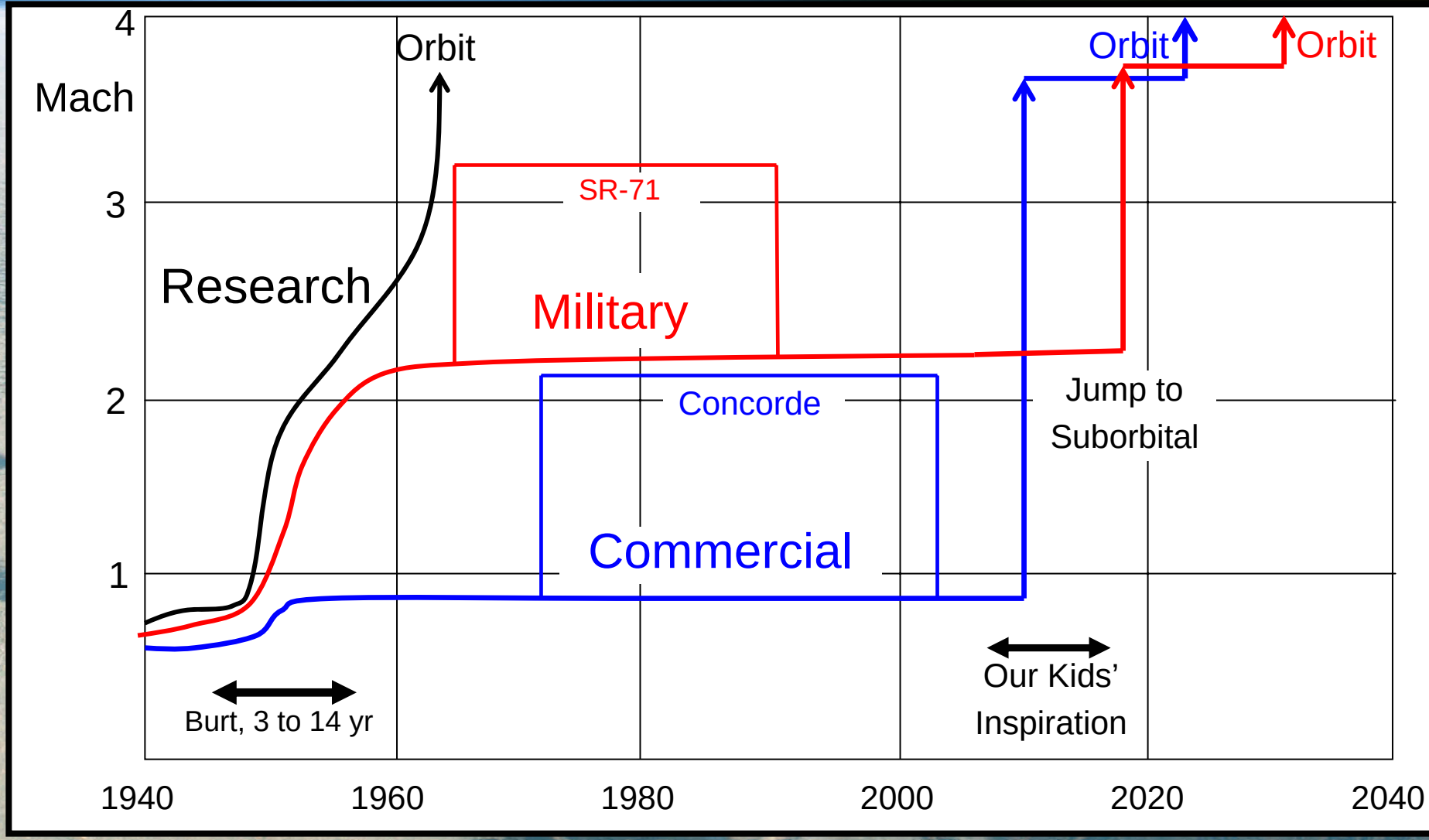
# A Prediction
## Commercial Jumps Ahead of Military

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# What Good is a Private Sub-orbital Space Industry? Just for Fun?

- The home computer – Internet example
  - ‘Fun’ really **is** defendable
- Inspiration for kids
  - Today’s technology products are enablers, not goals
  - Kids need to be inspired by a far-out dream/goal

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# Why we stopped flying SpaceShipOne

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# Your request to a non-expert….
## Rutan's Comments on S & T Focus for Defense?

- U. S. competitive position in Science and Engineering.
- True responsive space presence.
- Heavy transport.
- The "all UAV Air Force".
- Human contribution to global warming.
- Humanity's future in a connected world.

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# U. S. competitive position in Science and Engineering

- The education statistics are bleak
  - Science vs. lawyers/media/politicians/actors*

  * And other criminals
- The real reason – we are boring our youth
  - Development vs. research
- The solution – take real risks
  - Exploration
  - Adventure
  - Breakthroughs
- Strive to be great, not to be ‘equal’

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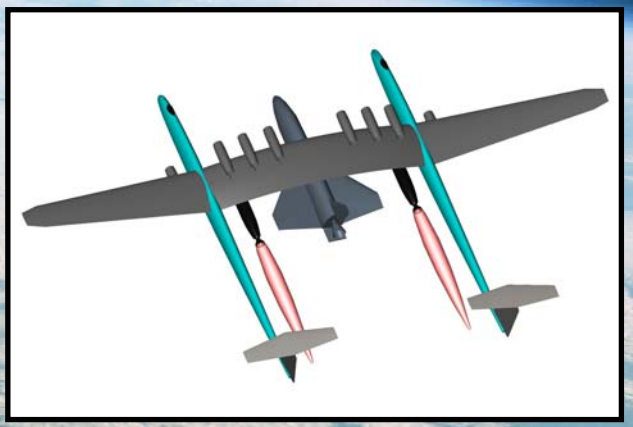
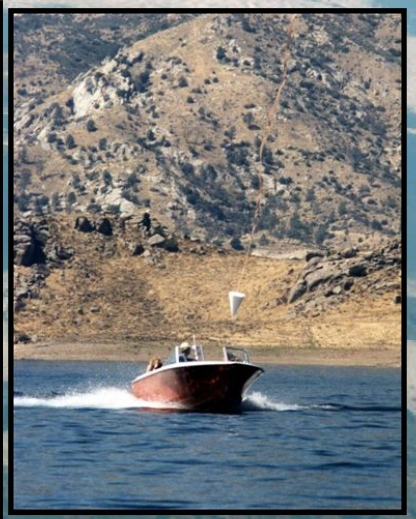
# True Responsive Space Access

- Air launch
- Routine, high-volume operations
- Sea recovery





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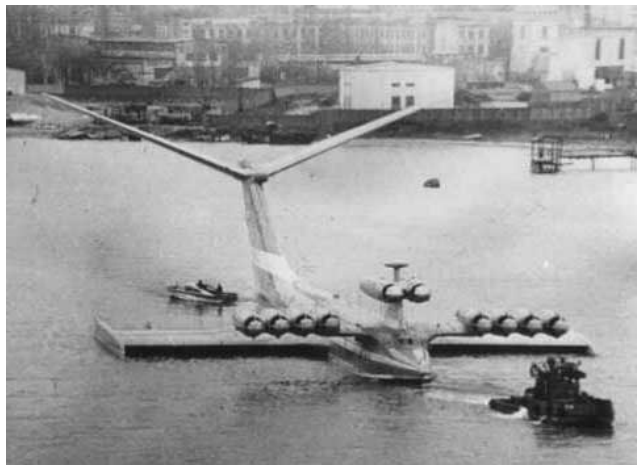
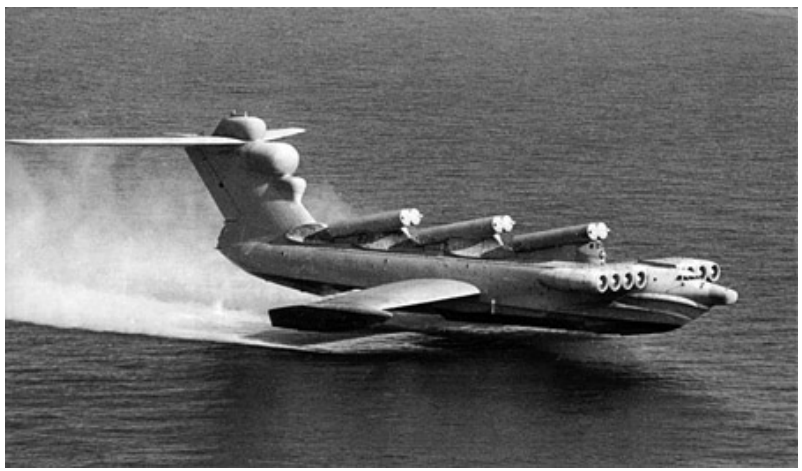
# Russian Ekranoplans (wing-ships)





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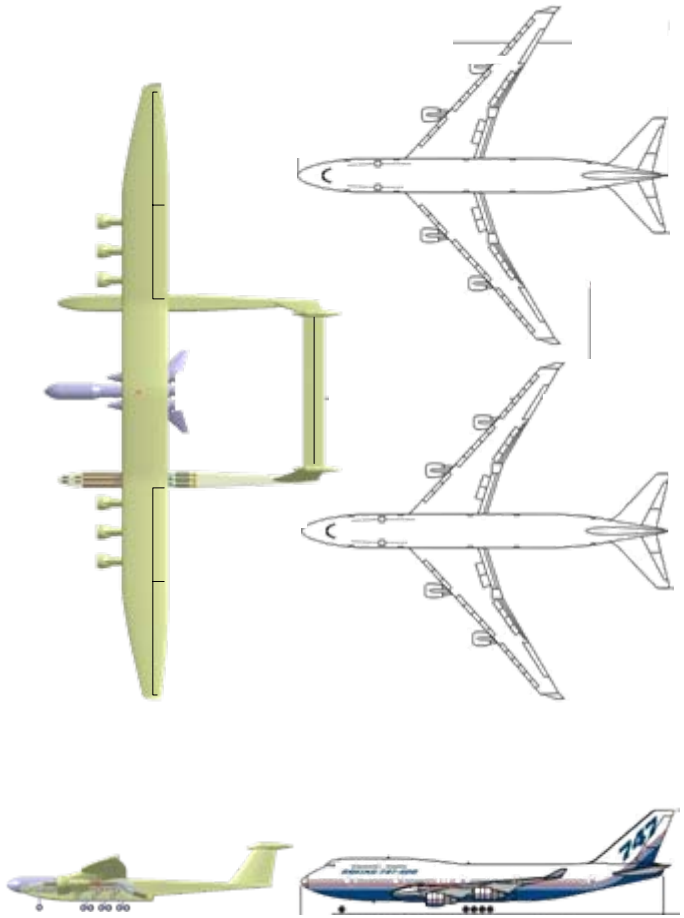
# Heavy lift via use of a large space launcher

## Payloads up to 450klb



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# UAV vs. Manned Aircraft Systems

- The fighter pilot's proficiency
  - Our leadership maintained?
  - Proliferation
- The fighter pilot's courage
  - Eliminate Capt Scott O'Grady?
- Cost savings?
  - Development and Ops

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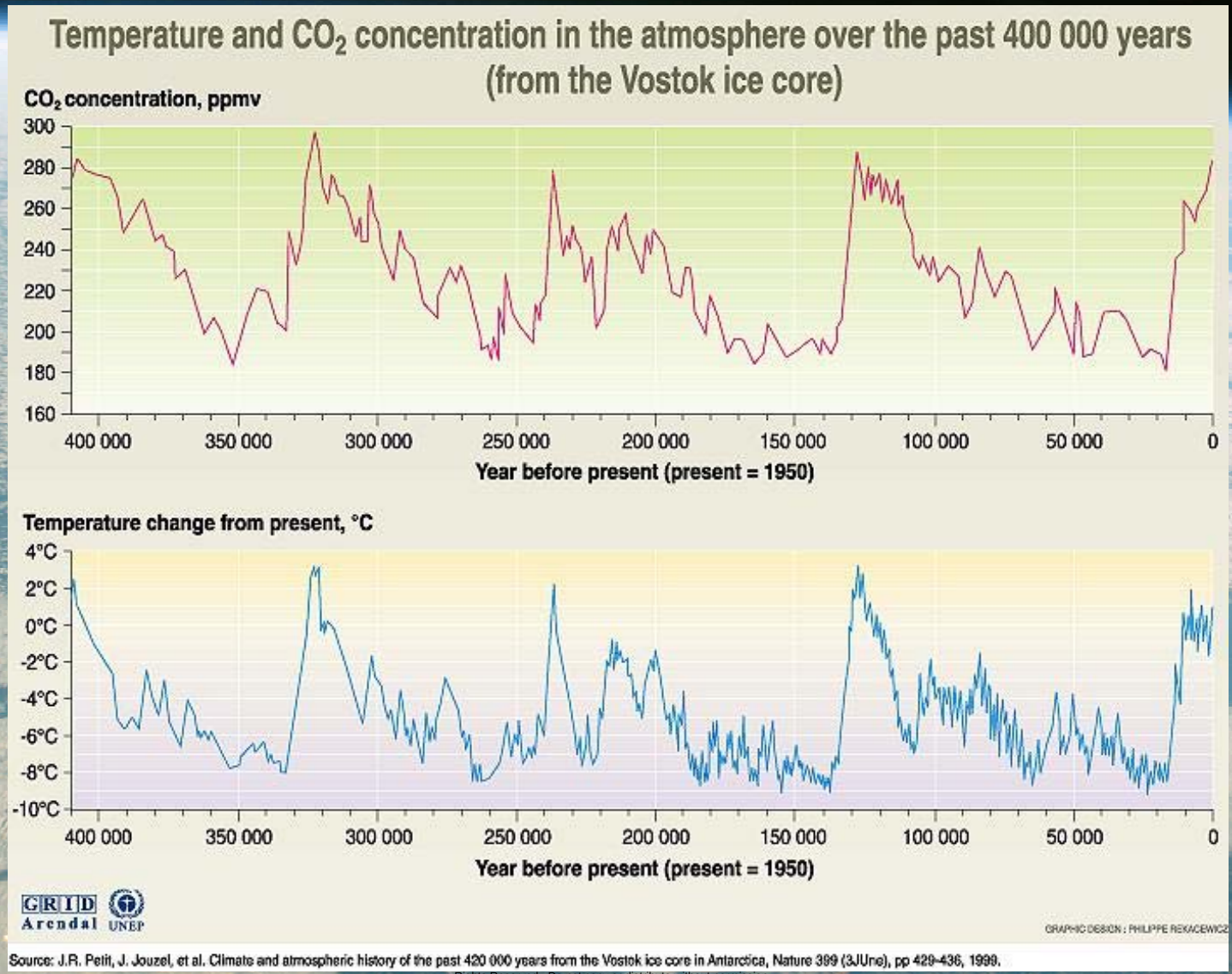
# Are we destroying the planet?

Consensus vs. Science

Technical solutions follow technical measurement

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# Humanity's future in a connected world

- Internet….the tip of a huge iceberg
  - Our need to travel, if a virtual mode is available
  - Countries – defined by belief, not by geography
- Humanity – we are just getting started

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# Pacific Theater Operational Science and Technology Conference

## *Future Solutions - ISR*

April, 2007

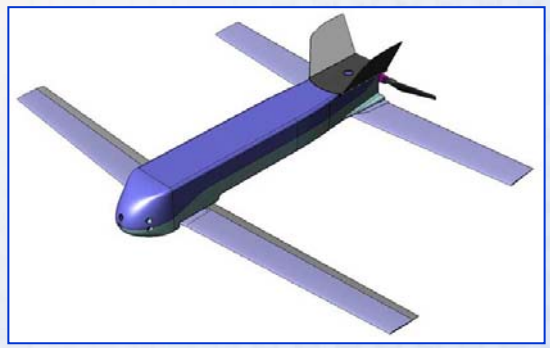
**John Grabowsky**
**Executive VP, GM UAS**
**AeroVironment, Inc.**

# Three New Platforms & Supporting Technologies

- Stratospheric ISR
  - Global Observer

- Squad-Level ISR
  - Wasp

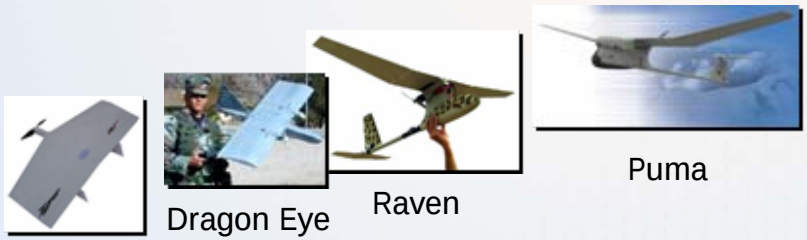
- ISR, with teeth
  - Switchblade



# AV's Operating Space

Altitude

***24/7/365***
***Affordable Persistence:***
***ISR, Comm Relay***

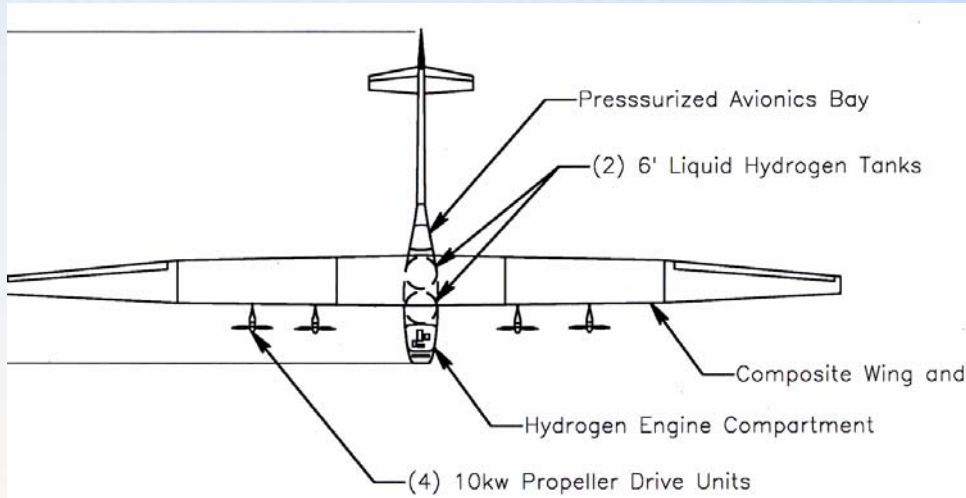



***Low-cost, easy to field information gathering for war fighters***

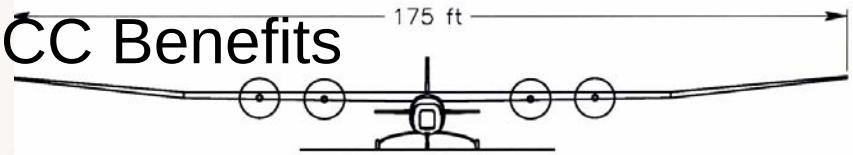
Endurance

# Value of Affordable Stratospheric Persistence

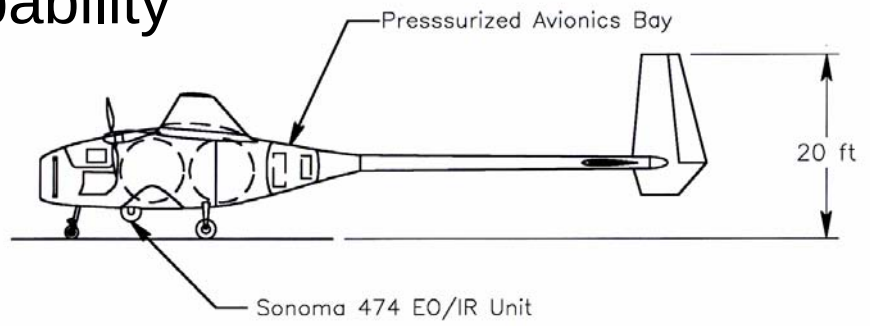
- Quick Reaction
  - In/out theater Bandwidth
  - Comm Relay
  - ISR
  - Psy Ops
  - Disaster Recovery




- Compelling O&M and LCC Benefits




- Ability to “Reconstitute Capability”



# 20 years of stratospheric flight experience

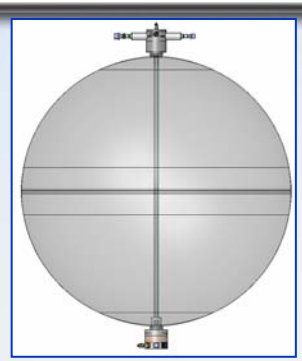
*Pathfinder-Plus*

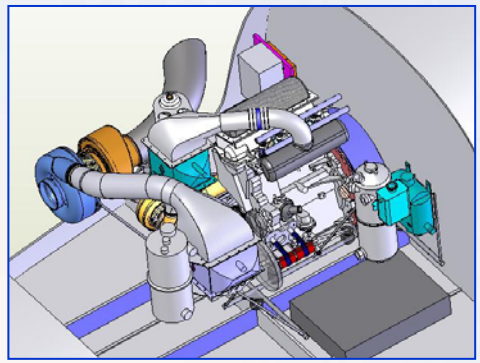
*Centurion*

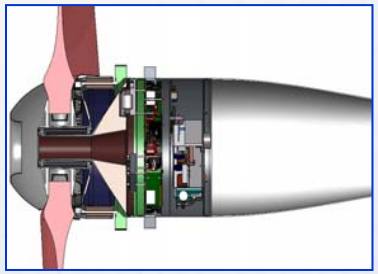
*Helios*

# Underlying Technologies

- $LH_2$ Tank
- $LH_2$ Powerplant
- Efficient Electric Generator
- Efficient Propulsion

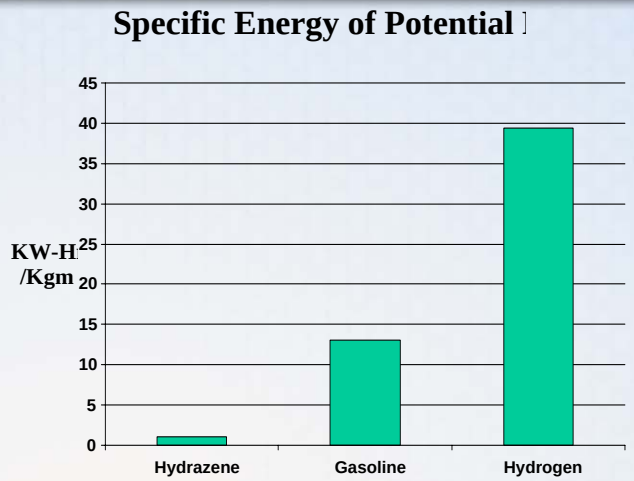




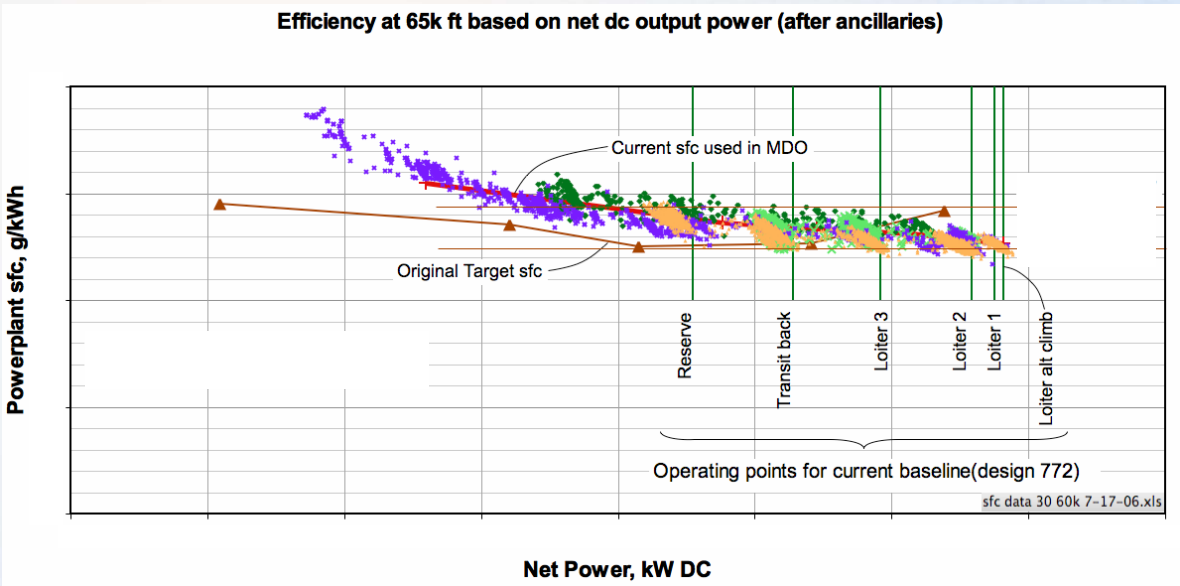


# Energy Densities and Efficiency

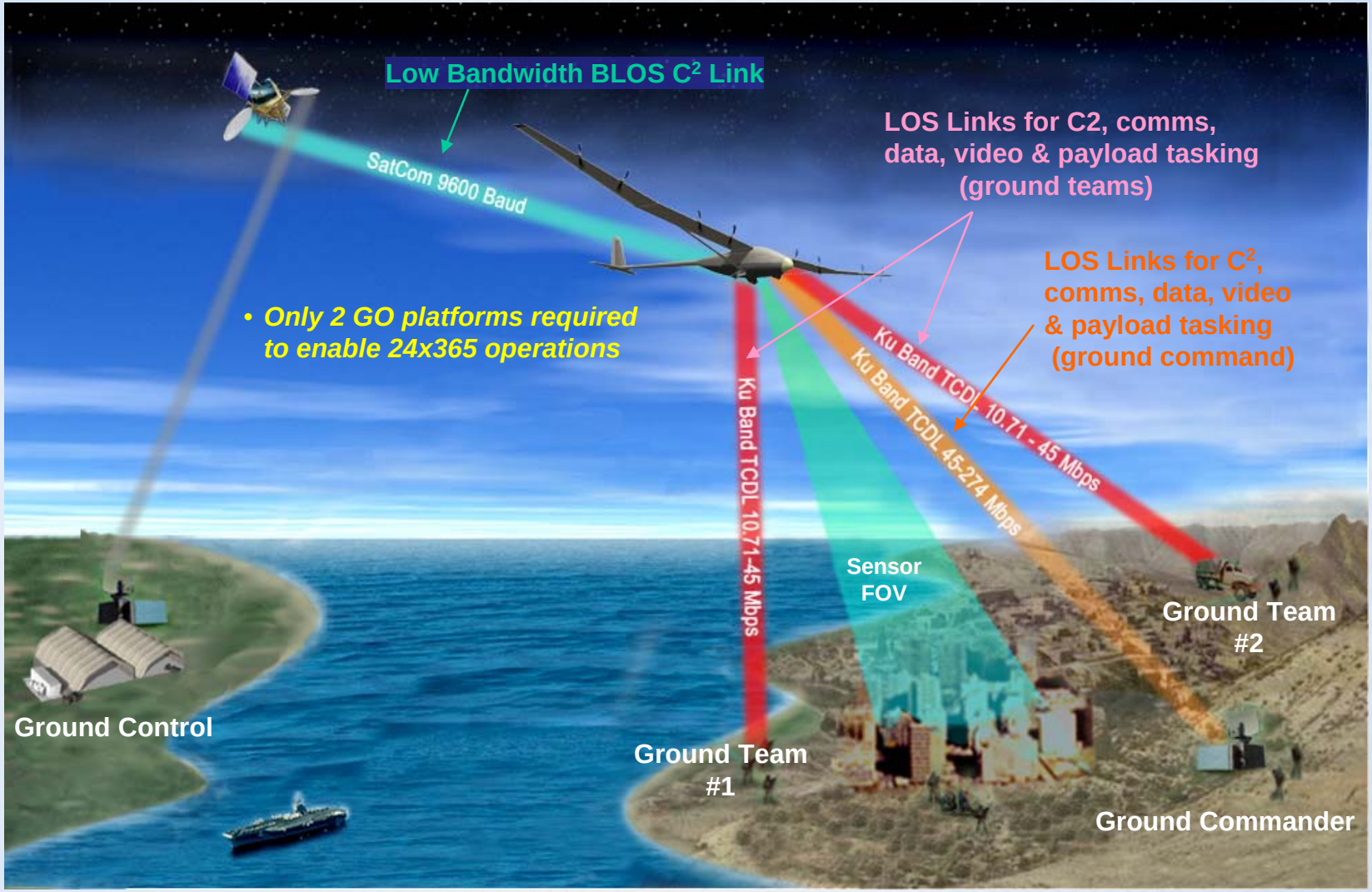
- Why Hydrogen?




- Specific Fuel Consumption



# Military ISR and Relay Mission



# Global Reach

Continuous (24/7/365) persistence over any point in footprint with 2 aircraft

# Squad-level ISR:  Wasp

# Requirements for Squad ISR

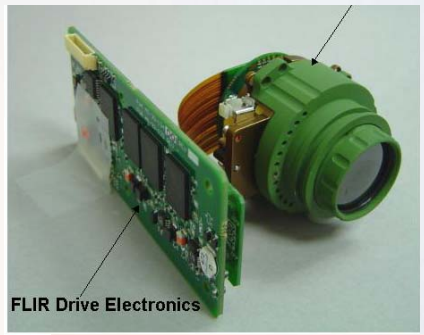
- Small, Lightweight, *System* Rucksack-portable
- Day and Night sensors
- 30+-minute endurance
- Rugged, Reliable
- Low cost
- Low-Observables

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

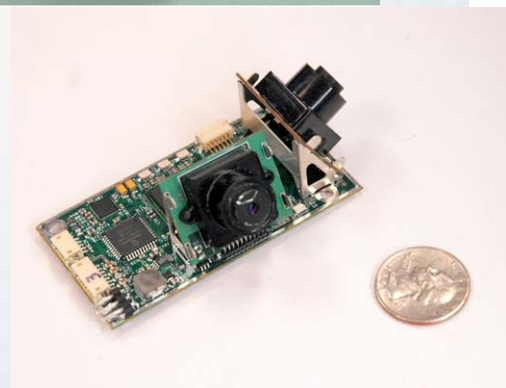
# Supporting Technologies: Payloads

- Electric Propulsion
  - Rugged
  - Quiet
  - Efficient
  - Inexpensive

- IR Payload
  - LWIR




- EO Payload
  - Digitally stabilized
  - Steerable

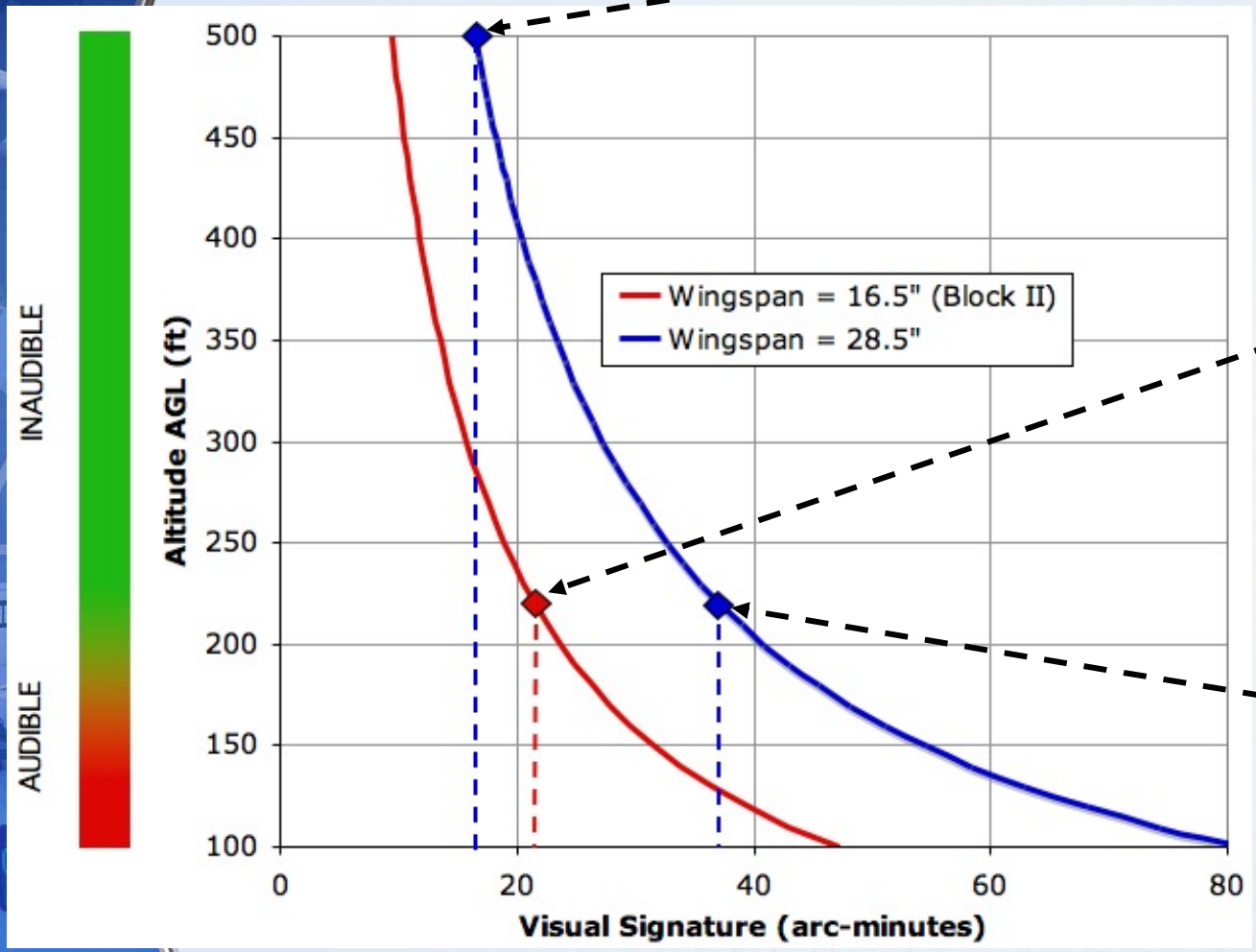


# Visual/Acoustic Signatures and Resolution

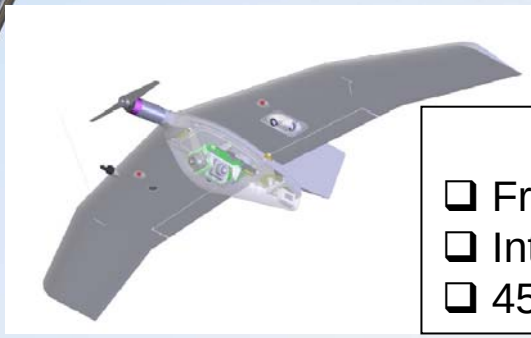
PTZ Full Zoom

Integrated EO

PTZ Full Zoom



# Wasp Block III Configurations

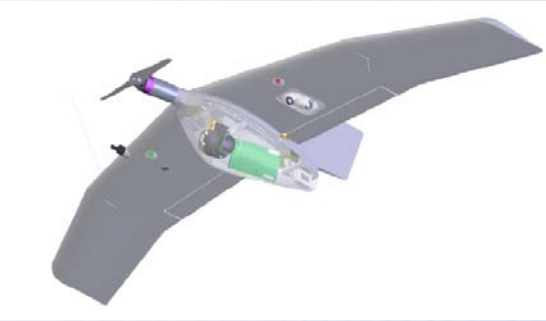


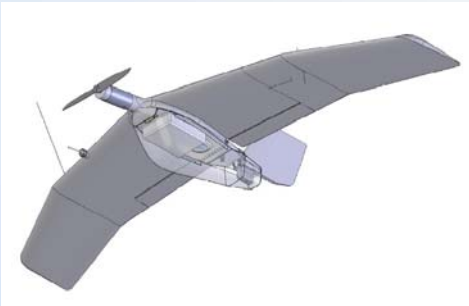
**Daytime Wasp**

- ❑ Front/side imager, digital image stabilization and pan-tilt-zoom
- ❑ Integrated dual EO payload
- ❑ 45-minute endurance

**Nighttime Wasp**

- ❑ Thermal imager
- ❑ Integrated dual EO payload
- ❑ 40-minute endurance





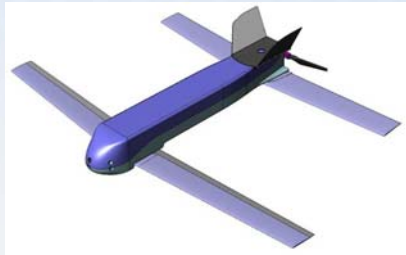
**Long Endurance Wasp**

- ❑ Extended endurance battery pack (double the capacity)
- ❑ Integrated dual EO payload
- ❑ 100+ minute endurance calculated

# Man-portable ISR, with teeth: Switchblade

# Squad-level Lethal UAV Requirements

- Man-Portable SYSTEM
  - Air Vehicle
  - Launcher
  - GCU
- Low Optical/Acoustic Signatures
- High Speed
- Autonomous Terminal Guidance
  - Small CEP
- Warhead
  - Lightweight
  - Lethal
  - Minimal Co-lateral
- Low Cost per round



Air Vehicle

Warhead

Launcher

Raven/Wasp GCU

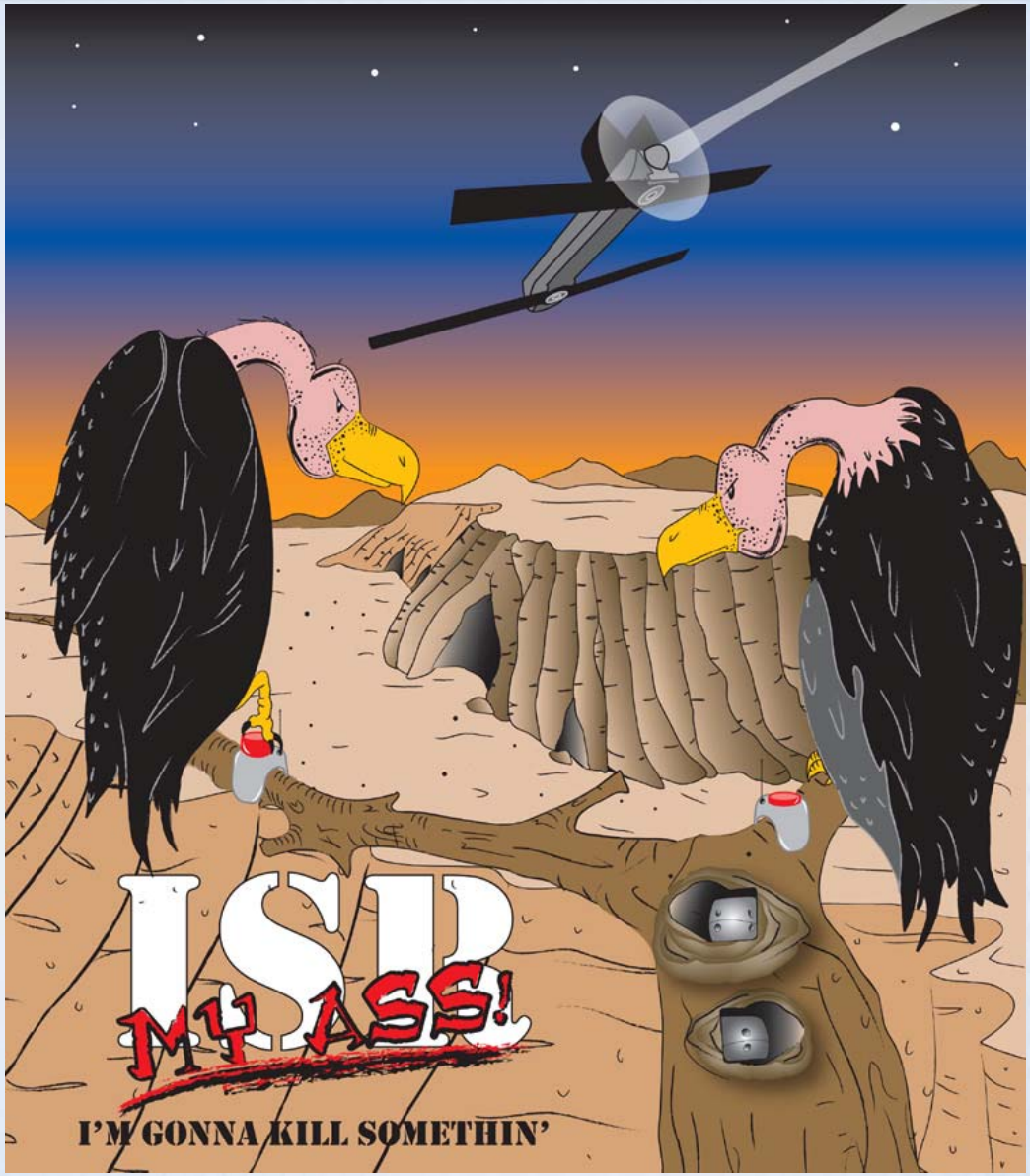
# Supporting Technologies

- Lightweight Launcher
  - Simple, reliable launch mechanism
  - Low acoustic signature
- Miniaturized Avionics
  - G-hardened
  - GPS, RF Data Link, IMU, Air Data
- Lightweight Propulsion
  - Quiet efficient motor, propeller, Batteries
- Lightweight Lethal Payload
- Autonomous Terminal Guidance
  - Operator Initiated
  - Low CEP Video Tracker

# Small CEP Tracker

QuickTime™ and a
Cinepak decompressor
are needed to see this picture.

# The End



Aligned with your needs.

# Pacific Operational Science and Technology Conference Panel Discussion Undersea Warfare

Mr. Roger Bagbey
Senior Vice President, Engineering Technology Center
Alion Science and Technology Corporation

4 April 2007

ALION
SCIENCE AND TECHNOLOGY

NDIA
NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

# USW Panel Agenda

- NDIA Undersea Warfare Division
- Basis for Industry Meeting PACOM's Needs
  - Knowing What's Needed for USW
  - Opportunity for Return on Investment
- An Example
- Summary

- **The USW Division defines Undersea Warfare as: Anti-Submarine Warfare (ASW), Mine Warfare (MIW), Surveillance, and Special Operations**
- **Organized into five focus areas:**
  - **Sensor Systems, Mine Warfare (MIW) Systems, Undersea Vehicles, Aviation, and C4I and Combat Systems**
- **Sponsors Two Major Technical Conferences**
  - **Joint Undersea Warfare Technology Spring Conference**
  - **Joint Undersea Warfare Technology Winter Conference**
- **Currently Conducting Two Technical Studies for USN Sponsors**
  - **ASW Common Tactical Picture Study, 8 June 2006- in process**
  - **Distributed Netted Sensor Study, 6 January 2006 – in process**

# Overview of USW Division

- **USW Division Identified Key Technology Areas**
  - **Deployment**
  - **Sensing**
  - **Communications**
  - **Distributed Command and Control**
- **2007 Spring Joint Undersea Warfare Technology Conference - About 400 attendees**
  - **Senior Navy Leadership Provided Classified USW Status and Concerns**
  - **126 Program and Systems Briefs Presented In A Classified Forum**

# Basis for Industry Meeting PACOM's Needs

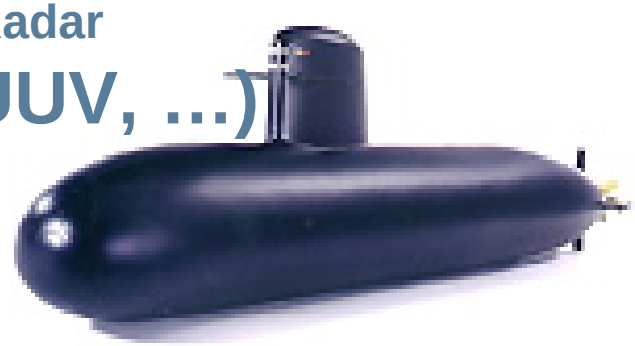


- **Knowing What's Needed**
  - **Threat**
  - **Operational Constructs**
  - **Constraints**
  - **Challenges**

- **Opportunity for Return on Investment**
  - **Availability of funding**
  - **Protection of Intellectual property**
  - **Timeliness of Return**

# Knowing What's Needed for USW Beyond 2010

- **Science &Technology**
  - **DARPA**
  - **ONR (BAA, SBIR, STTR, FNC, etc.)**
  - **NDIA (Bi-Annual Conferences, Special Studies)**
  - **NRAC, NSB (Special Studies)**
  - **Etc.**
- **System Development**
  - **PEOs/SYSCOMS**
    - **Performance (System) Specific RFP**
      - **Formal Acquisition Process**
    - **Directed BAA**
      - **e.g. Theater ASW, Periscope Detection Radar**
- **Navy Master Plans (ASW, MIW, UUV, …)**

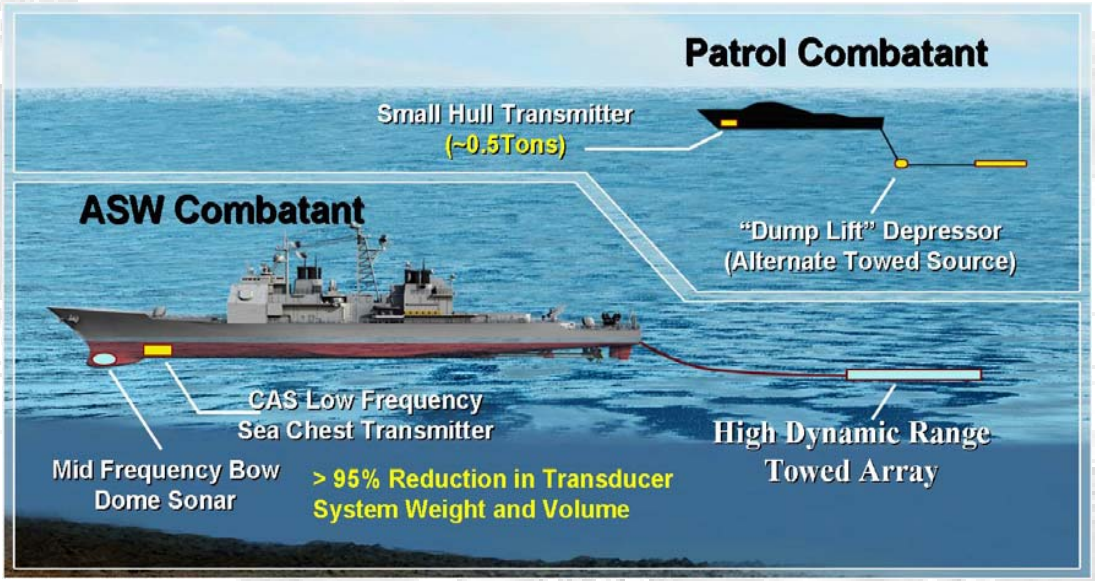


# Opportunity for Return on Investment

- **Availability of Funding**
  - General Decline Known & Accepted
  - PBD 753 Augments ASW R&D
- **Protection of Intellectual property-Versus:**
  - Peer Reviews
  - Open Sourcing
- **Timeliness of Return on Investment**
  - Rapid Development Concept

    versus
  - Business as Usual

# An Example from Alion Experience: Continuous Active Sonar (also Receive While Transmit (RWT))




## What is it?

- High Dynamic Range Electronics permits receiver cancellation of directly transmitted signal without disturbing echo reception
- Radar heterodyning technique converts continuous echo to narrowband signal with frequency proportional to range

## How does it work?

- More Energy on Target With Less Power (Smaller, Low Impact, Transmitters)
- Increased Time x Bandwidth Product (Lower Detection Thresholds)
- Narrowed Track Gates (Better Range Rate Resolution; Reduced Clutter)
- Enables Many Implementation Concepts (Ship Based; Off-board, & Distributed)

***Bottom Line: Longer Detection Ranges/Reduced Latency/Lower Cost***

# USW Discussion Summary

- **NDIA has a functional and focused structure and its members remain anxious to support PACOM's USW Needs**
- **Funding Limitations are a fact of life that Industry accepts**
- **Industry's ability to innovate is conditioned by DoD policies, e.g. Security, Peer Review , Open Sourcing , and Acquisition Timeliness**

**Industry can meet DoD S&T needs and welcomes more direct warfighter interaction**

# Questions and Comments

# Maritime Domain Awareness –

## *Future Industry Solutions… FY10 and Beyond*

**Tom Williams**

**4 April 2007**

# The Challenge

*Conventional Warfare* *Global War on Terror*

*"We Need a NORAD for Maritime Forces"*

*Admiral Vern Clark, Former CNO*
*(August 15, 2002)*

NORTHROP GRUMMAN

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# The Problem

- *Over 150,000 commercial ships*
- *80,000 involved in global trade*
- *40,000 ships within 1,000 mi of US coastline*

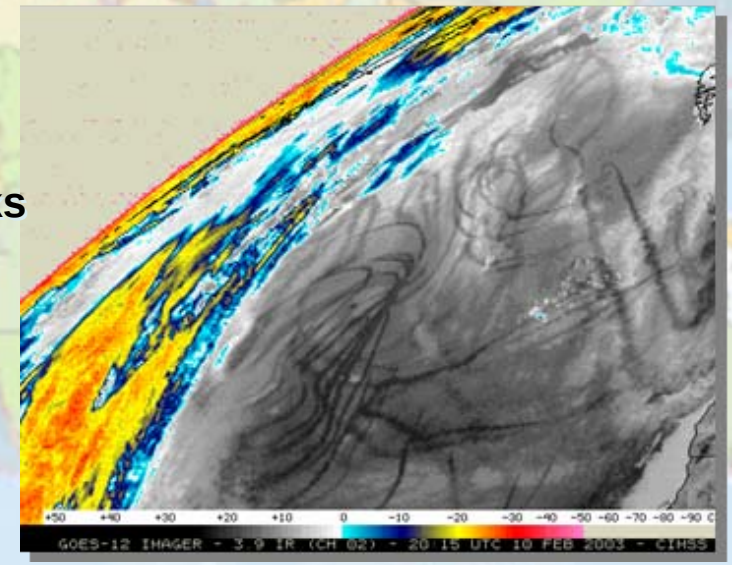
# Enabling Technology Investment Areas

- *Ability To Uniquely "Fingerprint" Thousands of Large and Small Hull Commercial Ships*
- *Fusion and Reasoning Tools*
- *Persistent Surveillance*
- *Cooperative Communications / Information Sharing*

# “Finger Printing”

- AIS (Automatic Identification System)
- EO/IR
- Radar/Radar Emissions
- Acoustics
- Hyperspectral
- Other Unintended Emissions

- Less Uncertainty
- More Targets
- Greater Ranges
- Bearings and Tracks



*“Knowing Who’s Who with Certainty”*

# Fusion and Reasoning Tools/Algorithms

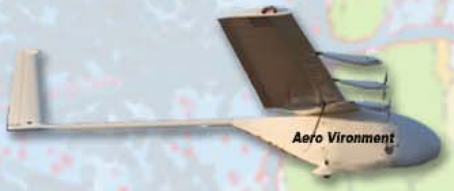
- Behavior Analysis / Pattern Recognition
- Netted and Shared Information

- *"Clutter Rejection"... Weeding Out the Good Guys*
- *Knowing Where Your Ship Has Been Lately?*

# Persistent Surveillance

Sensor / Capability vs. Power

Solar Electric

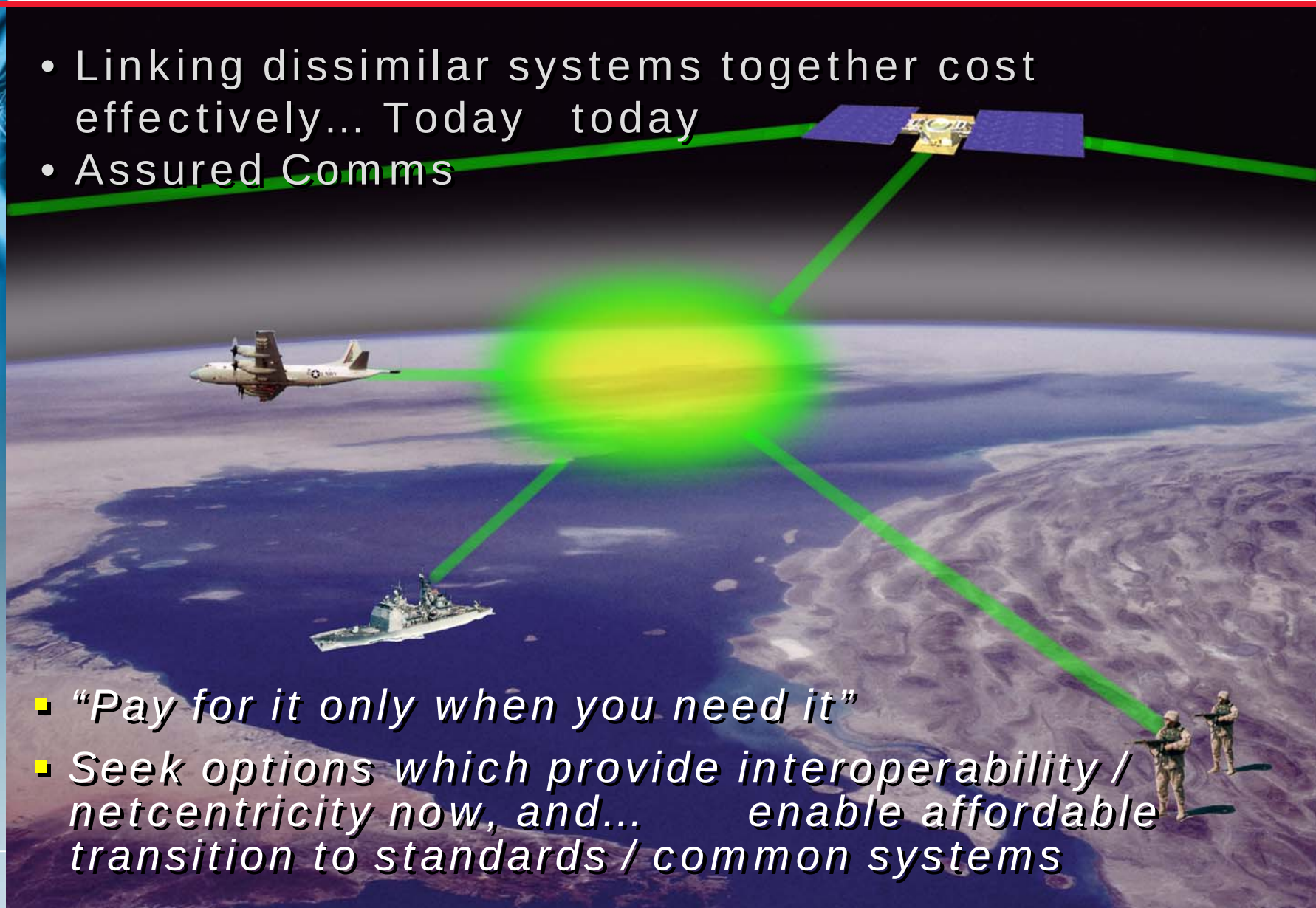



Hybrid Electric

Autonomous Refueling

- *Day → Week → Month → Continuous*
- *Tracking the Exceptions*

# Cooperative Communications / Information Sharing



# Enabling Technology Investment Areas

- *Ability To Uniquely "Fingerprint" Thousands of Large and Small Hull Commercial Ships*
- *Fusion and Reasoning Tools*
- *Persistent Surveillance*
- *Cooperative Communications / Information Sharing*

# Duck Hunting Made Easy

# *Intelligence Perspective*
# *U.S. Pacific Command*

## *3 Apr 2007*

***RADM Andy Singer***
***USPACOM J2 &***
***Director, Joint Intelligence***
***Operations Center***

UNCLAS

# Integrate Intel, Ops & Plans

- Set conditions for success … 2/3/5 unified action
  - Includes operational perspective and ‘So What’ factor
  - Links ops to future planning
- ‘Always On’ dynamic Intel interaction
  - Increases 2/3/5 situational awareness and info sharing 24/7
  - Shapes ops and plans … influences decisions
- New Core Value
  - Know theory of victory – challenge with Intel
  - Clarity of data and Intel – not consensus of opinion
  - Quality of analysis
  - Blue – Red team

# Intel Mythology

1. Outside world cannot contribute to understanding Intel

2. It is about stealing secrets
   - Higher classification ≠ better

3. Is a service + decision maker's master

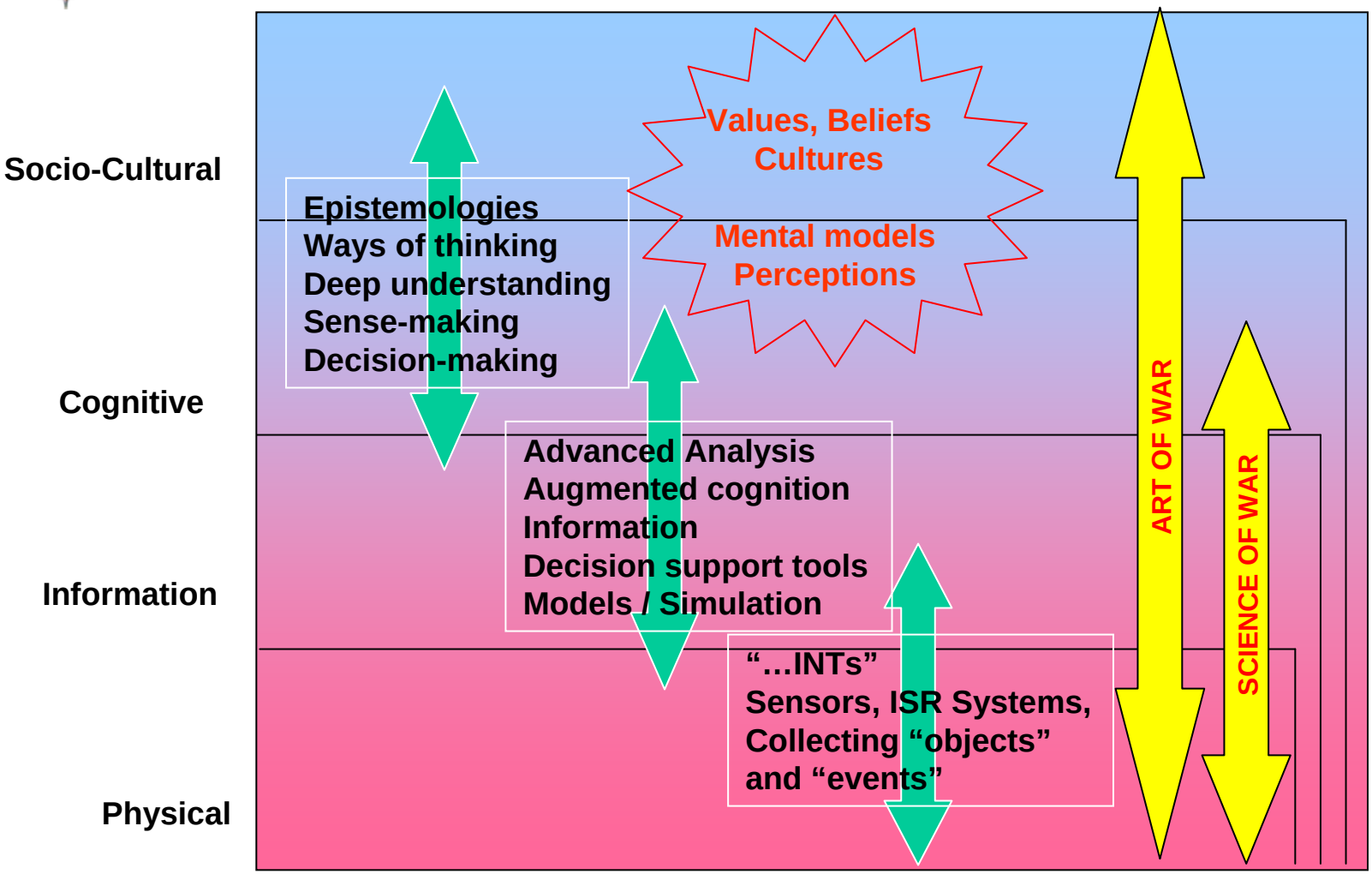
4. All we need is horizontal integration
   - Vertical first

5. Intel Operators vs. mechanics

**So what do we do about it?**

UNCLAS

# “Art and Science” / Domains of Warfare




UNCLAS

# DHS Science & Technology: Alignment for Success

## Pacific Operational Science & Technology Conference

Honolulu, Hawaii · April 3, 2007

Jay M. Cohen
Under Secretary
Science and Technology Directorate

Homeland Security

Homeland Security

# Surprise is nothing new to Hawaii!

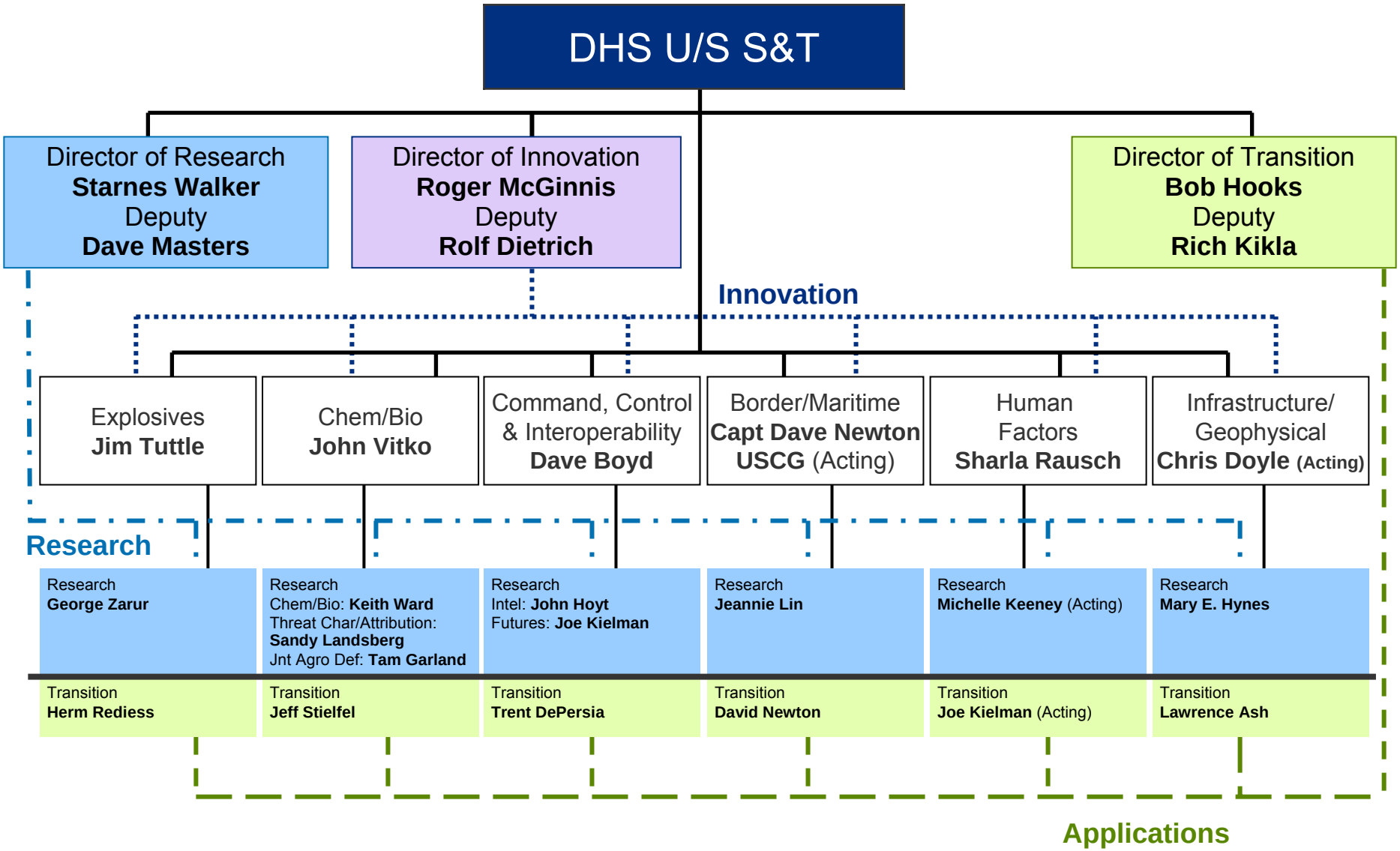
# DHS S&T Investment Portfolio

## Balance of Risk, Cost, Impact, and Time to Delivery

| | |
|---|---|
| **Product Transition (0-3 yrs)**<br>▪ Focused on delivering near-term products/enhancements to acquisition<br>▪ Customer IPT controlled<br>▪ Cost, schedule, capability metrics | **Innovative Capabilities (1-5 yrs)**<br>▪ High-risk/High payoff<br>▪ "Game changer/Leap ahead"<br>▪ Prototype, Test and Deploy<br>▪ HSARPA |
| **Basic Research (>8 yrs)**<br>▪ Enables future paradigm changes<br>▪ University fundamental research<br>▪ Gov't lab discovery and invention | **Other (0-8+ yrs)**<br>▪ Test & Evaluation and Standards<br>▪ Laboratory Operations & Construction<br>▪ Required by Administration (HSPDs)<br>▪ Congressional direction/law |

**Customer Focused, Output Oriented**

# S&T Organization



# Transition Portfolio

*Enabling Capabilities, Supporting Mission Critical Needs of DHS*

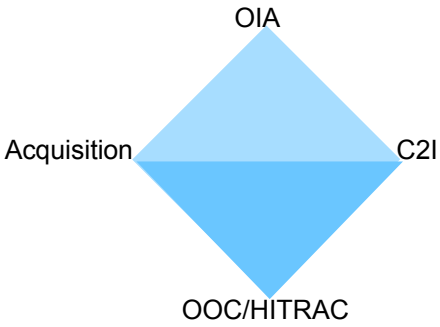
**Integrated Product Teams (IPTs)**

- 11 Capstone IPTs form the centerpiece of S&T's customer-driven approach to product transition
- Engage DHS customers, acquisition partners, S&T technical division heads, and end users in product research, development, transition and acquisition activities
- Identify our customers' needs and enable and transition near-term capabilities for addressing them

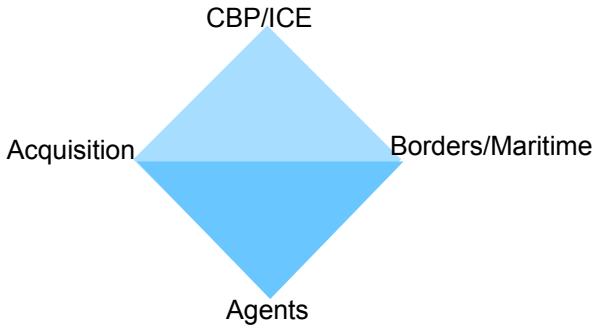
# DHS Requirements/Capability Capstone IPTs

## DHS S&T Product – "Enabling Homeland Capabilities" (EHCs)

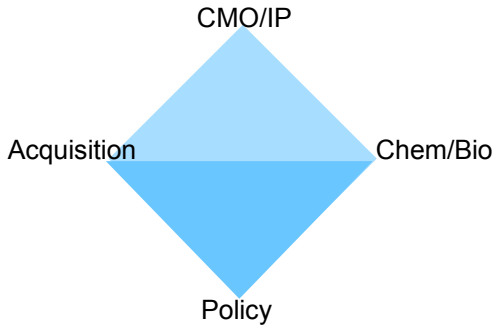
### Information Sharing/Mgmt



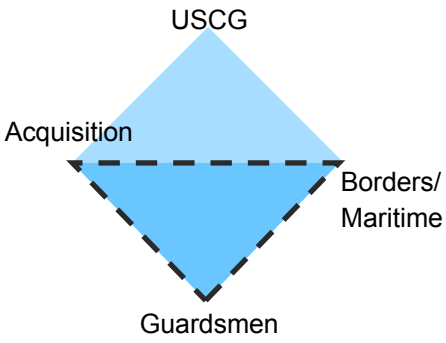

### Border Security



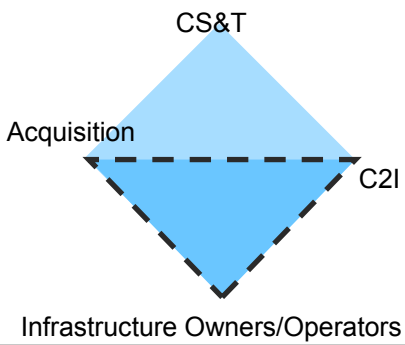

### Chem/Bio Defense



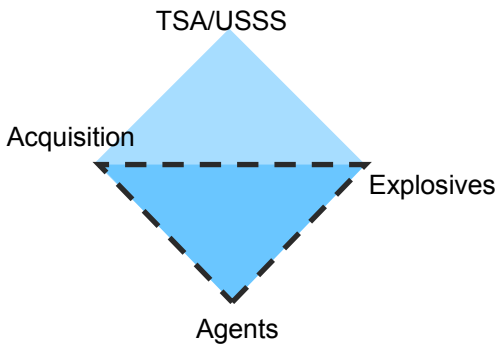

### Maritime Security



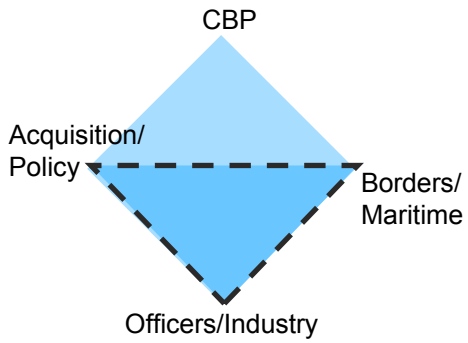

### Cyber Security



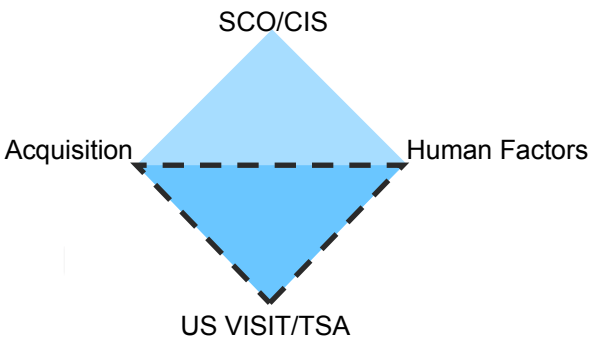

### Explosive Prevention



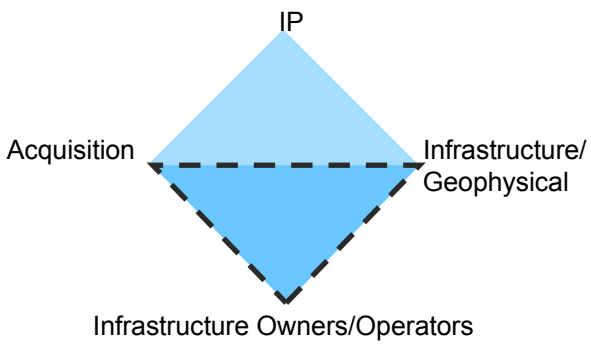

### Cargo Security



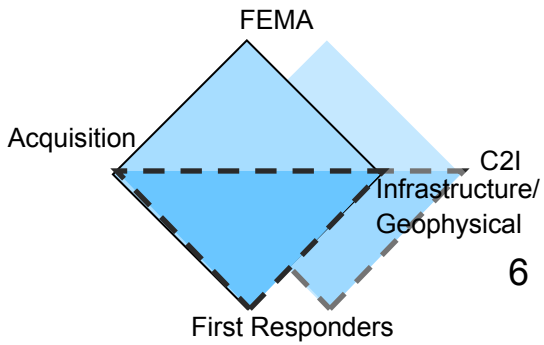

### People Screening




### Infrastructure Protection



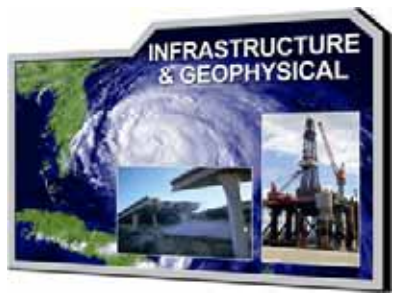

### Incident Management



# Basic Research Portfolio

*Discovery and Invention to Enable Future Capabilities*

- Brings the capabilities, talent and resources of the Homeland Security Centers of Excellence, DOE National Laboratories and DHS Labs to bear to address the long-term R&D needs for DHS in sciences of enduring relevance
- This type of focused, protracted research investment has potential to lead to paradigm shifts in the nation's homeland security capabilities



# Homeland Security Act of 2002

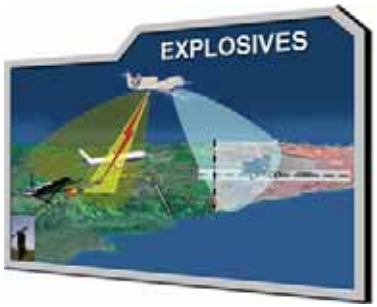
**HSARPA will….**

**“Support basic and applied homeland Security research to promote *revolutionary* changes in technologies; advance the development, testing and evaluation, and deployment of critical homeland security technologies; and accelerate the prototyping and deployment of technologies that would address homeland security vulnerabilities.”**

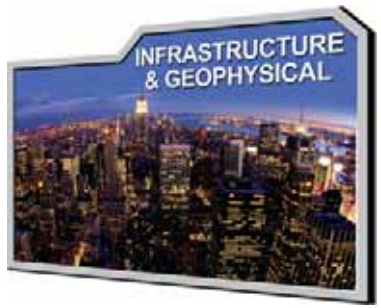
Homeland Security

# Innovation Portfolio

*High Risk, High Gain, Game Changers for Leap-Ahead Results*



- Promotes revolutionary changes in technology
- Focus on prototyping and deploying critical technologies
- Includes:
- HSARPA – Homeland Security Advanced Research Projects Agency
- “Homeworks” – 1% of budget highest risk, highest pay-off
- Small Business Innovation Research program
- *Visit www.FedBizOpps.gov, www.hsarpabaa.com and www.dhssbir.com*



# HIPS and HITS

**Homeland Innovative Prototypical Solutions (HIPS)** are designed to deliver *prototype-level demonstrations* of game-changing technologies in two to five years. Projects are moderate to high risk, with high payoff.

**High Impact Technology Solutions (HITS)** are designed to provide *proof-of-concept* answers within one to three years that could result in high-payoff technology breakthroughs. While these projects are at considerable risk for failure, they offer the potential for significant gains in capability.

# Homeland Innovative Prototypical Solutions (HIPS)

| Explosives | Chem/Bio | Command, Control & Interoperability | Borders/ Maritime | Human Factors | Infrastructure/ Geophysical |
|---|---|---|---|---|---|
| **Project Chloe-** High altitude aerial platform existing above civil aviation Counter-MANPADS<br>**SENSIT** – System to identify numerous liquids in baggage<br>**IED Defeat / APE VBIED Defeat** – Detection/prevention and mitigation technologies to counter IEDs | | **SCOPE** (Scalable Common Operational Picture Experiment) – Leverages Global Observer JCTD | **Scalable Composite Vessel Prototype (SCVP)** – Lightweight, composite material with high speed hull<br>**SAFECON –** 90 second container screening device | **FAST M2** (Future Attribute Screening Technology Mobile Module) – Relocatable Lab capable of testing for behavioral/ physiological cues of "hostile intent"<br>Double or triple wide trailer tested at various sites around the country | **Resilient Electric Grid** – System that will prevent cascading effects of power surge on electrical grids<br>**Levee Strengthening and Rapid Repair -** rapidly stop a breach in a levee<br>**Storm Surge and Hurricane Mitigation** |

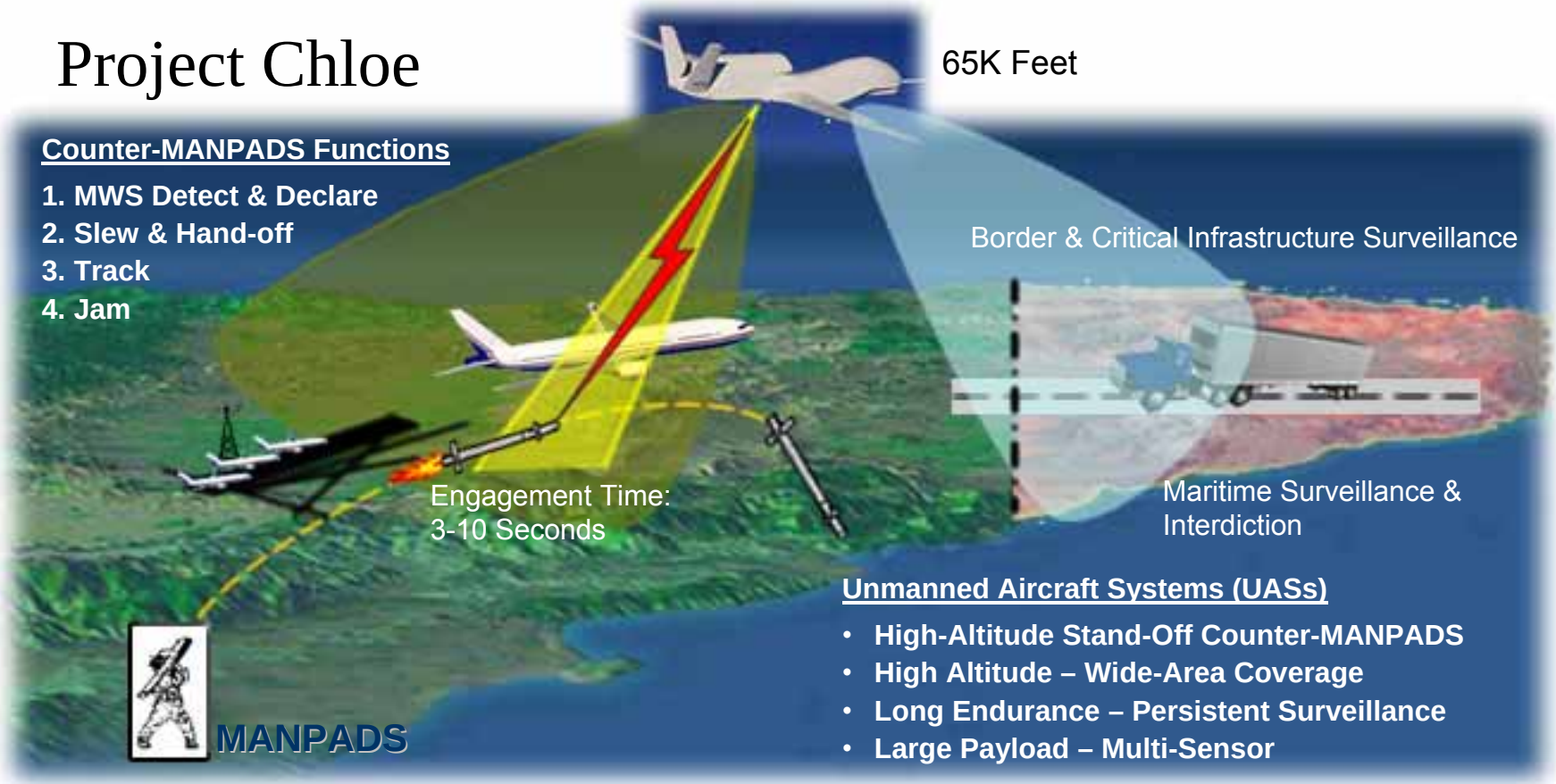
# High Impact Technology Solutions (HITS)

| | | | | | |
|---|---|---|---|---|---|
| | **Real Time Bio Detection and Identify**<br>**Cell-All -** Ubiquitous Chem/Bio/agent detector | **First Net** - First Responder Reliable Relay Link<br>**Phone Home –** Inter-operative and inexpensive hand-held radios | **Tunnel Detect** – Ability to detect, identify, and confirm illegal and clandestine underground border structures and activities | **Document Validator** –High proficiency scanner that can identity fraudulent docs<br>Leverage USSS system<br>**Biometric Detector** – High proficiency small biometric scanner | **Wide Area Surveillance/ Change Detection for Critical Infrastructure**<br>**Resilient Tunnel**– Tunnel Protection/Blast Mitigation |

# Homeland Innovative Prototypical Solutions

## Counter-MANPADS/Persistent Surveillance

### Project Chloe




**Operational Characteristics**

- Real-time sensor fusion/dissemination
- Multi-user / border surveillance requirements
- Commercial Aircraft MANPADS protection
- Automatic target detection/recognition
- Persistence (24/7, all-weather coverage)

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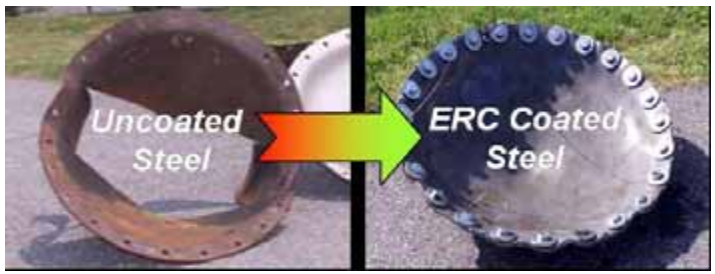
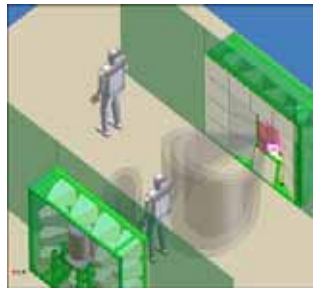
# High Innovative Prototype Solutions

## Improvised Explosive Devices Defeat

**Explosive Resistant Coating**



Reactive & Shaping Walls
*APE Project*

- *Puffers* for explosives trace material detection on people, bags/parcels, and vehicles
- Walk-through/whole-body imaging (e.g., backscatter)
- Advanced Protection Explosive (APE): cancellation methods for explosive shock waves
- Drive-through imaging technology (x-ray, neutron of materials only)

**Predict, Detect, Defeat and Destroy IED/VBIED at range (100 yards) to change the calculus of the bomber versus the defender**

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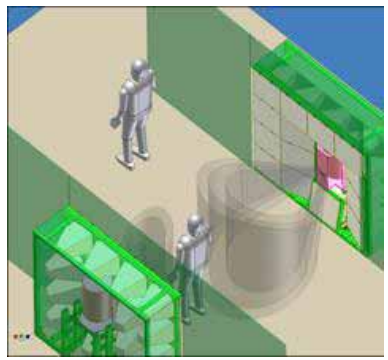
# Homeland Innovative Prototype Solutions

## Technologies for Suicide Bomber Defeat & Blast Mitigation



Suicide Bomber & Device Detection

Explosive Device Deactivation

Blast Mitigation

Reactive & Shaping Walls

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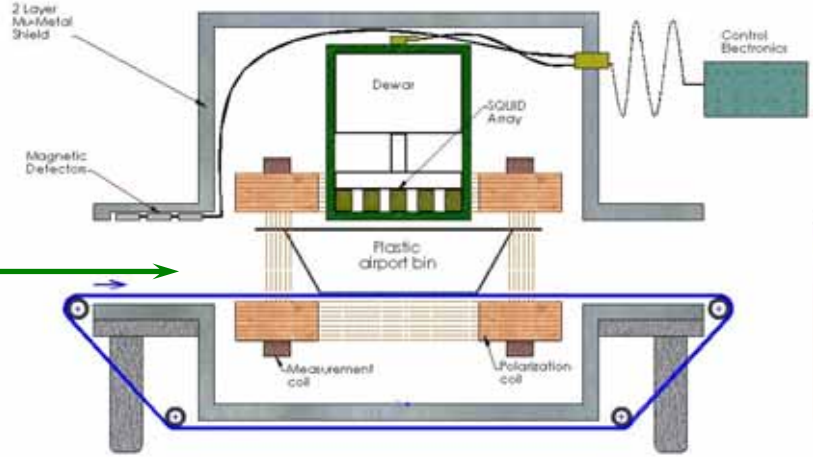
# Homeland Innovative Prototypical Solutions

## SENSIT

Liquid & Solid Explosive Detection at
Ultra-Low Field ***without radiation***



### Magnetic Resonance Technology

- Detect Liquid & Solid Explosives
- Detect Explosive Components
- Simple **"Green" / "Yellow" / "Red"** alerts
- Non-contact
- Extremely sensitive
- Materials remain inside baggage
- Applicable at any security portal

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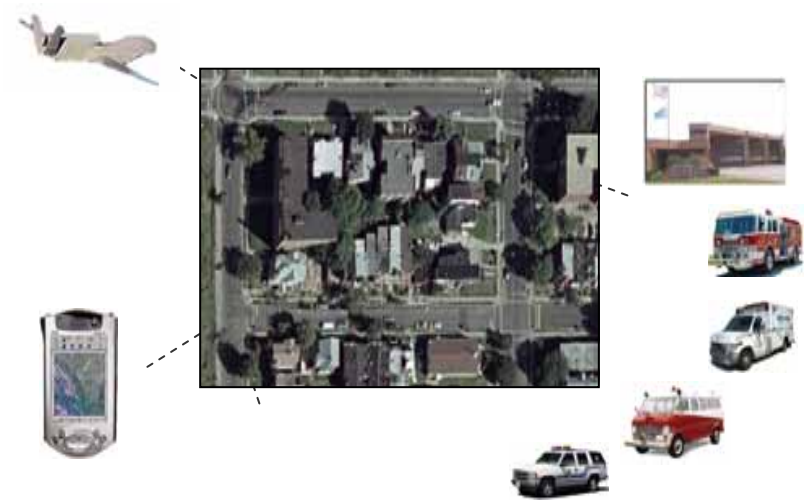
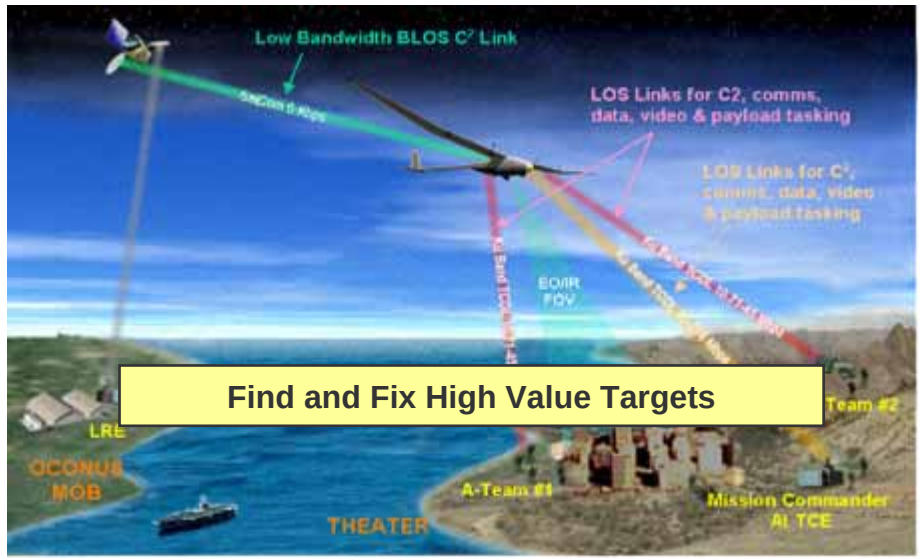
# Homeland Innovative Prototypical Solutions

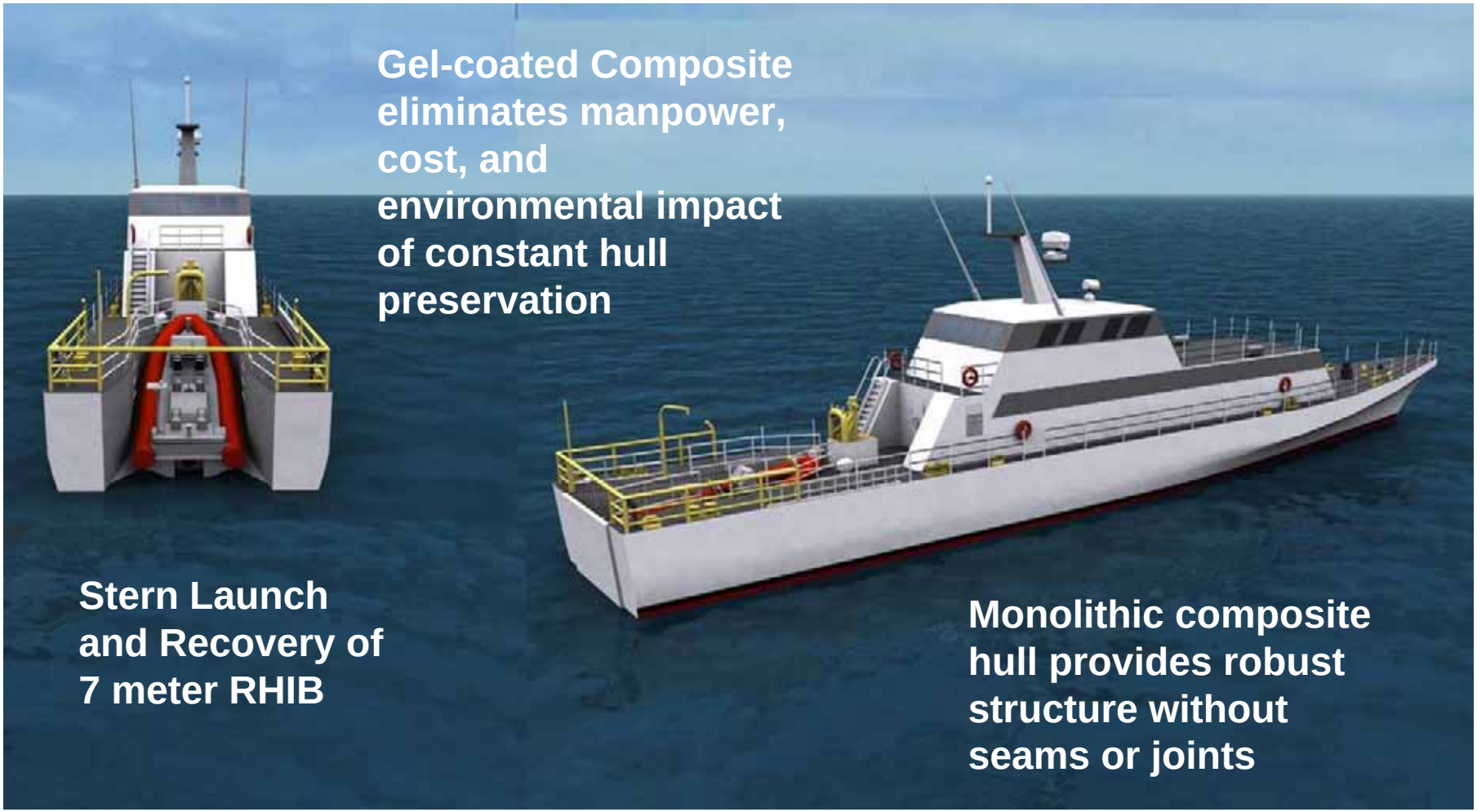
## Scalable Common Operating Picture Experiment JCTD





# Homeland Innovative Prototypical Solutions

## Scalable Composite Vessel Prototype

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# Homeland Innovative Prototypical Solutions

## SAFECON

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# Homeland Innovative Prototype Solutions

## Future Attribute Screening Technology Mobile Module (FAST M2)

**Systems**

- Queue management
- Behavioral profiling
- Rapid risk assessment
- Screening methodologies

**Operational Characteristics**

- Discover screening methods for intent
- Privacy protection for all participants
- Simple to operate and use

**Functions**

- Identity verification
- Attribute measurement
- Risk determination
- Behavior focused screening

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# Homeland Innovative Prototypical Solutions

## Levee Strengthening and Rapid Repair

**Pre-emptive mapping of weak levees**

**Pre-Flood Deployment of Protective And Rapid Repair Supplies to Problem Locations**

**Drop-in structures lofted by aircraft**

**Float-in structure guided by cables**

**Explosively Emplaced Support Structures**

**Roll-out protective coverings such as articulated concrete mats**

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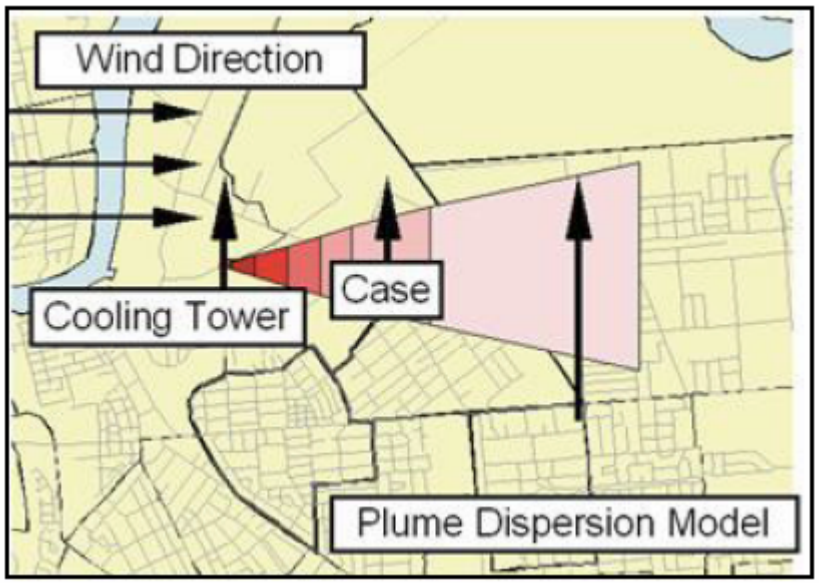
# High Impact Technology Solutions
## Real Time Bio Detect

Systems to detect biological agents in less than 60 seconds, and then provide RF information transfer to various centers for decision making and corrective action.




VS

Detection via cell culture

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# High Impact Technology Solutions

## First Net

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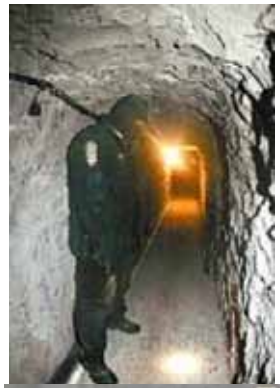
# High Impact Technology Solutions

## Tunnel Detection



- Air circulation
- Electricity
- Concrete infrastructures

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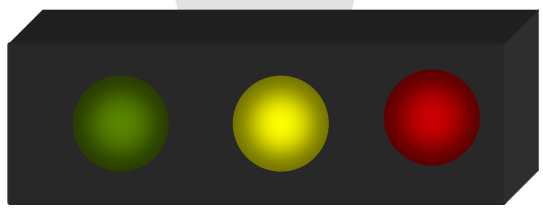
# High Impact Technology Solutions

## Document Validator



**Systems**

- Immigration Control
- Queue Management
- Identity databases

**Functions**

- Document Validation
- Identity verification
- Global identity awareness

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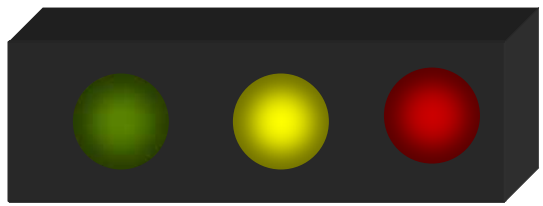
# High Impact Technology Solutions

## Biometric Detector



**Functions**

- Identity verification
- Denies right of passage to those on watch lists
- Mobility allows for use in remote locations
- Improved movement of legitimate individuals through checkpoints

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# High Impact Technology Solutions

## Cell-All Ubiquitous Chem/Bio Detect

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# High Impact Technology Solutions

## Critical Infrastructure Change Detection

**Explore Methods to Monitor Critical Infrastructure**

**Large and Remote Locations**

**Densely Populated Urban Environments**

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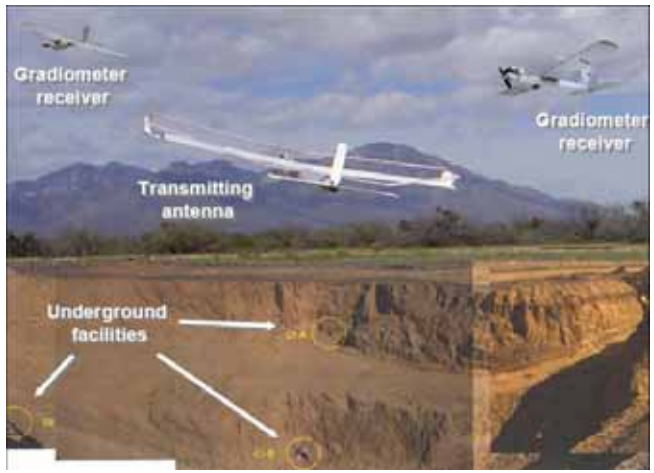
# Innovation/HSARPA BAAs

Broad Agency Announcements Released February 1:

- Tunnel Detection Technologies - develop and demonstrate a capability for rapidly detecting tunnels
- SAFE Container (SAFECON) – develop the capability to detect and identify WMD, explosives and contraband cargo and to detect humans in shipping containers
- Future Attribute Screening Technology (FAST) Demonstration Laboratory – provide efficient, rapid and accurate security screening of people and their credentials and belongings



***Visit www.FedBizOpps.gov or www.hsarpabaa.com for more information***

# Upcoming BAA Topic Areas

- Long-Range - Varied S&T Topic Areas
- CHLOE - High Altitude Endurance Unmanned Aerial System-Based Counter-MANPADS Technology Assessment
- IED & Vehicle-Borne IED Defeat - Technologies for Blast Mitigation and Suicide Bomber Defeat
- SBIR - Small Business Innovation Research Program
- First NET - First Responder Reliable Link
- Document Validator
- Biometric Detector
- SCOPE: Scalable Common Operating Environment

***Visit www.FedBizOpps.gov or www.hsarpabaa.com for more information***

# DoD-DHS Technology Transfer

- Identify and transfer technology from DoD to homeland security applications for emergency responders
- Create a coordinated, sustainable, iterative and inclusive process for tech transfer
- Leverage innovation and investments
- Promote agency and first responder awareness of process

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# S&T Directorate's A/P Liaison

- Gary Jensen, Director, Asia-Pacific Liaison
- DHS Science & Technology Directorate
- 26 years experience in the Pacific Region
- Established first Mid-Pacific Office for Naval Research
- Coordinated Pacific Region International Field Offices for ONR
- Contact:
  - gary.jensen@dhs.gov
  - Phone: 808-474-1240

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# S&T Activities in PACASIA

- **Government to Government Agreements**
  - **An existing umbrella S&T agreement with the Government of Australia,**
  - **An umbrella S&T agreement in progress with the Government of Singapore**
  - **Ongoing collaborations with both industry and government in Japan to test cargo container tracking devices under real-world operational conditions.**
  - **Plans to expand this cargo security initiative to Singapore as soon as our S&T agreement is in place.**

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# S&T Focus in PACASIA

- **Needs of our customers**
-
  - **Chemical and biological countermeasures and forensics;**
  - **Behavioral and physiological tools for people screening; and**
  - **Cargo tracking and inspection systems.**

.

- **Capitalize on the environment and challenges for innovative and leap-ahead capabilities in support of DHS missions and to save American lives. These include**

  - **Investigating emergency responder tools used by the Japanese government in response to earthquakes**
  - **Developing satellite-based tsunami forecasting capabilities with our partners in Naval Research**
  - **Developing hurricane intensity prediction approaches in partnership with the Office of Naval Research and the Mexican Navy**
  - **Maritime domain awareness and port security tools in partnership with Naval Research, TSWG, and allies such as Singapore.**

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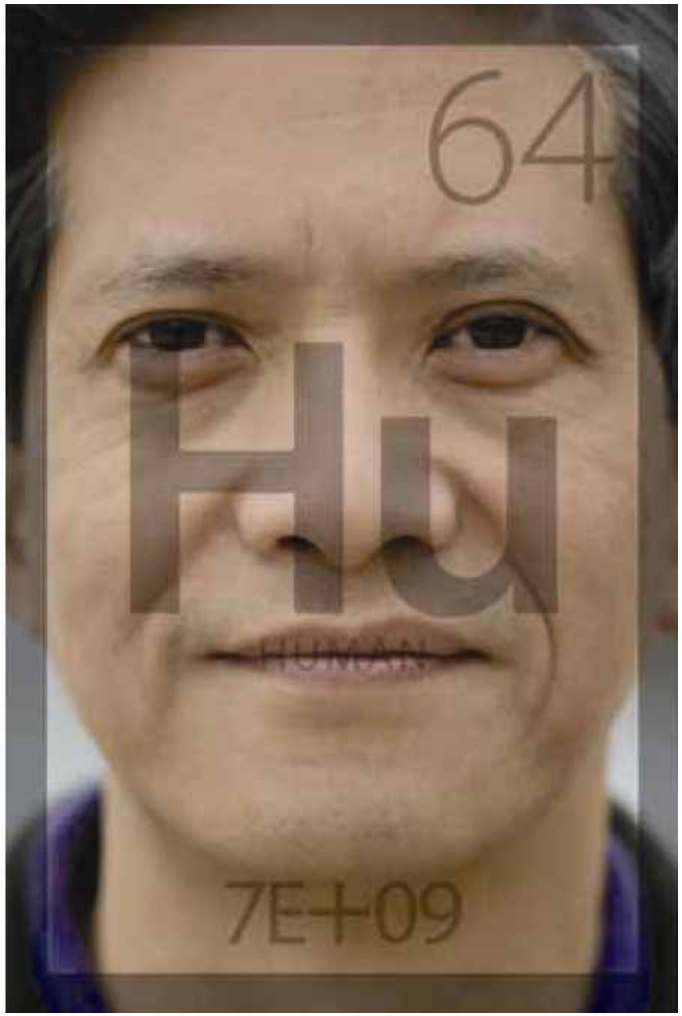
# It’s ALL about the *‘Human Element’!*




**Dow’s**

**“Human Element” Ad**

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# FROM SCIENCE...SECURITY

| Explosives | Chemical/Biological | Command, Control, & Interoperability |
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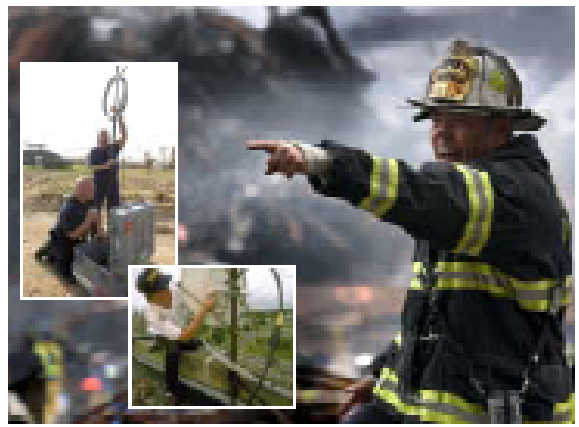
| | |  |
| **Borders/Maritime** | **Human Factors** | **Infrastructure/Geophysical** |
| | | |

# FROM TECHNOLOGY...TRUST

# Back-Up

# S&T Points of Contact

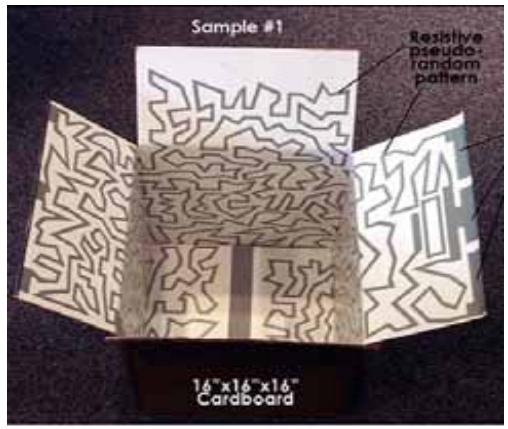
| Division | Email |
|---|---|
| Jim Tuttle | S&T-Explosives@dhs.gov |
| John Vitko | S&T-ChemBio@dhs.gov |
| David Boyd | S&T-C2I@dhs.gov |
| Dave Newton | S&T-BordersMaritime@dhs.gov |
| Sharla Rausch | S&T-HumanFactors@dhs.gov |
| Chris Doyle | S&T-InfrastructureGeophysical@dhs.gov |
| Bob Hooks | S&T-Transition@dhs.gov |
| Starnes Walker | S&T-Research@dhs.gov |
| Roger McGinnis | S&T-Innovation@dhs.gov |
| Lil Ramirez | S&T-InternationalPrograms@dhs.gov |

# Border Security:
# Representative Technology Needs

- Improved ballistic protection via personal protective equipment *(Borders/Maritime Division Lead)*
- Improve detection, tracking, and identification of all threats along the terrestrial and maritime border *(Borders/Maritime Division Lead)*
- Ability to access ICE databases in which voice information is entered; provide analytical, reporting, and automated case deconfliction; classify, identify voice samples *(C2I Division)*
- Non-lethal compliance measures for vehicles, vessels, or aircraft allowing for safe interdiction by law enforcement personnel *(Borders/Maritime Division Lead)*
- Non-destructive tools that allow for the inspection of hidden or closed compartments to find contraband or security threats *(Borders/Maritime Division Lead)*
- Improved analysis and decision-making tools that will ensure the development/implementation of border security initiatives *(Borders/Maritime Division Lead)*
- Ability to non-intrusively determine the intent of subjects during questioning *(Human Factors Division)*
- Ability for law enforcement personnel to quickly identify the origin of gunfire and classify the type of weapon fired *(Borders/Maritime Division Lead)*
- Ability for law enforcement officers to assure compliance of lawful orders using non-lethal means *(Borders/Maritime Division Lead)*

# Cargo Security:
# Representative Technology Needs

- Enhanced screening and examination by non-intrusive inspection *(Borders/Maritime Division)*
- Increased information fusion, anomaly detection, Automatic Target Recognition capability *(Borders/Maritime Division)*
- Detect and identify WMD materials and contraband *(Borders/Maritime Division)*
- Capability to screen 100% of air cargo *(Borders/Maritime Division)*
- Test the feasibility of seal security; Detection of intrusion *(Borders/Maritime Division)*
- Track domestic high-threat cargo *(Borders/Maritime Division)*
- Harden air cargo conveyances and containers *(*Borders/Maritime *Division)*
- Positive ID of cargo & detection of intrusion or unauthorized access *(Borders/Maritime Division)*



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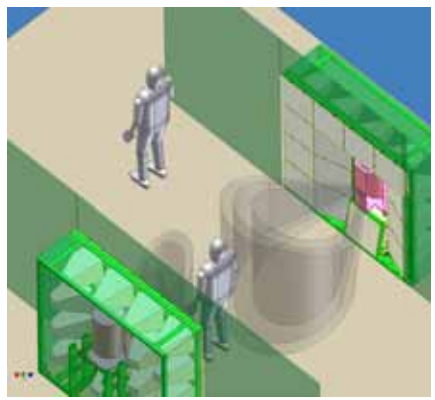
# Explosives Prevention:
# Representative Technology Needs

- Standoff detection on persons (portable solutions) *(Explosives Division)*
- System solution for detection in baggage (checked & carried) *(Explosives Division)*
- Capability to detect VBIED / large threat mass (container, trailer, ship, vessel, car, rail) *(Explosives Division)*
- Capability to detect homemade or novel explosives *(Explosives Division)*
- Capability to assess, render safe, and neutralize explosive threats *(Explosives Division)*
- Optimize canine explosive detection capability *(Explosives Division)*



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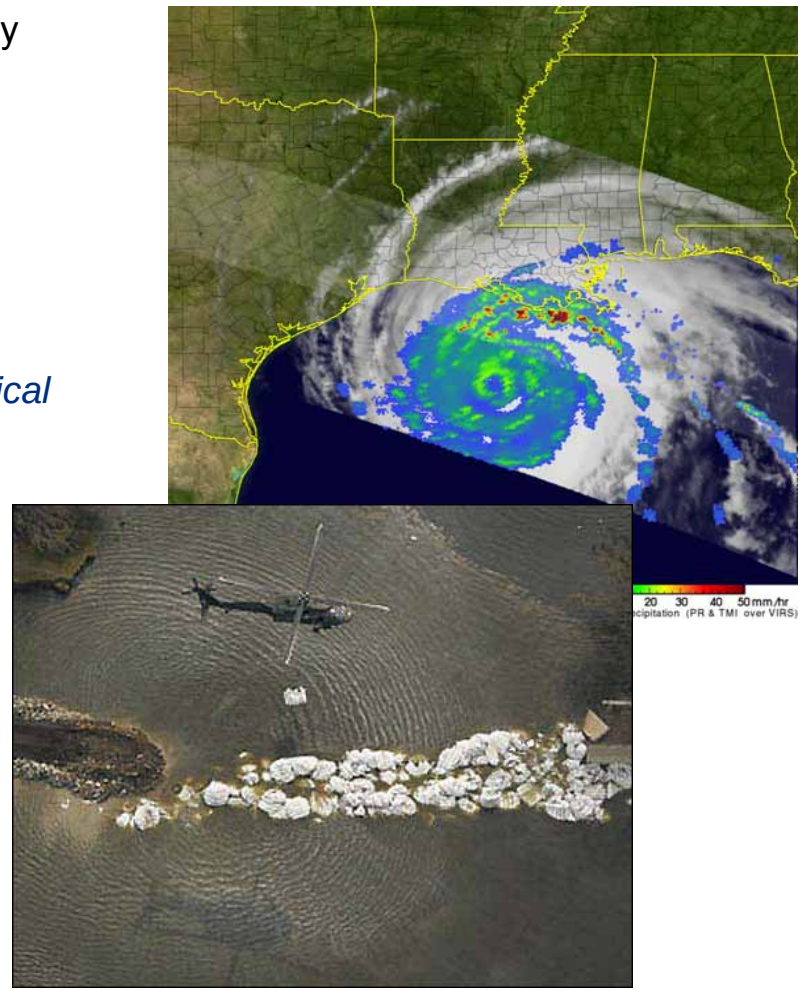
# Incident Management:
# Representative Technology Needs

- Integrated Modeling, Mapping and Simulation capability *(IP/Geophysical Division)*
- Personnel Monitoring (Emergency Responder Locator System) capability *(IP/Geophysical Division)*
- Personnel Monitoring (Physiological Monitoring of Firefighters) capability *(IP/Geophysical Division)*
- Incident Management Enterprise System *(IP/Geophysical Division)*
- Logistics management tool *(IP/Geophysical Division)*

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# Interoperability:
# Representative Technology Needs

- Development and evaluation of Internet Protocol (IP) enabled backbones *(C2I Division)*
- Test and evaluation of emergent wireless broadband data systems *(C2I Division)*
- Acceleration of development and testing of P25 IP-based interfaces *(C2I Division)*
- Identification and development of message interface standards *(C2I Division)*
- Transition of Land Mobile Radios communication architectures to cellular based architectures *(C2I Division)*
- Evaluation of access technologies *(C2I Division)*
- Development of the complementary test procedures *(C2I Division)*

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# Maritime Security:
# Representative Technology Needs

- Wide-area surveillance from the coast to beyond the horizon; port and inland waterways region - detect, ID, and track *(Borders/Maritime Division Lead)*
- Data fusion and automated tools for command center operations *(Borders/Maritime Division Lead)*
- Vessel compliance through non-lethal compliance methods *(Borders/Maritime Division Lead)*
- Enhanced capability to continuously track contraband on ships or containers *(Borders/Maritime Division)*

- Improved ballistic personal protective equipment for officer safety *(Borders/Maritime Division Lead)*
- Improved WMD detection equipment for officer safety; improved screening capability for WMD for maritime security checkpoints *(Borders/Maritime Division Lead)*

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# People Screening:
# Representative Technology Needs

- Systematic collection and analysis of information related to understanding terrorist group intent to engage in violence *(Human Factors Division)*
- Non-invasive monitoring: Identifying and tracking unknown or potential threats from individuals at key checkpoints. Real-time detection of deception or hostile intent through integrated system of human and machine methods *(Human Factors Division)*
- Capability in real-time for positive verification of individual's identity utilizing multiple biometrics *(Human Factors Division)*
- Capability for secure, non-contact electronic credentials; contactless readers or remote interrogation technologies for electronic credentials *(Human Factors Division)*
- Mobile biometrics screening capabilities, to include hand-held, wireless, and secure devices *(Human Factors Division)*
- High-speed, high-fidelity ten-print capture capability *(Human Factors Division)*

Homeland Security

# 2007 S&T Stakeholders Conference

## Washington, DC

For more information visit:
http://www.ndia.org/meetings/7680

*Coming Up…*

*DHS S&T Conference*
*London - Dec. 4, 2007*

*Details to follow*

# Security challenges from the perspective of a small city state

PACOM Operational S&T Conference 2007

3 Apr 2007

Richard Lim, Rear Admiral (Retired) RSN

Chief Executive

Defence Science and Technology Agency

# Singapore has enjoyed 42 years of peace and economic progress as an independent nation

**Key contributors to success:**

- **A diversified and open economy plugged into the global marketplace**
- **A strong commitment to defence and security (6% GDP)**
- **Social and religious harmony**

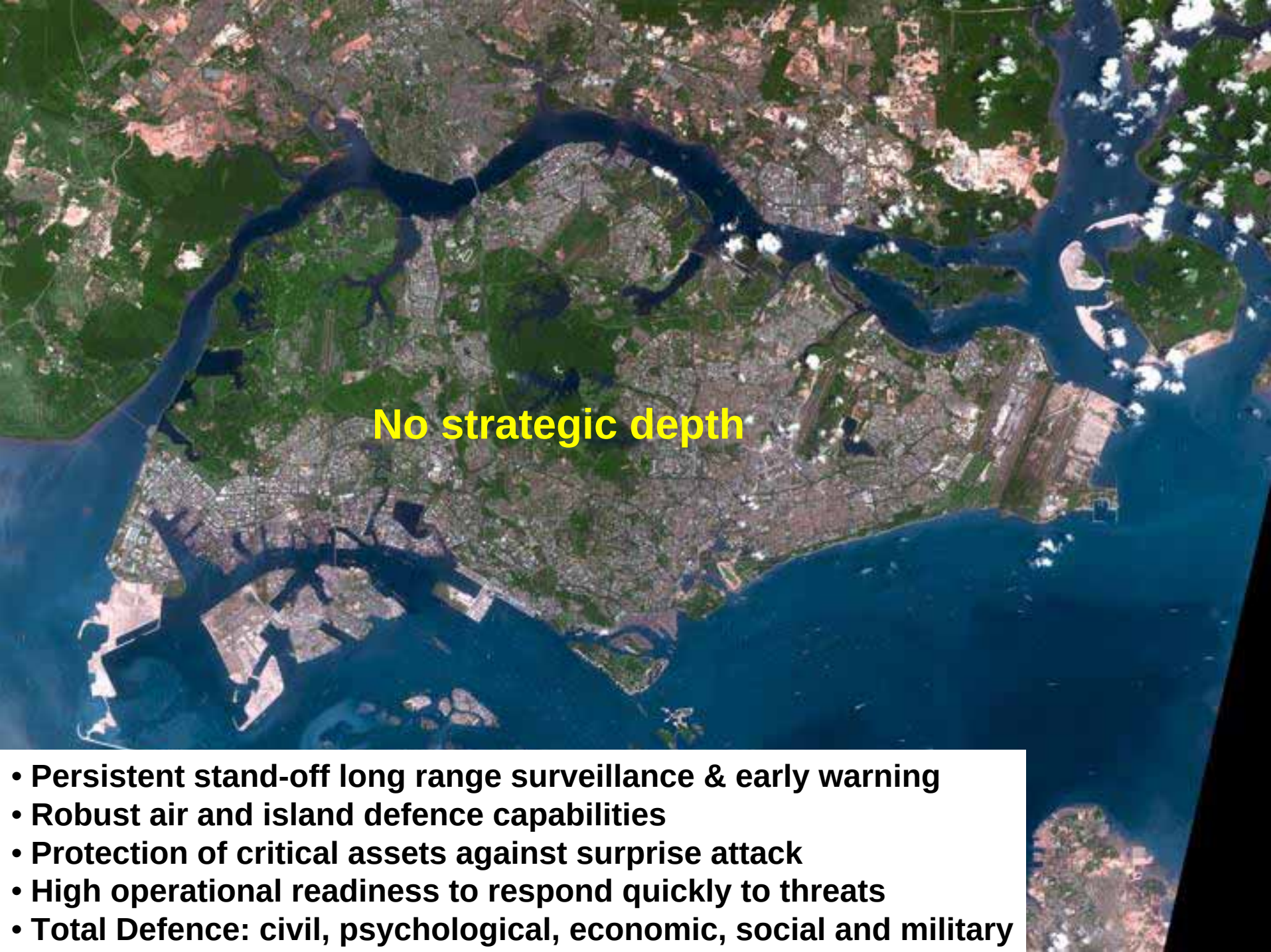
**But the fundamentals behind its security challenges remain basically unchanged since independence in 1965**

**Singapore**

- Area = 707 sq km (22% reclaimed)
- 42 km length; 23 km breadth
- Population = 4.3m (3.2m citizens)

**New York City**

- Area = 785 sq km
- Population = 8 million




- **Persistent stand-off long range surveillance & early warning**
- **Robust air and island defence capabilities**
- **Protection of critical assets against surprise attack**
- **High operational readiness to respond quickly to threats**
- **Total Defence: civil, psychological, economic, social and military**

Small population

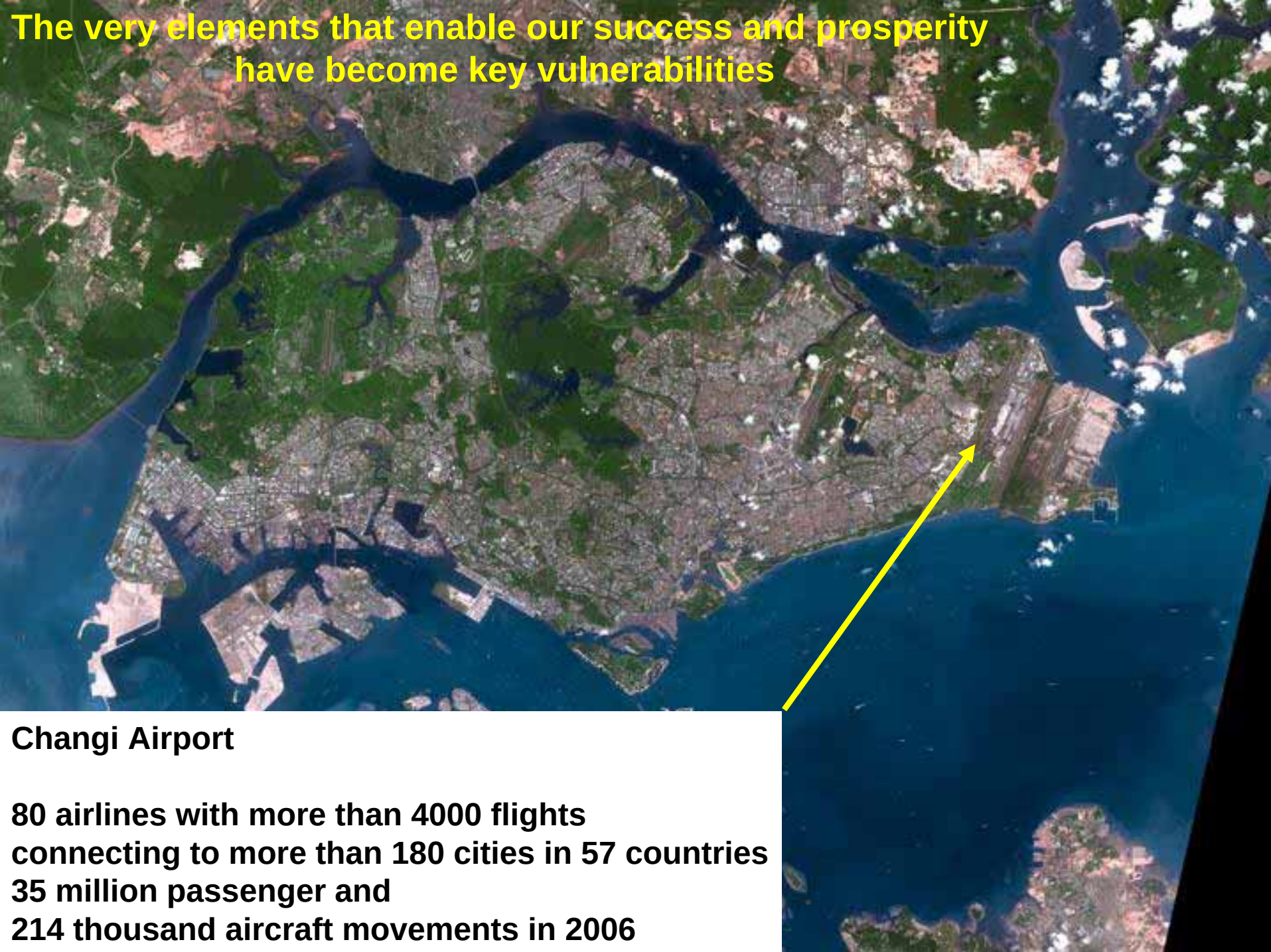
# Conscript Armed Forces

Two years of national service
300.000 when mobilised

Limited space for military training

# Overseas Training

LIVE
FOX NEWS channel
operation
IRAQI FREEDOM
SPECIAL REPORT
SHOWDOWN:
IRAQ
JW MARRIOTT HOTEL
JAKARTA
AFP
Our security challenges have become more complex




**Changi Airport**

**80 airlines with more than 4000 flights**
**connecting to more than 180 cities in 57 countries**
**35 million passenger and**
**214 thousand aircraft movements in 2006**

The very elements that enable our success and prosperity have become key vulnerabilities
60 thousand vehicles pass through the causeway each day
8.94 million tourists arrivals

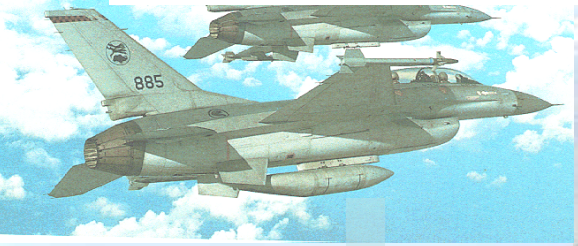
**The very elements that enable our success and prosperity have become key vulnerabilities**

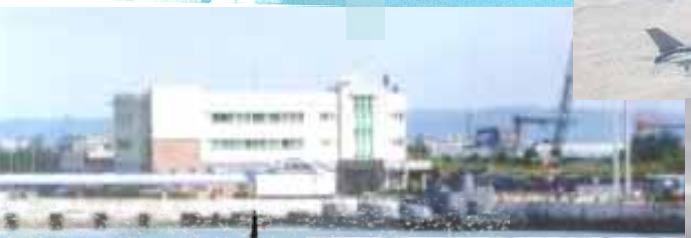
## Singapore Port

200 shipping lines with links to 600 ports in 120 countries
140,000 vessels call annually
24 million containers (TEU) 0r 6% of global container throughput handled in 2006

# SINGAPORE ARMED FORCES

**While architected for deterrence and the defence of Singapore, the SAF has found itself deployed for various operations other than war**





# Peace Support Operations

- Singapore is committed to the UN and its mission in maintaining international peace and security
- 1500 SAF peacekeepers sent to various missions since 1989
- Operating out of traditional areas
  - East Timor
  - Middle East: Iraq and Afghanistan

# Participation in UN PSO

| UN Mission | Date | Role(s) in Mission |
|---|---|---|
| UNTAG, Namibia | Oct to Nov 89 | Election Supervisors |
| Ops Nightingale | Jan to Mar 91 | Medical Team |
| UNIKOM, Iraq-Kuwait | Apr 91 to Mar 03 | Military Observers |
| UNAVEM II, Angola | Jul 91 to Dec 92 | Military Observers |
| UNTAC, Cambodia | May to Jun 93 | Helicopter Detachment, Election Supervisors |
| UNOMSA, South Africa | Apr to May 94 | Election Supervisors |
| UN HQ – DPKO, New York | Nov 95 to Present | Appointments in DPKO |
| UNSCOM (UN Special Commission in Iraq) | Jun 96 | Member of UN Special Commission Inspection Team |
| MINUGUA, Guatemala | Feb to May 97 | Medical Team |
| UNSMA, Afghanistan | May 97 to May 98 | UN Military Adviser |
| **International Force for East Timor (INTERFET)** | **20 Sept 99 to Feb 00** | **Medical Team, Military Liaison Teams** |
| **UN Transitional Administration in East Timor (UNTAET)** | **Feb 00 to May 02** | **UNTAET HQ Staff, Medical teams and Peacekeeping troops** |
| UN Mission in Ethiopia and Eritrea (UNMEE) | May 00 to Jul 03 | Military Observers |
| **UN Mission of Support in East Timor (UNMISET)** | **May 02 to 22 Oct 03** | **Force Commander, UNMISET HQ staff, Peacekeeping troops and Helicopter detachment**<br>**3 SAF PKF HQ Staff remain till May 04** |

# Timor Leste

- **INTERFET**
  - 4- men Liaison Team
  - 3 x LST for 2 months each
  - 1 x C130 for two weeks
  - 26- personnel Medical Team
  - 40 police personnel
  - Cumulative total of 373 personnel involved
- **UNTAET**
  - 4 x PKO HQ staff,
  - 3 x 61-men Platoon Task Force in Western Sector
  - 9 x 21-men Medical Team
  - 40 x Police Personnel

- **UNMISET**
  - May 02 onwards - Over 250 personnel
  - Force Comdr UNMISET- PKF
  - Staff Planners at PKF HQ
- Helicopter Detachment - 4 x UHIH
  - Infantry Company

# OEF / OIF

**LST**

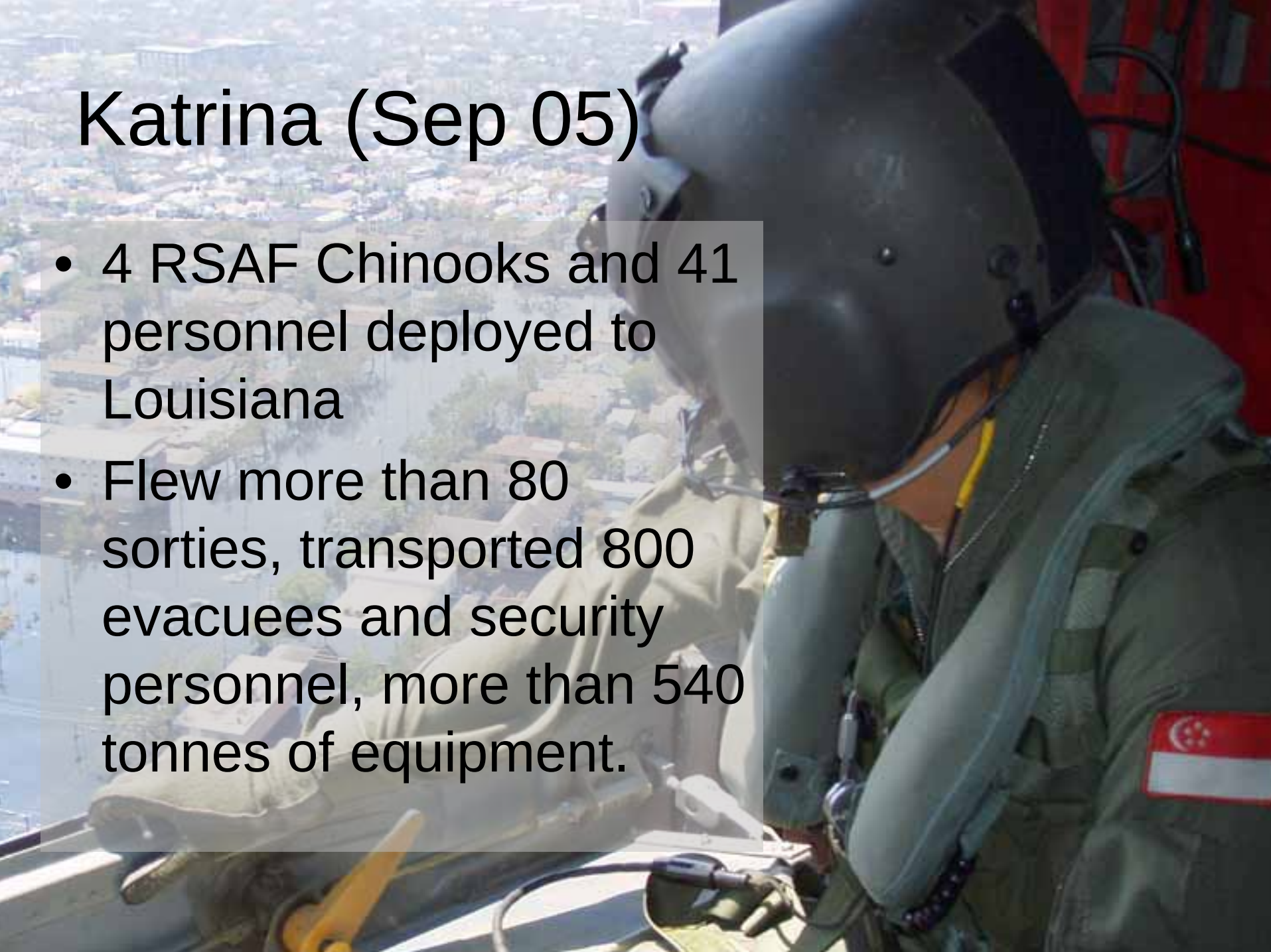
**KC-135**

**C-130**

- **Landing Ship Tank (LST)**
  - Monitor vessels to and from ports in Iraq
  - Compliant boarding operations
  - Health and comfort support to detained vessels
  - Platform support for helicopter operations
  - Guardship duties
- **KC-135**
  - Air-to-air refuelling
- **C130**
  - Strategic lift for personnel and cargo
  - Aeromedevac

# Indian Ocean Tsunami

# Katrina (Sep 05)



- 4 RSAF Chinooks and 41 personnel deployed to Louisiana
- Flew more than 80 sorties, transported 800 evacuees and security personnel, more than 540 tonnes of equipment.

# Yogyakarta Earthquake
**(27 May 06)**

- Medical detachment deployed
  - TNI Field Hospital in Plered, Bantul
  - Bantul District Hospital
- US$250,000 worth of humanitarian supplies (approx 24 tons)
  - 750 tentages
  - 4,200 blankets
  - 400 cot beds
  - 1,300 sleeping bags
  - Medical supplies

# Provincial Reconstructive Team

Bamiyan, Afghanistan

- Part of New Zealand Reconstruction Team
- Set up of dental clinic & training of locals in dentistry and basic healthcare
- Bridge construction and repair work

# Support for Homeland Security

**Maritime C3 and Coastal Surveillance**

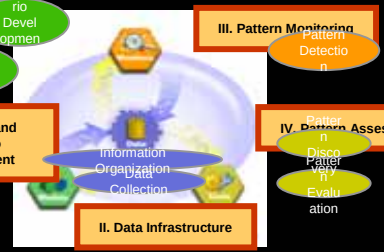
**Consequence Assessment**

**Police/SCDF C3**

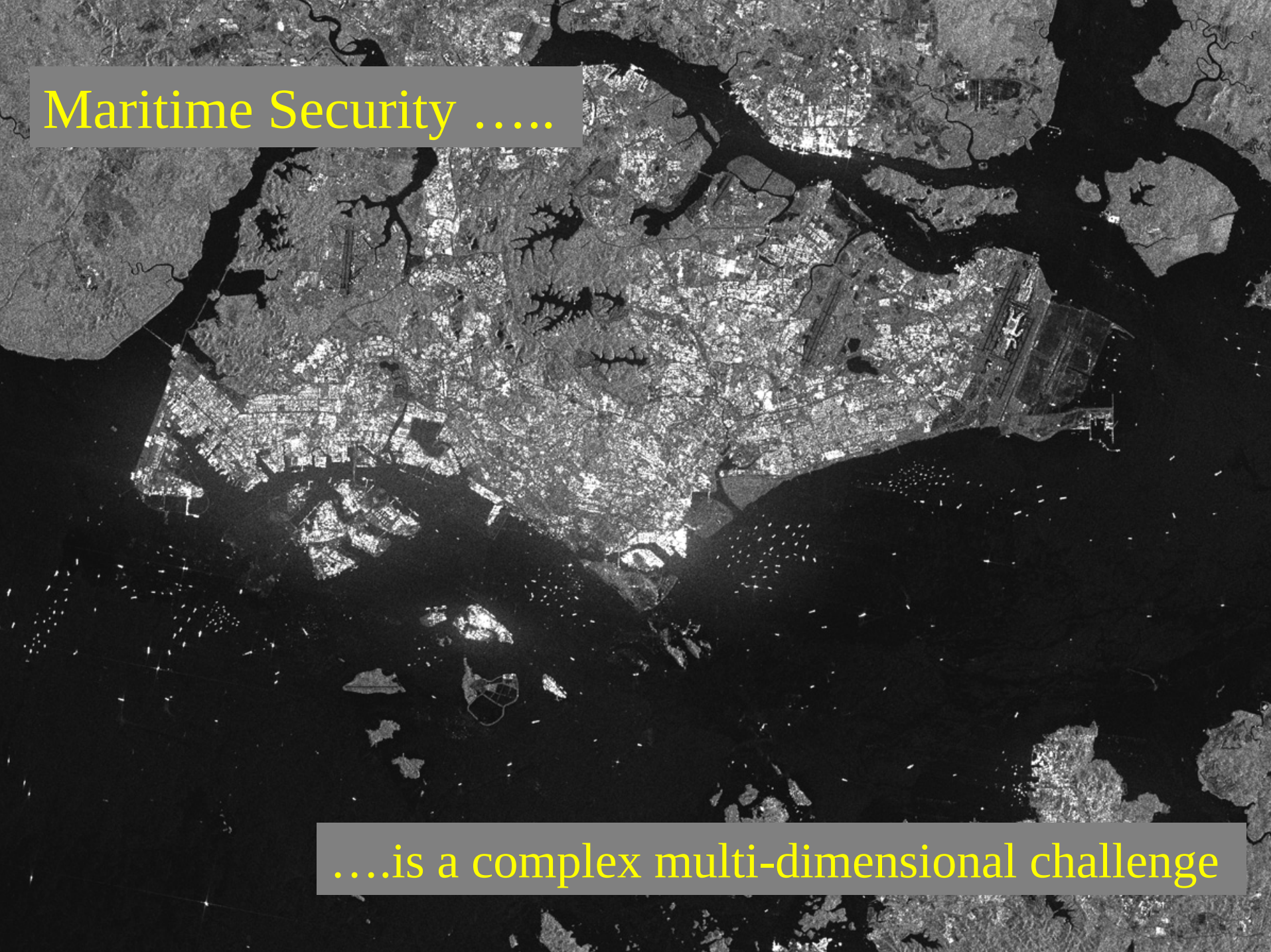
**Explosive Testing**

**Crisis Information Management**

**Infrastructure Hardening**

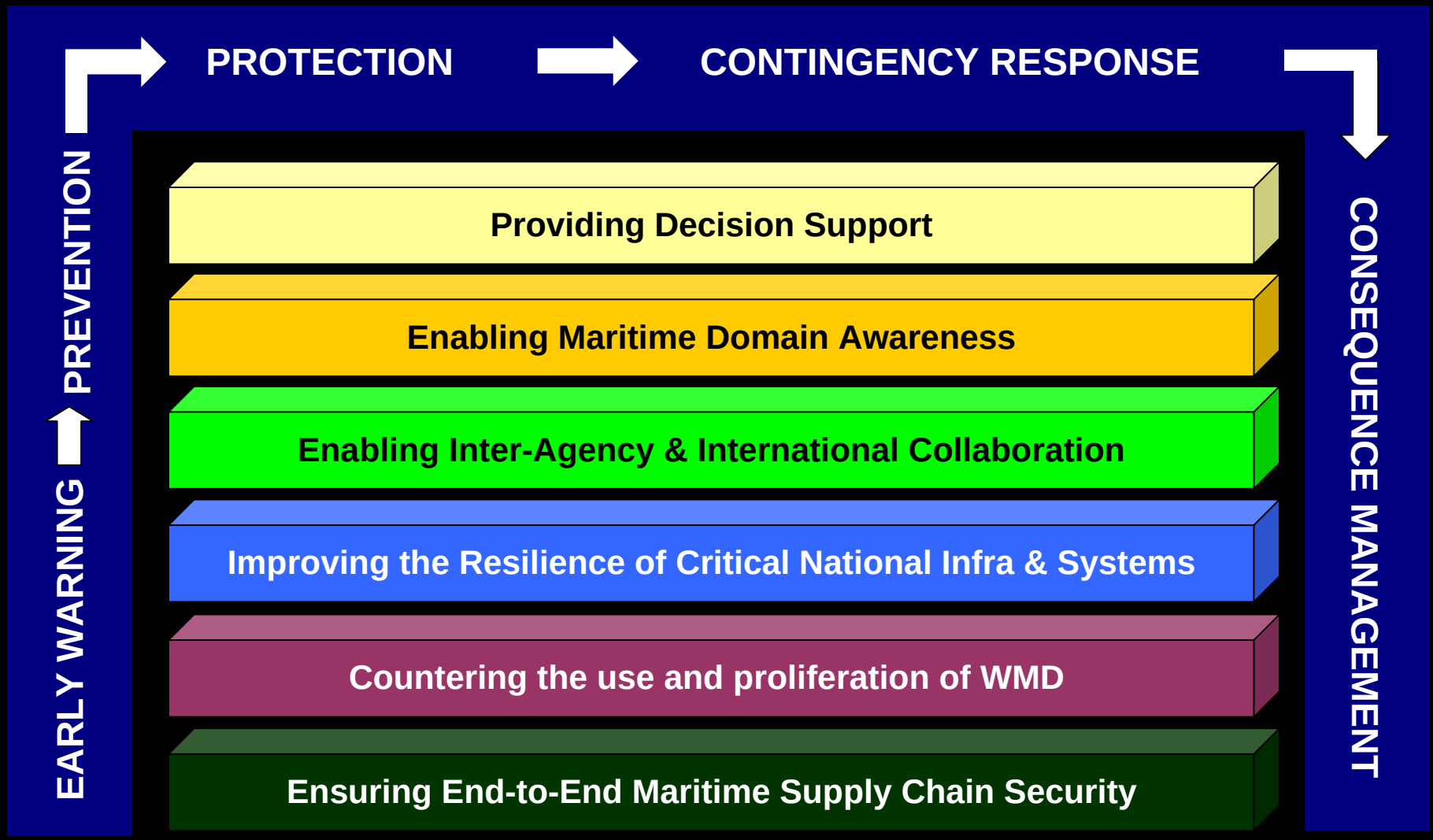



**Risk Assessment Horizon Scanning**


Maritime Security …..
….is a complex multi-dimensional challenge

**Half of the world's oil and almost one-third of the world's trade**

# Technology support in ……



PROTECTION

CONTINGENCY RESPONSE

EARLY WARNING

PREVENTION

CONSEQUENCE MANAGEMENT

**Providing Decision Support**

- Vulnerability and risk assessments of critical infrastructure

PROTECTION

CONTINGENCY RESPONSE

EARLY WARNING

PREVENTION

CONSEQUENCE MANAGEMENT

**Enabling Maritime Domain Awareness**

Video mosaic

PROTECTION

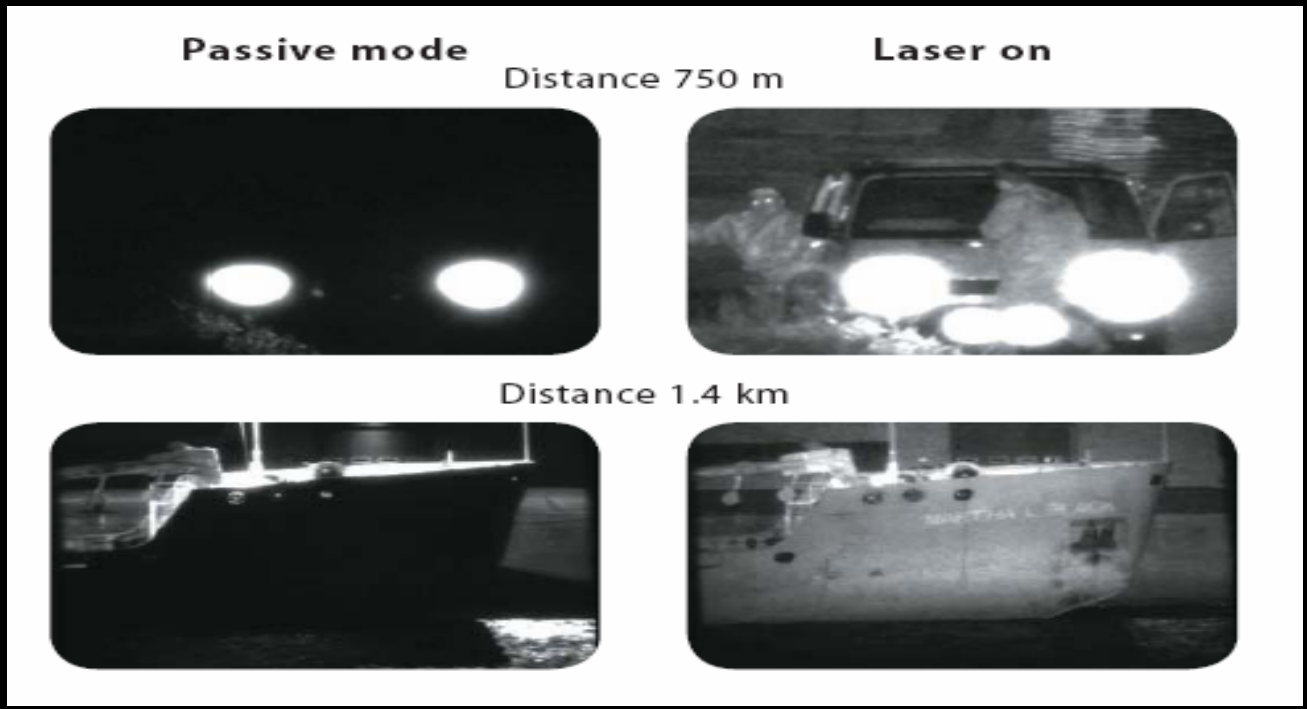
CONTINGENCY RESPONSE

EARLY WARNING

PREVENTION

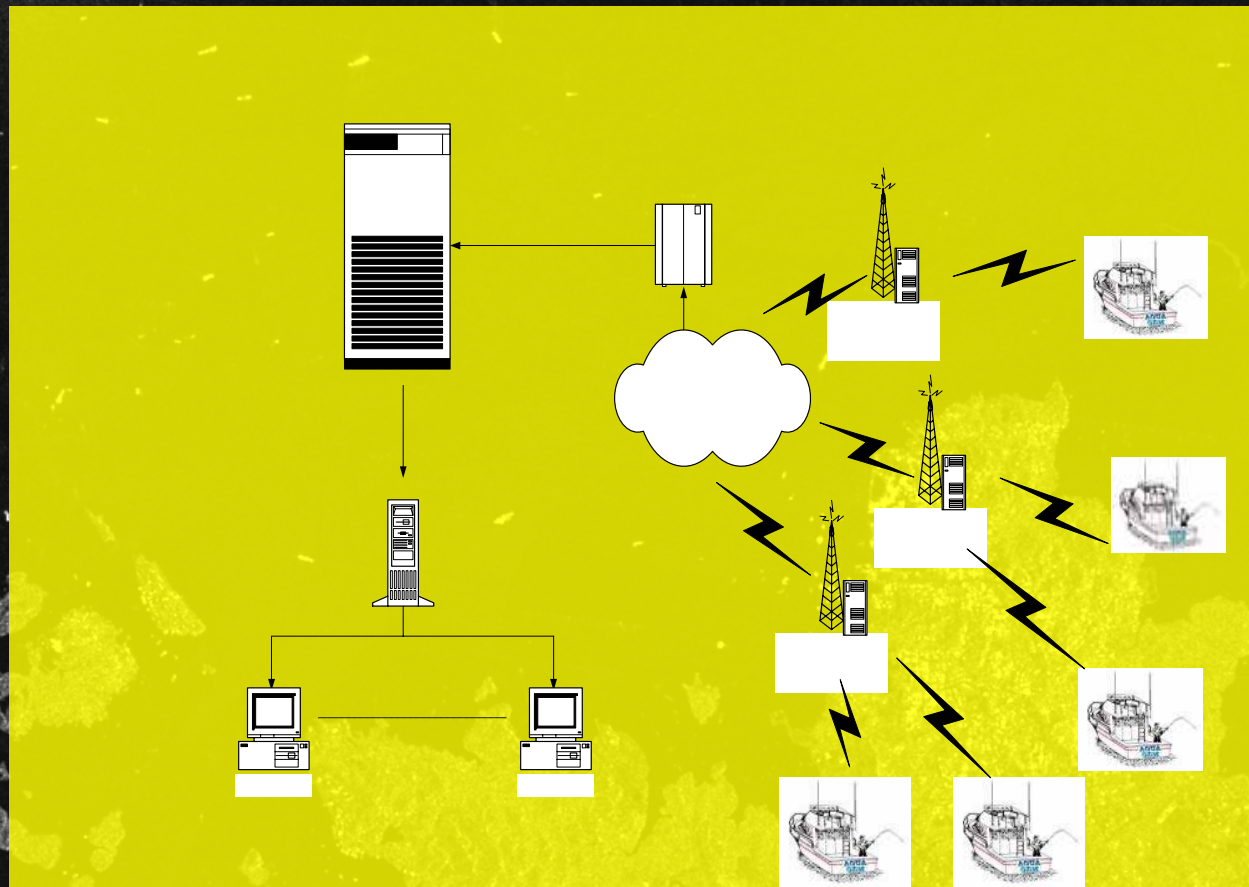
CONSEQUENCE MANAGEMENT

**Enabling Maritime Domain Awareness**

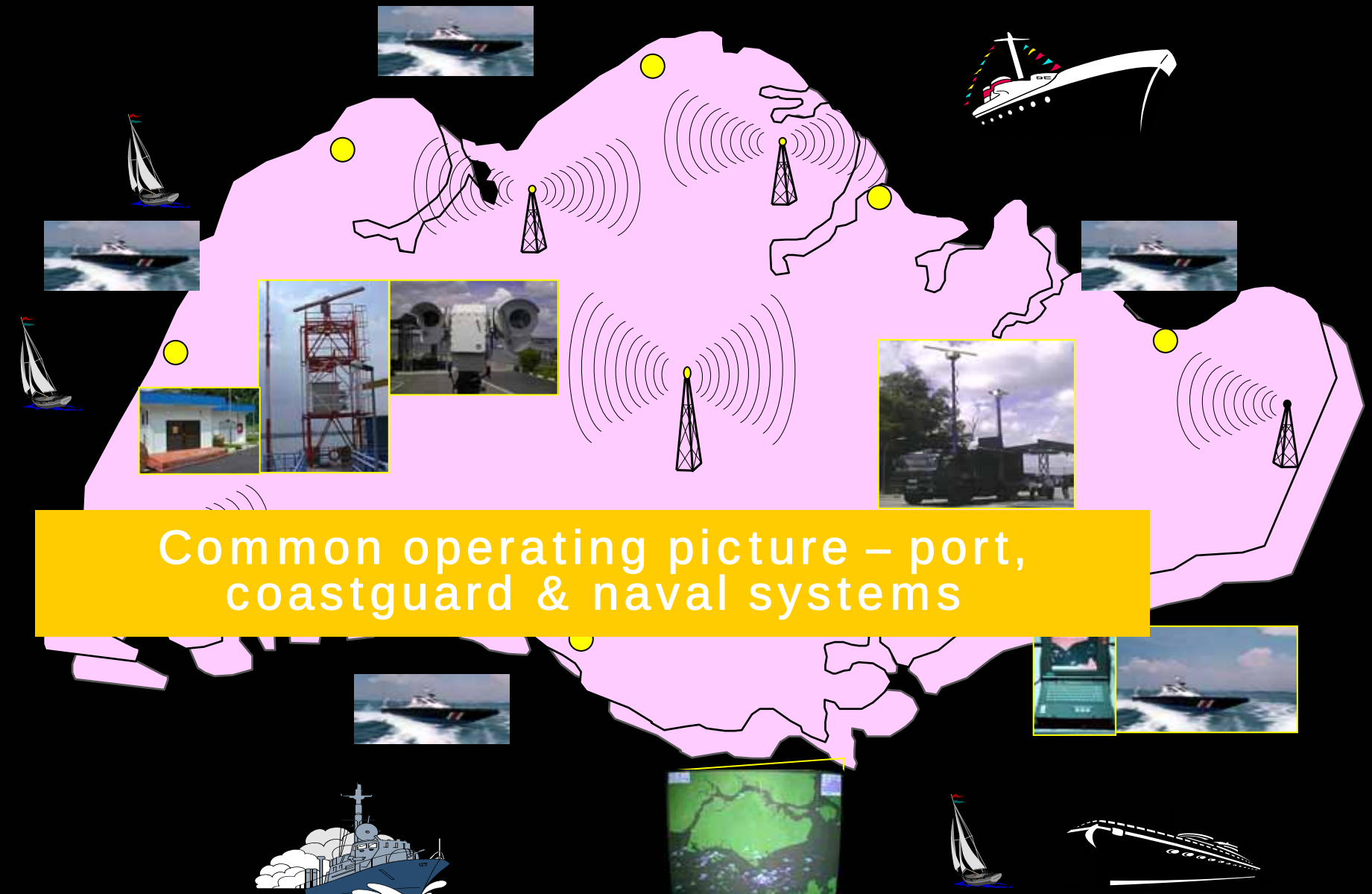



Active imaging

# Harbour Craft Transponder System



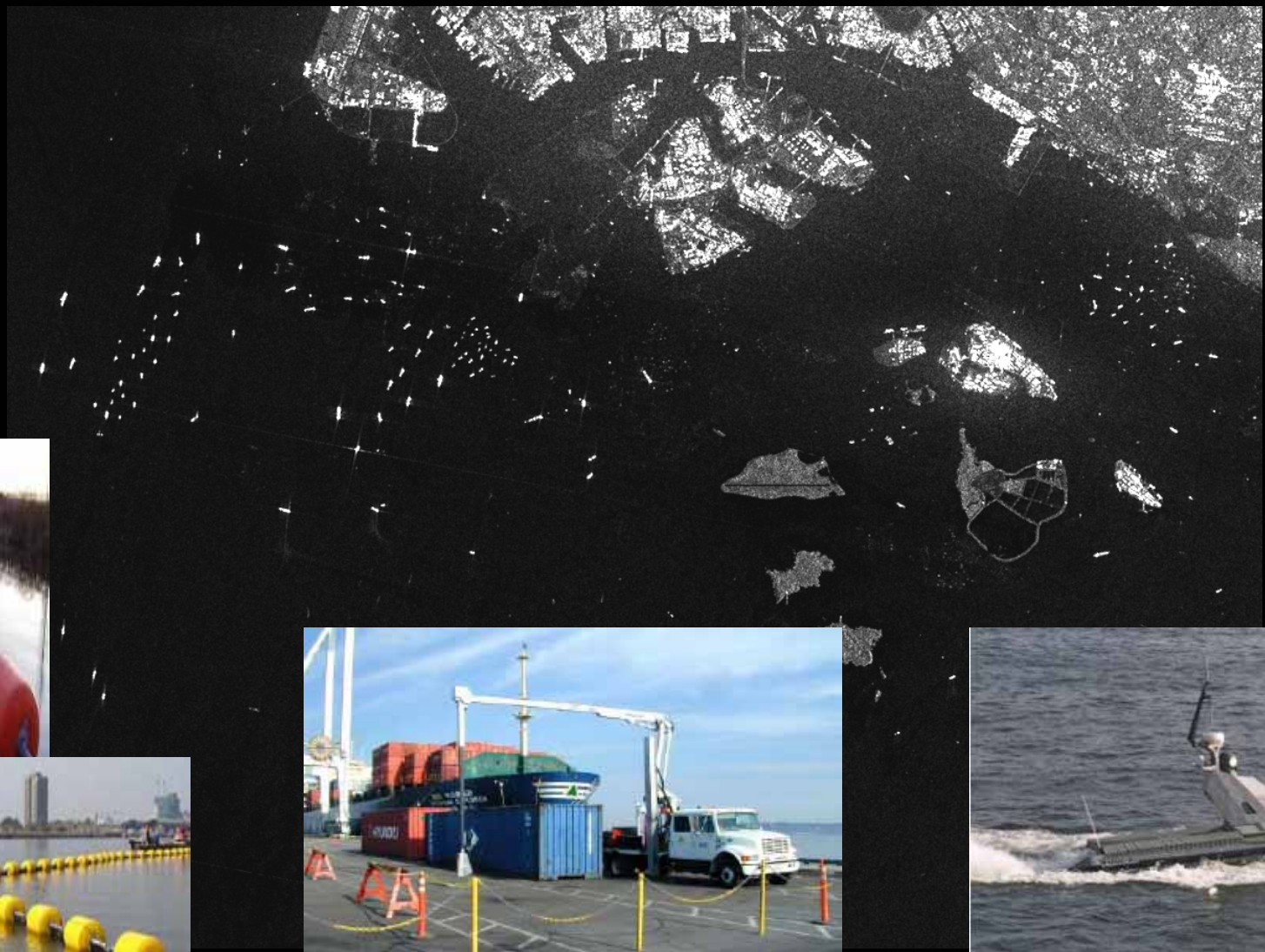
# Enabling Inter-Agency & International Collaboration



Common operating picture – port, coastguard & naval systems

Enabling Inter-Agency & International Collaboration
• Promote interoperability with international forces
CHANGI C2 CENTRE

# Enhancing Resilience of Critical National Infra & Systems



# Enhancing Resilience of Critical National Infra & Systems

Explosive effects testing

PROTECTION

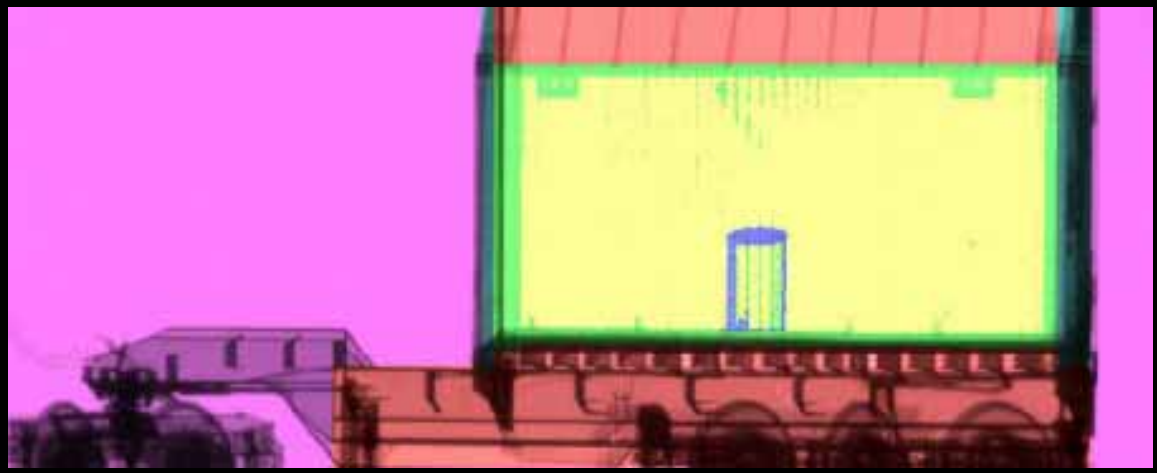
CONTINGENCY RESPONSE

EARLY WARNING

PREVENTION

CONSEQUENCE MANAGEMENT

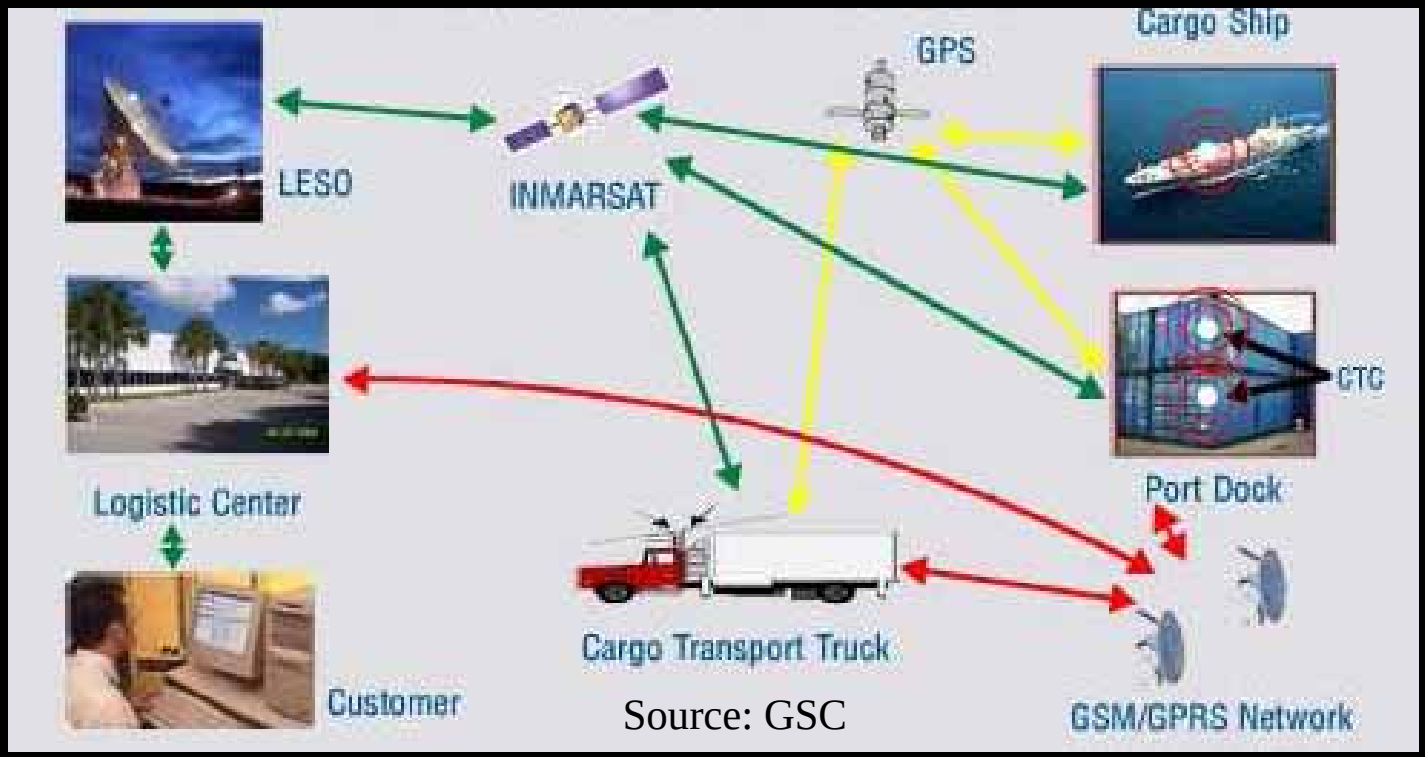
Countering the use and proliferation of WMD



EARLY WARNING → PREVENTION

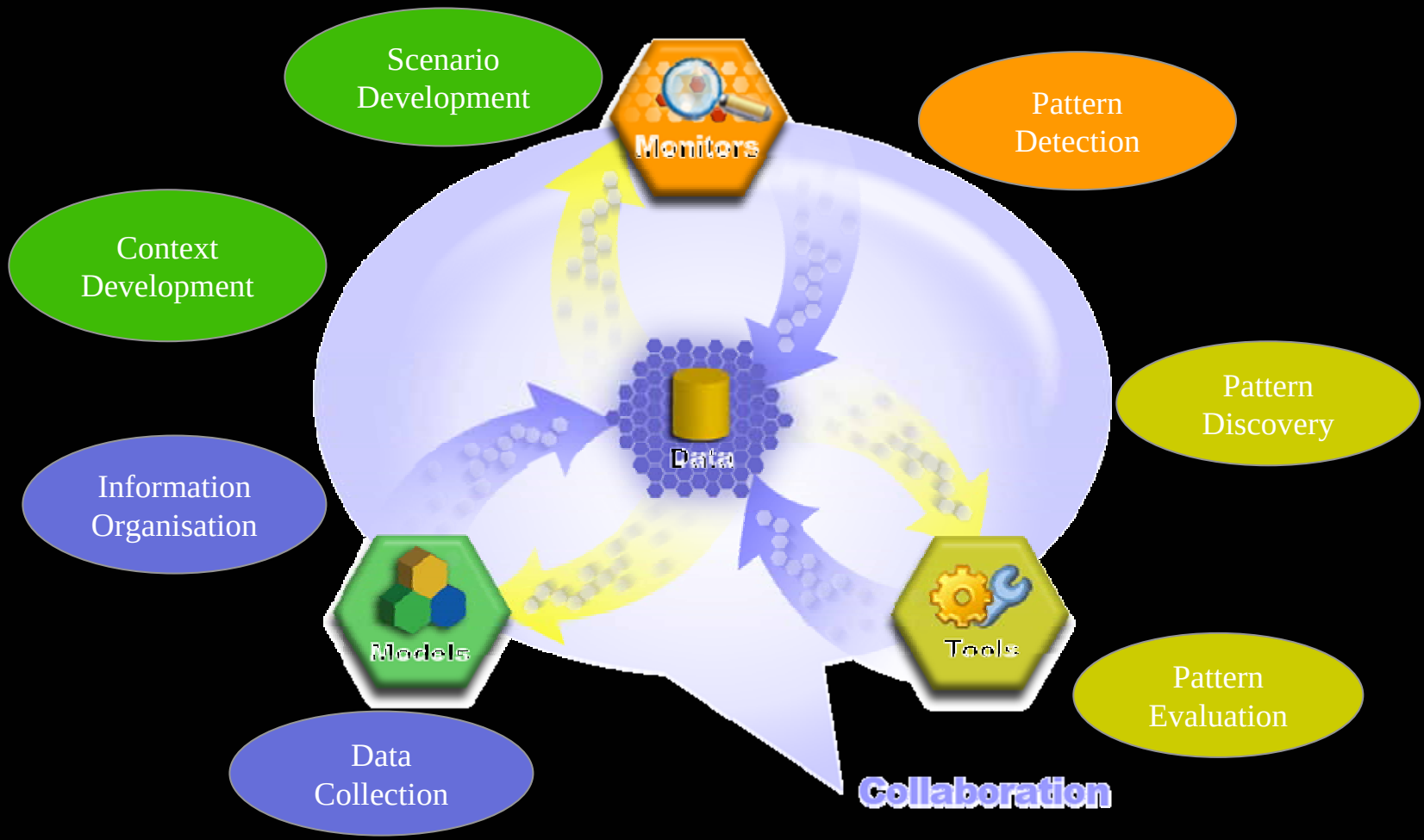
PROTECTION → CONTINGENCY RESPONSE → CONSEQUENCE MANAGEMENT

## Ensuring End-to-End Maritime Supply Chain Security




Source: GSC

# Risk Assessment & Horizon Scanning (RAHS)



International collaboration

# FPDA (Five Power Defence Arrangements)

# INDO-SIN Co-ordinated Patrols (ISCP)

# Malacca Strait Patrols

- Malacca Strait Sea Patrols (MSSP)
- Eyes in the Sky (EiS)

# Exercise Deep Sabre 05

- Singapore-hosted, first PSI exercise in Southeast Asia.
- Distinct Features:
  - Table Top Exercise (TTX)
  - Maritime Interdiction Operations
  - Combined Co-ordination Centre
  - Port Search Phase
  - Exercise Debrief Session

# CMA JCTD with PACOM

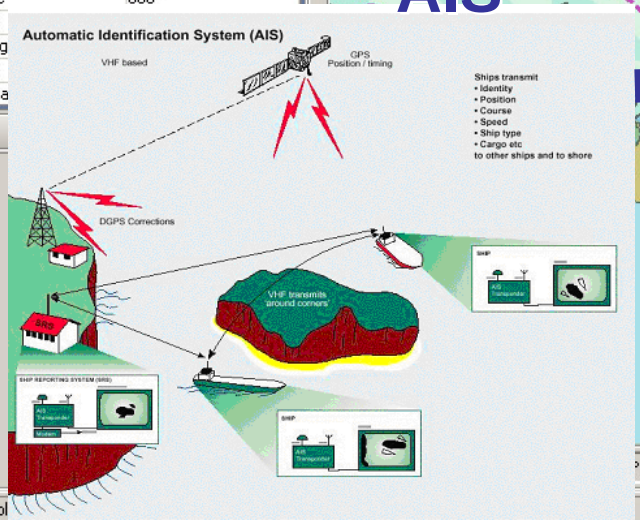
Coastal Command

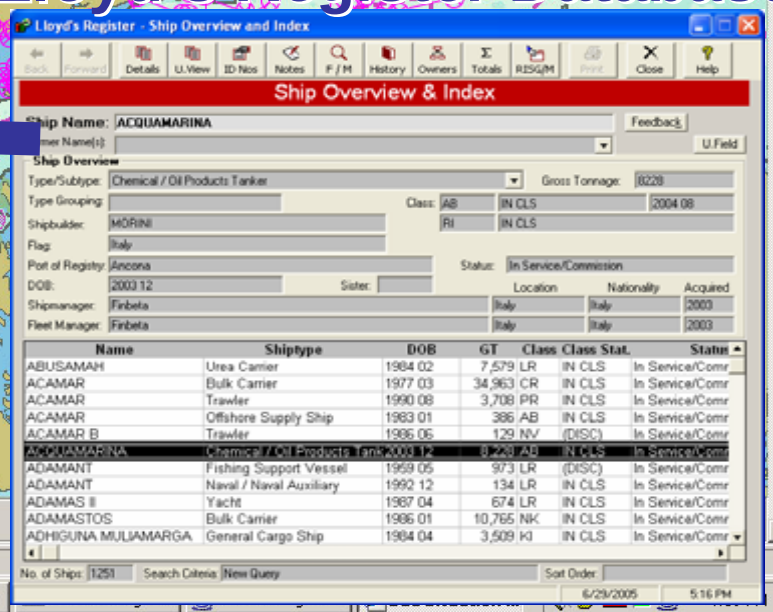
Coastal Sensors

Situation Awareness

AIS

Lloyd's Register Database




Overview

Layers

Maps

Grid Lines

Tracks

Tracks Labels

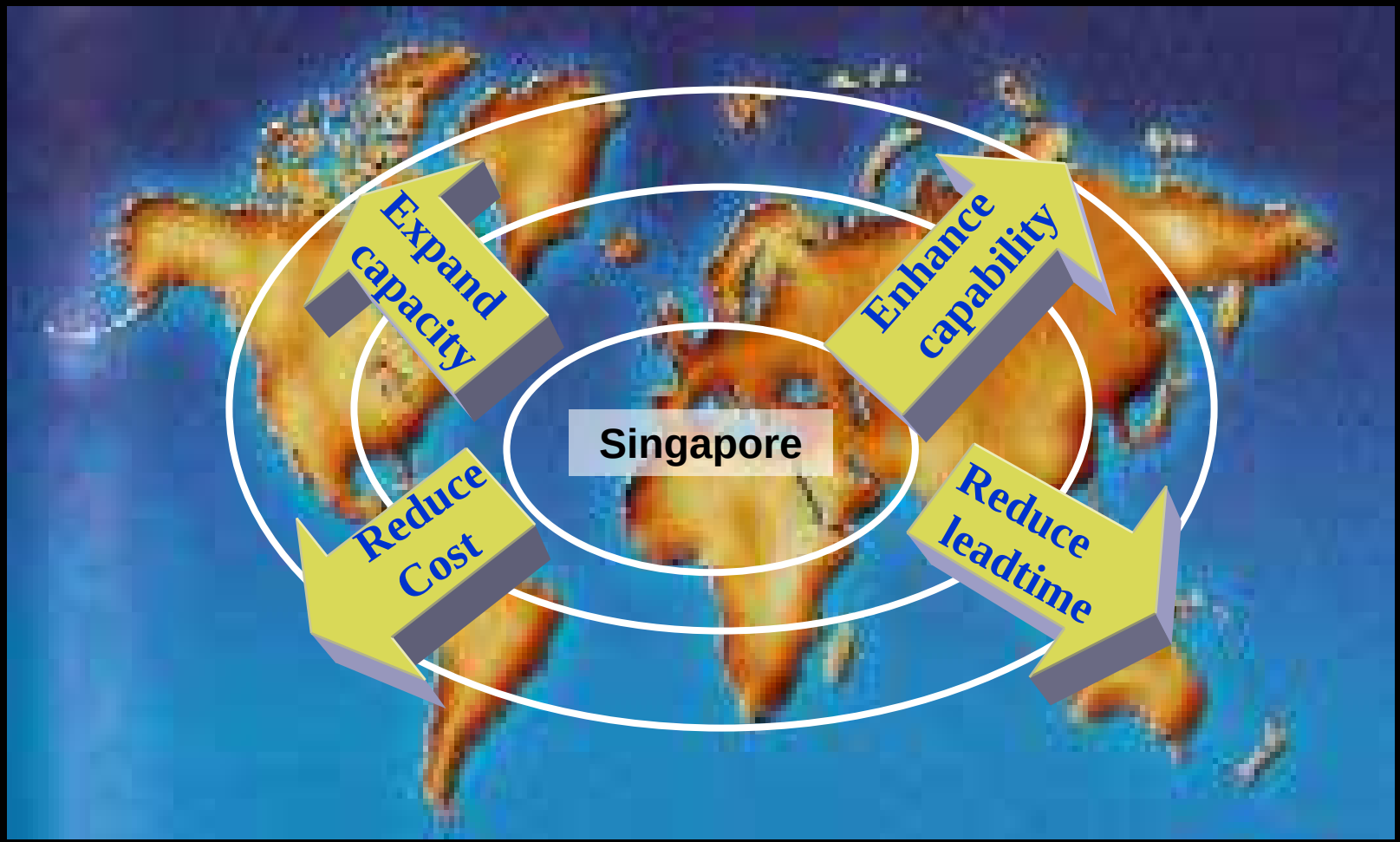
Speed Vectors

Track Details

| | |
|---|---|
| TN | AA504 |
| Identity | Unknown |
| Platform | CABLE LAYI |
| Source | P |
| Position | 011546N |
| | 1032324E |
| Course | 000° |
| Speed | |
| Bearing | |
| Range | |
| Nationa | |

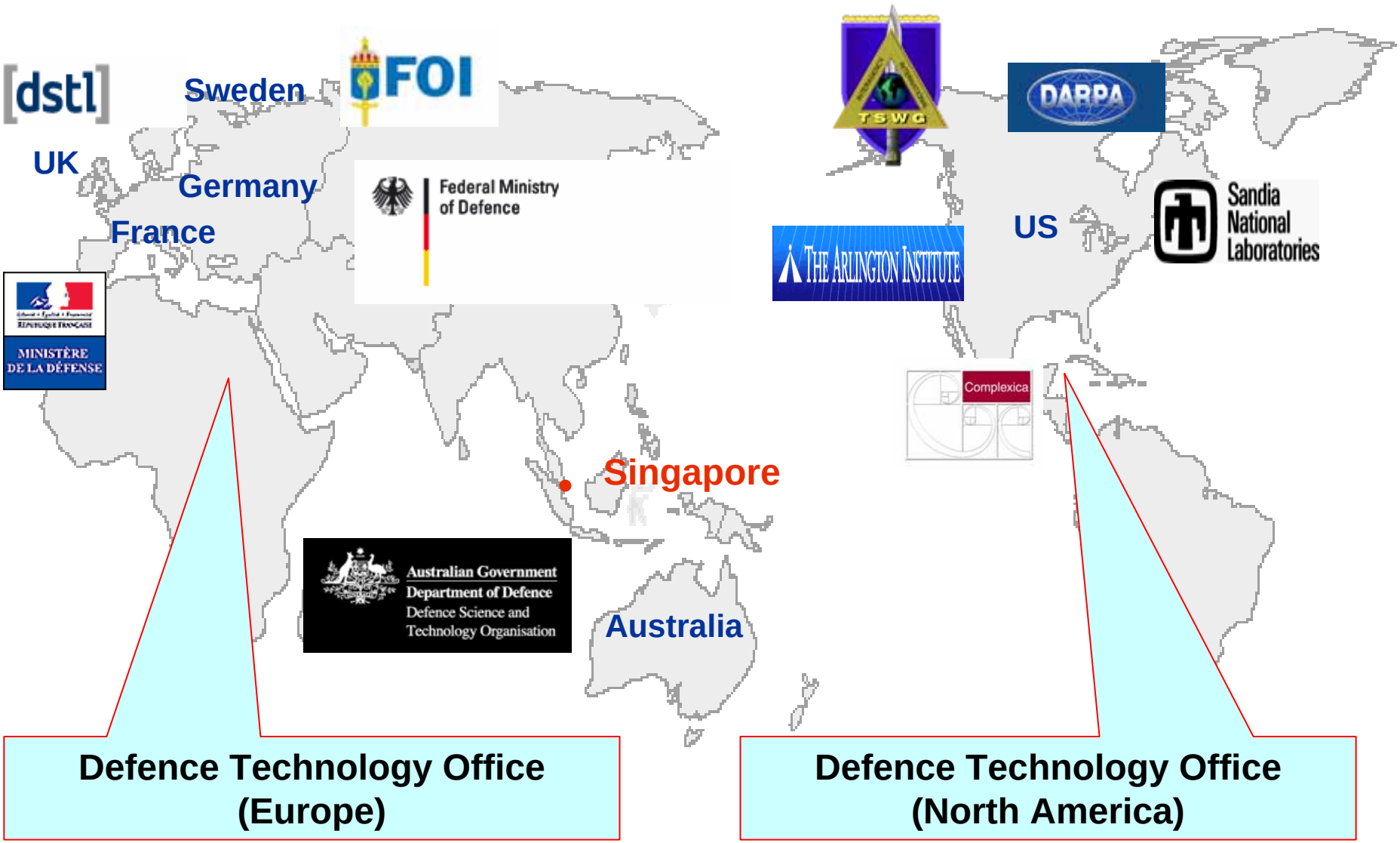
TRACKS: 330

# Technology Collaboration



# Our S&T Partners

# International Collaboration




**Defence Technology Office (Europe)**

**Defence Technology Office (North America)**

# Conclusion

- Singapore takes a systems level approach with technology as an enabler to meet the complex security challenges we face today
- Singapore participates in and seeks international collaboration to meet these challenges

Thank You

# Naval Science and Technology Update

## PACOM Science and Technology Conference

## 4 April 2007

# A Technological "Perfect Storm"?

Revolutionary Research . . . Relevant Results

## For decades, Western militaries have held a decisive technological advantage…

"It is by devising new weapons, and above all by scientific leadership, that we shall best cope with the enemy's superior strength."

**--Winston Churchill**

## Today, enemies are able to acquire weapons and technology quickly and cheaply…

"Acquiring weapons for the defense of Muslims is a religious duty. If I have indeed acquired these weapons, then I thank God for enabling me to do so. And if I seek to acquire these weapons, I am carrying out a duty. It would be a sin for Muslims not to try to possess the weapons that would prevent the infidels from inflicting harm on Muslims."

**--Osama bin Laden**

## And there also are nations willing to invest significantly in new technology…

"The 21st Century is also going to be an age of scientific change, with certain cutting-edge technologies likely to be applied to naval warfare...high-tech arms will make direct attacks on naval battlefields possible from outer space, remote altitudes and remote land bases...superconduction technology will bring superconductor ships to the naval order of battle, enabling ships to travel faster without noise...submarines will be able to go faster and deeper, with the seabed being the ideal place to build military bases."

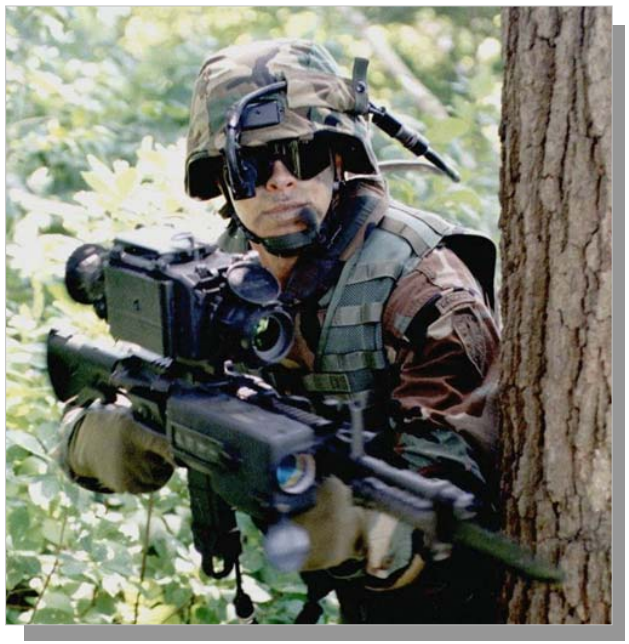
**--Chinese Naval Officers at the Navy Research Institute in Beijing**

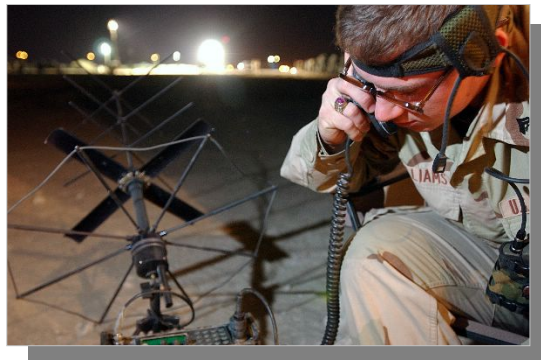
# Technological Dominance

Revolutionary Research . . . Relevant Results

Laser-Guided Munitions

**Today, Marines and Sailors have at their disposal the world's most sophisticated military technology**





Mobile Communications

GPS Navigation and Targeting

Network-Centricity, Information Warfare, and Intelligence

# Technological Democratization

Revolutionary Research . . . Relevant Results

**Internet—Information Warfare and Intelligence**

**In Afghanistan, Iraq, and elsewhere, our adversaries are leveraging sophisticated technology that is now easily available anywhere in the world—and at modest cost.**

**Cell Phones—Mobile Comms**

**Commercial Laser Rangefinder—Precise Targeting**

**Handheld GPS—Location with Extreme Accuracy**

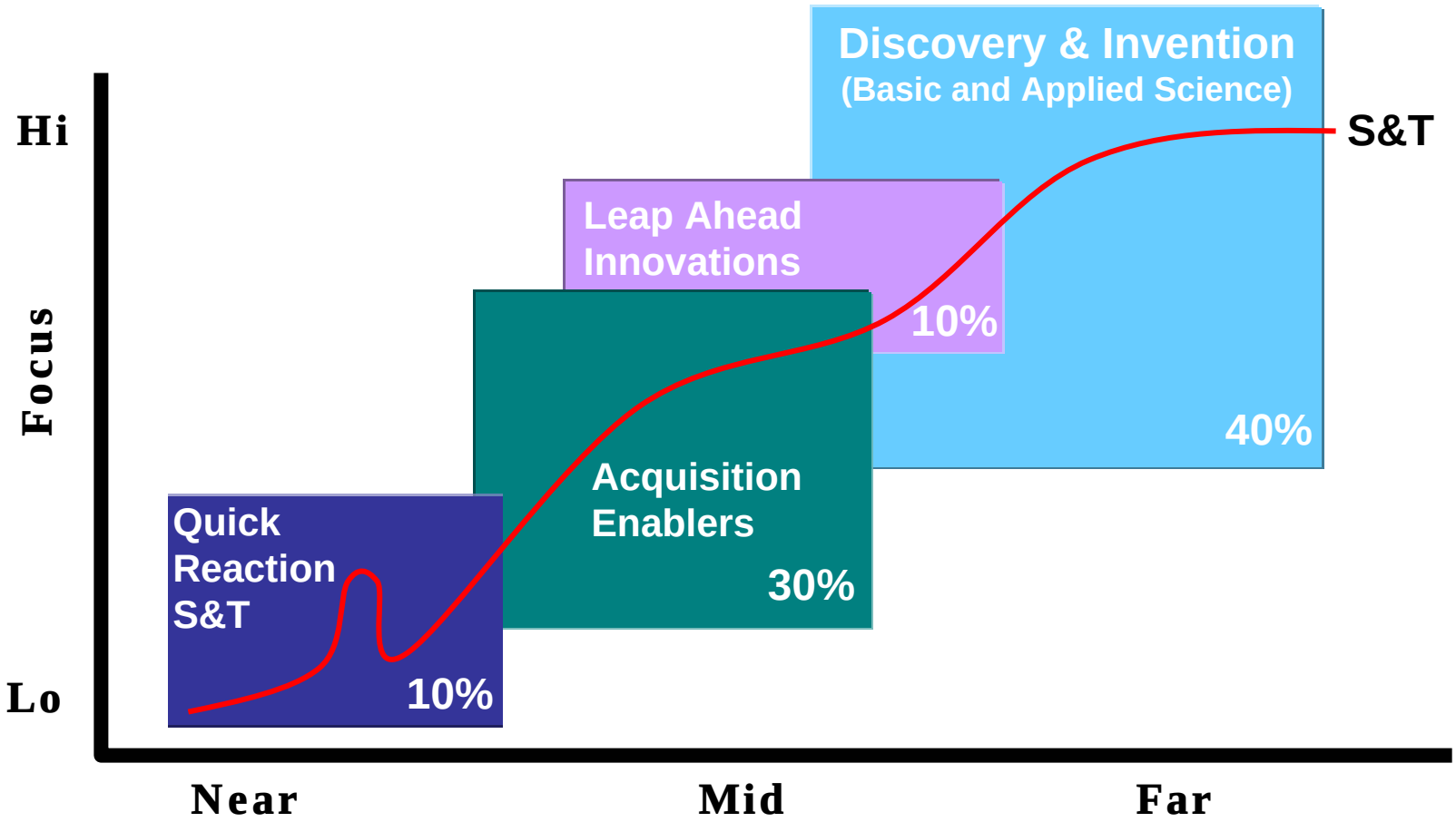
# S&T Strategy Objectives

Revolutionary Research . . . Relevant Results

- Ensure alignment of Naval S&T with Naval missions and future capability needs
- Balance and manage S&T portfolio based on key tenets:
  - Strive to engage with intellectual capital worldwide
  - Leverage U.S. and global technology insights
  - Maintain equilibrium between long-term basic research and near-term advanced prototyping
  - Be innovative and adaptive—lead science where it is critical to the Navy/Marine Corps vision
  - Leverage technology development efforts across the entire DoD
- Communicate S&T vision and approach to senior decision makers, key stakeholders, S&T partners, customers, and performers

# ONR S&T Portfolio Balance

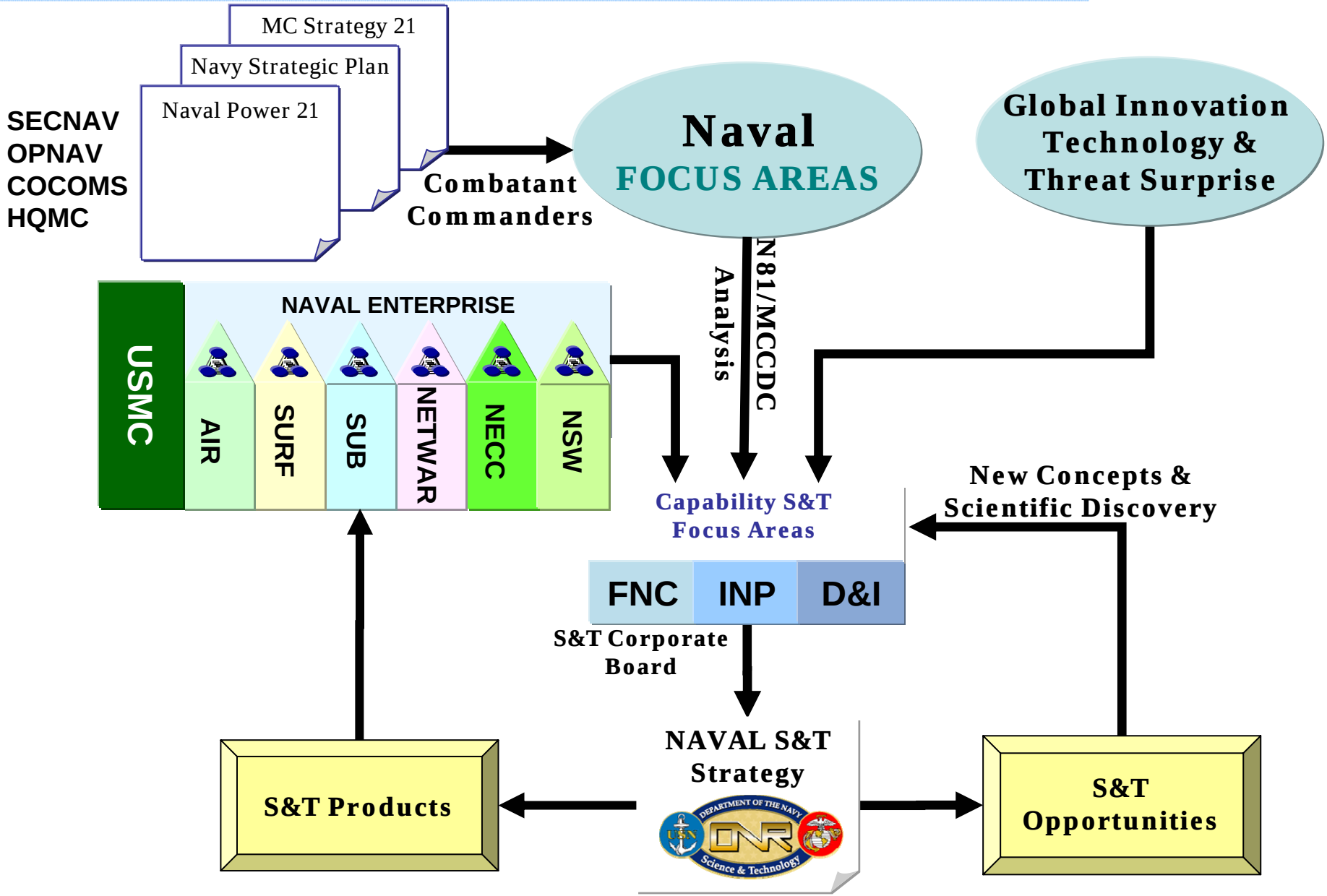
Revolutionary Research . . . Relevant Results




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

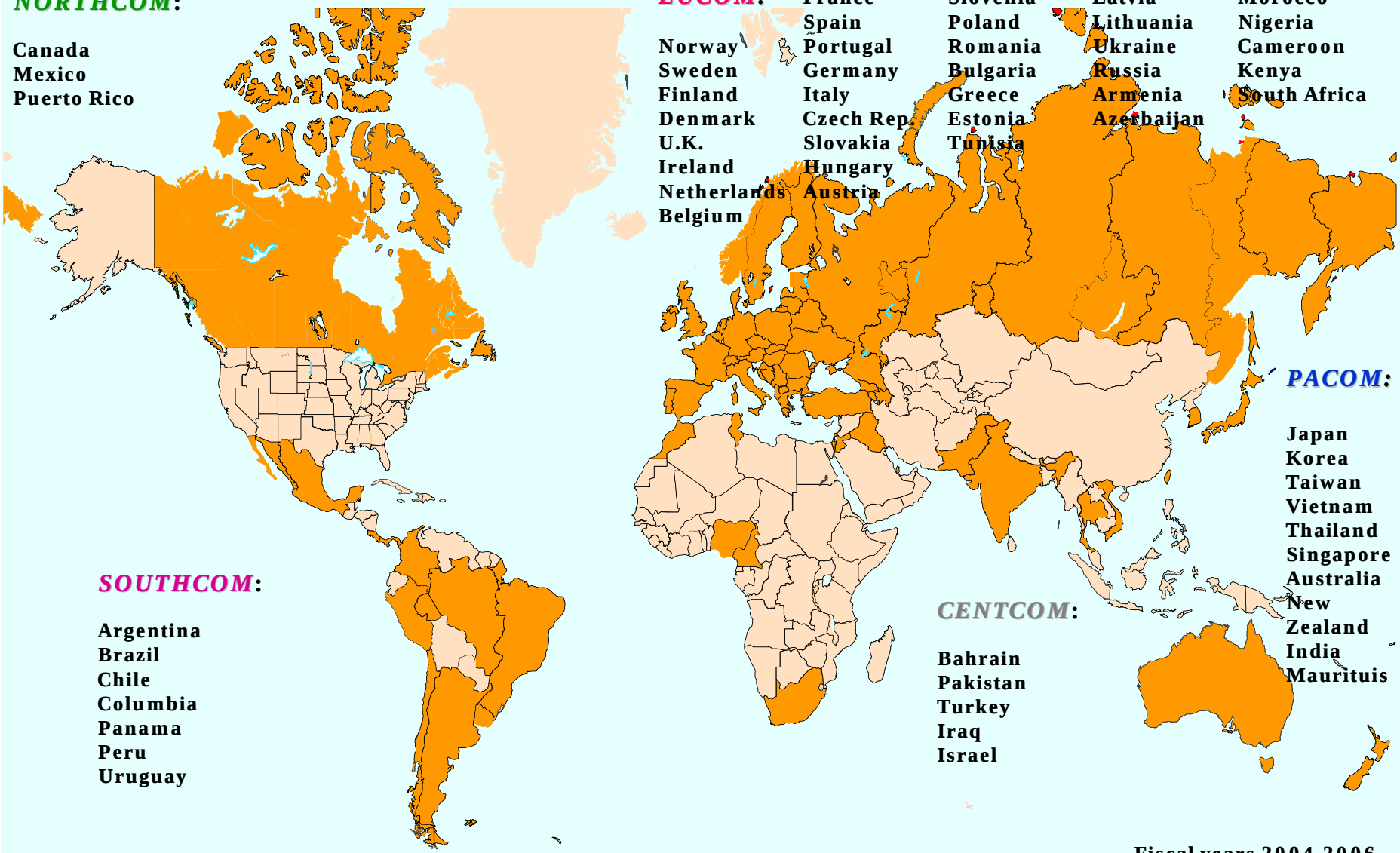
# Naval S&T Strategy Process

Revolutionary Research . . . Relevant Results



# International Engagement

Revolutionary Research . . . Relevant Results




Fiscal years 2004-2006

# Resulting Naval S&T Focus Areas

Revolutionary Research . . . Relevant Results

- Power and Energy
- Operational Environments
- Maritime Domain Awareness
- Asymmetric & Irregular Warfare
- Information, Analysis and Communication
- Power Projection
- Assure Access and Hold at Risk
- Distributed Operations
- Naval Warrior Performance and Protection
- Survivability and Self-Defense
- Platform Mobility
- Fleet/Force Sustainment
- Affordability, Maintainability, and Reliability

# Assured Access and Hold at Risk

Revolutionary Research . . . Relevant Results

**Vision: Attain maritime, littoral, and riverine access to denied areas and hold strategic and tactical targets at risk using lethal and non-lethal means.**

## Objectives

### Anti-Submarine & Mine Warfare

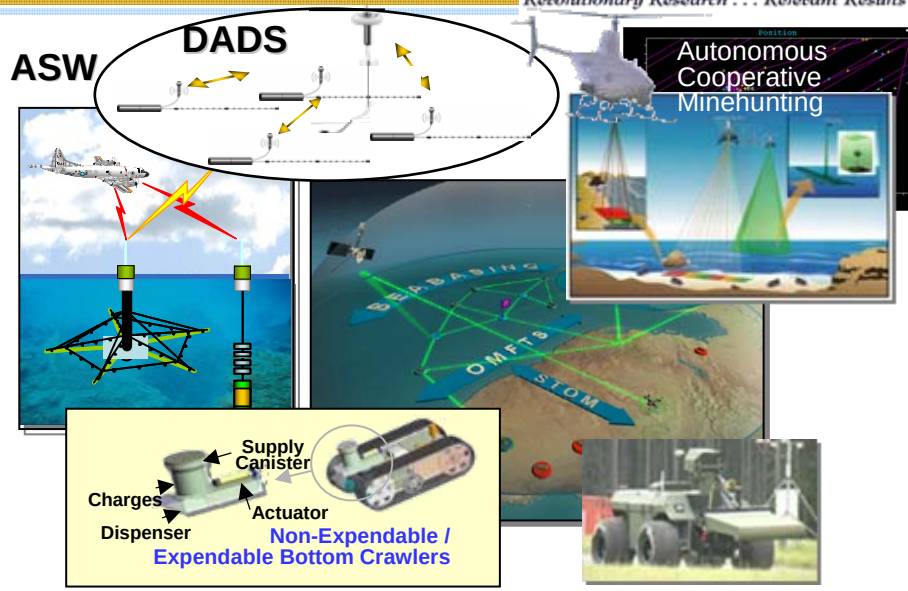
- Rapid Clearing and detection of mines
- Advanced autonomy in unmanned robotic systems to expand ground reach and reduce threat exposure
- Next generation data and contact fusion to expand the regional ASW, mine & amphibious warfare operating picture to the theater level

### Distributed Surveillance

- Distributed, networked surface, ground, and underwater sensors
- Unmanned systems with onboard processing
- Autonomous Maritime Reconnaissance/Neutralization

### Battlespace Shaping

- Non-lethal technologies to stop small vehicles and large ships
- Battlespace shaping technology for enabling information operations
- Decisive operations through a heavy EW attack area
- Access in GPS denied areas – Alternatives to GPS technology
- Operationally responsive use of space
- Tagging, Tracking, and Locating Technologies




## Key Research Topics

**Anti-Submarine Warfare Surveillance**
**Mine Hunting**
**Unmanned Vehicles**
**Intelligent and Autonomous Systems**
**Networked Sensors**
**Space Technologies**
**Nanoscale Electronic Devices & Sensors**
**Solid State Electronics**
**Functional Materials**
**EW – Attack**
**ISRT - EM**
**Large Vessel Stopping**
**Non-Lethal Weapons**
**Navigation and Precision-Timekeeping**

# Distributed Operations

Revolutionary Research . . . Relevant Results

**Vision**: **Enable dispersed small units to dominate extended battlespace through advanced warfighter training, unambiguous situational awareness, robust communications and sense and respond logistics.**

## Objectives

### Training
- Enhancement of Physical and Cognitive Performance
- Simulation – based scenarios for enhanced training
- Rapid assimilation of cultural environments

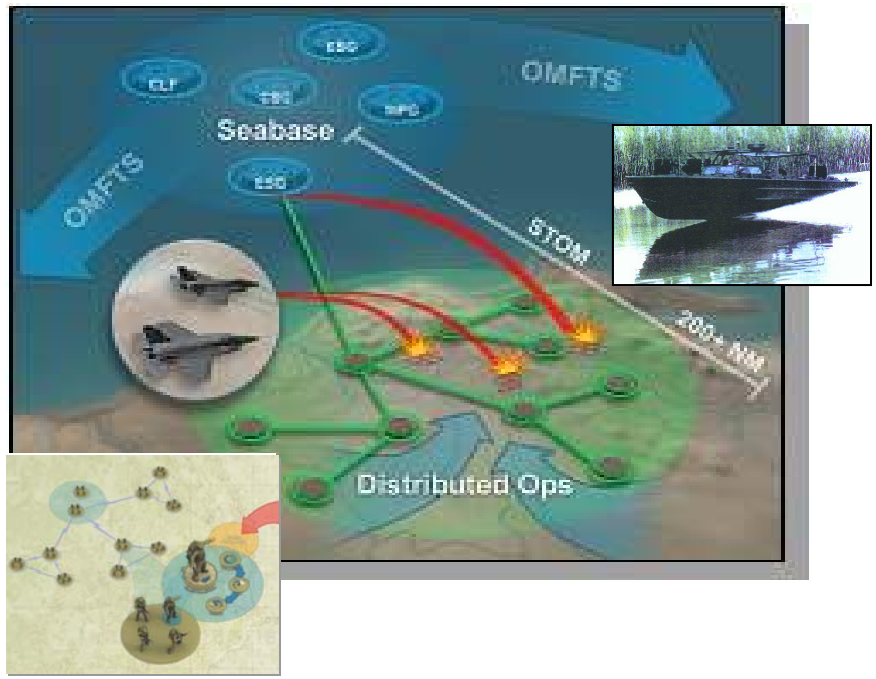
### Communications
- Robust Command and Control networks
- Airborne relays on manned and unmanned platforms

### Logistics
- Rapid re-supply and medical evacuation whenever possible
- Real–time automatic supply sensors and network
- Optimize medical self-sufficiency

### Fires
- Integrate firepower of distributed ground, offshore, and air assets
- Blue Force Tracking down to the individual

### Survivability
- Warfighter stealth technology
- Warfighter exoskeleton technology

### Maneuver
- Adaptable and survivable tactical mobility systems to enhance operational tempo and extend range of vehicles and soldiers
- Advanced materials to reduce combat load




## Key Research Topics

**Training, Education & Human Performance**
**Expeditionary C4**
**Communications and Networks**
**Expeditionary Logistics**
**Expeditionary Firepower**
**Precision Strike**
**Expeditionary ISR**
**Unmanned Air and Ground Vehicles**
**Special Warfare / EOD**
**Land Mine Countermeasures**
**Expeditionary Maneuver/ Individual Mobility**

# Survivability and Self-Defense

Revolutionary Research . . . Relevant Results

**Vision: Enable manned and unmanned platforms to operate in any hostile environment and avoid/survive attack through innovative materials, sensors, countermeasures and counter-weapons.**

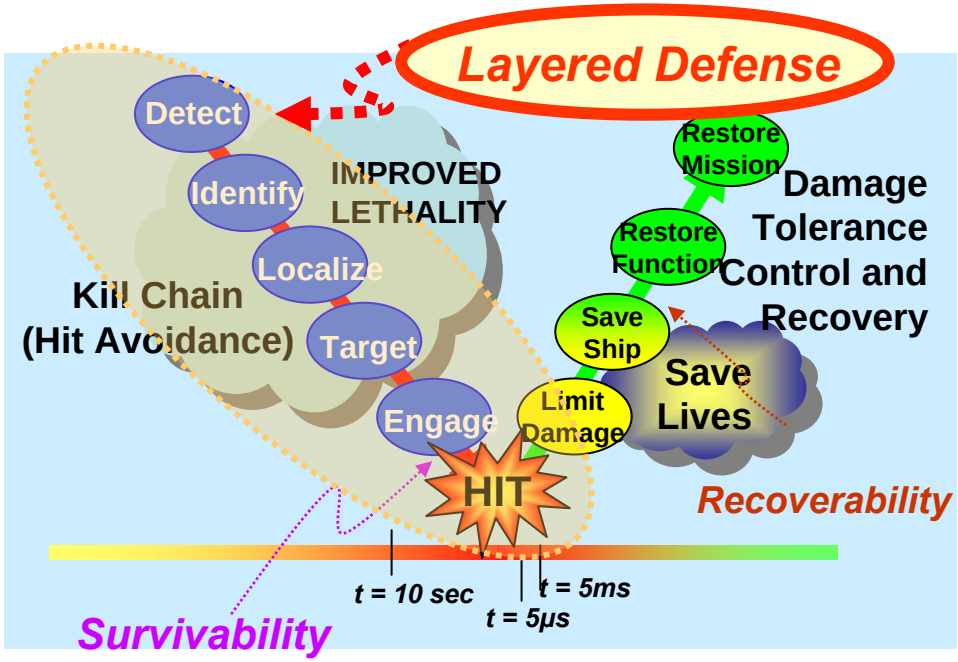
## Objectives

### Platform Stealth
- Reduce above water and subsurface signatures
- Multi-spectral LO technologies

### Countermeasures & Counterweapons
- Threat weapon tracking
- Automated decision making
- Low False alarm rate 360 degree detection
- Hard kill and soft kill against threat kinetic weapons
- Increase standoff to outside threat damage range
- Directed energy weapons for speed of light engagement
- Counter-LO

### Survivable Platforms
- Advanced materials in platform construction
- Damage tolerant platform architectures
- Automated damage control focusing
- Advanced materials for self healing platforms

### Force Protection
- Anti-swimmer technology
- Detect and determine threat intent
- Non-lethal response




## Key Research Topics

**Signature Control (LO/CLO)**
**Undersea Weaponry**
**Torpedo Defense**
**Directed Energy**
**Survivable Platforms Structures**
**Functional Materials**
**Electro-Optics**
**Solid State Electronics**
**EW Attack**
**ISRT – EM**
**Expeditionary Force Protection**
**Non-Lethal Weapons**

# Future Naval Capabilities

Revolutionary Research . . . Relevant Results

The **Future Naval Capability** program is aligned with the pillars of Naval Power 21, and focuses on providing enabling capabilities to close warfighting gaps.

Examples of current (FY07) enabling capabilities and corresponding products in execution:

| | FY05 | FY06 | FY07 | FY08 |
|---|---|---|---|---|
| Products in Execution | 129 | 119 | 114 | 112 |
| Product Transitions | 31 | 27 | 48 | 24 |
| Enabling Capability Transitions | 5 | 3 | 10 | 11 |
| Enabling Capabilities in Execution | 36 | 37 | 39 | 48 |

| Pillar | Enabling Capabilility | Products |
|---|---|---|
| **Sea Shield** | *Mine Countermeasures* | Communications and Navigation Aids for MCM Operations, Buried Mine Sensor Development for Detection and Classification of Buried Sea Mines |
| | *Over-the-Horizon Missile Defense* | Distributed Weapons Coordination, Advanced Area Defense Interceptor, Distributed Sensor Coordination |
| | *Defense of Harbor against Asymmetric Threats* | Intelligent Video Surveillance, Underwater Threat Neutralization, Passive Acoustic Fiber-Optic Array for Swimmer Detection, Terminal Swimmer Detection and Targeting |
| **Sea Strike** | *Advanced Naval Fires Technology* | Adaptive Expeditionary Maneuver Warfare System, Advanced Fires Coordination Technology, Advanced Gun Barrel Technology, Advanced Target Acquisition |
| | *Transparent Urban Structures* | Sensing Through Walls, Detect and ID Facilities, Decision Aids |
| | *Modular Scaleable Effects Weapons* | Scalable Effect Weapon Concept Development, Indirect Prototype (Scalable Effect) |
| **Sea Basing** | *Sea Base Mobility and Interfaces* | Small to Large Vessel At-Sea Transfer Sea Base Connector, High Speed Seabase-to-Shore Connector, High Rate Vertical / Horizontal Material Movement, High Lift Density Air Interface Ramp Technologies, Intra-Connector Material Handling |
| | *Surface Connector Vehicle Transfer* | |
| **FORCEnet**: | *Marine and UxV Tactical ISR* | Dynamic Replanning/Autonomous Vehicle Control, Fully Integrated Advanced Demonstrator Engine, Multi-Vehicle Cooperation / Targeting, Multi-Vehicle Networking / Comms Software |
| | *Global Information Grid-Compliant Networking* | High Altitude Airborne Relay and Router Package, Integrated, Autonomous Network Management,Intra-Battle Group Wireless Networking Block II |
| **Enterprise/ Platform Enablers** | *Compact Power Conversion Technologies* | Multi-Function Motor Drive, BiDirectional Power Control Module, Power Management Controllers |
| | *Maintenance Reduction Technologies* | Improved Non-Skid Coatings, High Performance Topside Coatings, Improved High Ship Rudder Coatings |

# Making an Impact Today

## Modular Hybrid Pier

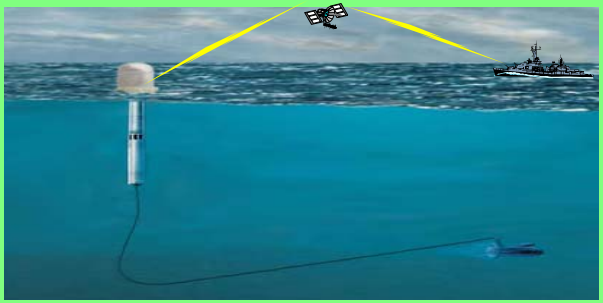
Modular, double-deck pier constructed of new corrosion-resistant concrete

- Demonstrated in FY05
- Transitioned to P327/N46 in FY07

## Next Generation Submarine Comms at Depth

Two-way comms support submarine comms at depth

- At sea test in late FY07
- Transitions to PEO C4I PMW770 in FY08



## Intra-Battle Group Wireless Networking

High bandwidth, line-of-sight, wireless network within a battle group using existing advanced digital network system

- Block II transitioned to PMW160 in Dec 06
- Deployed on *John C. Stennis* strike group Jan 07

## QuikClot

Hemostatic agent that almost instantaneously stops severe arterial bleeding

- Original product already in battlefield use with Marines
- FDA approval for Advanced Clotting Sponge expected in late FY07/early FY08

## Lightweight Mortar System

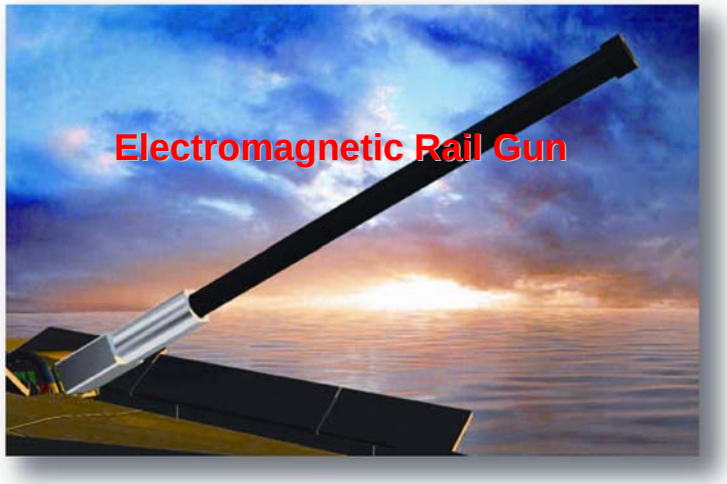
Developed lightweight 81mm and 60mm mortar tubes base plates, and bipod assemblies

- Lightweight 81mm gun tube design transitioned FY06
- Lightweight 81mm bipod and base plate and 60mm mortar systems designs transitioned FY07

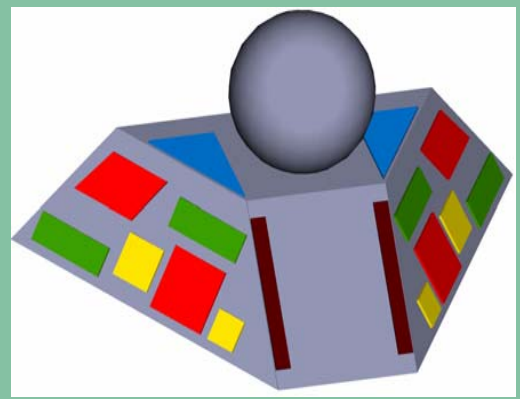
# Innovative Naval Prototypes

Revolutionary Research . . . Relevant Results

## Current INPs



## Potential INPs

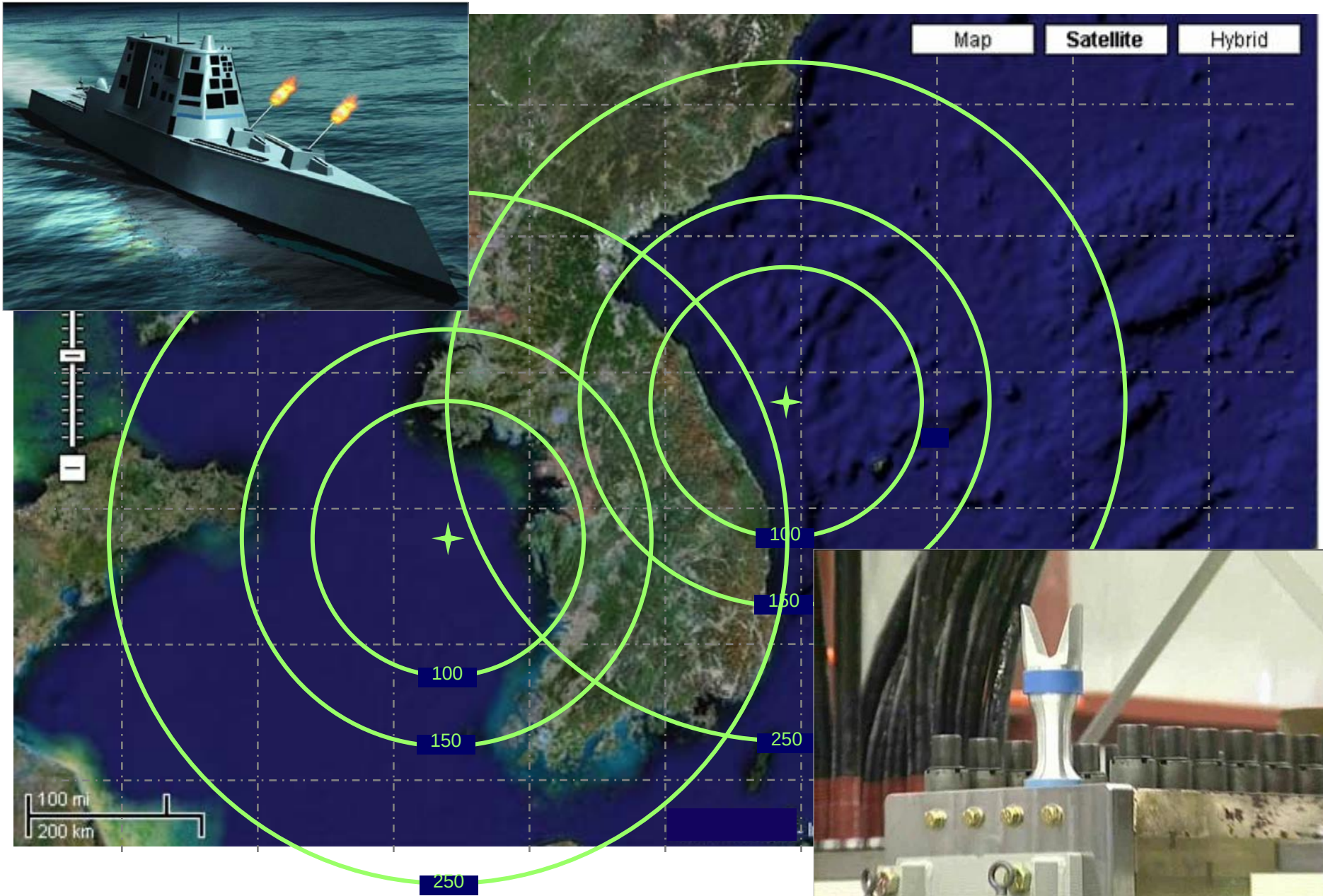


Integrated Digital Apertures and Array Radars

# Electromagnetic Rail Gun

Revolutionary Research . . . Relevant Results





# Persistent Littoral Undersea Surveillance (PLUS)

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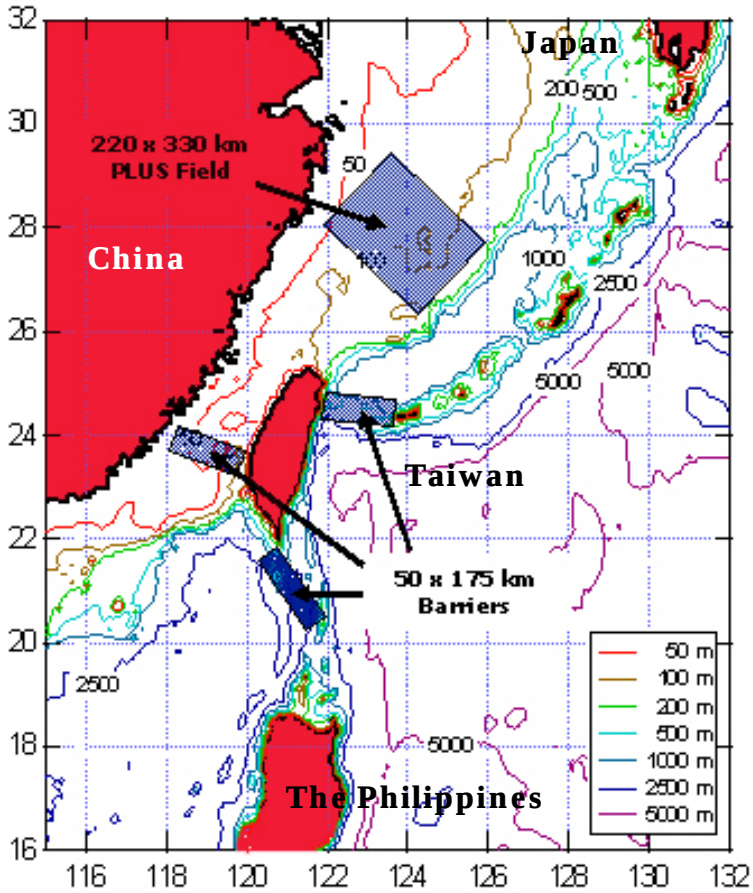
**Mission:**

Hold-at-Risk ASW strategy requires effective undersea surveillance against multiple, quiet targets over large littoral areas (100 x 100 nm) for months



**Game Changing**

- Inverts ASW asymmetry using autonomous, mobile, controllable sensor/weapon network
- Adapts to environment, targets, and threats
- Persists clandestinely for months
- Autonomous self deployment

**Innovative Elements**

- Autonomous, cooperative behavior among structured, mobile sensors (gliders, mobile scanning arrays, intervention units)
- Feedback control to meet operational detection thresholds
- Adaptive target closures yielding actionable kill chain

# A Swiftly Changing Planet

- In an era of increasing globalization, new technology is more readily available—and more quickly—than ever before
- The natures of "combatant" and "weapon" are changing, and new challenges can come from anywhere in the world

- We must accept the fact that adversaries will use our technology against us
- To stay competitive on tomorrow's battlefields, we must:
  - **Ensure** our people and research enterprises are more innovative
  - **Maintain** our technological advantage

# Questions?

***If technology doesn't seem like magic—it's probably obsolete.***