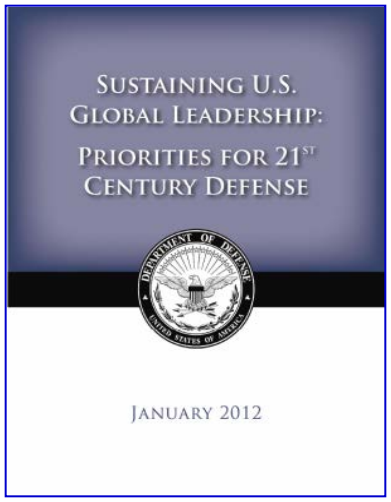
Science & Technology Challenges for the Asia-Pacific Region

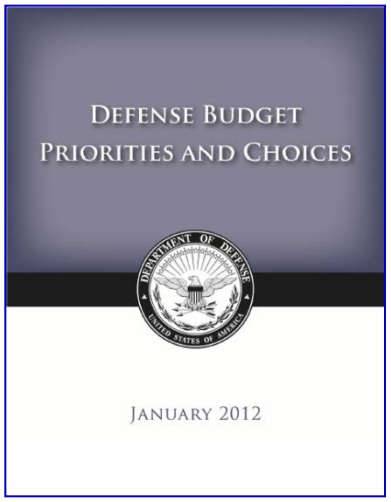
22 October 2013

Al Shaffer

Assistant Secretary of Defense for Research and Engineering (Acting)

Key Elements of Defense Strategic Guidance





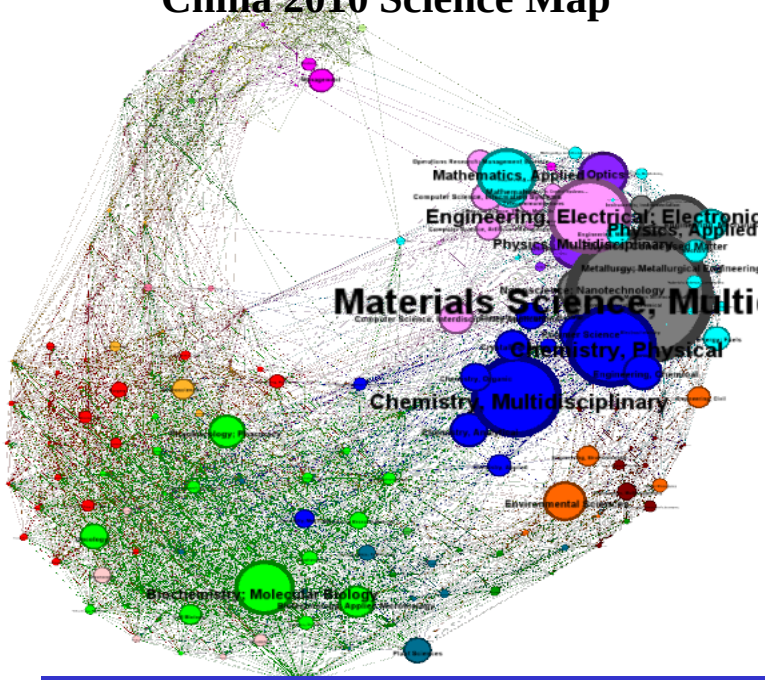
- **The military will be smaller and leaner, but it will be agile, flexible, ready and technologically advanced.**
- **Rebalance our global posture and presence to emphasize Asia-Pacific regions.**
- **Build innovative partnerships and strengthen key alliances and partnerships elsewhere in the world.**
- **Ensure that we can quickly confront and defeat aggression from any adversary – anytime, anywhere.**
- **Protect and prioritize key investments in technology and new capabilities, as well as our capacity to grow, adapt and mobilize as needed.**

Complexities of Our National Security Environment

- **Global environment is ever changing and uncertain**
- **Future is hard to predict**

National Security Challenges - July 2012 -
LTG Michael Flynn, USA

China 2010 Science Map



- **Spread of free markets and open societies has accelerated globalization**
- **Our next conflict could be an unconventional conflict against a highly asymmetrical threat**

Ability to Operate in the Commons will be Critical

“(Ladies and) Gentlemen, we are out of money.

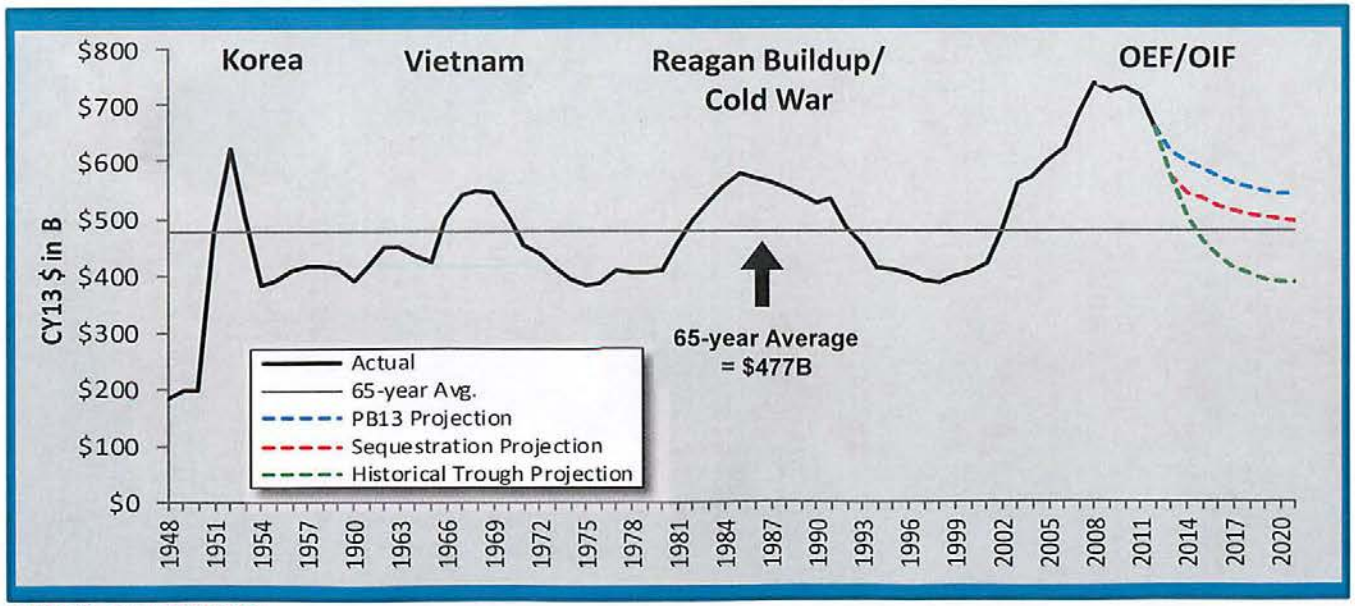
Now we must think!”

Winston Churchill to
Parliament during World War II
(Stolen from Ernest Rutherford)

The Reality….

"Our current security challenges are more formidable and complex than those we faced in downturns following Korea, Vietnam, and the Cold War. There is no foreseeable "peace dividend" on our horizon."

GEN DEMPSEY, CJCS
Testimony to SASC, 12 Feb 2013



UNCLASSIFIED

Defense R&E Strategy

"*Protect and prioritize key investments in technology and new capabilities, as well as our capacity to grow, adapt and mobilize as needed.*"

-SECDEF, January 2012 Strategic Guidance

1. Mitigate new and emerging capabilities

- Electronic Warfare
- Cyber
- Counter Space
- Counter-WMD

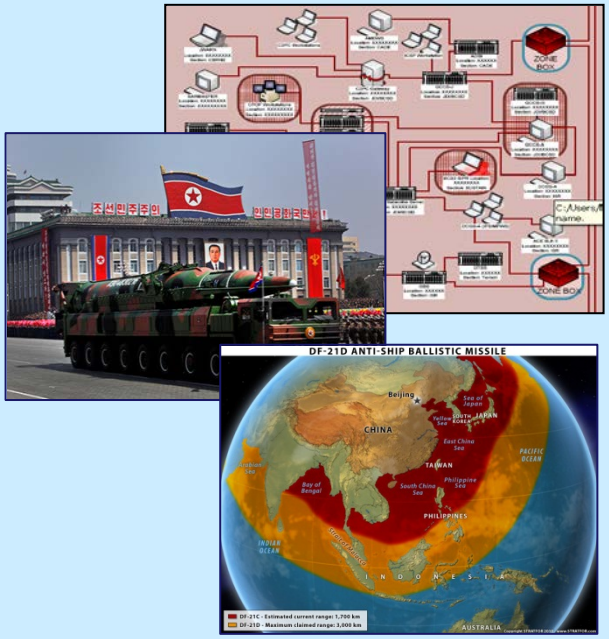
2. Affordably enable new or extended capabilities in existing military systems

- Systems Engineering
- Data Reuse
- Engineered Resilient Systems
- Developmental Test & Evaluation

3. Develop technology surprise through science and engineering

- Autonomy
- Basic Research
- Data-to-Decisions
- Human Systems

Technology Needs



- Middle East Instability
- North Korean Nuclear Ambitions
- Anti-Access/Area Denial
- Cyber Attacks
- Electronic Warfare

Prototypes

The Department can cost-effectively drive innovation in aviation, space, maritime and ground combat systems through prototyping

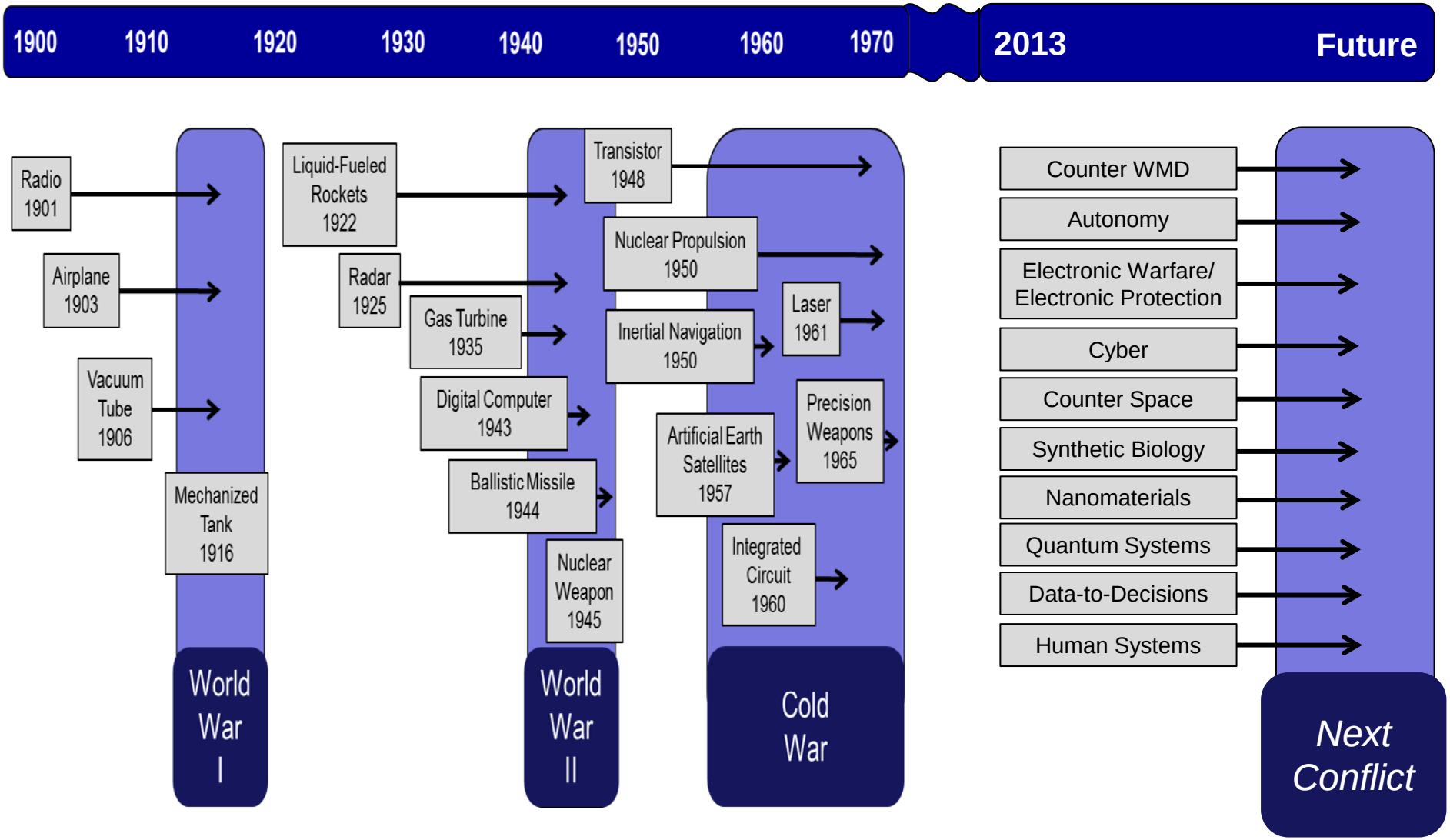
Proof of Concept:

“X”- Plane Prototyping

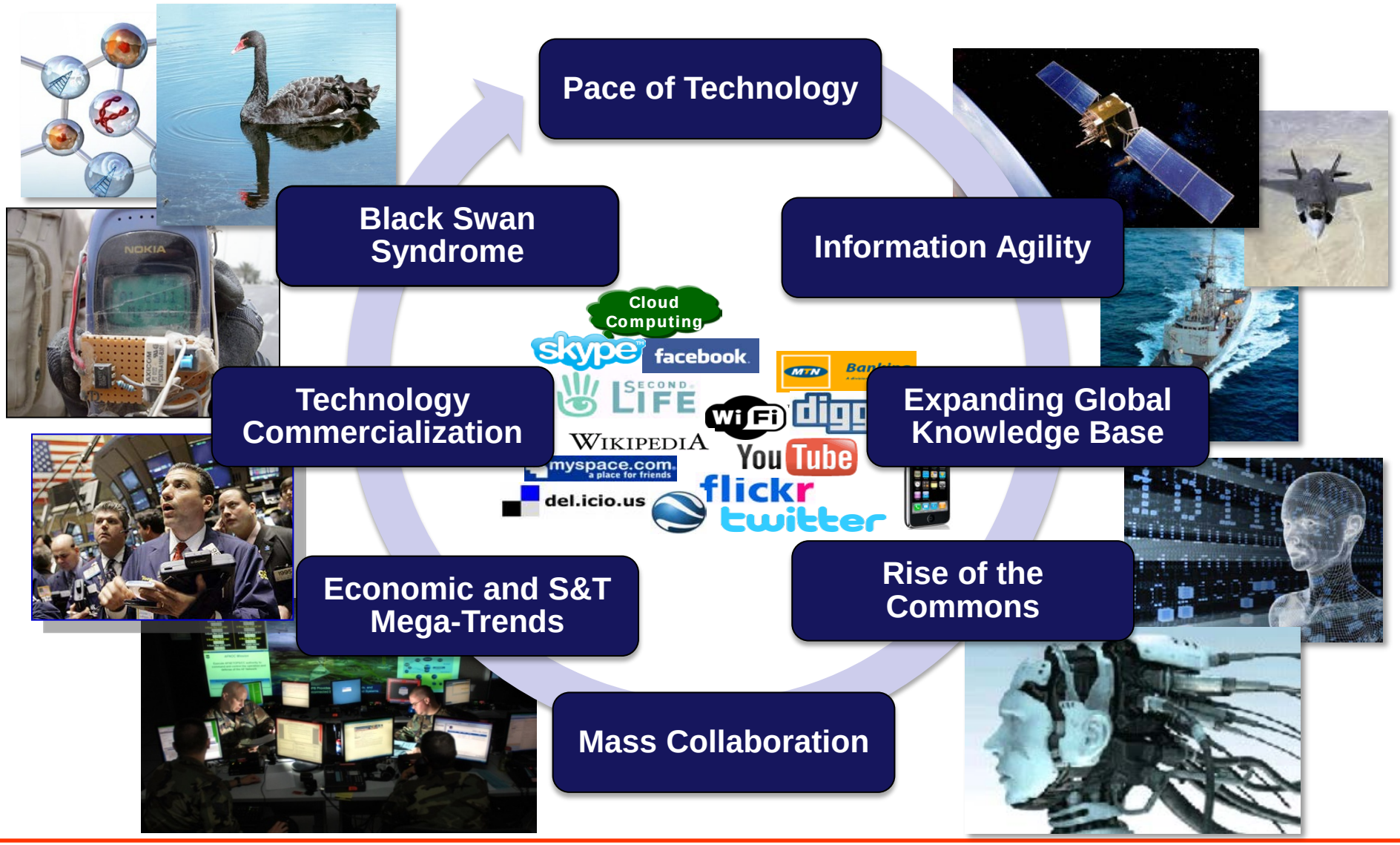
Prototype Development Programs have expanded the state of the possible in military aviation without each necessarily driving a follow-on procurement activity



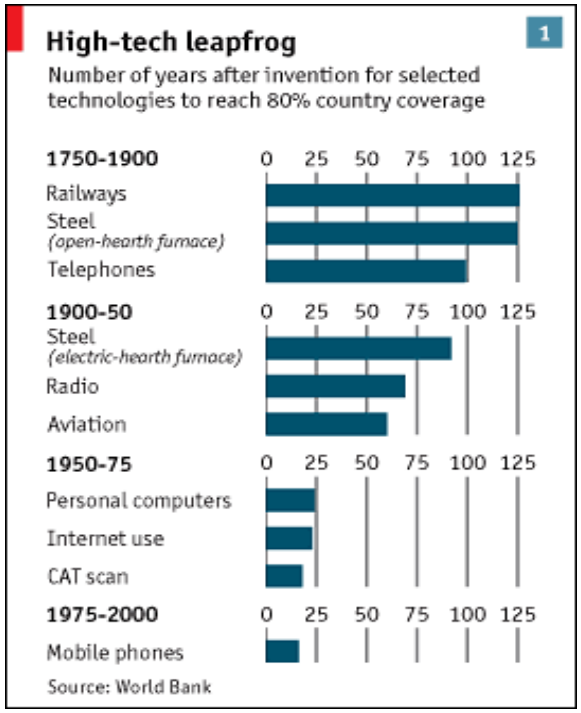

Lab Demo to Forcing Function:
Technology Investment Stocks Cupboard



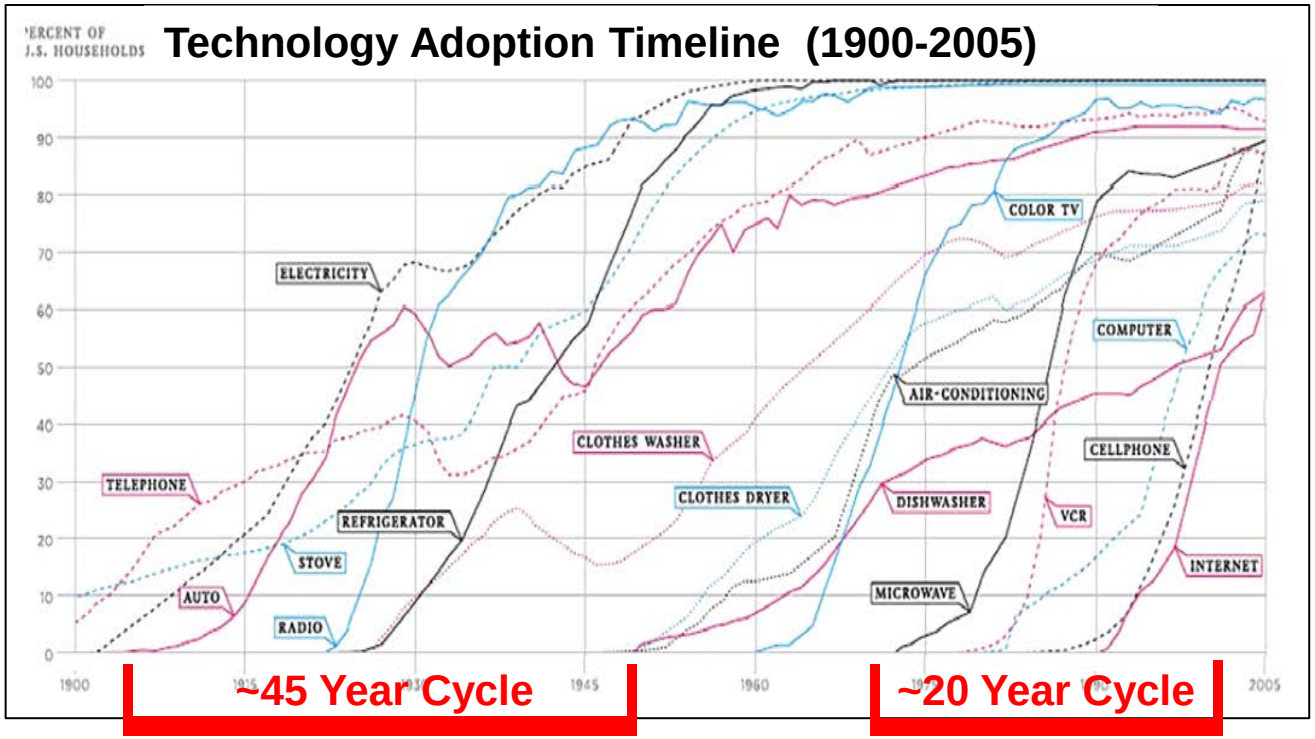
A New Reality:
Global Dimensions Affect DoD S&T



Pace of Technology



The Economist, Feb. 9, 2008



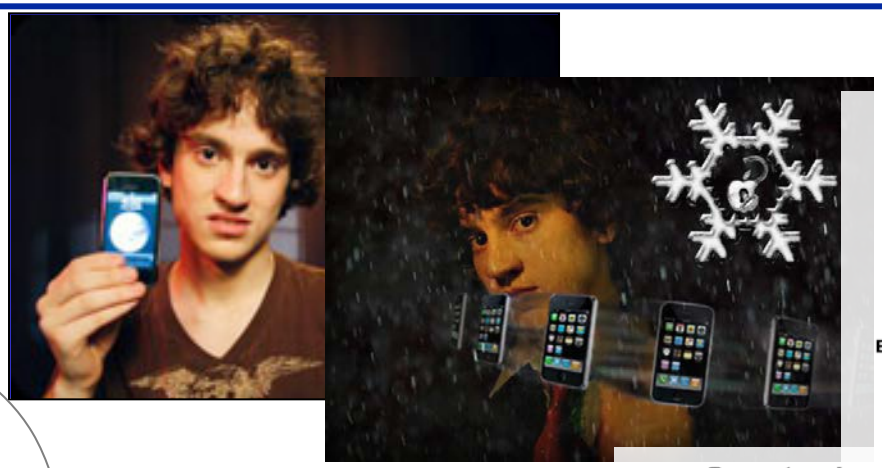
It took 23 years to go from modeling germanium semiconductor properties to a commercial product

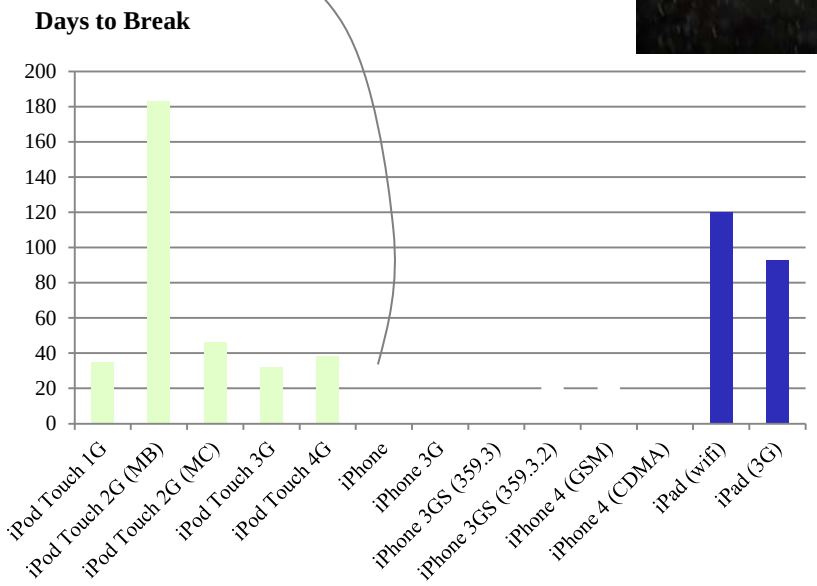
The carbon nanotube was discovered in 1991; recognized as an excellent source of field-emitting electrons in 1995, and commercialized in 2000

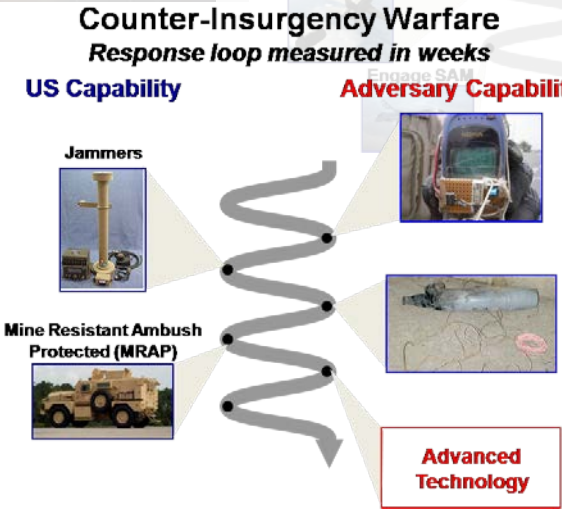
The Pace of Technology Development and Market Availability is Exceeding the Pace of Acquisition

Information Agility

Apple and AT&T released the iPhone on 29 June in an exclusive agreement. Hotz spent ~500 hours working on his "summer project" and the hack was available in July.



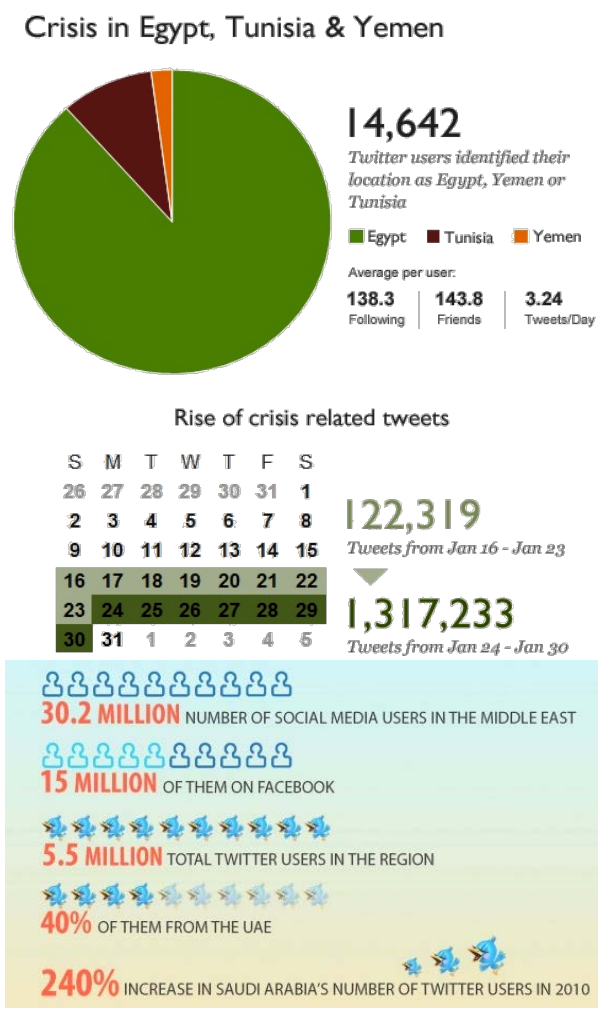


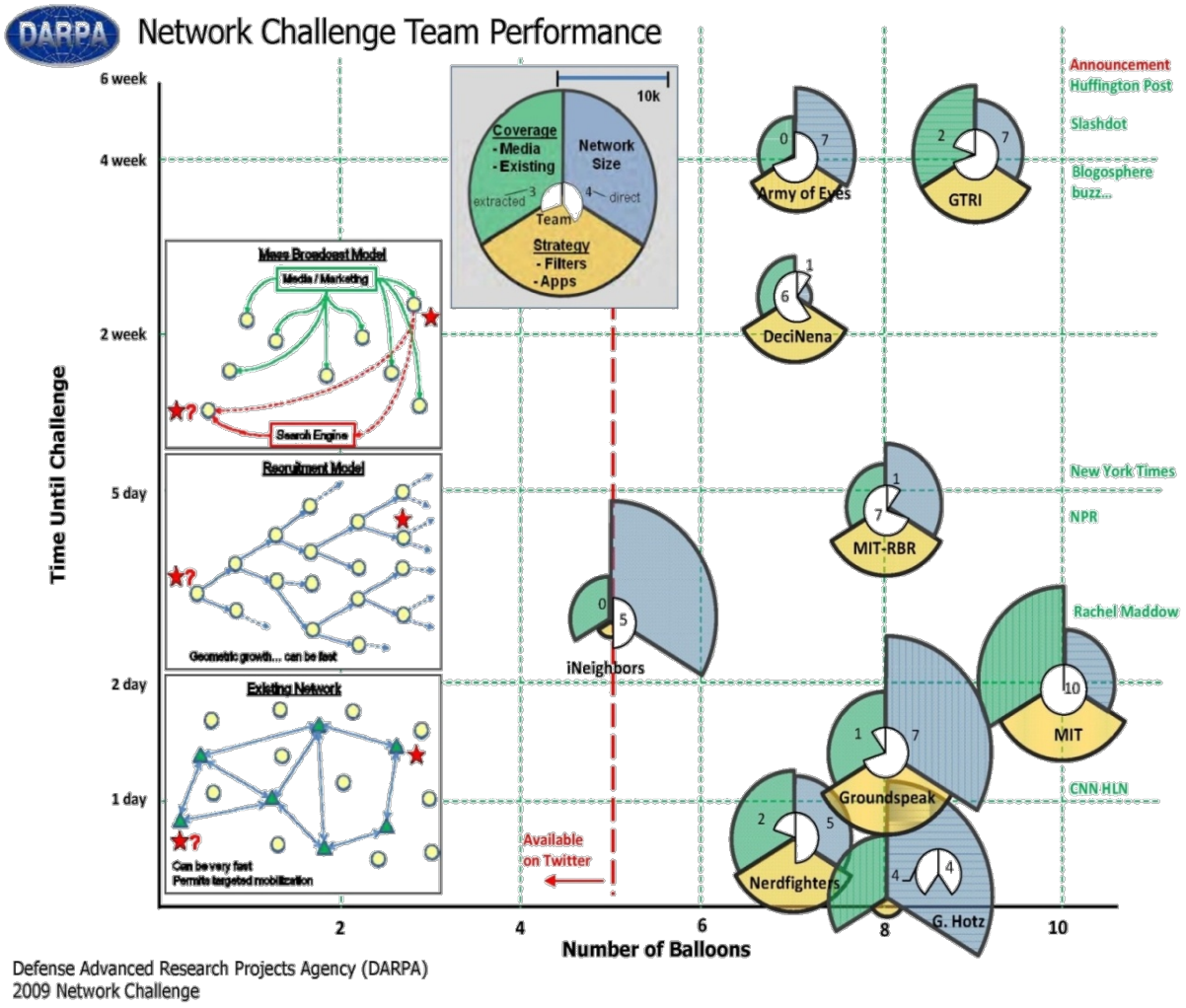


Today's adversaries are light and agile, and rapidly react and innovate in response to US actions.

This is the New Asymmetry—Victory Goes to the Agile and Innovative

Mass Collaboration



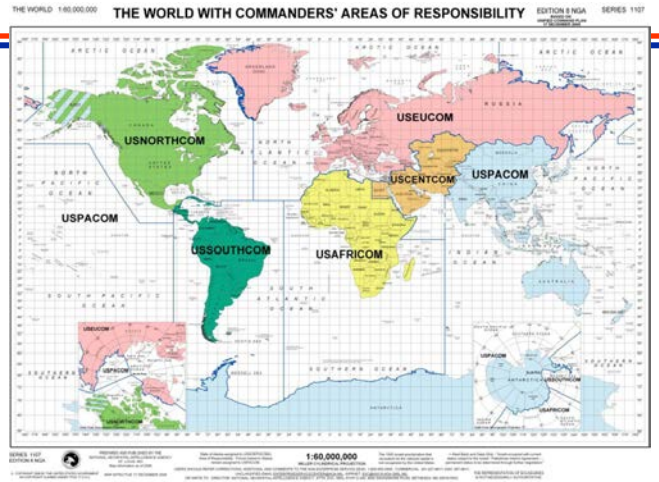


Defense Advanced Research Projects Agency (DARPA)
2009 Network Challenge

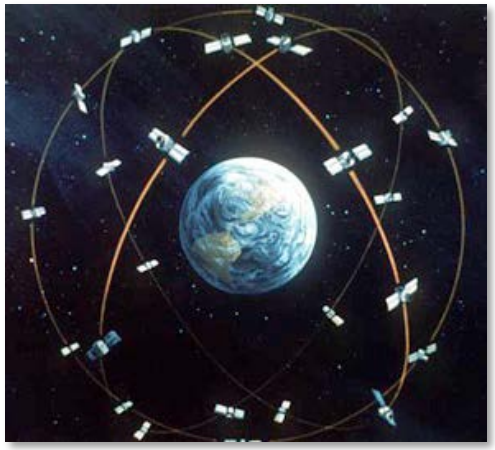
Ad-hoc Groups Can Quickly Solve (or Create) Massively-Complex Problems

Rise of the Commons

Electronic Warfare

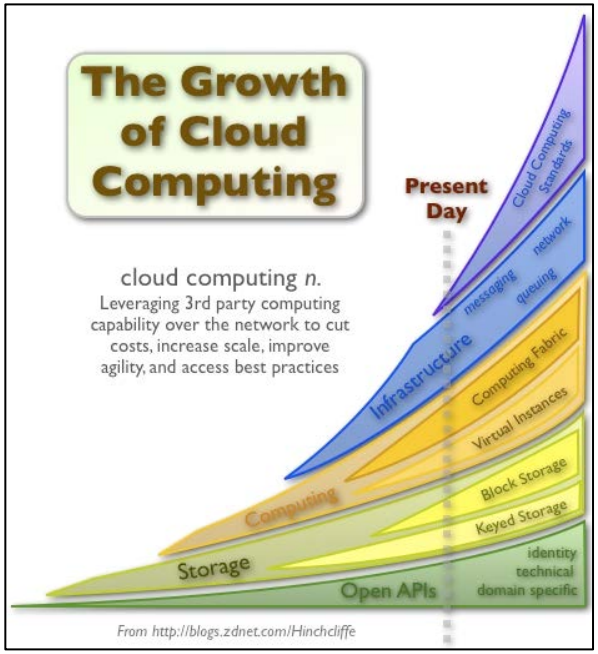


Oceans



Space

Cyber



Ubiquitous Data

Military Operations Increasingly Depend on Being Able to Operate in Places "No One Owns" – *The Enablers*

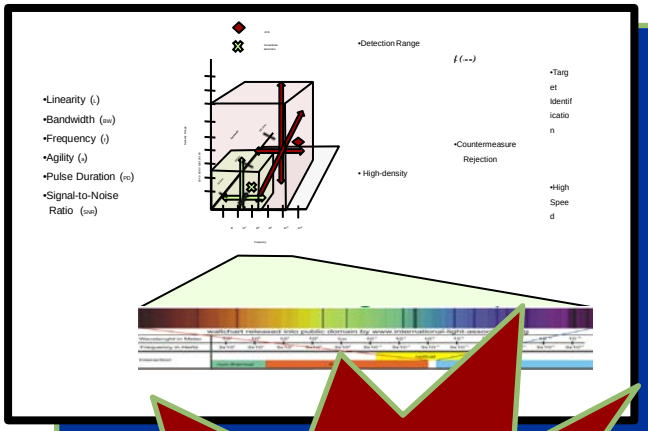
Anti-Access/ Area Denial
Current A2/AD Priorities

- **Electronic Attack / Electronic Protection**
- **Cyber Operations**
- **Space / Counter Space**
- **Undersea Operations**
- **Counter Missile / Missile Defense**
- **Counter Integrated Air Defense Systems**

Electronic Warfare

U.S. EW Superiority is Being Broadly Challenged

- Digital signal processing expanding
- Threat systems more lethal, longer range, mobile
- Sensors are networked and active – passive combinations are appearing
- Radar and radio systems are trending to software-driven waveform generators
- Weapon seekers are more sophisticated with spectral diversity and ECCM processing
- Advanced jamming techniques and technologies are now available to adversaries



OPPORTUNITIES FOR NEW APPROACHES

Globally Accelerating Technology

Counter-Electronics HPM Advanced Missile Project (CHAMP) Joint Capability Technology Demonstration (JCTD)

- Extensive, joint RF test data base
- Narrowband HPM Advanced Counter Electronics Source (ACES) developed by AFRL HPM S&T
- Compact pulsed power system matured by AFRL, SNL, and industry
- Physics-based, supercomputing-enabled numerical simulation of HPM source & effects

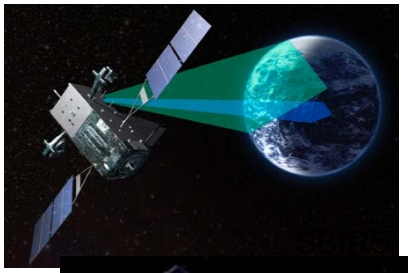
- **Sponsor: PACOM;**
- **Team: AFRL (lead) , Boeing, Sandia, Ktech**

(U) Space and Cyberspace

From 2012 Chairman's Joint Operational Access Concept

- Space and cyberspace are increasingly important and contested domains with critical importance for the projection of military force.
- Future enemies will seek to contest space control and cyberspace superiority as means to denying operational access to U.S. joint forces.
- Gaining and maintaining space and cyberspace superiority will be a constant challenge

SATCOM



Missile Warning

GPS III

PNT

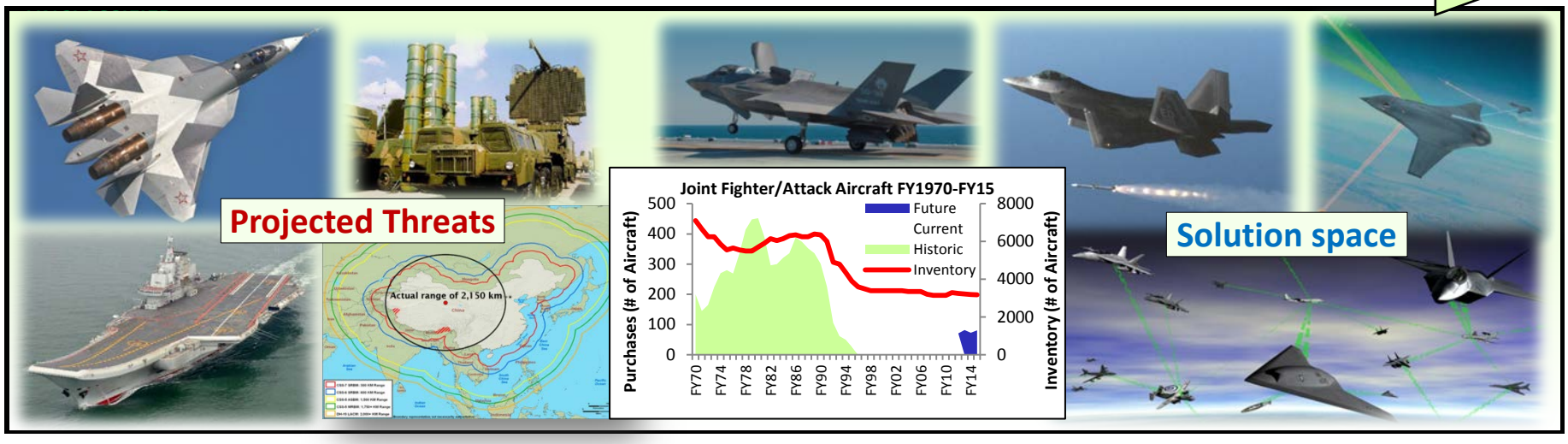
ORS-1

ISR

The current and future strategic environment is driven by three trends – space is becoming increasingly congested, contested, and competitive.
- 2011 National Security Space Strategy

System of Systems & Prototyping: Air Dominance Initiative (ADI)

What is our technology development plan for capability in 2020 – 2050 ?



Purpose

- OSD directed DARPA /USAF/USN technology game-plan to ensure Air Dominance through 2050
- Baseline our currently funded acquisition projects to ensure maximum integrated development; security umbrella put in place
- Identify high-payoff technology concepts
- Prototype those high risk technologies and determine which ones merit an acquisition program

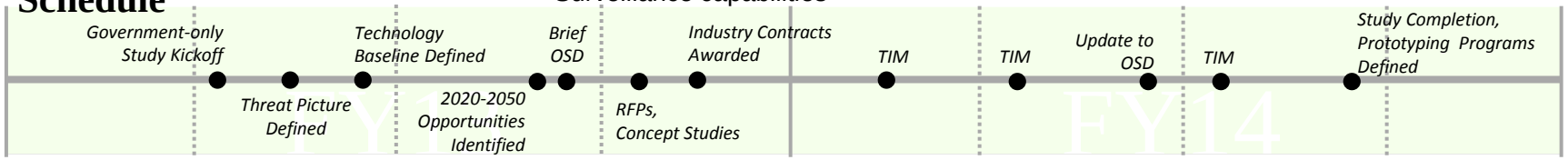
Key Technologies

- No single silver bullet program
- Systems approach to Air Dominance
- Next generation platforms
- Advanced networking capabilities
- Ensured, reliable navigation
- Passive and active system defense
- Electronic attack technologies
- Area denial capabilities
- Situational awareness technologies
- Cyber effects considerations
- Surveillance capabilities

Metrics

- Study completed in 18 months
- Maximum use of existing systems
- Cost of proposed concepts must be within available budgets
- Close integration coordination with focus on combined effects
- Prototype demonstrations completed within 5 years

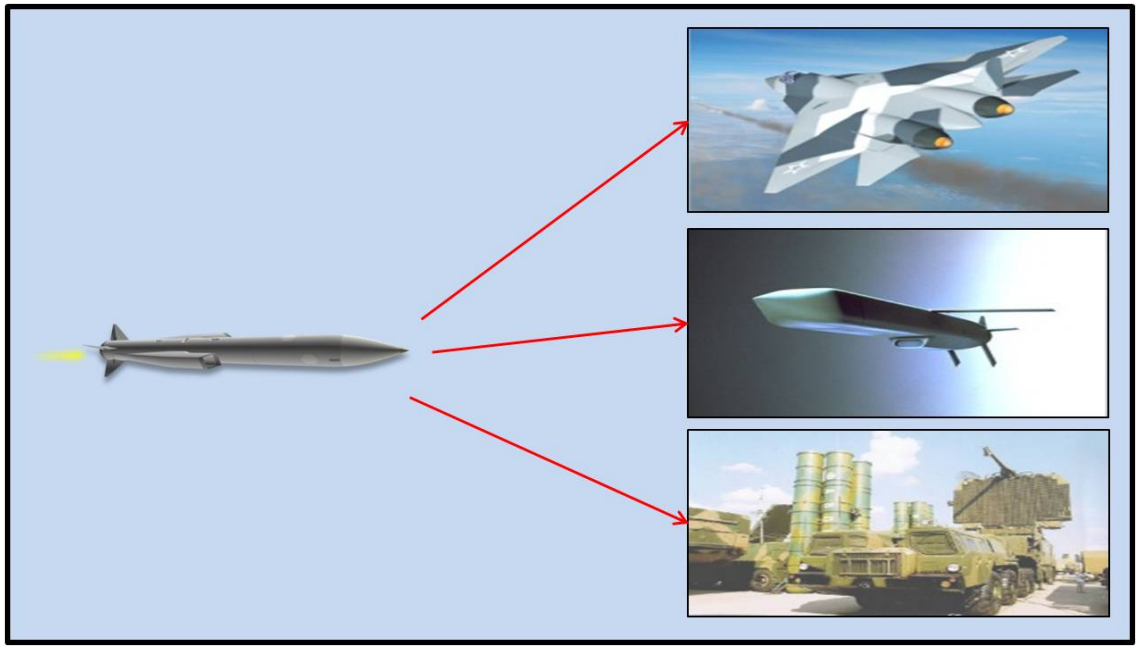
Schedule



Missile Demonstrators

DARPA/Navy Long Range Anti Ship Missile (LRASM)

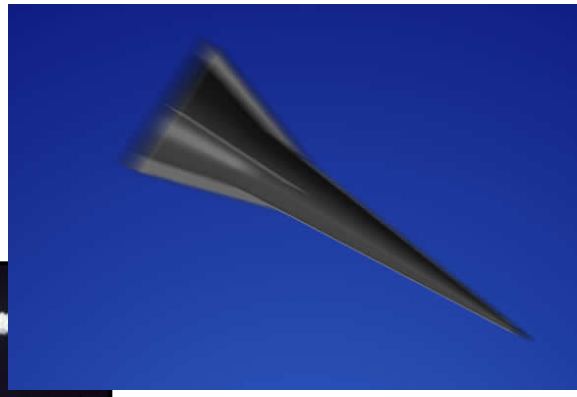
DARPA/AF Triple Target Terminator (T3)

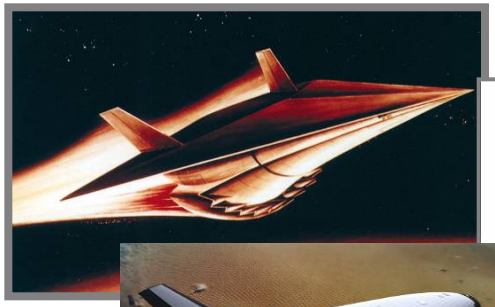


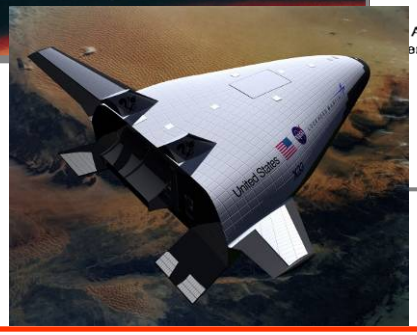
Photos courtesy NASA, Richard Hallion

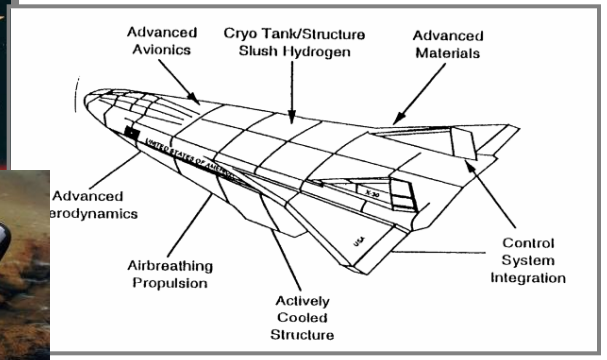
Hypersonic Research … Turning the Corner

- **Successes**
  - X-15
  - Space Shuttle
  - X-43A
  - X-51A
  - Advanced Hypersonic Weapon (Nov 2011)









- **Did not meet goals**
  - Aerospace plane
  - NASP
  - X-33

Photos courtesy NASA, Richard Hallion

Summary

- **Asia-Pacific rebalance is the foundation of our R&E strategy**
- **DoD is working on advanced programs to enhance the ability to control the enablers**
- **A key is gaining control of the enablers.**

Backup Slides

Defense R & E Strategy

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-SECDEF, January 2012 Strategic Guidance

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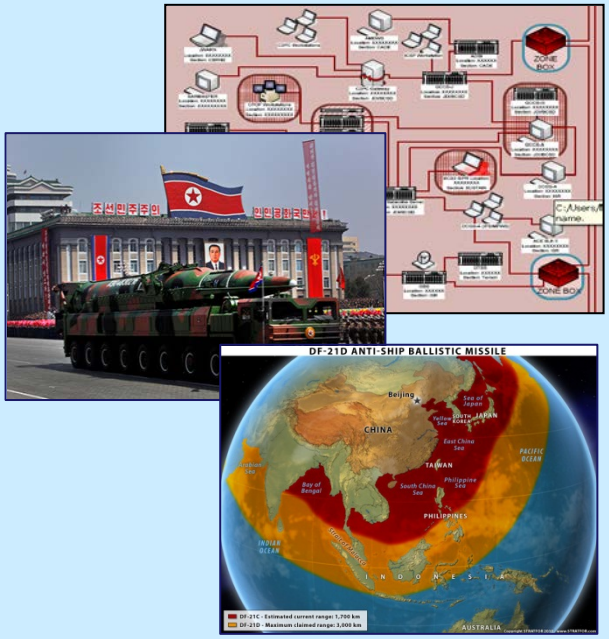
- Developmental Test & Evaluation

3. Develop technology surprise through science and engineering

- Autonomy
- Basic Research
- Data-to-Decisions
- Human Systems

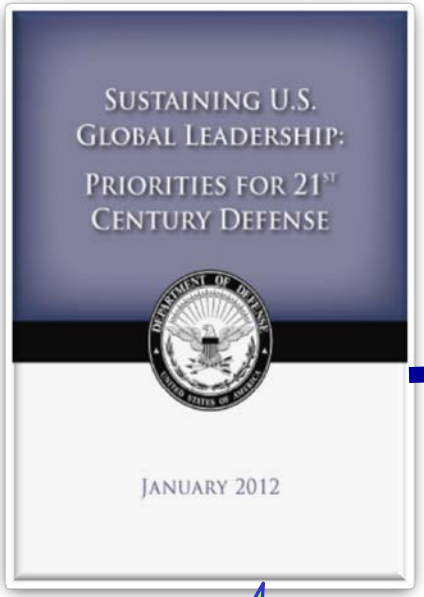
ASD(R&E) Should Lead the Future

Technology Needs



- Middle East Instability
- North Korean Nuclear Ambitions
- Anti-Access/Area Denial
- Cyber Attacks
- Electronic Warfare

Priorities for 21st Century Defense

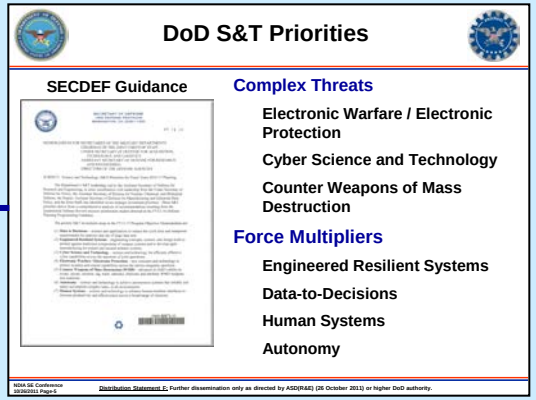


Missions in the Commons

Primary Missions of the U.S. Armed Forces

- Defend the Homeland and Provide Support to Civil Authorities
- Counter Terrorism and Irregular Warfare
- Conduct Stability and Counterinsurgency Operations
- Provide a Stabilizing Presence
- Deter and Defeat Aggression
- **Project Power Despite Anti-Access / Area Denial Challenges**
- Counter Weapons of Mass Destruction
- Operate Effectively in Cyberspace and Space
- Conduct Humanitarian, Disaster, Relief and Other Operations
- Maintain a Safe, Secure and Effective Nuclear Deterrent

S&T Focus Areas



- Counter AA/AD capabilities
- Tailored and adaptive capabilities
- Low-cost, Small-footprint operations
- Developing and integrating partnership capabilities

Tech Surprise:
Human Systems, Data-to-Decisions, Autonomy

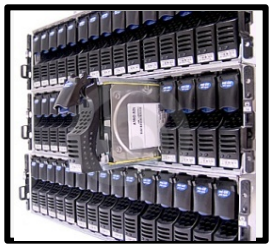
Human Systems

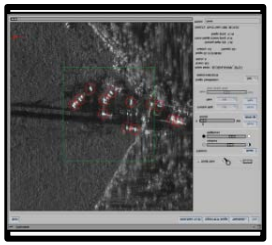
- System Interfaces
- Personnel & Training
- Protection & Sustainment
- Social & Cultural Understanding

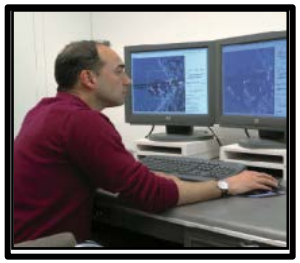
Data-to-Decisions

- Data Management
- Analytics
- User Interface

Multi-Layer Approach

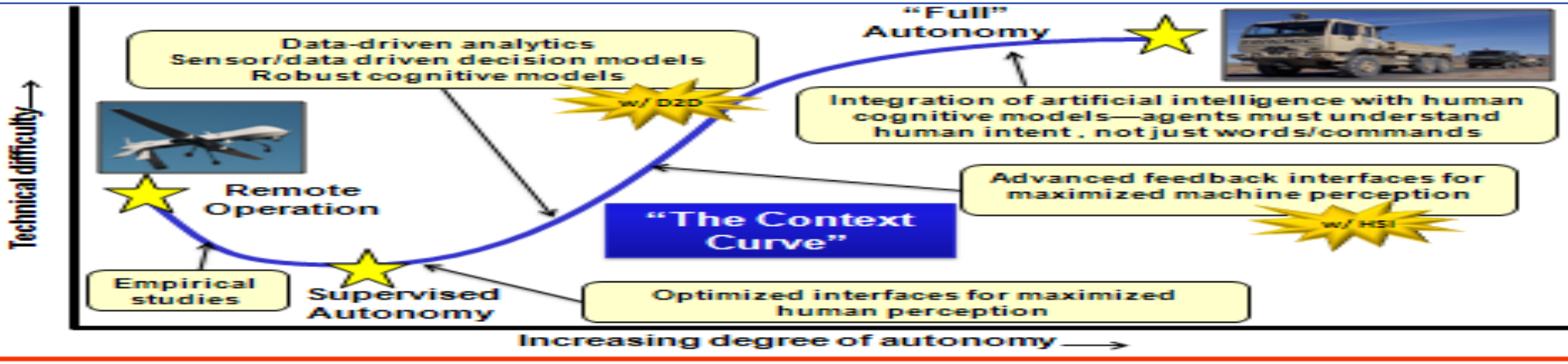




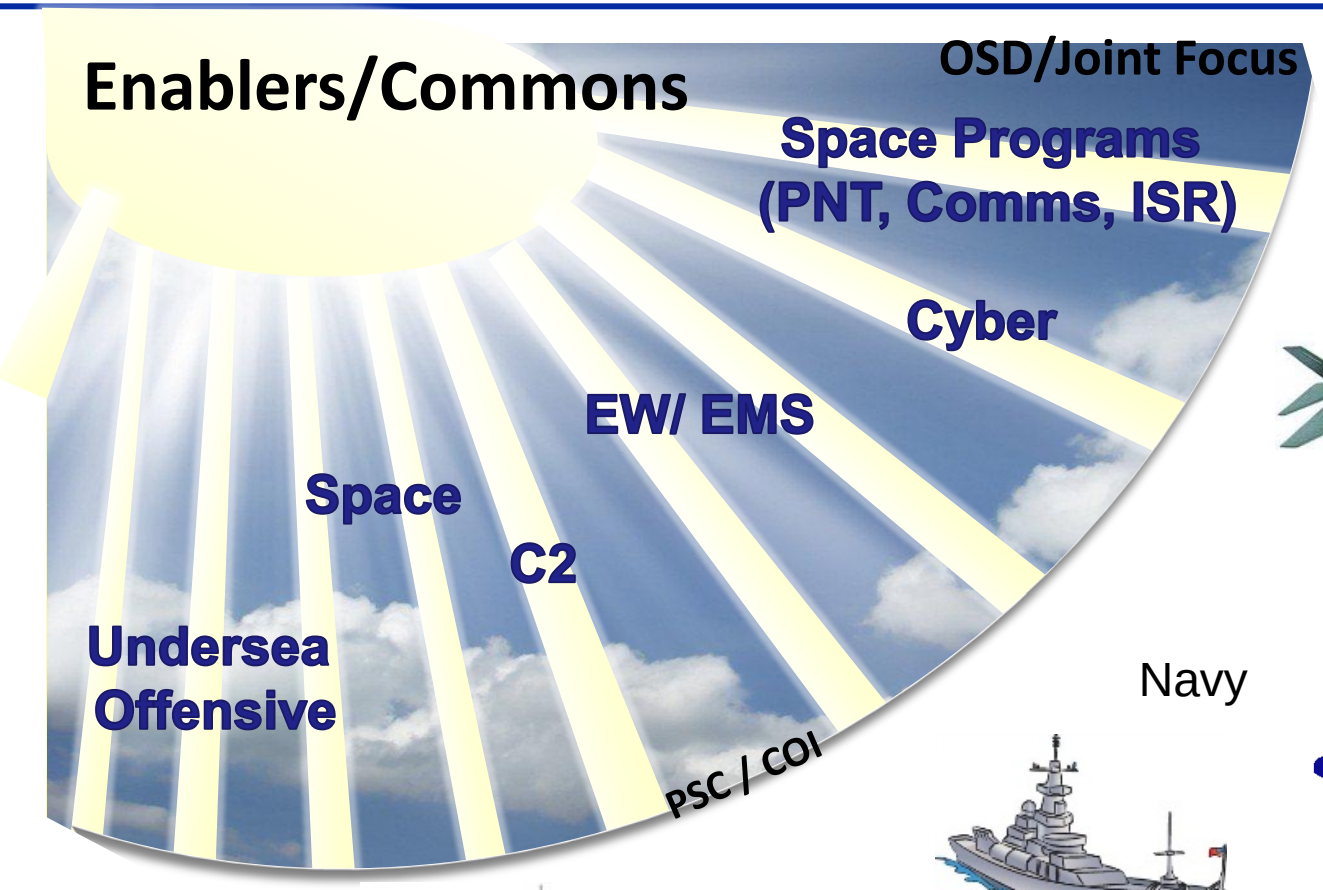


Autonomy

Environment – Capability - Technology



DoD S&T Budget Focus



Service Focus

Air Force

Navy

Army /
Marine Corps

Enabling Future Acquisition
- Developmental Prototyping

DEFENSE INNOVATION MARKETPLACE

R&D Resources for DoD and Industry

CONNECTING INDUSTRY & DoD

The Defense Innovation Marketplace is a centralized resource to reinvigorate innovation.

For Industry, the Marketplace is a resource for information about Department of Defense (DoD) investment priorities and capability needs. Additionally, industry uses this site to submit proprietary IR&D summary reports which are separately stored, accessed and used solely for compliance with the Defense Federal Acquisition Supplement at 48 CFR 231.205-18(c)(iii)(C).

For Government, the Marketplace provides access to search tools to assess and then leverage industry IR&D projects for current and future programs.

NEW IN THE MARKETPLACE

Strategic Documents

- Science and Technology Priorities for the FY 2015 Budget
- CNO's Navigation Plan 2014-2018
- MDA Space & Missile Brief
- MURI Program Review Presentations Posted
- DISA Forecast to Industry Day 2013

Doing Business with DoD

- Development & Demo of Low Observable Technologies **NEW**
- In-Process Monitoring for Additive Manufacturing **NEW**
- Autonomy & Collaborative Ops for Unmanned Systems **NEW**
- Gov't/Univ. Coop in support of Basic and Applied Research and

News & Events

- Air Force Lifecycle Management Center Meeting with Industry
- Defense Daily's Open Architecture Summit
- RIF Awards FY2012
- Top Downloads in August
- AFOSR Basic Research Small Business Interchange Day

INNOVATION OPPORTUNITIES

Resources for Industry
DoD Info for Business & Program Planning

Submit IR&D Data
Share projects with DoD Customers

Resources for DoD
DoD employee access of IR&D Search tool

FEEDBACK

Search Trends

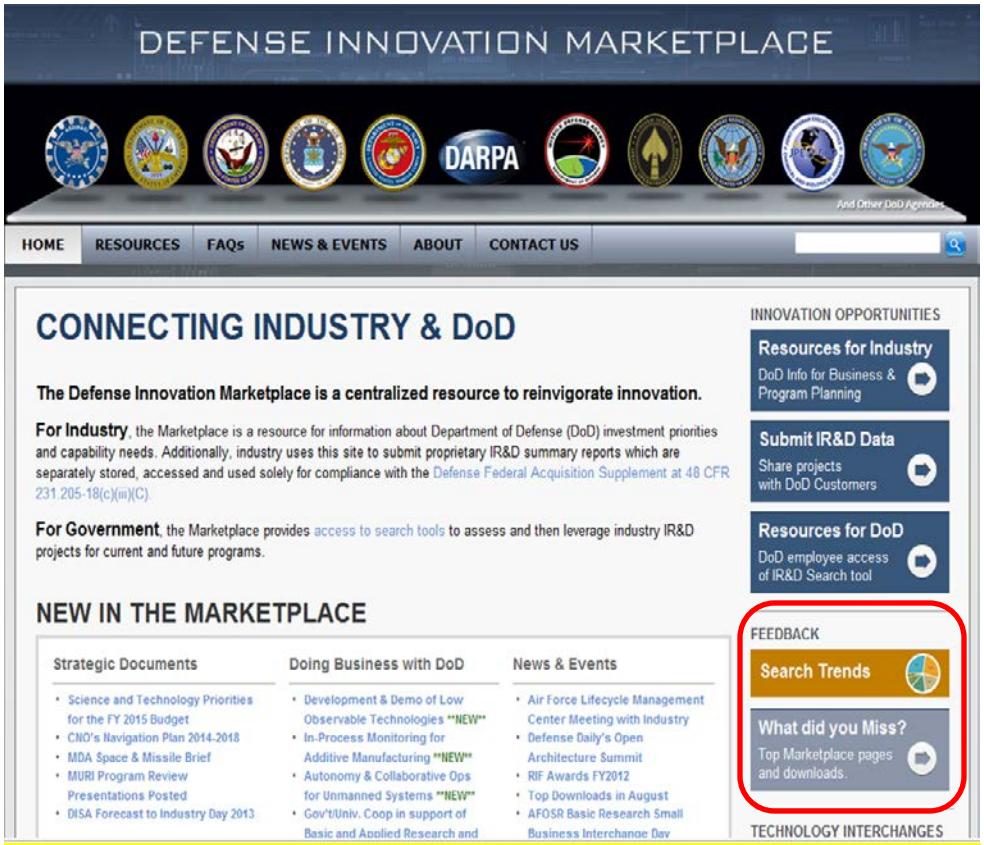
What did you Miss?
Top Marketplace pages and downloads.

TECHNOLOGY INTERCHANGES

DEFENSE INNOVATION MARKETPLACE

RESOURCES FOR INDUSTRY

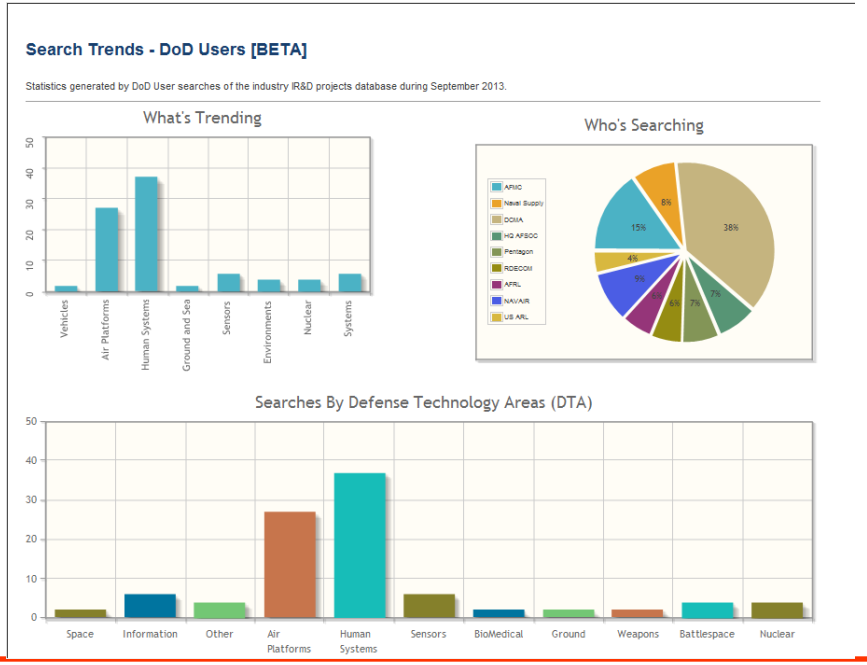
Improve industry understanding of DoD needs



www.DefenseInnovationMarketplace.mil

Marketplace: Resources for Industry

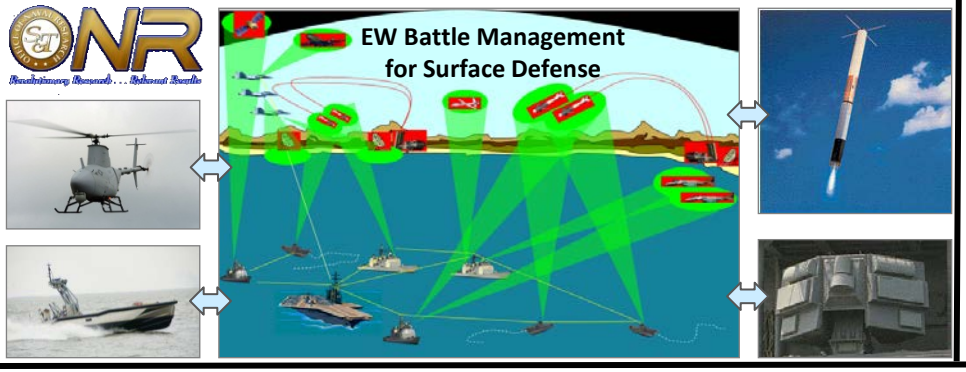
- DoD R&D Roadmaps; Investment Strategy
- Business Opportunities with the DoD
- Virtual Interchanges & Events
- Secure Portal for IR&D Project Summaries
- Top Downloads/Pages visited
- DoD SEARCH Trends



DoD S&T Complex Threats

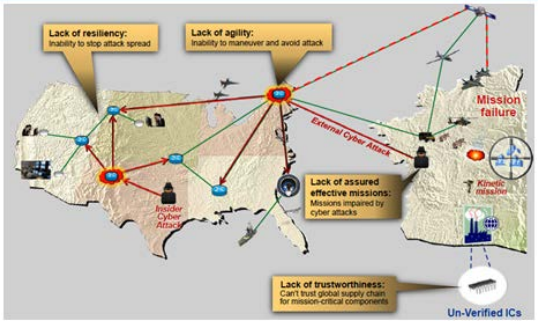
Electronic Warfare & Protection

- RF/Mixed Signal Component Technologies
- EO/IR Component Technologies
- Underlying technology enablers



Cyber Science and Technology

- Assuring Effective Missions
- Resilient Infrastructure Trust
- Cyber Experimentation & Measurement
- Agile Operations



Counter Weapons of Mass Destruction

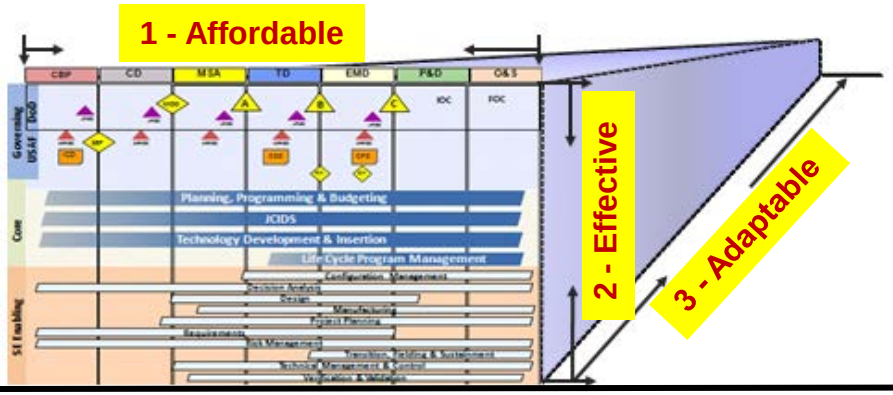
New concepts and technology for remote identification of nuclear, chemical, and biological material, and to assist in mitigation, containment, and attribution of the materials

- Broad Area Search
- Persistent Monitoring
- Tagging and Tracking

DoD S&T Force Multipliers

Engineered Resilient Systems

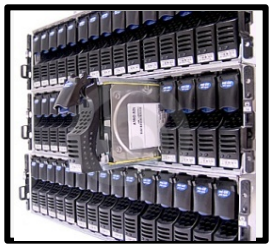
- Spans the Systems Lifecycle
- Uncertain futures & resultant mission volatility

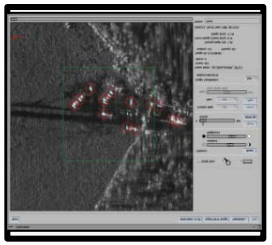


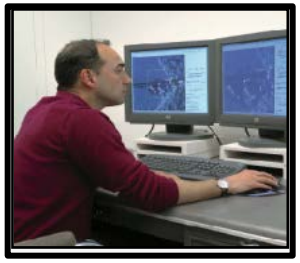
Data-to-Decisions

- Data Management
- Analytics
- User Interface

Multi-Layer Approach





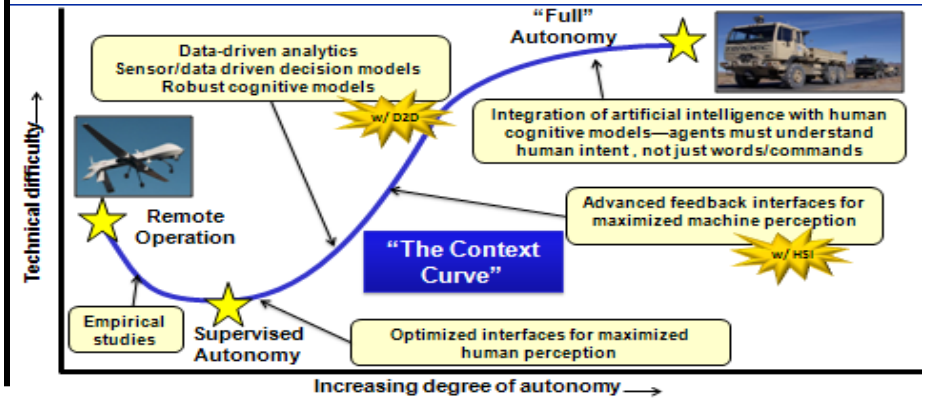


Human Systems

- System Interfaces
- Personnel & Training
- Protection & Sustainment
- Social & Cultural Understanding

Autonomy

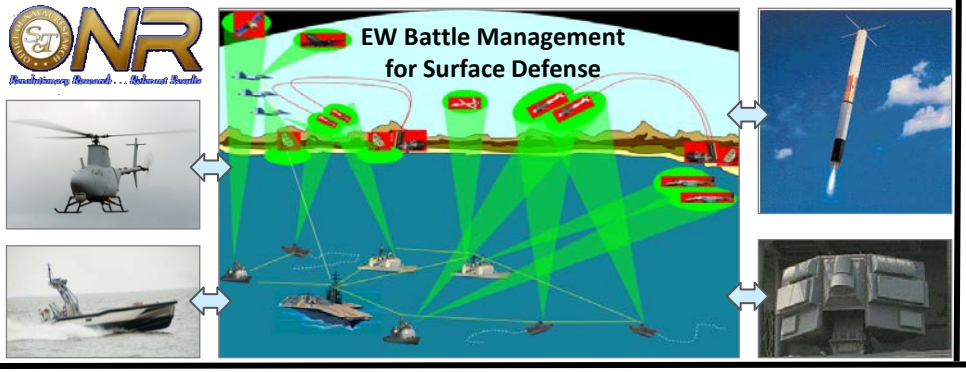
Environment – Capability - Technology



DoD S&T Complex Threats

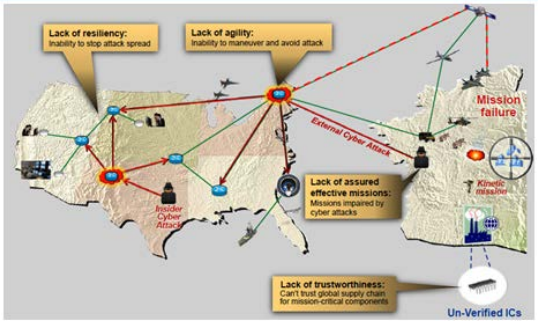
Electronic Warfare & Protection

- RF/Mixed Signal Component Technologies
- EO/IR Component Technologies
- Underlying technology enablers



Cyber Science and Technology

- Assuring Effective Missions
- Resilient Infrastructure Trust
- Cyber Experimentation & Measurement
- Agile Operations



Counter Weapons of Mass Destruction

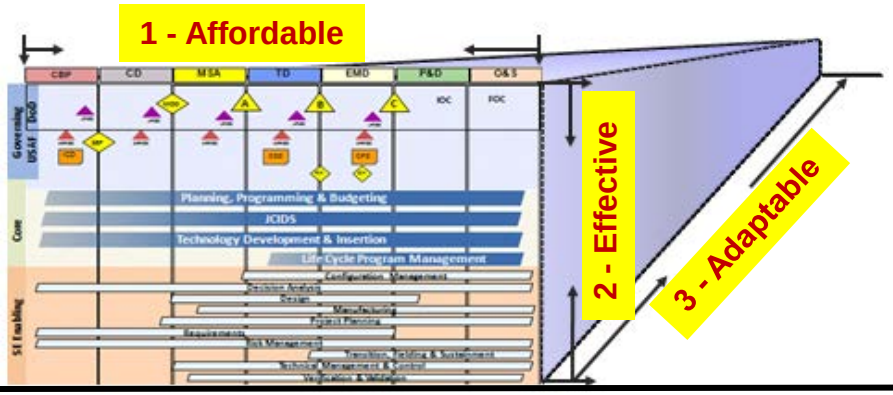
New concepts and technology for remote identification of nuclear, chemical, and biological material, and to assist in mitigation, containment, and attribution of the materials

- Broad Area Search
- Persistent Monitoring
- Tagging and Tracking

DoD S&T Force Multipliers

Engineered Resilient Systems

- Spans the Systems Lifecycle
- Uncertain futures & resultant mission volatility



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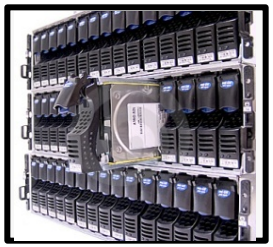

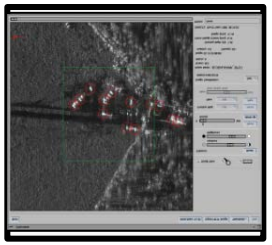

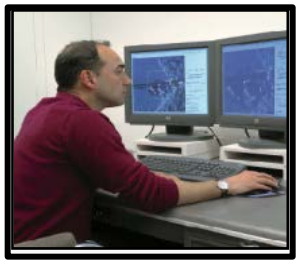

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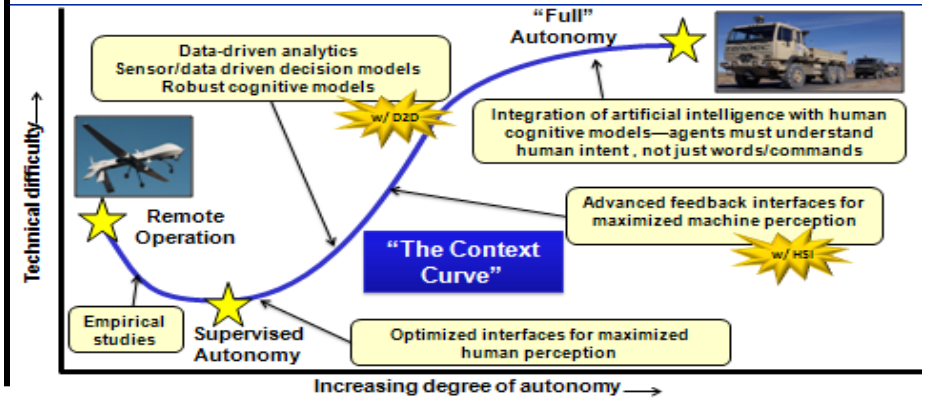
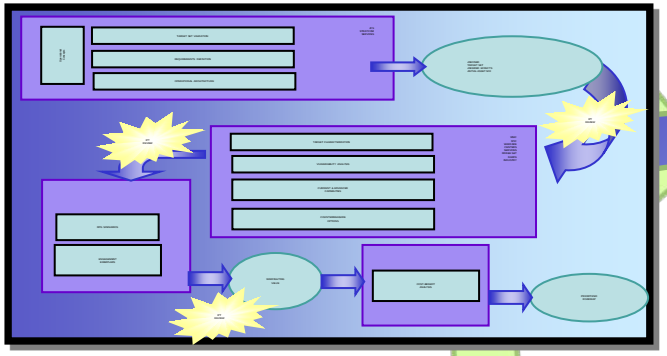


Electronic Warfare

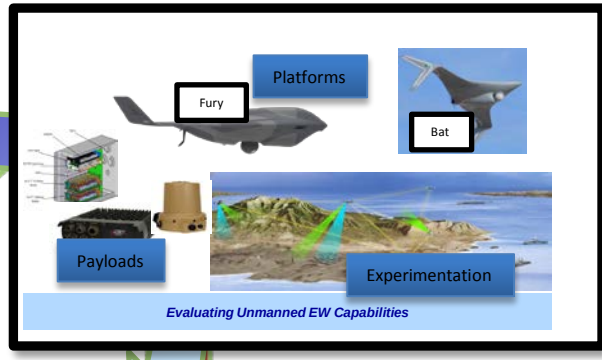
ASD(R&E) and Services Engaged in New Concept Exploration

- S&T EXCOM Driven RDA Task Force
- Advanced Components for Electronic Warfare (ACE) research
- EW- Cyber Convergence
- Experimentation & Prototyping

ANALYTICS

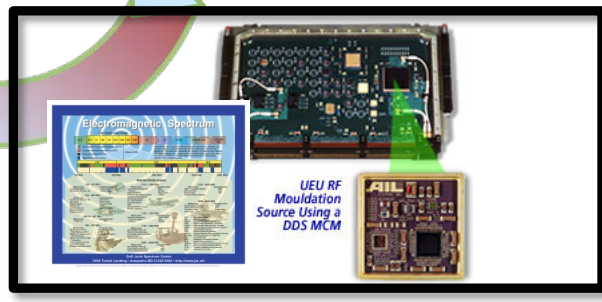


EXPERIMENTS



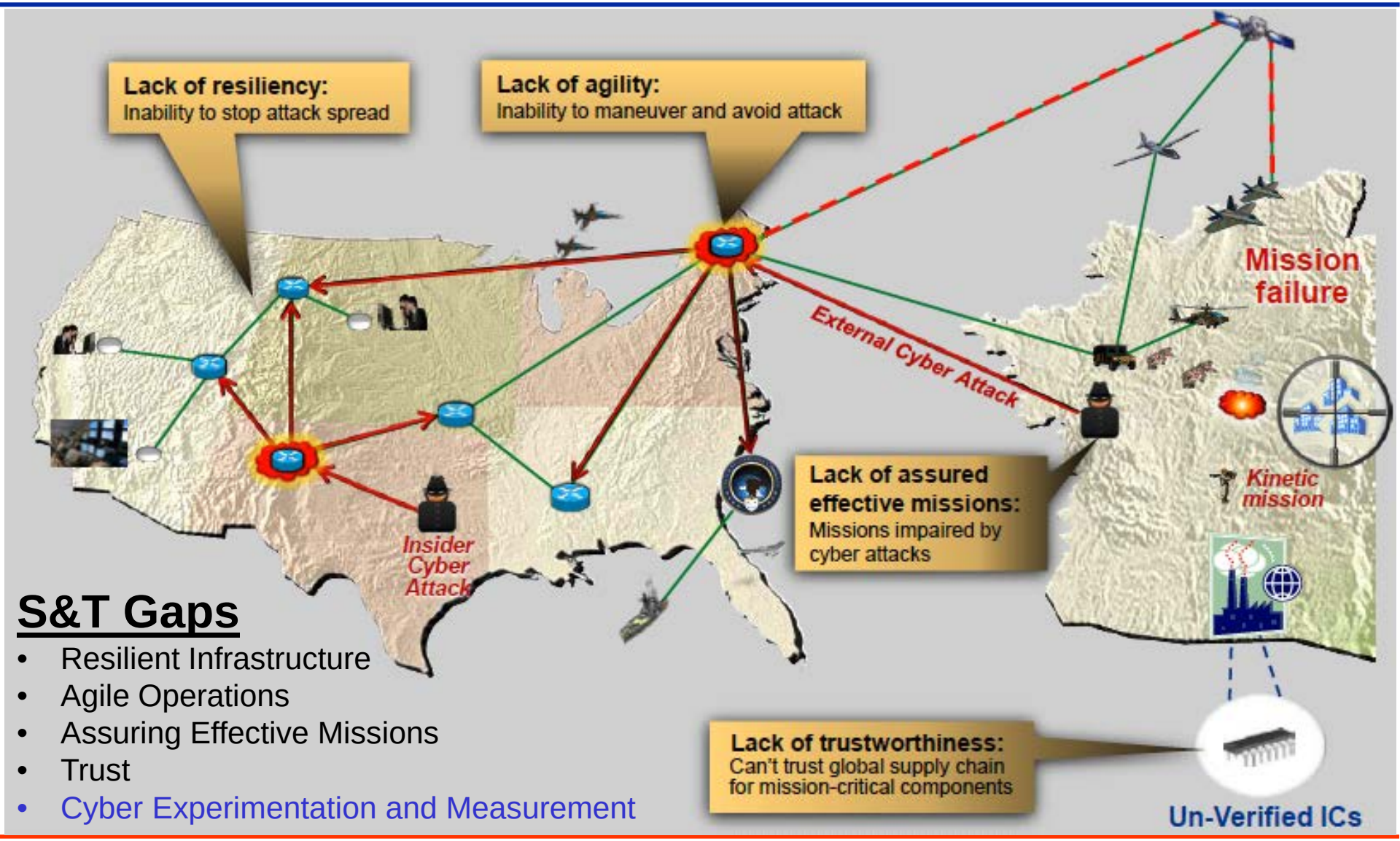
ROADMAPS

RESEARCH



Contact the EW&C Office @ 703-695-1208

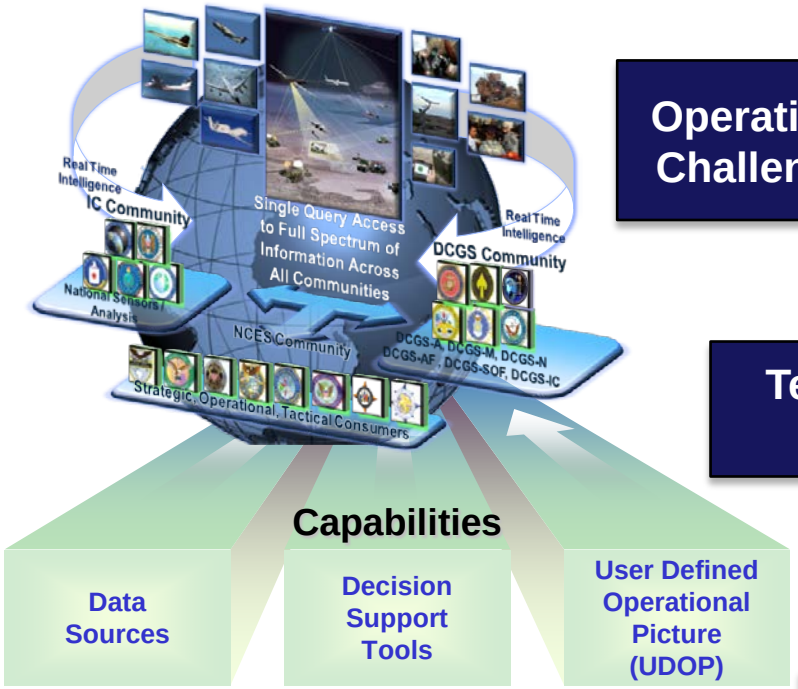
Cyber PSC – Problem Statement



S&T Gaps

- Resilient Infrastructure
- Agile Operations
- Assuring Effective Missions
- Trust
- Cyber Experimentation and Measurement

CLOUDBREAK



Operational Challenges

- Multiple domains and distributed databases
- Single process of accreditation for cross-domain access

Technical Issues

- Analysis and production of Intel data
- Dynamic network mapping and unified cyber SA across networks
- Discoverable enterprise services across domains
- Dynamic / reconfigurable COP

Benefit

- A common C2 enterprise architecture across COCOMs
  - Transition C2 tools and capabilities to Warfighter
  - "plug-and-play"

Candidate Measures of Success

- Timely SA / assessment of Red and Blue
- Reduce percentage of time devoted to data mining versus analysis and production
- Successful execution of military and non-military missions in the presence of cyber attacks

Counter-electronics High-powered-microwave Advanced Missile Project (CHAMP)

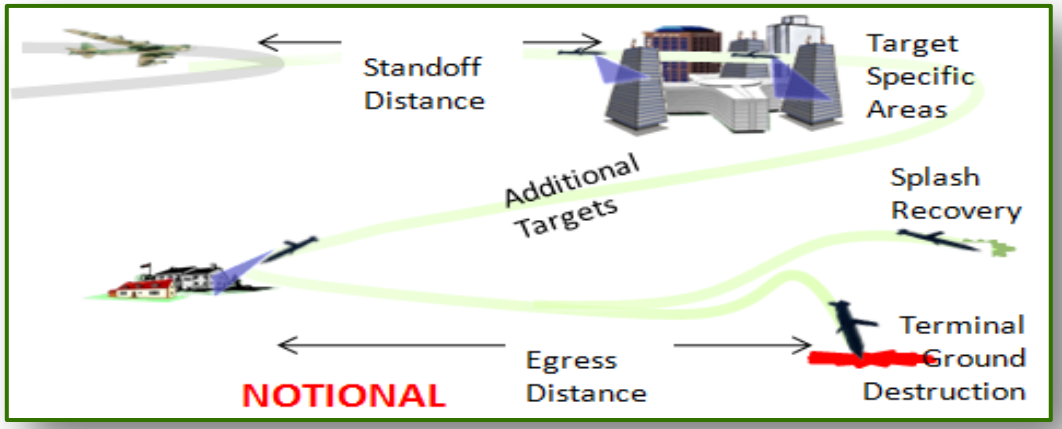
COCOM Sponsor: PACOM; **OE:** Mr. Scott Stephens

FY09

Technical Issues

- HPM device
- Missile package, fuzing/firing
- Predictive Modeling & Simulation tool

Candidate Measures of Success

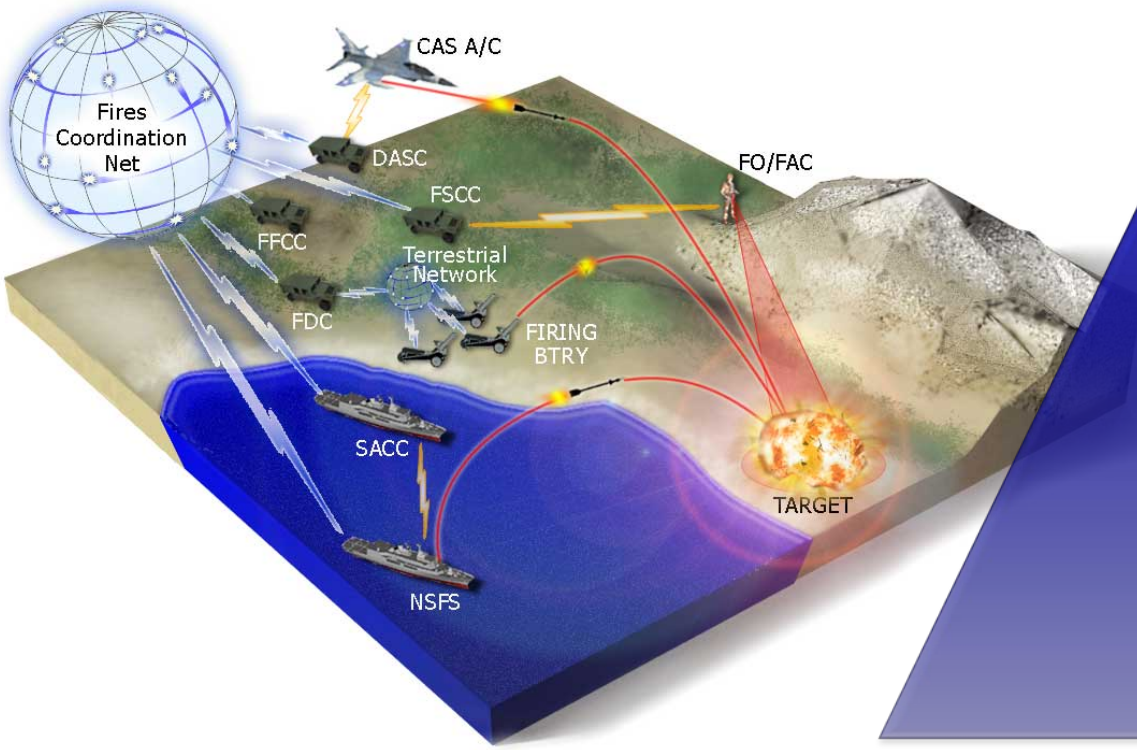


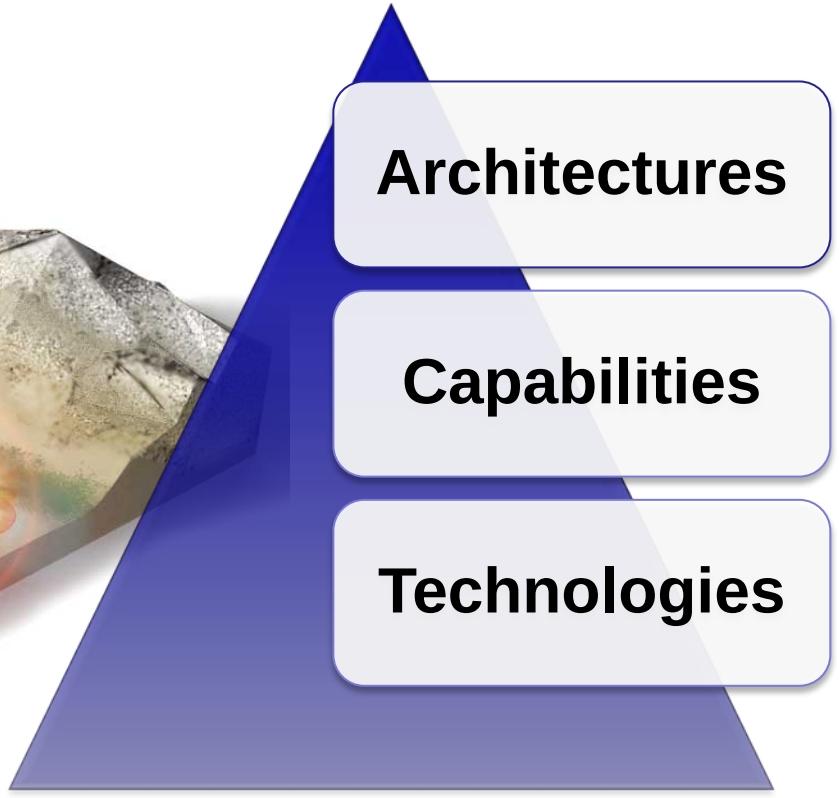
- Year 1: HPM payload and modifications to the aerial platforms
- Year 2: System integration, HPM effects tests, pointing demo with inert system, and static demo
- Year 3: All Up Round flight test, result verification static test and Operational Utility Assessment. Results incorporated into Non-Kinetic Counter Electronics Analysis of Alternatives. Final Military Utility Assessment pending.

Benefit

- Provide the Warfighter with an ability to destroy/disrupt their electronic systems, or any installations with electrical components, without having to use a kinetic (hard kill) system.
- Relatively inexpensive compared to dropping 2 missiles per aimpoint into a target kinetically.
- Capable of degradation, disrupting, or damaging systems

Architecture – Technology Trade Space





Architectures Drive Technologies
Technologies Inform Architectures

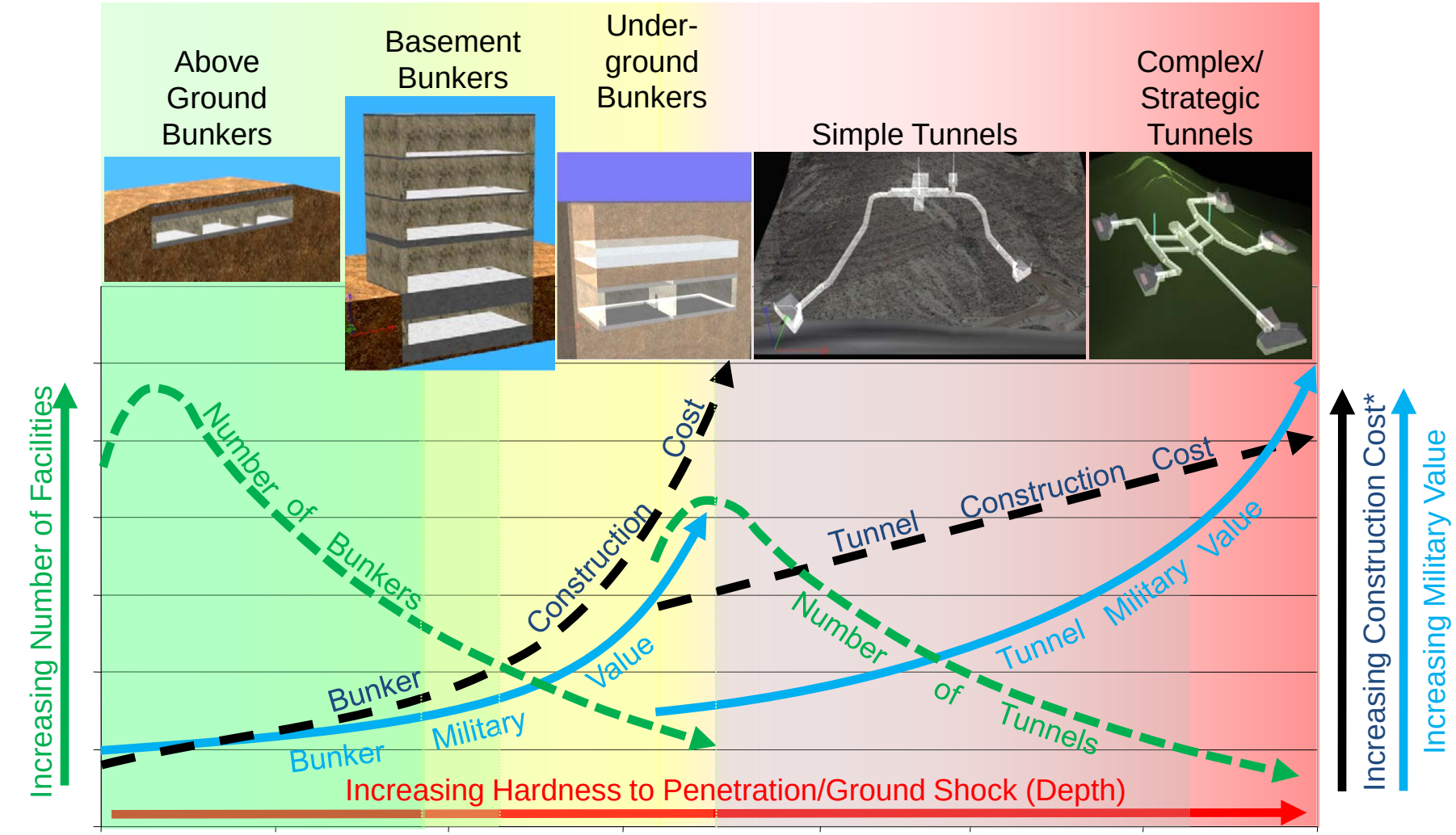
Critical Enablers for the Regional Missile Defense Mission*

- **Fast Missiles**
- **Long-range radars with precision tracking**
- **Reliable defense discrimination of threat objects**
- **Effective networking of defense assets across wide areas**

Defense Science Board Report on Science and Technology Issues of Early Intercept Ballistic Missile Defense Feasibility

http://www.acq.osd.mil/dsb/reports/ADA552472.pdf

HDBT Numbers, Hardness, Cost, Value Comparisons



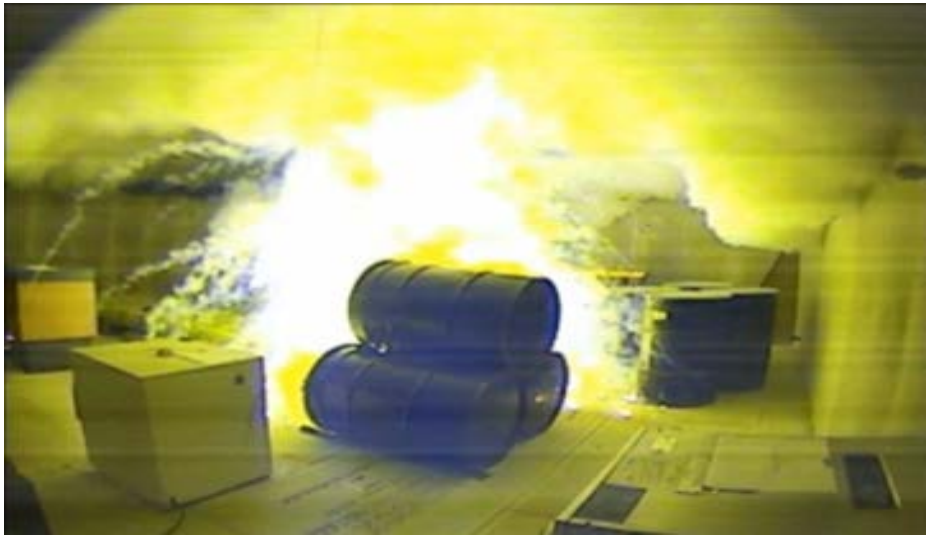
*Equal mission area used for bunker and tunnel cost comparison

Example CWMD Technology (DTRA)

Multipurpose weapon with enhanced AD capability

Optimize HE/Agent defeat fill in a penetrating case

Sub-Scale Agent Defeat Phenomenology



Past MDD in MDAP Acquisition

- AIM-9X Block II
- Long Range Stand-Off (LRSO)
- Offensive Anti-Surface Warfare (OASuW)
- Integrated Force Protection Capability – Increment 2 Intercept (IFPC-I2 I)
- Small Diameter Bomb (SDB) II
- Joint Air-Ground Missile (JAGM)
- Guided Multiple Launch Rocket System Alternative Warhead (GMLRS-AW)

……..

MDD: Materiel Development Decision

MDAP: Major Defense Acquisition Program

Resilience and Operate Thru

In order to deter attacks on U.S. or allied space systems, DoD will mitigate the benefits to an adversary of attacking U.S. space systems by enhancing the resilience of our space enterprise and by ensuring that U.S. forces can operate effectively even when our space-derived capabilities have been degraded.

- Space Policy DoD Directive 3100.10

Technology & Idea Needs:

- **Small commoditized launchers with rapid launch capability**
- **Large dispersed affordable constellations**
- **Alternate, affordable non-space means for A2/AD environment**
- **Electromagnetic domain awareness and spectrum management tools**
- **Multi-path communications networking – space, air, maritime**