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E3 Testing of Directed Energy Systems: A Challenging Future

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14. ABSTRACT
Efforts to put lasers and other Directed Energy Weapons (DEW) in the hands of warfighters continue. Concepts in development, for High Energy Laser (HEL) or High Power Microwave (HPM) in the future, may include Airborne Tactical Laser and Airborne Active Denial System. Network-Centric Operations (NCO) expand as systems are 'linked' and tested. Directed Energy Weapons will be integrated on Net-ready platforms. Compatibility testing and susceptibility to electromagnetic radiation is required. Standards, such as MIL-STD-464 and MIL-STD-237D, are being revised to include HPM levels and frequencies for E3 tests. In the past, HEL and RF testing has been conducted in separate laboratories by separate communities. But now, facilities for E3 testing will have to change. Testing of networked DEW systems must be supported on ranges and in anechoic facilities typically used for E3 testing. Preparation is needed. Some new capabilities must be developed. This presentation discusses what needs to be done to upgrade existing E3 facilities to include DEW test capabilities. Included is a brief discussion of current efforts toward providing such a DEW test capability. Recommendations that are based upon past experience are discussed.

15. SUBJECT TERMS
Lasers, Directed Energy Weapons (DEW), High Energy Laser (HEL), High Power Microwave (HPM), future, Network-Centric Operations, Compatibility, susceptibility, electromagnetic radiation, MIL-STD-464, E3, RF, testing, networked, anechoic, facilities

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War-Winning Capabilities … On Time, On Cost

E3 Testing of Directed Energy Systems: A Challenging Future

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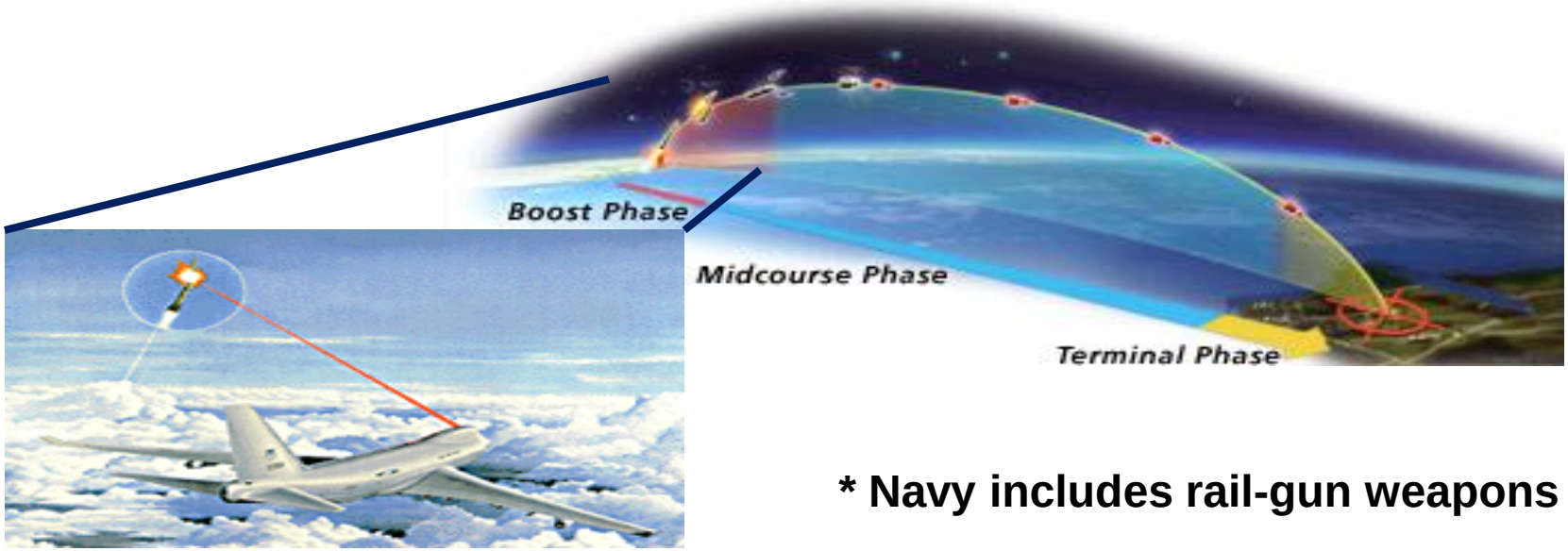
DoD E3 Program Review
4 March 2009

Overview

- What do we mean by Directed Energy(DE)?
- Thoughts on the Future
- Needed enhancements to facilities
- Recommendations for path ahead
- Summary

Definition

- **Directed Energy (DE): Ability to apply focused energy in militarily useful amounts to deter or defeat adversaries. DE includes lasers and high power microwave (HPM) weapons.***



*** Navy includes rail-gun weapons**

What's in the Future?

Near: 2008-2013

- Completion of ABL ACTD
- ATL EUE
- KC-X
- ADS
- ELLA Risk Reduction Tests
- Protection efforts /-464B testing--includes HPM
- JSF
- LAIRCM

Far: 2018 & Beyond

- Relay Mirror
- Laser Fighter
- Bomber Defense

2008 2013 2018

Mid: 2013-2018

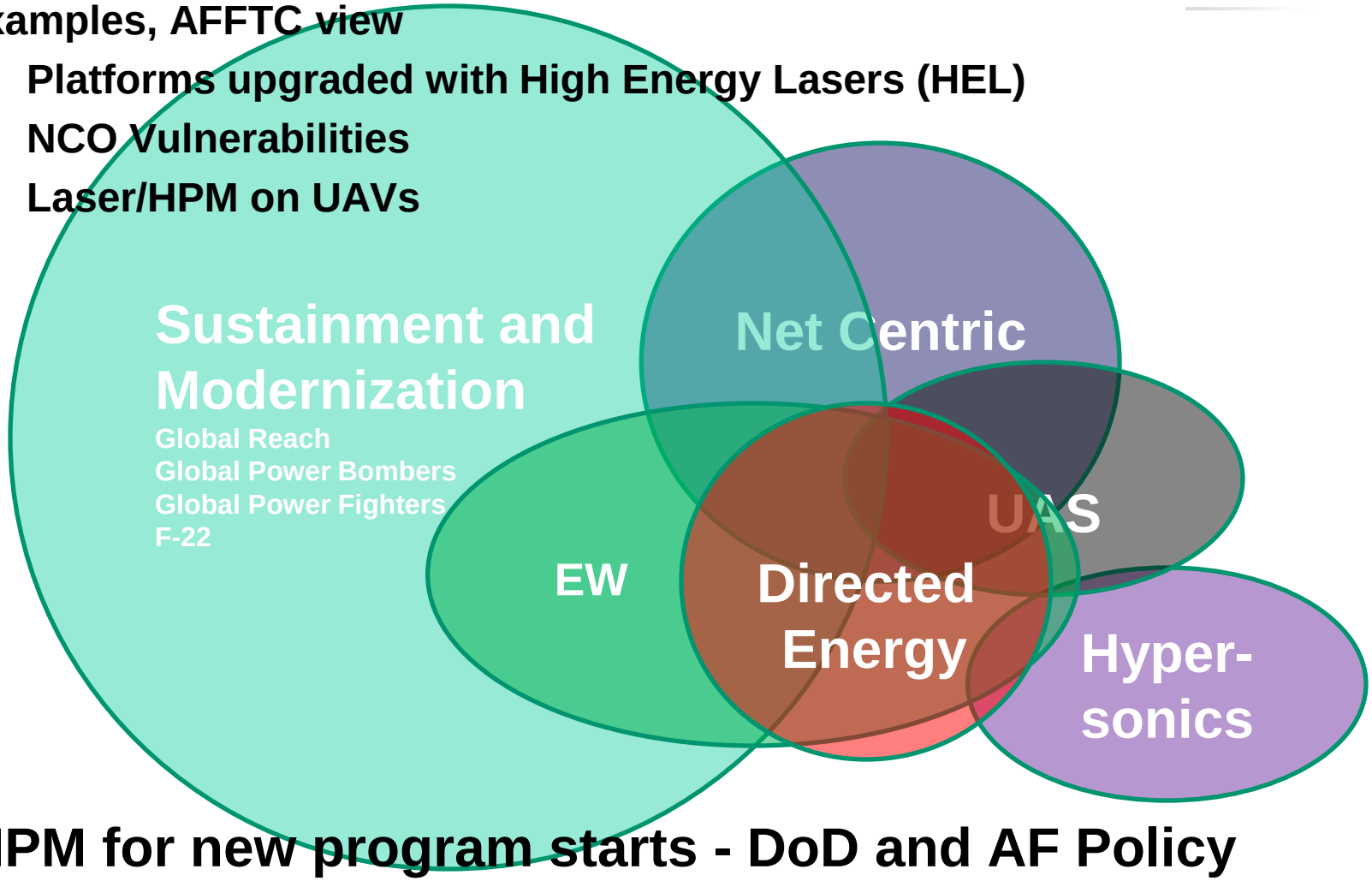
- Solid State Laser Demonstrations
- ABL production platform T&E
- Airborne HPM systems
- Possible DE on unmanned systems

Directives and Requirements Related to DE and E3

- DoDD 3222.3, DoD E3 Program
  - Air Force Supplement available
- DoDI 5000.02
  - Signed 2 December 2008, strengthens requirements for spectrum supportability in Section 11 of Enclosure 12, titled "Spectrum Supportability,"
- MIL-STD-464B, circa 2009, include DE – HPM rE product levels
- New Joint Spectrum Center (*JSC*) E3 Policy Enforcement Working Group
  - Air Force E3 experts contributed lessons learned from aircraft and weapons related incidents

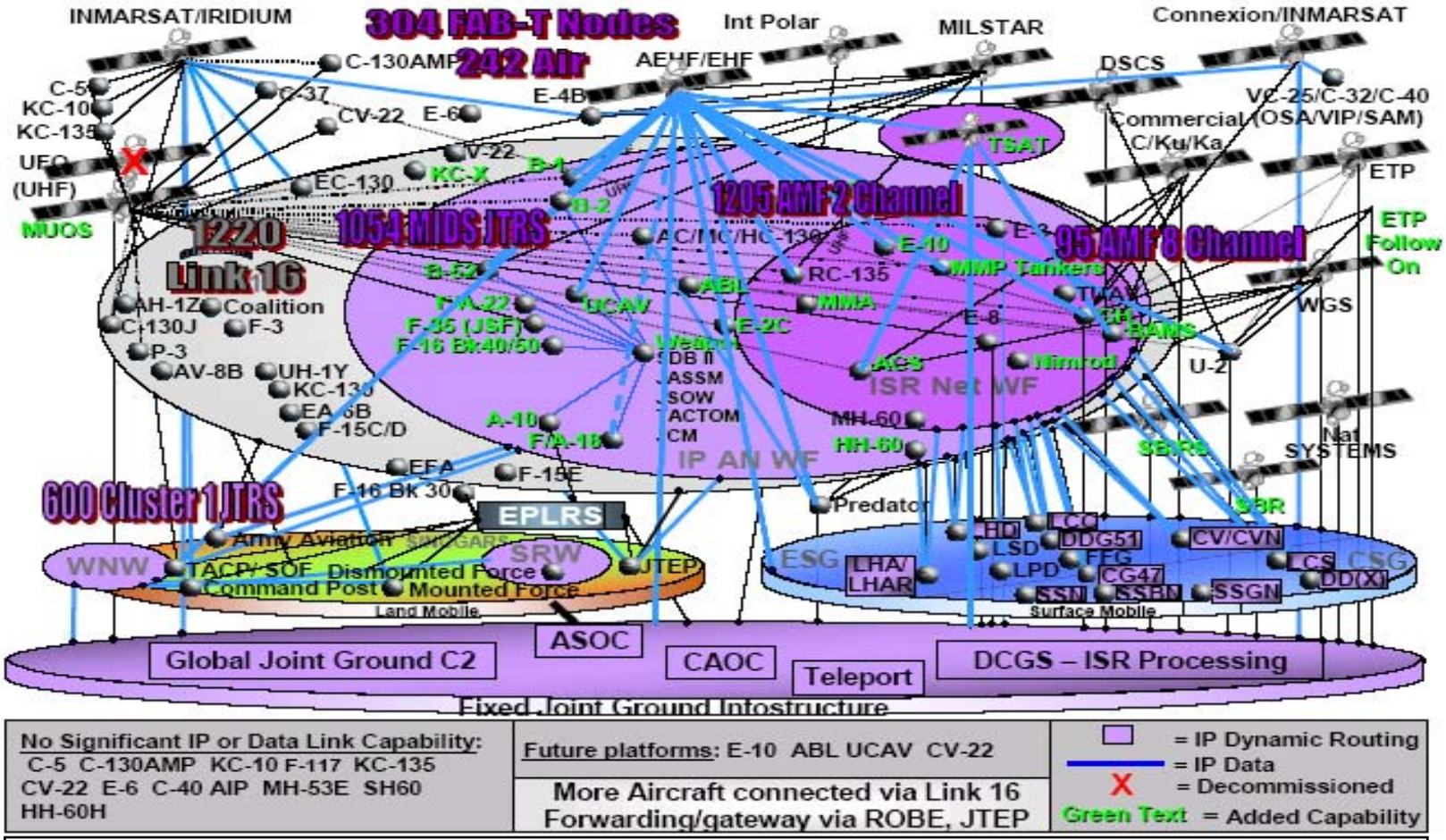
DE and the Future

- **DE Future overlaps Other Future Technologies**
  - **Examples, AFFTC view**
    - **Platforms upgraded with High Energy Lasers (HEL)**
    - **NCO Vulnerabilities**
    - **Laser/HPM on UAVs**



- **E3/HPM for new program starts - DoD and AF Policy**

The Future of NCO!



No Significant IP or Data Link Capability:	Future platforms: E-10 ABL UCAV CV-22	= IP Dynamic Routing
C-5 C-130AMP KC-10 F-117 KC-135 CV-22 E-6 C-40 AIP MH-53E SH60 HH-60H	More Aircraft connected via Link 16 Forwarding/gateway via ROBE, JTEP	= IP Data X = Decommissioned Green Text = Added Capability

Air Force FY 2013 Communications Network Architecture

Source: AF/XOR-J; BG Andrew Dichter, October 2005

Technological Future Yields Potential for Cheap Threats

"Drive-By HPM"

RF Weapons Threaten Information Systems:

– "The development of RF weapons has profound consequences for the United States. As the most technologically sophisticated nation, the United States is vulnerable to an attack that strikes directly at the heart of its information systems."

» Wm J. McCarthy, CAPT, USN, Center for Strategy and Technology, Air War College, Air University, Maxwell AFB, 2000.

Complexity => Vulnerability => Evaluation

The Possible Future

- **Survivability testing for FCS, JSF and KC-X**
  - **Based upon CONOPS of Systems and SoS**
- **Emerging need for DE Testing Outside and Inside**
  - **Security, Availability, Control of Test Environment**
  - **Control Collateral Damage***
  - **HPM energy levels**
  - **Lasers of higher power**
- **Secure testing of Anti-stealth radar**and HPM arrays+**

•"… test community indicated an errant beam burned out small motors that power seats and windows in cars parked near the test area." Circa 1992 – *Fried Chips,* Aviation Week and Space Technology, October 20, 2008

• "Breakthroughs in Electronics Warfare May Deploy in 2 Years," Next Big Future - nextbigfuture.com, January 26, 2007**

+ "Light Boosts Destructive Power of Microwave Weapons/ Sensors," Fulghum, David A. Aviation Week, Jan 21, 2007

The “Instrumentation Wedge”

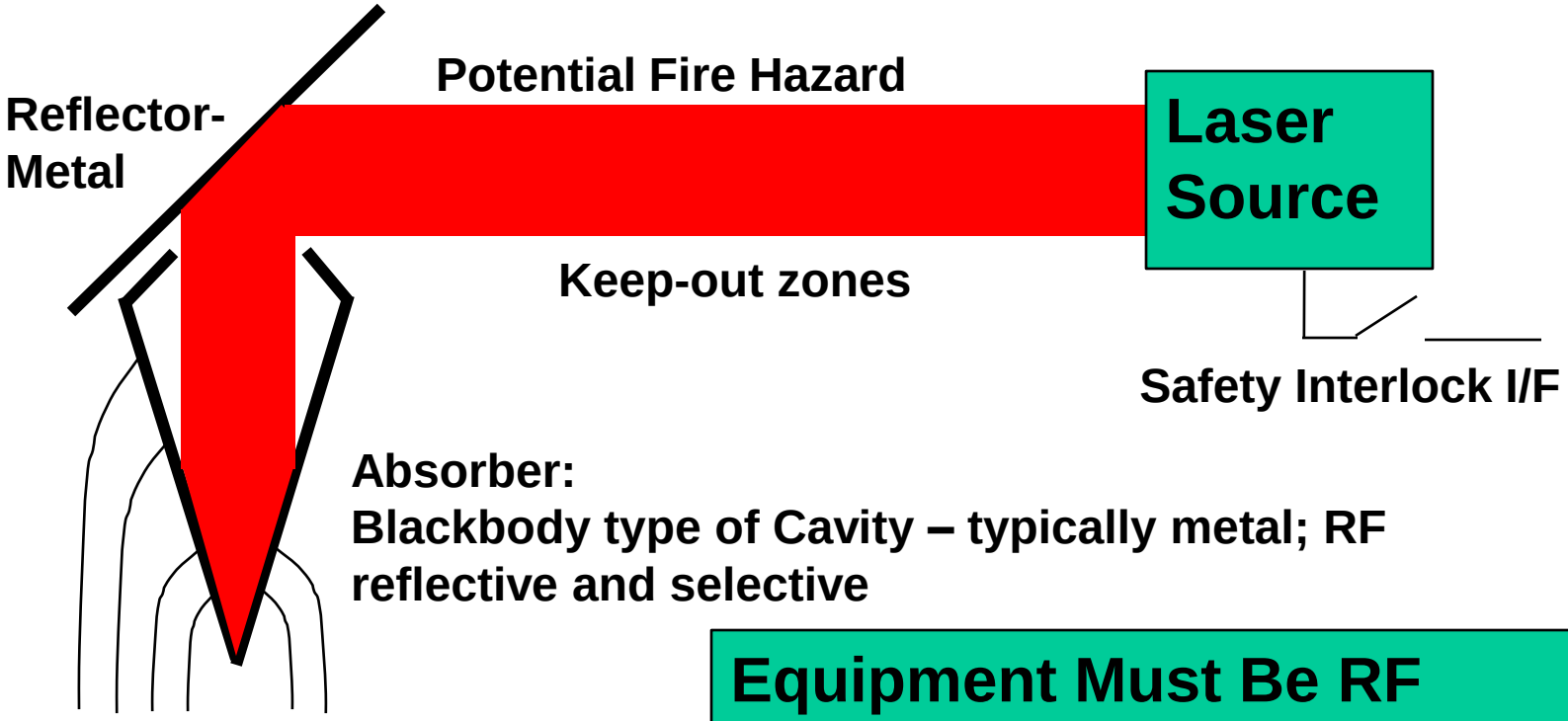
- Instrumentation for Safety
- More instrumentation required
  - Includes Propagation effects
- More sensitive and exotic instrumentation
  - Non-Invasive RF fiber sensors
- More shielding of instrumentation
  - Simulators and Sensors not normally in anechoic chambers

E3 Facility Needs of the Future

- Sensors for HPM and HEL energy
- Modeling and Simulation
  - Safety and Effectiveness
- High-Speed time/event-synched instrumentation
- Network-Centric Links: Link-16, JTRS, MIDS, SATCOM, TTNT, etc. for HPM Survivability Testing
- RF compatible High Fidelity IR and Visible Scene Generators
- Test planning tools for LVC, CTE, etc.
- Space DE vulnerability? May require E3 in a vacuum environment; difficult and expensive
- Beam Dumps for Lasers

E3 Facility Example Need:
Laser Beam Dump/Calorimeter++

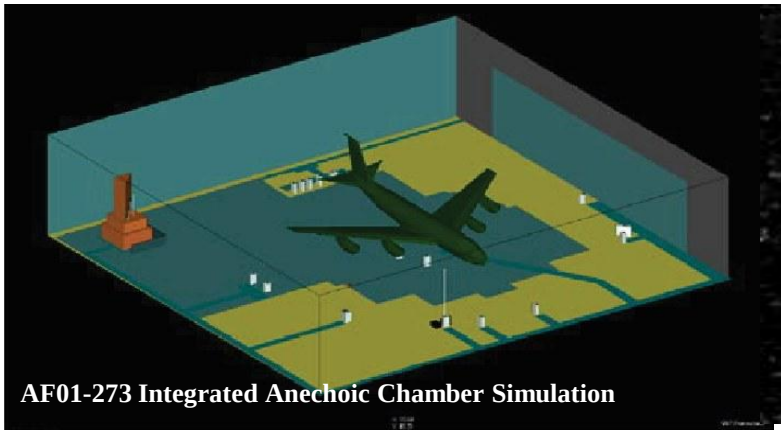
- RF compatible instrumentation
- Safety – Exposure, Fire, and Beam-handling



Equipment Must Be RF Compatible

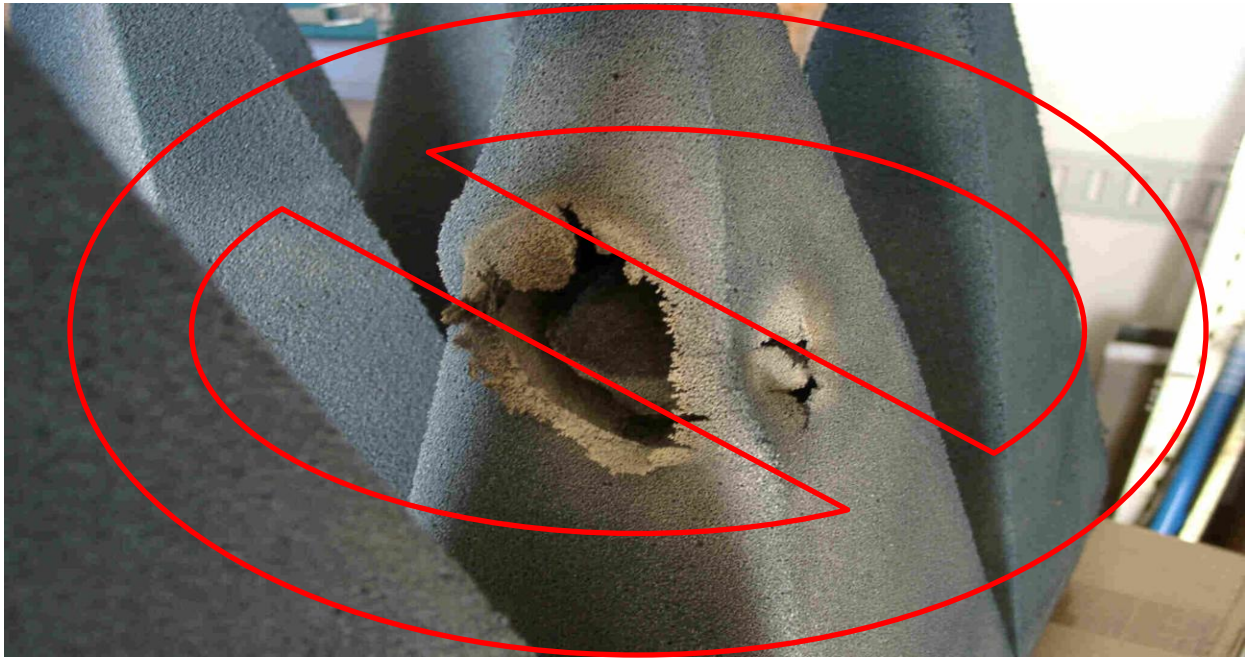
++ Submitted for T&E S&T funding, Jan 2009

DE Test Safety In Chambers



AF01-273 Integrated Anechoic Chamber Simulation

AF03-261 Infrared/Ultraviolet Background Monitoring System



Who You Gonna Call?

- DETEC (Directed Energy Test and Evaluation Capabilities) Some infrastructure development has been funded through
  - 2003 - Initial Tri-Service Study: Twelve projects for DE, five for laser systems; seven for HPM
  - 2006 - Tri-Service Study Update conducted, published shortfalls and completed Solution Call [Funding expected with 2009 Update]
  - S&T areas being funded
- Research Labs - ARL, AFRL, and NRL have DE offices
- NAVAIR/NAVSEA – China Lake, Patuxent River, or Dahlgren
- Army facilities at White Sands Missile Range, Aberdeen, Adephi, Picatinny, etc.
- AF Material Command WPAFB - MIL-STD-461 & 464 (adding HPM to Electromagnetic Environmental Effects testing)
- AF DE Action Group - Formerly AF DE Task Force
- Air Force DE Consortium
  - DE OL, Kirtland AFB; AAC, Eglin AFB; AFFTC, Edwards AFB, AEDC, Arnold AFB.
- Your Local SBIR POC - to prepare for future T&E of HEL and HPM

Recommendations

- We need to prepare for future DE Systems
  - The future includes complicated systems needing survivability testing
    - Evaluate Performance and Compatibility
    - Upgrade existing facilities and ranges
    - Accommodate lasers and higher power RF sources
- DE Infrastructure Development
  - Paths to achieve capability
    - DETEC
    - S&T
    - SBIRs

Summary

- Definition and systems involving DE
- Future of Test - DE with other future systems
- Survivability of Systems regarding DE, including NCO
- Discussed needed enhancements to anechoic facilities
- Current Efforts
- Recommended Path Forward – Obtain funding for DE Infrastructure

E3 and DE have a Joint Future

Questions?

"Do not depend on the enemy not attacking, but depend on our position that cannot be attacked."

- Sun Tzu, Circa 500 B.C.

References

Backup slides

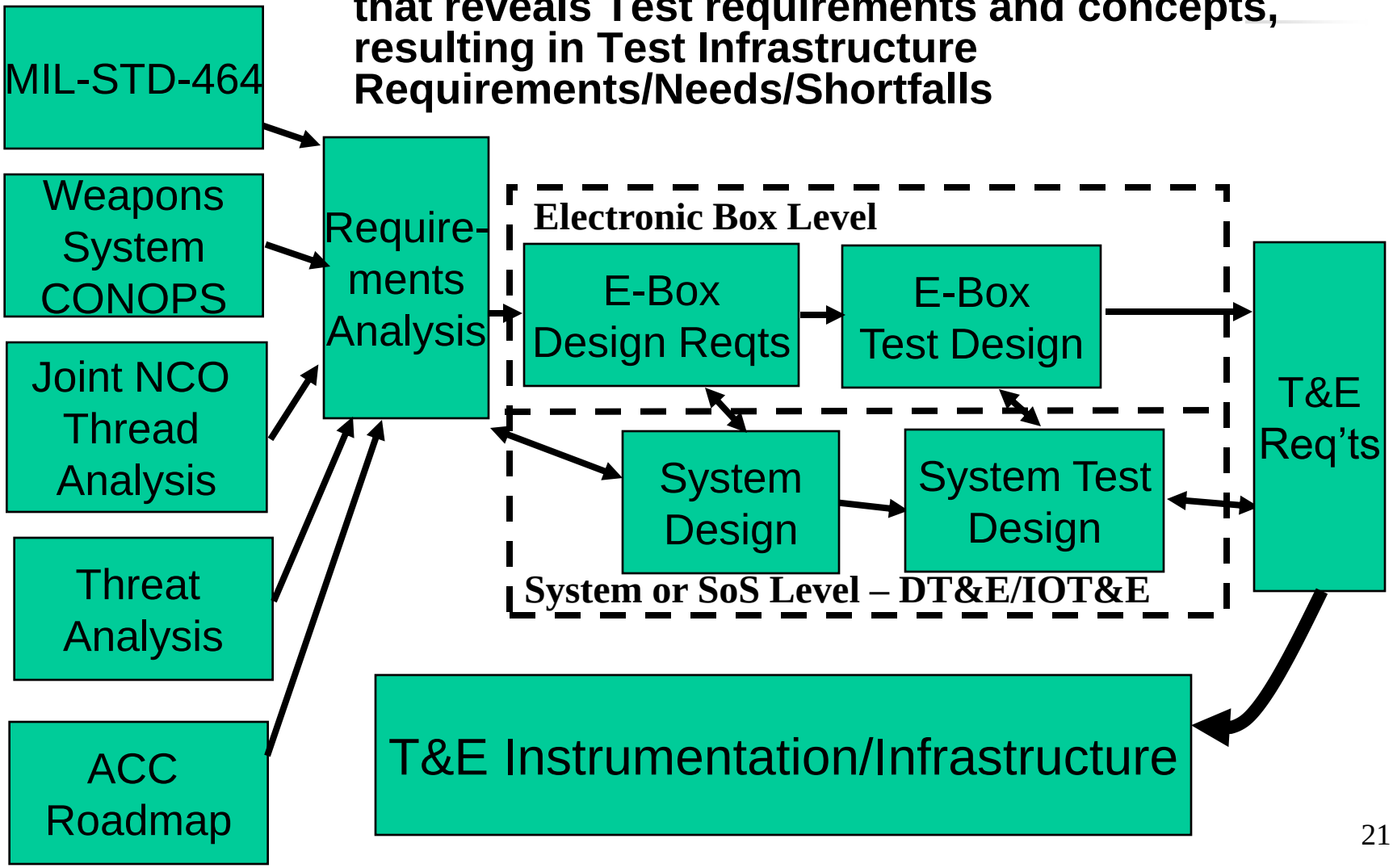
Farther Future Issues

- **HPM arrays and Anti-stealth radar***
  - **High power semiconductors may make it possible +**
- **Dealing with DE implications for Hypersonic flight – Plasmas**
- **Ability to map DE signatures; HPM systems and Laser quirks**

+ "Light Boosts Destructive Power of Microwave Weapons/ Sensors," Fulghum, David A. Aviation Week, Jan 21, 2007

Preparing for T&E Relevance

- **Requirements go through a maturing process that reveals Test requirements and concepts, resulting in Test Infrastructure Requirements/Needs/Shortfalls**



Strategy Vs. Technology

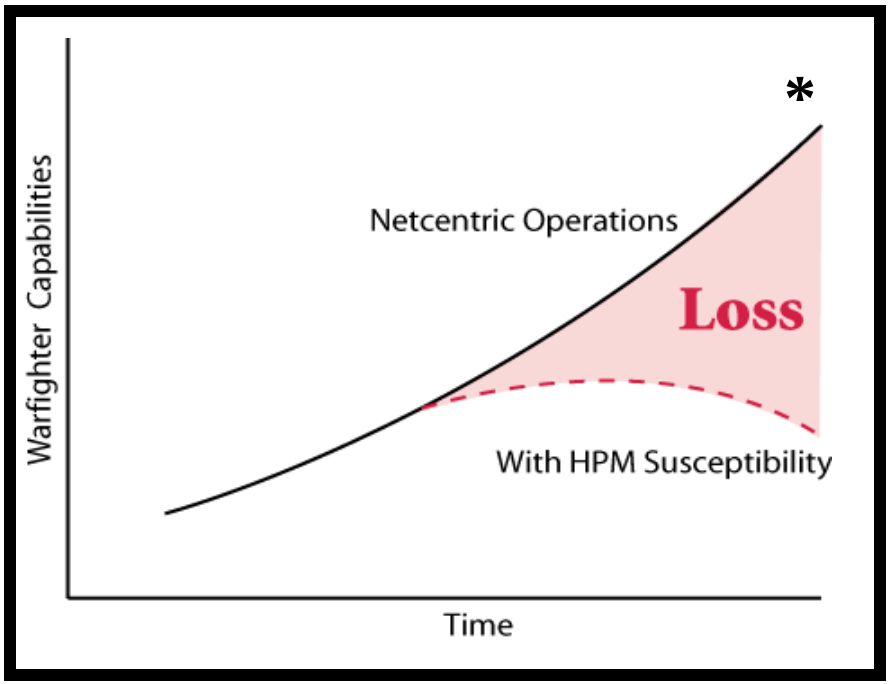
"In war, do not launch an ascending attack head-on against the enemy who holds the high ground. Do not engage the enemy when he makes a descending attack from high. **Lure** him to **level ground** to do battle."

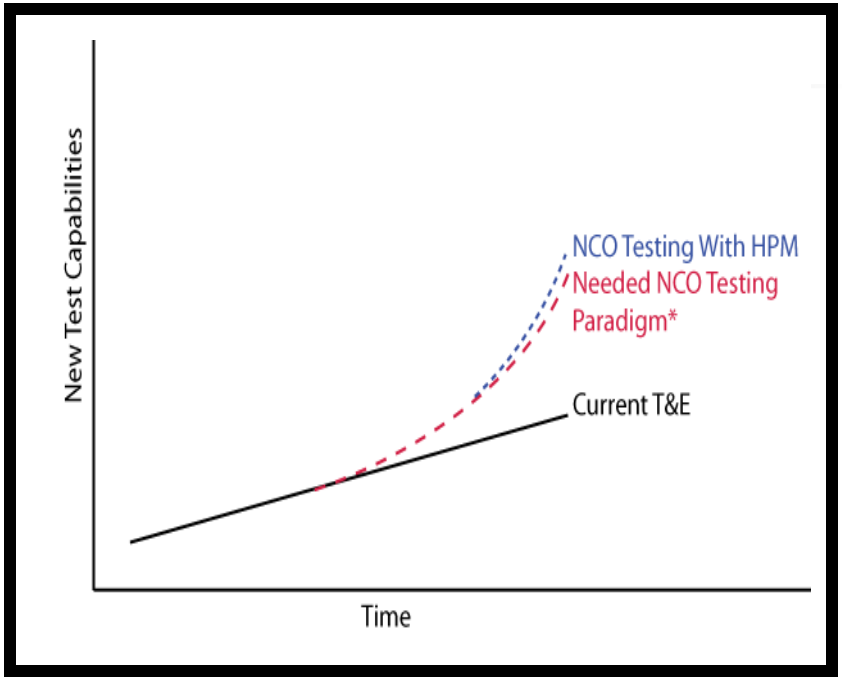
– Sun Tzu, The Art of War, circa 500 B.C., as quoted by Theresa Hitchens, *Scientific American*, March 2008, p. 79

- Lure him…
- Level the playing field

Goal: Take away the asymmetric advantage

NCO T&E Needs Increase Non-linearly



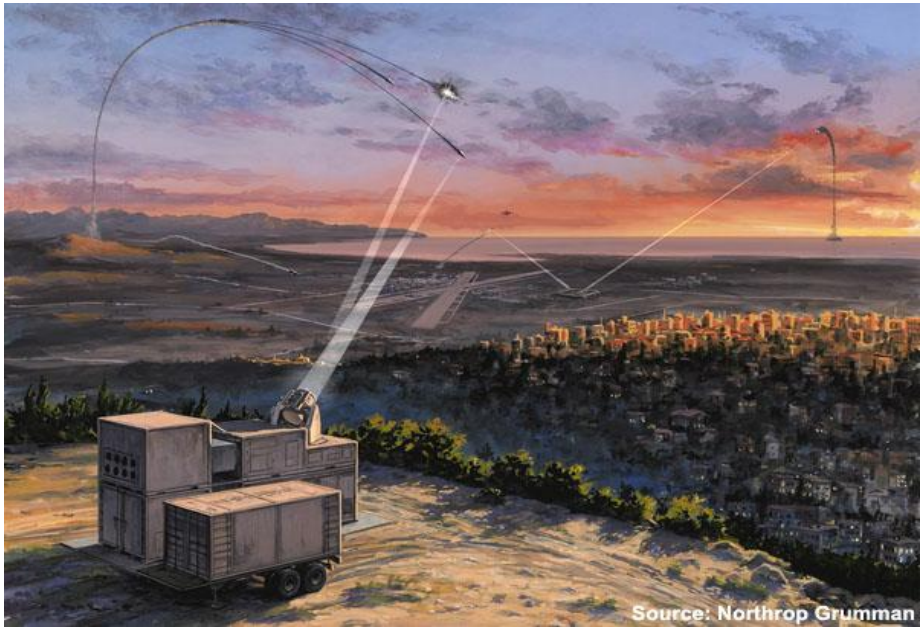


- **Use of Net-Centric Operations Systems is increasing**
- **Need to develop capabilities to support Collaborative Test Environments (CTEs) and Live, Virtual, and Constructive Events**
- **Need to add HPM susceptibility tests**

Collaborative NCO Needs Collaborative T&E Solutions

* Taken from "Wanted: A New Test Approach for Military Net-Centric Operations" David Carstairs, ESC, Guest Editorial, -ITEA Journal, September/October 2005.

Ex: Skyguard laser-based air defense system



- **Need to add HPM susceptibility tests**

* Taken from **How To Counter Rockets, Artillery, Mortars (12/18/2006) Militaryperiscope.com**