

The background of the slide is a blue-tinted collage of military technology. In the upper right, an F-35 fighter jet is shown in flight. In the center, a large naval ship, possibly a Zumwalt-class destroyer, is depicted. In the lower right, a heavy-duty military truck with a large radar or sensor dome on its back is shown. On the left side, there are several white, stylized chevron arrows pointing towards the right. The CSBA logo is in the top left corner.

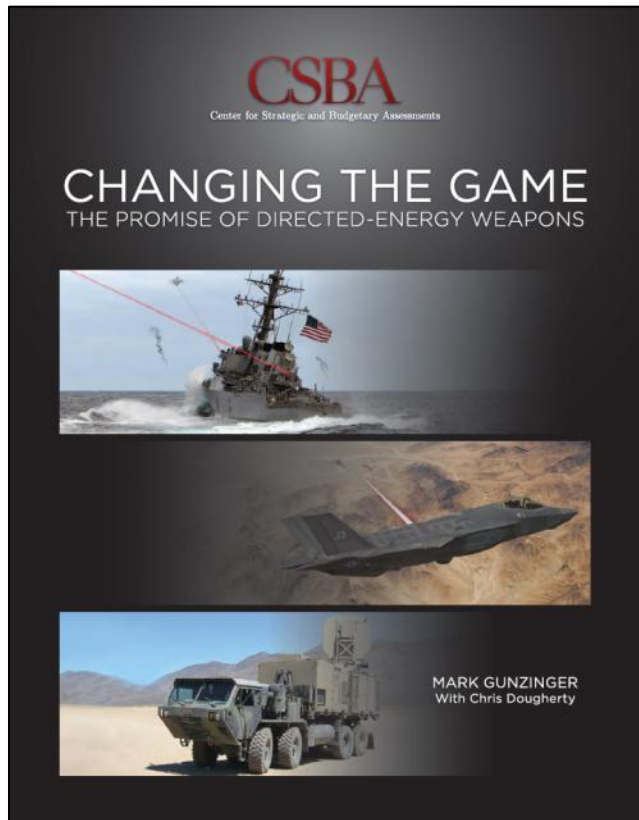
CSBA

Center for Strategic and
Budgetary Assessments

CHANGING THE GAME

The Promise of Directed Energy Weapons

April 19, 2012



- **Why CSBA conducted this assessment**
- **Power projection: toward an operational stalemate?**
- **Promising directed energy (DE) concepts**
- **Major findings and recommendations**

- **Asymmetric challenges to the U.S. military's ability to project power**
 - **Proliferation of PGMs, advanced air defense threats, maritime exclusion capabilities, state- and non-state-actors equipped with G-RAMM**
- **A need for new capabilities that will help the U.S. military maintain it's freedom of action in operating environments that are becoming increasingly non-permissive**
- **A defense program of record that continues to procure weapon systems with declining cost-benefit ratios**
- **Potential to leverage existing and emerging technologies to counter A2/AD threats and possibly reduce requirements for expensive, expendable systems**

1. Forces postured overseas support initial response to an emerging crisis
2. Rapidly deploy land- and sea-based air forces to spoil or halt an enemy offensive
3. Roll-back enemy air and maritime threats
4. Build up overwhelming combat power in theater
5. Launch decisive counteroffensive operations

HIGHLY DEPENDENT ON

Sufficient secure bases in close proximity to an enemy to support large, high-signature military formations

Secure lines of communication to support force deployments and sustain forward operations

A superior precision reconnaissance-strike complex consisting of sensors, precision-guided weapons, and information networks

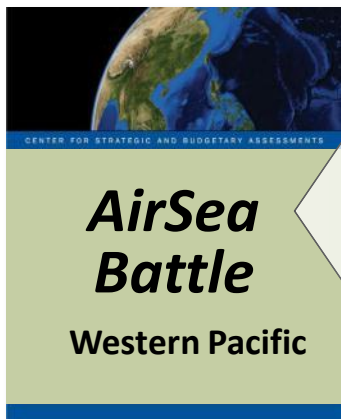
Secure networks for command and control, support targeting, provide precision navigation and timing



“Sophisticated adversaries will use asymmetric capabilities, to include electronic and cyber warfare, ballistic and cruise missiles, advanced air defenses, mining, and other methods, to complicate our operational calculus...

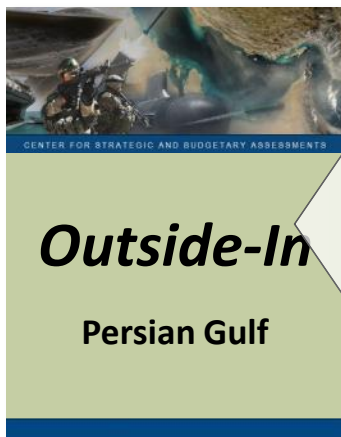
...the proliferation of sophisticated weapons and technology will extend to non-state actors as well”





- Battle network vs. counter-battle network (C4ISR, including space)
- Missile attack vs. missile defense (primarily cruise & ballistic missiles)
- Air superiority vs. air defense
- Sea control vs. sea denial (surface and undersea operations)
- Force sustainment vs. counter-sustainment (home vs. away game)

“competitions” critical to operational success or failure



- Missile attack vs. missile defense (ballistic missiles, ASCMs, G-RAMM)
- Sea control vs. sea denial (surface and undersea operations)
- Force sustainment vs. counter-sustainment (bases, channelization)
- Air superiority vs. air defense
- Battle network vs. counter-battle network

Missile Defense

vs.

Missile Attack

Defending against ballistic and cruise missile salvos with kinetic interceptors that cost millions each may not be sustainable

Defending against swarms of UAVs, fast attack craft, and ASCMs could rapidly deplete ship-based kinetic defenses

Air Superiority

vs.

Air Defense

Defeating advanced IADS may require new investments in counter-countermeasures, stealthy platforms, and EA capabilities

Countering enemy campaigns to blind U.S. networks that underpin our precision reconnaissance-strike complex

Sustainment

vs.

Counter-Sustainment

Sustaining stocks of expendable munitions over extended logistics line communication may become a U.S. center of gravity

Sea control

vs.

sea denial

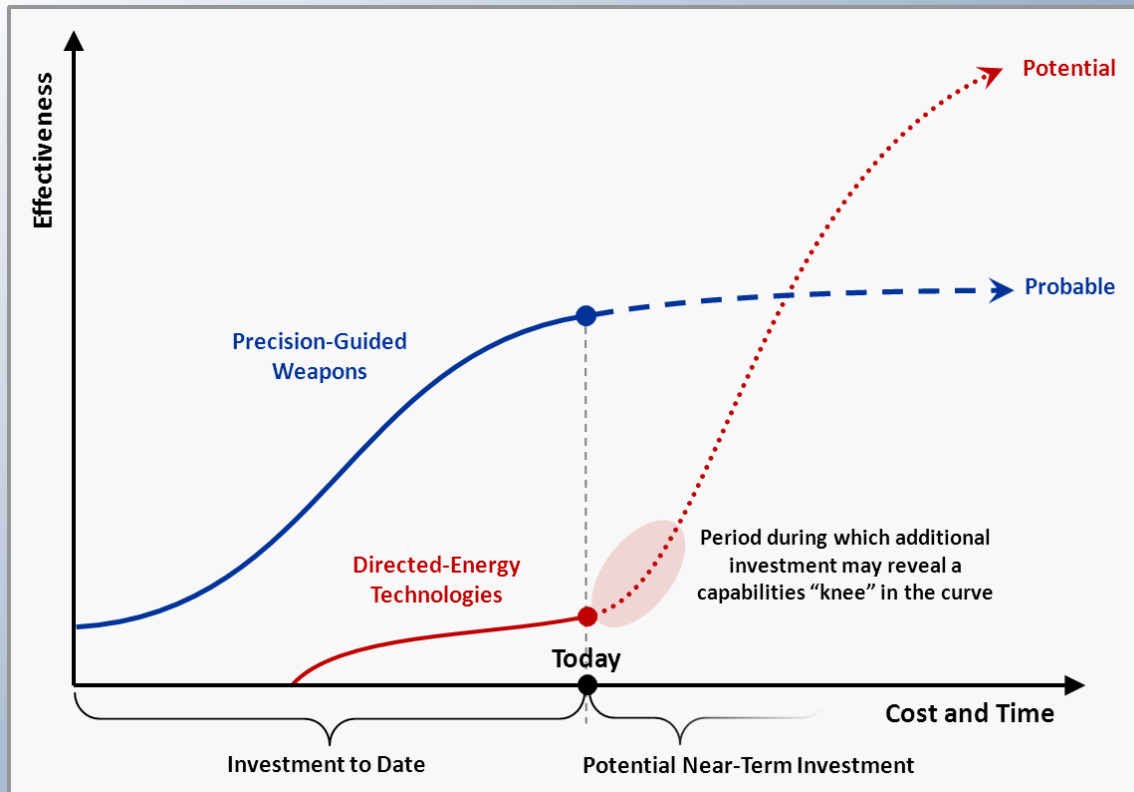
Battle Network

vs.

Counter-Network

A Need for a New Breakout

"more of the same" may not be the best approach



When it comes to procurement, for the better part of five decades, the trend has gone toward lower numbers as technology gains have made each system more capable.

In recent years, these platforms have grown ever more baroque, have become ever more costly, are taking longer to build, and are being fielded in ever-dwindling quantities.

Given that resources are not unlimited, the dynamic of exchanging numbers for capability is perhaps reaching a point of diminishing returns.

—Robert M. Gates

Create Advantages in Time

- ✓ Time to engage missiles not driven by flight time of an interceptor
- ✓ Improve ability to counter salvos
- ✓ Create effects before enemy deploys countermeasures

Create Favorable Cost-Exchange Ratios

- ✓ Prevail in the missile offense-defense competition
- ✓ Reduce the home vs. away disadvantage for U.S. forces
- ✓ Reduce sustainment requirements

Create a Wide Range of Effects

- ✓ New applications that span the “find, fix, track, target, attack” targeting chain
- ✓ Tailorable, selectable effects
- ✓ Lethal and non-lethal effects

Create Advantages in Magazine Depth

- ✓ Increase mission duration of refuelable manned and unmanned aircraft
- ✓ Increase time on station for naval units
- ✓ Increase potential for platforms to carry other mission packages

New DE weapon systems could complicate an enemy's planning and force them to question the effectiveness of their offensive and defensive capabilities



Missions	Weapons	Baseline Loadout	Alternative 1: Maximize DDG Time on Station	Alternative 2: Maximize Strike Capabilities	Alternative 3: Maximize BMD Capabilities
Anti-Air Warfare	Laser Defenses	0	2	2	2
	SeaRAM CiWS	21 (deck)	21 (deck)	21 (deck)	21 (deck)
	Evolved Sea Sparrow Missiles	32 (8 cells)	220 (55 cells)	0	0
	Standard Missile 2	40	10	10	10
	Standard Missile 6	34	17	17	17
Ballistic Missile Defense (BMD)	Standard Missile 3	6	6	6	61
Anti-Surface Warfare	Anti-Submarine Rockets	4	4	4	4
Strike	Tomahawk Cruise Missiles	4	4	59	4
	Multiplier	Baseline	x12 Time on Station	x15 Strike Capacity	x10 BMD Capacity

- Potential to reduce requirements for kinetic weapons
- Free capacity to support other missions
- DE and kinetic systems are complementary, not competing



- Ship-based SSL to counter air & surface threats (UAVs, ASCMs, FACs)
- Ground-based deployable laser to defend high-value forward bases against air and missile threats, including ballistic missiles
- High power microwave weapon on a cruise missile and LO UAVs
- Tactical relay mirror on aerostats/UAVs
- SSL on large aircraft, including the Long Range Strike-Bomber and possibly tanker/battle management aircraft
- Ground-mobile high-energy lasers for counter-G-RAMM, air defense
- Non-lethal weapons, including the Active Denial System
- Kilowatt-class laser IR countermeasures



- Electric lasers for small aircraft such as fighters and UAVs
- Ship-based Free Electron Laser for air and missile defense
- Strategic relay mirror system

- The proliferation of precision weapons and other asymmetric capabilities has *already changed the game* for U.S. power-projection operations
- There is a significant potential for future DE (and cyber, electromagnetic warfare) capabilities to create new operational advantages
 - Unlikely that buying more of the same will be sufficient to counter emerging threats, especially in a time of decreasing defense budgets
- The U.S. military has the opportunity to buy-back its freedom of action and shift the cost imposition calculus in its favor
 - Greatly complicate an enemy's offensive and defensive planning

*DE weapons will not completely replace kinetic capabilities;
DE and kinetic weapons will be complementary and synergistic*

Develop a defense acquisition plan that is focused on transitioning the most promising DE concepts to operational capabilities over the next 5 - 10 years

- Leverage DE capabilities to enable new operational concepts such as AirSea Battle
- Support the Navy as a “first adopter” for weaponizing a high-power SSL for ship-based defense against UAVs, fast attack craft, and possibly cruise missiles
- Army and Air Force leverage mature technologies to field deployable ground-based laser modules to defend critical bases in the Western Pacific and SWA
- Support the Air Force and Navy as lead services for developing HPM weapons for cruise missiles and UAVs
- Transition promising non-lethal DE capabilities (e.g., ADS) to the program of record
- Additional testing is needed to determine lethality against a range of targets

- There are still some technological challenges that must be overcome before high-power DE capabilities become reality
- Today, however, institutional resistance and lack of funding, not tech maturity, may be the most significant barriers to transition
- An education effort is needed to better acquaint commanders with the potential of new DE applications
 - Will it take a catalytic event, such as a technology breakout by an enemy, before the U.S. military realizes DE's full potential?

FY2011 Funding (\$M) for Kinetic Missile Defense Programs and DE Technologies

