REPORT

OF THE

DEFENSE SCIENCE BOARD/DEFENSE POLICY BOARD

TASK FORCE

ON

THEATER MISSILE DEFENSE

JANUARY 1996

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MEMORANDUM FOR THE SECRETARY OF DEFENSE

THROUGH: UNDER SECRETARY OF DEFENSE (ACQUISITION AND TECHNOLOGY)
UNDER SECRETARY OF DEFENSE (POLICY)

SUBJECT: Report of the Defense Science Board (DSB)/Defense Policy Board (DPB) Task Force on Theater Missile Defense (TMD)

We are pleased to forward the final report of the DSB/DPB Task Force on TMD, co-chaired by Ted Gold and Dave Jeremiah. The Task Force had a broad charter to review DoD's TMD policies, plans and programs, and its comprehensive report addresses threat issues, arms control considerations, organizational options and program priorities.

The report highlights the progress that the Task Force found in TMD since the Gulf War, but also raises concerns about current deficiencies. The Task Force addressed the problem of coping with uncertainties about the future threat. Its sensible recommendations about threat modeling, red teaming and hedging are not limited to TMD, but applicable to much of DoD's development activities.

The Task Force also tackled the controversial subject of the ABM Treaty and its effect on theater missile defenses. Subsequent to its interim report, which expressed strong concerns about the demarcation path the US was on, the US has modified its course which now may be closer to the Task Force's recommendations. The Task Force remains concerned, and recommends energetic involvement by Policy and Acquisition leadership to overcome the tendencies to establish unnecessary ceilings on TMD system performance.

A particularly serious deficiency identified by the Task Force is the lack of a strong and knowledgeable joint voice in the TMD development process. The Task Force also noted the absence of a joint TMD architecture integrating both cruise and ballistic missile defenses. The Task Force's recommendations to redress these deficiencies include making USACOM a major player in the development of the TMD architecture. We endorse the Task Force's vision of the objective for TMD: to provide some protection of diverse assets against a variety of threats rather than aiming for perfect protection against one (or a few) threats. We also share its concern about the COEA; massive studies obscure rather than illuminate.

The Task Force was concerned that there will not be sufficient funds to field all the systems as proposed, but, at least in the near term, resources can be rearranged to fund their legacy systems and adequate development for the longer term. A more robust threat will generate future resource shifts if necessary.

We support the findings of the Task Force and believe that its recommendations deserve favorable consideration. We also believe that this effort confirms the value of joint DSB/DPB studies (it was only the second such effort). We would thus be pleased to collaborate in other areas where policy and technology intersect.

Dr. Craig Fields
Chairman, Defense Science Board

Dr. Harold Brown
Chairman, Defense Policy Board

OFFICE OF THE SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD
CHAIRMAN, DEFENSE POLICY BOARD

SUBJECT: Report of the Defense Science Board (DSB)/Defense Policy Board (DPB) Joint Task Force on Theater Missile Defense

Attached is the final report of the DSB/DPB Task Force on Theater Missile Defense (TMD). Significant TMD policy, budget and program initiatives were undertaken during our deliberations, and thus we make no pretense at having kept up with these moving targets. The report, reflecting guidance the Task Force received when we delivered an interim report last year, focuses on four topics: coping with uncertainties about futures paths of the theater missile threat, demarcation between theater and strategic missile defenses, meeting the challenge of developing joint TMD, and lastly, setting priorities for specific TMD programs and projects.

The term theater missile belies its import. They are not just another combined arms battlefield weapon. The motives of potential adversaries to possess these weapons are decidedly strategic. They offer a relatively low cost way to threaten population centers and critical military targets like ports and other points of entry in order to coerce neighbors, breakup coalitions and deter US military involvement in their region. They can raise the stakes even higher when they carry chemical, biological or nuclear payloads. The gravity of this threat requires that continued special attention be given to efforts to counter it.

First the good news. The Task Force found much progress since the Gulf War: some improvements already in the field, much more in development, greater involvement by the warfighters, more joint exercises, a comprehensive doctrine for joint TMD.

One feature of the new security landscape -- greater uncertainty about future threats -- presents a great challenge to planning and executing acquisition programs. To meet this challenge, (not unique to the theater missile threat), the Task Force recommends that the intelligence and acquisition communities modify the current threat "validation" process. We prescribe a much greater role for threat modeling and red teaming including an expansion of the sort of skunk works red team that BMDO has underway at the Air Force's Phillips Laboratory. We also recommend more use of hedge programs and other means designed explicitly to deal with uncertainty and surprise.

Compliance criteria for the ABM Treaty, which itself does not limit TMD systems, never-the-less presents the issue of distinguishing theater from strategic ballistic missile defenses. The Task Force expressed strong concern in our interim report that the US was proceeding down a demarcation path that would severely restrict TMD performance. Our concerns included restraints and inhibitions imposed against the use of external sensors and a compliance mentality that resulted in unnecessarily severe restrictions on TMD performance. Subsequent events, including initiatives by the DoD and the May 1995 Clinton/Yelstin Summit Statement, provide a framework to allow much more effective TM defenses consistent with the principles of the ABM treaty. Policy and Acquisition leadership will be needed to make this happen since implied limitations on performance and the use of external sensors remain.

TMD is inherently a joint mission. The Task Force found a vision of joint TMD promulgated by the Joint Staff (in Joint Pub 3 - 01.5) but no joint TMD CONOPS nor complementary comprehensive approach on the developer's side. We did not find a joint architecture which integrates defenses against both ballistic and cruise missiles (nor integrates both into theater air defense). Future CINCs will need such an architecture and we should not count on their being able to kluge one together during a crisis.

To remedy this situation we recommend several steps. Some of these may be controversial, for example, making USACOM a central player in the creation of an overall joint TMD architecture and assigning BMDO additional responsibilities for the development of active defenses against land attack cruise missiles. However, *any* attempt to strengthen the joint voice will likely engender opposition and in any case there will eventually be a high price to pay for continuing the current arrangement. We recognize that TMD is a complex undertaking with each service promoting its own programs and policies. The key to creating and maintaining effective capabilities is to have a single overall vision for TMD, a vision that is grounded in the joint environment and designed for joint (and coalition) warfighting conditions.

The report includes a discussion on how much defense is enough (we conclude that practical and far less than perfect defenses offer considerable value) and raises our concern about the affordability of all the active defense systems in development. The Task Force is also concerned about advanced submunitions and other countermeasures to descent phase ballistic missile defense systems but did not find a coherent and implementable boost phase program in place to counter these threats. The Task Force is particularly enthused about the potential of the advanced airborne radar sensors under development in ARPA to contribute to much more effective cruise and ballistic missile defenses and we also recommend more attention to joint C3 and passive defenses. The report includes other findings and recommendations regarding testing, intelligence collection against real targets, attack operations and the COEA process.

We greatly appreciate the time and effort put in by Task Force members, government advisors and support staff. It has been a pleasure to work with this talented group.

Theodore Gold
Co-Chairman

David E. Jeremiah
Co-Chairman

DSB/DPB TASK FORCE ON TMD

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Tasking

The Defense Science Board /Defense Policy Board (DSB /DPB) Task Force had a broad charter to review US theater missile defense (TMD), including purpose, threat, plans and programs. The Terms of Reference are shown in Appendix B. Deliberations began in February 1995.

The Task Force, after delivering its interim report in March 1995, received additional guidance from the Deputy Secretary of Defense to focus on:

- the threat projection process
- the Anti-Ballistic Missile Treaty (ABM) and TMD
- the Joint role in TMD requirements and acquisition processes
- setting priorities for the non-core TMD programs

The Task Force was not asked for recommendations on national missile defense.

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General Observations

This report focuses on problems and deficiencies in the TMD program. However, the Task Force also found that the TMD program has made substantial progress in the past several years. We begin by citing examples of this progress before turning to the problems.

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General Observations

1. **There has been considerable progress in the TMD program since the Gulf War** (also since the last DSB/DPB TMD study in 1991)

- **Funding for TMD increased more than tenfold to >$2 billion**
  - as BMDO emphasis shifted from national to theater defenses
- **Improvements to Gulf war capabilities are being fielded**
  - upgrades to PAC-2, Hawk, Space Sensor support
- **More involvement by CINCs**
  - including BMDO's CINC exercise program
- **Recent Joint exercises:**
  - including JTF95, Roving Sands
- **More substantial capabilities in development**
  - PAC-3; Navy Area Defense (SM-2 BLK IVA, formerly Navy Lower Tier); THAAD; Navy Theater Wide Missile Defense (formerly Navy Upper Tier)
  - initial deployments in late 90s
  - some effort on other advanced concepts
- **Technology programs aimed at cruise missile threat**
  - addressed in 1994 DSB Cruise Missile Defense Study
- **Doctrine for Joint TMD (JTMD) published (Pub 3-01.5)**
  - articulates comprehensive vision of TMD

General Observations

2. In Spite of the Progress We Have Concerns About What Is Missing

- **An integrated requirements and development approach to joint theater air and missile defense**
  - it is too much to expect future Joint Force Commanders (JFCs) to kluge together an effective JTMD during a crisis
  - insufficient priority and resources for JTMD C^4I
- **Capability for timely response to plausible emergence of land attack cruise missile threat**
  - although some progress since 1994 DSB Cruise Missile Defense Study
- **Coherent Boost Phase Intercept (BPI) solution to submunitions, and other countermeasures to descent phase intercept**
  - need a viable early deployment option
- **Enough testing and data collection**
  - needed to ensure robustness of hit-to-kill systems
  - too much hubris about models/simulations (e.g., Cost and Operational Effectiveness Analysis(COEA))
- **Sufficient intelligence collection on threat missile characteristics**
  - both radar and infrared
- **Coordination of efforts to improve attack operations**
  - however, finding mobile launchers will remain a very difficult problem
- **Integration of passive defense into TMD**
  - particularly important for chemical/biological warfare (CBW)

General Observations

3. We Also Have Concerns About What Is Amiss

- **US has been on an ABM Treaty demarcation path that could substantially limit TMD capabilities**
  - Clinton/Yeltsin Summit statement and recent Congressional actions may reflect new course

- **A threat projection process preoccupied with observation**
  - a major problem that is not unique to missile defense
  - need more attention to improving ability to anticipate (and shape) future threats beyond the time horizon of current hard data

- **A requirements driven acquisition process that misses opportunities for affordable and useful concepts**
  - also not unique to missile defense but problem exacerbated in ballistic missile defense arena by appetite for "complete" solutions and very low leakage

- **A Capstone TMD COEA which may not yield desired insights of critical issues**
  - scenarios drive results out of proportion to confidence in any ability to foresee the real future

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Findings and Recommendations

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The dimensions of today's theater missile (TM) threat appear to be understood at the senior levels in DoD. Therefore, we will not detail the threat specifics (developers, possessors, characteristics), but instead only briefly touch on the nature of the TM threat, including both it's ballistic and cruise missile variants, and the future paths it may take.

We then focus on the problem and process of projecting threats to guide acquisition efforts in these uncertain times and offer several recommendations, some broadly applicable to DoD.

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The Nature of the Theater Missile Threat

TMs pose a growing danger to US ability to project military power and deal with major regional contingencies
- raises the risks and costs of US intervention
- could be show stopper

TMs appeal to regional and "wannabe" powers as strategic weapons to:
- intimidate neighbors
- deter super power (US) intrusion in their affairs by raising price, coercing coalition partners

For these purposes, TMs are less expensive, more survivable and penetration capable than manned aircraft.

TMs can be effective terror weapons against cities, even if inaccurate and armed only with conventional warheads. TMs become more dangerous yet with nuclear, biological, and chemical (NBC) warheads often categorized collectively as weapons of mass destruction (WMD). In fact these warhead types pose quite different threats, with the chemical warhead being far less dangerous than the other two.

Military targets in theater vulnerable to missile attack include sea and air points of debarkation (PODs), and other large fixed logistic nodes:
- in Gulf War: two sea PODs received over 95 percent of sea cargo; five air PODs handled almost 80 percent of air cargo

We include Unmanned Air Vehicles (UAVs) along with ballistic and cruise missiles, as part of the theater missile threat. UAVs can be used:
- for reconnaissance and targeting to increase US casualties
- more ominously, as platforms to deliver biological warfare (BW) agents (even small BW payloads can be lethal over large areas)

The Theater Missile Threat: Possible Paths

- Today's threat is mostly relatively short-range ballistic missiles and ship-attack cruise missiles
- Also already here, or coming soon, are longer-range Theater Ballistic Missiles (TBMs), land-attack cruise missiles, Unmanned Air Vehicles (UAVs), and penetration aids for all missile types

SCUD type TBMs and anti-ship cruise missiles are widely proliferated.
- world wide totals of tens of thousands
- dozens of possessor nations

Longer-range TBMs have been shipped from China to the Middle East and more are under development (e.g., by North Korea).
- increases strategic reach (more targets for coercion) and survivability (more space to hide)

There is considerable uncertainty about the future path of the TM threat but there are several possibilities for which we must prepare.

We must expect countermeasures to our defense deployments
- advanced submunitions could be particularly stressful
- also maneuvering, decoys and other penetration aids

The land attack cruise missile threat — including low observables — could emerge rapidly
- potential adversaries have motives and means (low cost, survival and penetration features, availability of technology and systems)
- will also present US with combat identification (CID) and fratricide problems that were not present in Desert Storm
- very low observable (VLO) variants later

A major regional adversary could afford thousands of TMs
- Iraq's small-scale (88 launches) use may not be future model
- e.g., Germany launched approximately 20,000 V-1s (cruise missiles) and V-2s (ballistic missiles) during the period from June, 1944 to March, 1945

While the characteristics of future TM threats can be broadly sketched, the uncertainties, particularly questions of "when is the threat?" pose daunting challenges to program planning.

Threat Projections and the Acquisition Process

- The acquisition and intelligence communities have yet to tailor processes for threat projection to the circumstances and greater uncertainties of the new security environment
- A greater role is needed for a disciplined process of analysis and threat modeling
- The community needs to recognize that observed threats, reactive threats, and technologically feasible threats are all components of a "validated" threat

Everyone acknowledges that the threat is more uncertain and threat projection more difficult in the post-Cold War world. Instead of a single threat following familiar acquisition practices, we must now worry about a diverse set of nations and motives, possibly on steep (and thus rapidly changing) learning and acquisition curves for military technologies, using nonstandard acquisition practices, and we must do this with fewer intelligence resources.

This situation affects the roles of evidence and model-based threat projections

- increasing danger of limiting projections to "observed threats"
- absence of evidence is not evidence of absence today or in the future

Goal should be to improve our ability to anticipate — not merely observe — serious threats, in order to:

- guide collection efforts: e.g., potential adversaries' Science and Technology (S&T) infrastructure becomes a more important collection target
- develop hedges: prepare to respond in much less than typical US acquisition timelines
- shape the future threat: US initiatives, programs and demonstrations may help dissuade and deter

Directives (DIA Regulation 55-3) are in place which call for identifying reactive and technologically feasible threats along with the evidence based or observed threat projections

- however, the execution has been uneven at best
- there is strong bias against reactive and technologically feasible threats — the baseline threat is usually the evidence-based or observed threat

A greater role for model-based threat projections must be embodied in a more disciplined process to avoid their own set of dangers: threat exaggeration and multiplicity (the latter can lead to a "threat of the month" environment and program disruption).

Threat Projection and the Acquisition Process (cont.)

- BMDO has a Red Team effort in place to identify reactive and technologically feasible countermeasures to our theater ballistic missile defense

- However, Red Team activities and results are not adequately integrated into the TMD program, and are not yet used as a tool to help manage the overall TMD program

A Red Team Skunk Works effort was:

- established in 1993 in response to a DSB Task Force recommendation and
- includes a small but impressive "Countermeasure Hands-on Skunk Works" (at the Air Force Philips Laboratory)

The Red Team effort (including Skunk Works) has begun to work with respect to advanced submunitions

- identified a serious threat
- demonstrated (designed, built, flown) in experiments
- coordinated effectively with intelligence community
- brought this threat to the attention of senior decision makers

Dealing with Uncertainty and Surprise

Uncertainty and surprise are inevitable
- can exist in threat, defense mission, scenarios, environments and wartime defense performance
- need to attempt to reduce the uncertainties and prepare to deal with surprises arising from the inevitable remaining uncertainties

Ways to reduce uncertainties

Strengthen collection efforts against real targets and effect a closer coupling between intelligence collection, especially Measurement and Signature Intelligence (MASINT), and system design. Design more robustness and graceful degradation into systems — to stay farther away from "known" performance "cliffs" and to hedge against uncertainties, both in where cliffs are and other unknowns.

Test over a wider range of threat possibilities, environments and system performance parameters.

Dealing with surprises from inevitable remaining uncertainties

Systematically assess possible surprises and develop hedges and responses/adaptations, ranging from Pre-planned Product Improvement (P^3I) to pre-planned near-real-time adaptation during war.

Pursue ACTDs specifically as hedges against threat uncertainties.

Develop approaches for near-real-time adaptation during missile-defense campaigns, which may last days or weeks (or longer). For example:

- design system sensors to diagnose engagements, not just conduct them (i.e., view system sensors as real-time MASINT collectors)
- record all sensor data and arrange for it to be rapidly analyzed
- arrange to have design engineers on standby in the continental US (CONUS) (and in theater) during campaigns to help assess situation, design adaptations
- selectively engineer software so that it can be rapidly modified during a campaign
- develop pre-planned software alterations

Pay for more robustness and pre-planned adaptation features by accepting (somewhat) less performance in the nominal design regime.

Threat Projection Support to the Acquisition Process: Recommendations

Define a new process and framework for managing threat projections to avoid the problems of too much dependence on either evidence- or model-based projections. As illustrated in Figure 1, a range of potential threats should be identified:

- based not only on what the adversary has been observed to do, but also what technology and expense would allow him to do
- emphasize threats which could substantially degrade US capabilities with reasonable ease whether or not there is current evidence of such an effort

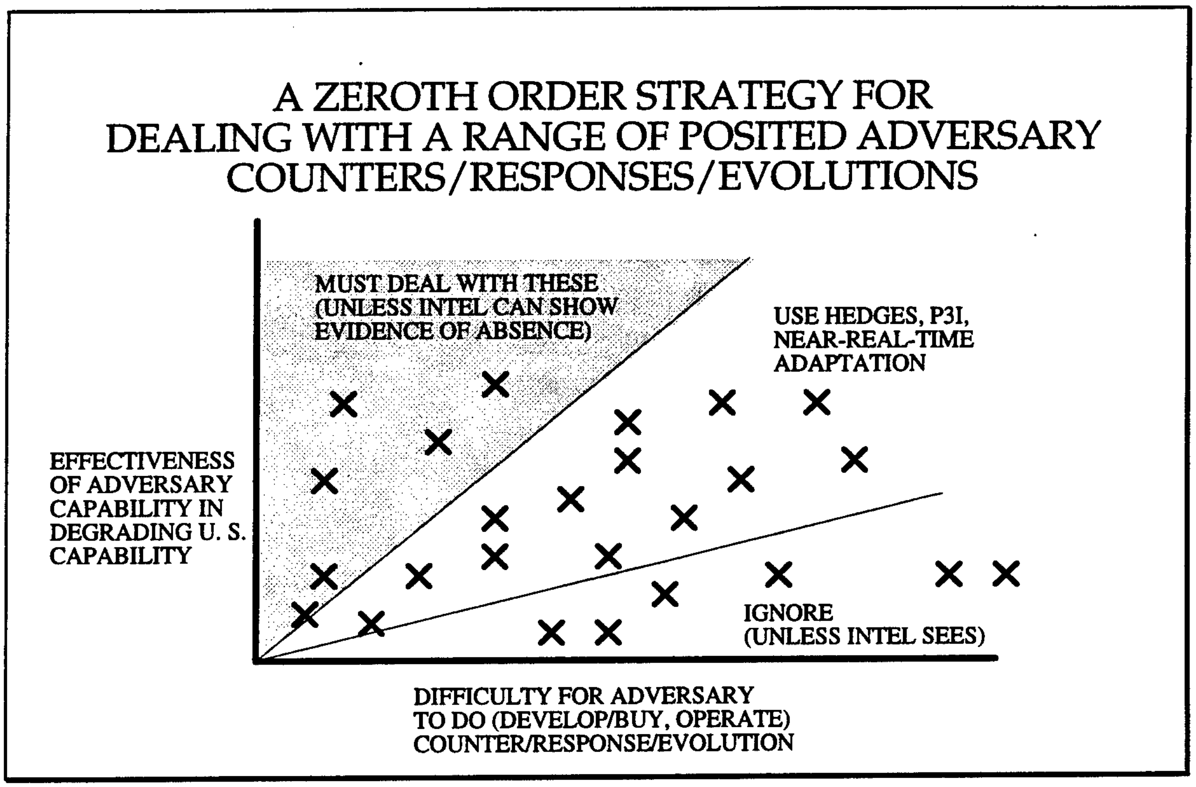

Figure 1

Threat Projection Support to the Acquisition Process: Recommendations (cont.)

- In order to implement this process, a stronger technology projection and threat modeling capability should be developed jointly by the Acquisition and Intelligence communities
  - should involve Red Teams to identify threats (feasibility/cost) and Red/Blue interactions to assess relative effectiveness

- The process should have a broad architectural perspective and not overly focus on vulnerabilities of individual programs
  - all systems have vulnerabilities; there is a need to identify cross-cutting vulnerabilities

- Funding for these activities should be the responsibility of both the Program Managers and DIA

- DIA should retain responsibility for overall quality control of the resulting restructured System Threat Acquisition Report (STAR) process; their technology analysis capability should be expanded

- Under Secretary of Defense, Acquisition and Technology (USD(A&T)) should issue direction requiring Red Team activity across the TMD problem

- USD(A&T) should also task BMDO to expand the charter of it's Red Team activities and provide resources to address both the ballistic and cruise missile threat — (in addition to continuing its TBM countermeasure modeling and experiments)
  - identify and categorize (in format of Figure 1) a range of potential ballistic and cruise missile variants: range, accuracy, RCS, penetration aids, etc.
  - complement with appropriate Skunk Works and other experiments

- The BMDO Director should
  - ensure the involvement of the program offices in assessing results of TMD Red Team activities and their implications for programs
  - issue an annual report of TMD Red Team and associated Red/Blue activity to USD(A&T), which:
    - — characterizes threats in difficulty/effectiveness space (Figure 1)
    - — describes strategy and status of programs to deal with set of threats
    - — addresses possibilities for surprise and plans/programs to deal with them

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The ABM Treaty and TMD

The ABM Treaty does not restrict TMD systems per se. The problem is distinguishing theater defenses from ABM systems, which are constrained by the Treaty. We have been concerned that the US was proceeding down a demarcation path which would severely restrict TMD performance.

Subsequent events have changed that course, including the May 1995 Clinton/Yeltsin Summit Statement, which provides basic principles for a less restrictive approach to TMD consistent with the ABM Treaty.

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The ABM Treaty and TMD

- When we began this study, the Task Force found the US on an ABM treaty demarcation path that could severely restrict TMD performance
- Systems were technically constrained and opportunities for more robust and effective TMD were not being exploited
- The Task Force expressed these concerns in its March 1995 Interim Report

- **ABM Treaty does not limit TMD systems per se, but prohibits**
  - giving non-ABM systems capabilities to counter strategic ballistic missiles or their elements during flight
  - testing non-ABM systems in an ABM mode

- **What constitutes "strategic ballistic missiles," "capabilities to counter" and "testing in an ABM mode" are undefined.**

- **The demarcation approach we found would severely limit TMD performance by restricting interceptor velocities and inhibiting use of external sensors and sensor netting**
  - affects THAAD, Navy Theater-Wide defense, use of Cooperative Engagement Concept (CEC)
  - greater than <u>ten-fold</u> difference in defense coverage against certain threats
  - Treaty derived restrictions reinforced other obstacles to desired joint architecture
    - — integrating systems into JTMD difficult enough because of Service stovepipes
    - — Program Managers strive to stay as far away from perceived treaty boundaries as possible to protect their programs
    - — threshold parameters intended to trigger review become instead de facto performance ceilings

- **In evaluating TMD "capabilities to counter" strategic ballistic missiles, the US had focused not on the <u>demonstrated</u> capabilities of TBMD systems, but**
  - Tended to overstate capabilities by using theoretical capabilities (computer simulation based) to determine ABM compliance of TBMD systems in one-on-one intercept conditions, rather than force-on-force, in more realistic conflict settings
- **Included limits on capabilities not verifiable by National Technical Means (NTM)**
  - by contrast, as a historical matter, the US evaluated Soviet systems on demonstrated capabilities as discerned through our verification means (NTM)

The ABM Treaty and TMD: Interim Report Recommendations

- **The effort (upon which the Task Force was briefed) to negotiate, through the Standing Consultative Commission (SCC), a "demarcation line" between ABM and TMD systems was misdirected and should be abandoned**
  - it focused on imposing performance constraints on TMD systems (e.g., limits on velocities, use of external sensors) that would severely constrain both sides from meeting future theater ballistic missile threats
  - it would give the Russians veto power over a key US national security program designed to deal with critical non-Russian threats
  - it seeks to define a line that does not exist because even the most limited TMD system has some capability to counter strategic ballistic missiles

- **The DoD should take the lead in bringing the US government around to a different approach**
  - DoD has had responsibility for US compliance with the treaty since shortly after the ABM Treaty entered into force in 1972

- **Internal DoD guidance should be prepared to provide guidelines for development of TMD components and systems**
  - these guidelines should be based upon "demonstrated" capabilities, not on theoretical capabilities as determined by computer simulations
    - — demonstrated capabilities are those which can be verified by NTM
    - — this is the appropriate standard since the ABM Treaty is verified by NTM alone
  - the guidelines should provide that no US TMD system (or component) will be flight tested against a target missile with parameters in the flight test that are in excess of 5 km/sec velocity and 3,000-3,500 km range.
    - — US TMD systems that have not been so tested will not have been tested in an ABM mode and therefore will not possess the effective capability to counter strategic ballistic missiles that could realistically threaten the credibility of the Russian strategic nuclear deterrent

- **The DoD should identify a list of confidence building measures** (e.g., exchange of early warning or flight test data) and possibly also TMD technology projects or operational exercises which could be pursued with the Russians in conjunction with close US allies. These measures should not include:
  - limits on the configuration, number, deployments or geographical location of TMD systems
  - limits on TMD systems to use data from any source, including sensors external to the TMD systems itself, providing data directly to the interceptor missile

- **This approach builds on current US policy and is consistent with the principles behind the ABM Treaty and the post-Cold War relationship between the US and Russia**
  - two sides no longer openly threaten each other with nuclear destruction by means of ballistic missile attack
  - the TMD systems the US is developing and deploying are not directed at Russia but at defending against threats from other countries

- **These systems will not undermine the basic logic of the ABM Treaty**
  - ABM Treaty sought to reinforce deterrence by ensuring that neither side could use ABM systems to threaten the credibility of the other's nuclear deterrent
  - the TMD systems at issue will not pose a realistic threat to the Russian strategic nuclear deterrent

- **The proper agenda for Russia and the US is not to extend the ABM treaty to limit TMD, but to cooperate in TMD system development**
  - the Joint Statement points in this direction, stating that the two sides "...will consider expanding cooperative efforts in theater missile defense technology and exercises, study ways of sharing data obtained through early warning systems, discuss theater missile defense architecture concepts, and seek opportunities for joint research and development in theater missile defense"
  - a joint effort in this field could, like manned space flight, be an important common project for the two countries

The ABM Treaty and TMD: Current Status

Subsequent to the March Interim Report, DoD initiated actions which led to the May 10, 1995, Clinton/Yeltsin joint statement of principles which provided in part:

"Theater Missile Defenses may be deployed by each side which will not pose a realistic threat to the strategic nuclear force of the other side and will not be tested to give such systems that capability."

Under Secretary of State Lynn Davis and Deputy Minister Georgy Mamedov have developed a framework to guide the Standing Consultative Commission.

By establishing "*realistic* threats" and the "strategic nuclear *force*" as the standards, the joint statement provides a basis to develop and deploy more effective TMD consistent with the principles of the ABM Treaty. The Task Force also believes that the Davis/ Mamedov framework is useful in that it endorses a demonstrated test for determining whether TMD systems had ABM capability (i.e., demonstrated against targets with velocity greater than 5 km/second or ranges in excess of 3,500 km) as recommended by the Task Force. This will be helpful in dealing with the US "compliance community" issues which have dominated internal debate over the last several years. We remain concerned, however, that limits negotiated either with the Russians or derived from compliance decisions taken by the US Government will continue to be imposed on other TMD systems that have not demonstrated this capability.

As the Task Force understands the current situation, two concerns (higher velocity TMD systems such as Navy Theater-wide and external sensors) remain which can place significant limitations upon the continued development of TMD. Although the policy community is attempting to provide better definition which will permit development and deployment of highly effective TMD systems, the Task Force still sees evidence of a disconnect between policy objectives and compliance criteria. Parameter thresholds established for the sole purpose of triggering reviews of potentially ambiguous situations too often become performance ceilings as program managers strive to avoid perceived treaty boundaries in order to protect their programs. These actions by both program managers and the "compliance community" will continue to unnecessarily constrain effective TMD development until such time as either external or internal policy statements and directives make clearer which issues are outside the ABM limitations.

All members of the Task Force agree that the specific restrictions placed on intercept systems that have been historically imposed by the ABM Treaty can and should change as the overall security situation changes. All members also agree on the desirability of gaining the collaboration of Russia and China in restraining the proliferation of offensive missile capabilities. Some members argued further, that because of the legal and political role of the ABM Treaty as a condition for offensive constraint, and because all TBMD systems have some capability against strategic missiles, the broad conditions of TBMD deployments will have to be worked out with both Russia and China.

Organizing For Joint TMD

Tasking
General Observations
Findings and Recommendations
  Threat Projections; Dealing with Uncertainty
  The ABM Treaty and TMD

Organizing for Joint TMD

  TMD Programs/Activities
Summary of Findings and Recommendations
Appendices

TMD is inherently a joint mission, the success of which requires coordinated and integrated exploitation of active and passive defense and attack operations. This vision of JTMD is promulgated in a recent Joint Staff publication on JTMD Doctrine.

In this section, we identify institutional obstacles impeding the realization of this vision and offer recommendations on strengthening the joint voice in the TMD requirements and development processes.

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Joint Theater Missile Defense

- The Joint Staff has provided a vision of JTMD (in JOINT PUB 3 – 01.5)
  - freedom to conduct joint operations without undue interference from enemy TM operations
  - recognizes the political significance of the missile threat, "...in many cases, their political impact may outweigh their military significance"
- We do not, however, see the development of a JTMD CONOPS, nor a corresponding integrated effort in the development community

The Joint Pub identifies TMD as inherently a joint mission including possible (we would say probable) operations within an Alliance or coalition arrangement.

Defines TMD as the "...integration of joint force capabilities to destroy enemy theater missiles in flight or prior to launch or to otherwise disrupt the enemy's theater missile operations through an appropriate mix of mutually supportive:

- passive missile defense,
- active missile defense,
- attack operations, and
- supporting C^4I measures."

Assigns the JFC the responsibility for planning a multi-service integrated JTMD campaign to minimize the effect of theater missile attacks.

JCS Pub 3 - 01.5 outlines what ought to be accomplished for effective TMD. However, it does not institutionalize or provide a basis for developing the means to execute TMD nor for integrating the various systems into a joint capability for successful missile defense.

JTMD Process Responsibilities

RESPONSIBILITY	RESPONSIBLE AGENT
Establish policies, priorities	OSD, JCS
Develop concept, doctrine, needs	JCS, Services
Establish operational architecture	CINCs, Services
Develop engineering architecture	Services, BMDO, role for designated CINC
Execute programs, train, equip,	Services, OSD
Employ, and operate	CINCs, Service Component

The above chart identifies the actors and actions needed to develop and field effective joint theater missile defenses.

Missing items or unassigned responsibilities are:

- a common and consistent set of standards, policies and priorities
- a JCS concept
- current and future operational and engineering architectures

The operational architecture is generally defined as the concept for joint operations elaborated through descriptions of tactics, techniques, and procedures. The engineering architecture can be described as the translation of operational requirements into descriptions of systems, their desired characteristics, and connectivity.

The two activities — development of operational and engineering architectures — must be closely coupled. New technology enables new CONOPS; new CONOPS create opportunities for technical solutions. Indeed, at the broad collection of systems level we are addressing — joint theater missile defense — the distinction is artificial. An overall JTMD architecture must describe the systems, how they should be used and how they must connect together and to the rest of the world to provide effective TMD.

The JTMD architecture — to be useful to the acquisition process — must also provide a road map showing how fielded capabilities can change over time. The road map should not be limited to showing paths to a single "objective system" only. Instead, it should account for the very real uncertainties and multiple plausible futures we face by identifying hedges and providing options that can deal with these alternative futures. However, the current requirements and objective-system-driven acquisition process does not foster such a perspective.

The Role of Joint Force Commanders (JFC)

Although TMD is inherently joint — requiring the right mix of multi-service capabilities to prevent launch, shoot down missiles, and protect against their effects — the joint voice in development activities is much weaker than that of individual Services

A future JFC may be able to meld together an adequate JTMD system from the separate pieces being developed, but we should not count on it. Why should we wait until a war is upon us to create an effective joint capability?

US capabilities (current and in development) are not being integrated across the "seams" of National and Service systems. There are no joint operational or engineering TMD architectures to identify the appropriate mix of JTMD elements to guide development activities and no mechanism to ensure their integration.

- There is some architectural basis for joint active defense against theater ballistic missiles (through BMDO) but it does not include cruise missile defense (even though some of the systems are used for both). Indeed, there is no joint approach at all for overland cruise missile defense.

- Doctrine calls for attack operations but is not clear about the best targets or the best means to find and attack them. There is no integrated joint approach to address these challenges.

- Doctrine also prescribes Command, Control, Communications, Computers, and Intelligence (C^4I) but the means and responsibilities are not identified. BMDO has made some progress in Command and Control (C^2) for TBMD. However, there is no mechanism to aggressively pursue the broader joint problems and opportunities for JTMD C^4I.

- A joint requirements and acquisition approach has been established for CBW defense (directed by Public Law 103-160) but there appears to be no effort to integrate these or other passive defense efforts with the other elements of TMD.

On a more positive note, the CINCs are getting more involved and sponsoring exercises (JTF 95 by USACOM, Roving Sands by CENTCOM) and other relevant JTMD activities ("TMD in a Box" by EUCOM).

Organizing For Joint TMD: Recommendations

For Secretary of Defense

- Direct USD(A&T) to establish policies and priorities for achieving integrated TMD capabilities (complete in 3 months)
- Direct Chairman, JCS, to publish a concept for JTMD that establishes the framework upon which operational concepts and development activities can be based (complete in 6 months)
- Appoint the Director, BMDO as the engineering architect for active overland TMD (including C^4) by adding Cruise Missile (CM) defense to existing BM defense responsibilities. However, this will require further evolution of BMDO from a weapon and sensor technology demonstrator to a Battle Management C^3 integrator and systems engineer
- Direct all the Service Acquisition Executives and Director, BMDO to ensure that applicable development programs operate in the JTMD architecture

For Chairman, JCS

- Direct the Combatant CINCs to develop theater-specific JTMD concepts of operations on the basis of the concept that the CJCS develops (complete in 12 months)

For Secretary of Defense and Chairman, JCS:

Designate USACOM to be the focal point for JTMD
- Make it responsible for developing the overarching JTMD architecture
- Give it a small (10s not 100s) qualified support staff
- Direct BMDO and Services to support USACOM (as managers of passive defense, active defense, attack operations, and C^4I elements)
- Provide funds for tests and exercises
- Assign the National Test Facility to USACOM to help it develop and evaluate concepts and capabilities
- Make the Joint Precision Strike Demonstration live up to its name by making it truly joint

- **USACOM responsibilities should include**
  — developing (working with other CINCs) CONOPS for current and emerging JTMD
  — developing a JTMD architecture and road map which encompasses the appropriate mix of passive defense, active defense, and attack operations
  — ensuring the development, testing, and exercising of C^4I for JTMD

Organizing For Joint TMD: Recommendations (cont.)

The Task Force recognizes the formidable Service opposition to establishing a stronger joint presence in acquisition affairs. While some may suggest Service opposition may be self-serving, there may also be legitimate concern about creating more bureaucracy and split responsibilities. This, however, is a unique joint task which requires unique solutions; problems raised by the Services can be mitigated by assembling a first rate staff, giving them the levers to get things done and creating an environment of mutual trust and cooperative problem solving (in the spirit of Integrated Process Teams (IPTs)).

We also recognize that giving this responsibility to a CINC represents a significant change from past practice. We considered alternatives within the development community — e.g., BMDO or lead Service — but concluded these are ill-suited to bring the joint perspective to the broad TMD challenge. Getting the CINC to look beyond today's problems will require strong direction from the Chairman and OSD, close cooperation with the developers, and sufficient resources. USACOM will also face the challenge of working with the other combatant CINCs to ensure their inputs are considered and integrated into the TMD architecture.

Additional resources are essential. We realize we are calling for additional tasks to be placed on the already full plate of a new command still staking out new responsibilities.

> Note: The recommendations of the 1993 DSB Task Force on Acquisition Reform, which were approved by the Secretary of Defense, directly increased CINC involvement (specifically USACOM) in the weapon system requirements process.

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We begin by discussing requirements for TMD (How much is enough?) and then offer observations or recommendations on:

- COEA
- core and non-core active TMD systems
- advanced airborne surveillance and fire control sensors (including Aerostat options)
- C^4I for JTMD
- passive defense
- attack operations

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How Much Defense Is Enough?

Performance goals and thresholds and program schedules and deliverables for active defense against TMs should be established in the context of:
- other delivery means available to adversaries (don't pay for extra locks on the front door if windows remain unlocked)
- other means to mitigate the threat including deterrence, international agreements as well as the other elements of TMD: passive defense and attack operations

There is a tendency in the TMD community, more so than other defense areas, to search for "perfect" or "complete" solutions.

Very low leakage (<10 percent), while a desirable goal, will likely not be a practical overall objective for TMD except against small-scale attacks
- a wide range of civilian and military assets to defend
- many different situations and scenarios
- adversaries will invest in countermeasures
- very expensive, requires multi-tier defense over large areas
- adversaries have other delivery means

Very low leakage is not necessary to reduce effectiveness of conventionally armed TMs as either a military or terror weapon.

Against WMD, particularly nuclear or biological payloads, very low leakage is necessary to negate these weapons, but less than perfect active defense can still contribute though not "solve" the TM/WMD threat. Raising the price to an adversary, while clearly not as satisfactory as denying delivery, is a worthy and practical objective for today's investment decisions.

In spite of the persuasiveness of the multi-tier paradigm, the rationale for the current multi-system TMD program has more to do with providing some defense in situations where otherwise there would be none, rather than contributing to a multi-tier low-leakage defense. The psychological factor of having some defense can be very important (e.g., SCUD attacks against Israel).

The elements of TMD are themselves part of larger non- and counter-proliferation contexts to address the theater missile and WMD threats. For example, international diplomatic suasion (backed by military capabilities) could play an important role in heading off the threat of a regional adversary acquiring thousands of missiles.

Active Theater Ballistic Missile Defense Programs

- Concerns were expressed to the Task Force about affordability and redundancy of active TBMD systems
  - are there too many systems chasing too few $?
  - choices and priorities among systems mainly depend on policy preferences and judgments about the likelihood of threats
- We recommend that BMDO be tasked to explore:
  - new architectures based on using distributed sensors to support several interceptor systems
  - the use of a common kill vehicle in several interceptors

Defensive systems — PAC-3, THAAD, Navy Area and Theater Wide, Medium Extended Air Defense System (MEADS), and Boost Phase Intercept (BPI) — complement each other by:

- defending against different threats
- protecting different assets
- offering some defense in situations which otherwise would have none

Thus the problem is not redundant systems, but rather choosing among alternative objectives.

Affordability is a valid issue. Extensive deployment of all these systems would eventually require substantial increased funding for TMD. However, investments in TMD serve as a hedge against an uncertain future. If the missile threat continues to grow, then the importance of missile defense could well justify increased future funding for substantial deployments. On the other hand, a significant level of current investment may have a dissuasive effect and contribute to a preferred future with a curtailed missile threat.

The affordability challenge in the long term could also be mitigated through new architectures based on distributed sensors shared by different shooters. The advanced airborne radar system under development by Advanced Research Projects Agency (ARPA), for example, could be the prime sensor for BPI (Airborne Intercept [ABI]), MEADS, Patriot, and SM-2 against cruise missiles. A space based mid-course tracking system (Brilliant Eyes), if deployed for National Missile Defense (NMD), could also be the prime sensor for THAAD. Other savings could be achieved by the use of a common kill vehicle for several interceptors, e.g., a variant of the Advanced Interceptor Technology (AIT) kill vehicle might be used for THAAD, Navy Theater-Wide and ABI. We recommend that BMDO be tasked to explore these and similar options.

Choices among the systems mainly depend on policy preferences and judgments about the likelihood of threats and scenarios

- situations when Patriots or THAAD are not available, e.g., early entry lodgments? — then Navy Area Defense
- provide wide area and population defense? — then THAAD and Navy Theater Wide Defense
- long-range TBMs (>1000km) a concern? — then, THAAD and Navy Theater Wide Defense
- protect remote (from the launcher) allied populations against longer-range TBMs? — then Navy Theater-Wide supported by external sensors such as SBIR
- cruise missiles a concern? — then, PAC-3 and Navy Area Defense
- worried about emergence of advanced submunitions? — then BPI
- vulnerability of mobile troops to short range missiles? — then MEADS

These choices will not necessarily be illuminated by a requirements-driven analysis (which assumes the existence of a commonly agreed upon set of requirements) that relies on complex, many-on-many engagement simulations to evaluate the performance of alternative "objective system" TMD architectures.

- this is why we are concerned about the TMD Capstone COEA

The TMD COEA

- Good people involved, addressing some of right issues and undoubtedly serving a useful team-building purpose, bringing people and organizations together, as well as validating models and data
- However, we remain skeptical that, as configured, it will provide the desired insights and understanding of the critical investment decisions

The TMD COEA was briefed several times to the Task Force.
We believe the basic approach is inappropriate

- too massive: it involves 100s of people and promises over 5,000 pages of results.
- too mechanical: identified many 100s of cases to examine by using detailed force-on-force simulations, but these simulations add little to an understanding of most of key issues.
- overly driven by "requirements": does not examine underlying constraints and assumptions.
- biased by weapon system and individual Service perspectives.
- under-emphasizes sensor and Command, Control, and Communications (C^3) options, particularly those which can support new joint architectures (although we have been told these are to be examined in "excursions").
- not conducive to new CONOPS or creative approaches.

At best, it is an inefficient use of resources — create a huge pile, then see if there is a pony inside — that could be better employed.

In our interim report, we recommended that the COEA group be tasked to provide an initial cut at key issues to senior decision-makers and tailor subsequent analysis based on feedback. This does not appear to have been done, but we still believe it worthwhile to constitute a small group to address the critical issues. They should be tasked to evaluate program and investment options in terms of their contributions to managing the risks associated with future uncertainties (instead of, or at least, in addition to meeting objective system requirements).

The Core TBMD Systems

- The three Core TBMD programs — Patriot PAC-3, THAAD and Navy Area System — address critical deficiencies and provide complementary capabilities in today's systems
- We have two concerns
  - insufficient testing and intelligence collection to ensure avoidance of fragile performance: particularly important for hit-to-kill systems
  - THAAD performance inhibited by ABM Treaty derived constraints

Patriot PAC-3 continues the evolution of the Patriot system.
- promises substantially improved capabilities over PAC-2 in defended area and lethality and has CM defense capabilities
- little capability against longer-range TBMs and has deployment constraints

THAAD — the first dedicated TBM defender — promises to be a much more capable TBM defender than PAC-3.
- much larger defended area, particularly against longer-range TBMs
- exo- and endo-atmosphere intercept capability
  - — favorable altitude regimes for hit-to-kill intercepts

However, potentially achievable defended footprints are being severely constrained (especially against longer-range TBMs) by ABM Treaty compliance findings that prohibit THAAD's use of external sensors. It does not contribute to low-altitude CM defense and is most expensive TBMD program (accounts for more than 30 percent of the TMD budget over the next 6 years).

Navy Area System will give TBMD a capability to widely deployed Aegis family
- can provide TBMD in situations where land-based defenses are not in place
- offers CM defense
- the proposed approach, with a fragment warhead, while promising less probability of hit-to-kill, offers growth potential and avoids putting all eggs in one technology basket

Hit-to-kill systems provide substantial advantages, but there are dangers of their being fragile performers. It is important to learn all we can about the flight characteristics of threat missiles and to test our systems in a realistic environment, including both observed and anticipated countermeasures (See pg. 15-17). Intercept environments are challenging even in the absence of deliberate countermeasures. (As evidenced by problems Patriot faced due to the break up and corkscrewing of the Iraqi Scuds during reentry.) As one program manager cautioned, "debris happens."

TBMD Non Core Systems

The three "competing" concepts address very different problems

- MEADS is intended to move with and protect mobile ground forces including their moving support bases
- Navy Theater Wide offers protection of very large areas against longer-range TBMs
- BPI is of great interest because of feasible countermeasures against all the other TBMD systems. We conclude that BPI is in most need of increased attention and investment.

The three concepts are discussed in the following pages.

MEADS (Formerly CORPS SAM)

- Intended to defend mobile ground forces against short-range missiles and other air threats including UAVs
- Has become a major international cooperative development program (involving the US, France, Germany, and Italy) since the initiation of our Task Force
- We recommend that serious consideration be given to using new architectures — employing airborne sensors to direct rearward-based Surface-to-Air Missiles (SAMs) to provide coverage of forward mobile forces — to help meet MEADS requirements

The Army and Marines want a theater missile defense capability when operating out of range of theater missile defense systems. An issue is the vulnerability of mobile ground forces to missile attack. Mobile ground forces are actually moving only a small percentage of time when in combat and do present targets (e.g., forward area assembly areas and helicopter logistics nodes) for missile attack.

However, camouflage, concealment and deception (CCD) and other passive defense measures, suppression of enemy Reconnaissance, Surveillance Target Acquisition (RSTA) and attack operations, can play important roles in mitigating the short range missile threat to our mobile ground forces. (Attack operations have a better chance against the short range missiles because more sensors and shooters can be brought to bear against much smaller and closer operating areas these missiles must launch from.) Furthermore, while missiles pose perhaps the dominant threat to rear areas, mobile ground forces must contend with artillery, rockets and other threats. For these reasons, the missile threat to our mobile ground forces is unlikely to be the show stopper that it could be when targeted against PODs and populations.

Emerging concepts and technology, using airborne sensors to direct SAMs, will allow rearward-based SAMs to defend forward forces even against low flyers. (The concept will be demonstrated in the Mountain Top ACTD.) We recommend that such architectures be seriously considered, in conjunction with, and as a part of, the MEADS program. Using existing and already under development SAMs (e.g., ERINT) in this manner can reduce the demands (capability and quantity) and thus the cost of equipment that has to be made agile and survivable enough to keep up with maneuver forces.

Navy Theater Wide

- Navy Theater-Wide is the most cost-effective approach for protecting large areas against longer-range TBMs
- It is important for the program to develop properly and then be able to deploy quickly
- BMDO and Navy should be tasked to evaluate kill vehicle options accounting for realistic environments and plausible countermeasures, and to recommend preferred approach before committing to a design

Deployment flexibility — ships can be close to launch area and between launch area and defended area — allows defense of very large regions

- particularly against longer-range TBM threats (>1,000 km)
- requires external sensors and high-velocity interceptors (>3 km/sec) to achieve these large footprints

It is more important for the program to develop properly rather than rush to deploy.

The lightest front end (kill vehicle) and therefore the largest theoretical defended footprint (against the longer-range TBMs) are achieved if intercept capabilities are limited to the exo-atmosphere.

However, a capability to intercept in the high endo-atmosphere (e.g., above 30-50 km altitude) as well as above the atmosphere (which could be achieved with a THAAD-like or AIT front end) provides more resilience against countermeasures and can defend against shorter range TBMs.

Boost Phase Intercept Systems

- BPI should be an important element in TMD
  - to deal with advanced submunitions and other threats to defensive mid-course and terminal TMD systems
- However, there is no coherent BPI plan nor any mature concept
- All BPI concepts have warts. However, substantial — albeit far from perfect — capabilities can be developed

Instead of a coherent plan, we found advocacy of particular concepts and an absence of serious CONOPS.

So-called "complete" solutions are chimerical since our adversaries will have other ways to deliver WMD and explosive payloads including Special Operation Forces (SOF), covert means and cruise missiles.

Less-than-perfect BPI capabilities can help deter WMD use, e.g., by causing payload to fall on launcher's own territory.

A key issue is when is BPI needed

- a judgment call but we opt for sooner rather than later
- advanced submunitions can be effective against important target sets, although attacker pays accuracy and payload penalties
- potential for advanced submunition has been demonstrated by BMDO's countermeasures hands-on "Skunk Works"

Because advanced submunitions and other serious threats to US descent phase defense are potential and not yet real, BPI activities should be structured as a hedge program, rather than as a formal acquisition program. The objectives should be to:

- create and sustain options for timely deployment in case the threat materializes, and
- exploit the program's deterrent value to dissuade the development of advanced submunitions and other countermeasures to our descent phase missile defense systems

Boost Phase Intercept Systems — Recommendations

- A robust BPI hedge should include more than one concept.
- To achieve some BPI capability, we recommend that highest priority be accorded to the airborne intercept system (ABI) coupled with airborne sensors (ABR).
  - ABI provides the earliest availability
- Include serious attention to the role of Intelligence Preparation of the Battlefield (IPB) to improve operation area delineation (also important for attack operations against TM).

Lower priority is the Air Borne Laser (ABL):
- introduces new technology which may have high payoff in other missions
- also offers some advantages over ABI, like longer-range kill
- is a well-managed program with strong USAF enthusiasm

However, the ABL:
- has higher technical risk than ABI
- is an imperfect performer (even with optimistic estimates) as is the ABI
- does not provide for post-boost TBM kill (and therefore its effectiveness could be severely degraded by faster burning boosters) and we are skeptical of its utility against low-altitude CMs

Space-Based Laser is an option only in the much longer term:
- impressive technological achievements and offers advantages of continuous availability if enough satellites are in place
- however, is very expensive, and is susceptible to fast-burn boosters and also does not counter cruise missiles

Boost Phase Intercept Systems — Recommendations

- Fighter Aircraft (A/C) and UAVs are both feasible platforms for an ABI system
  - fighters offer earlier availability, while UAVs don't put pilots at risk (unless suppression of enemy air defenses (SEAD) is necessary to ensure UAV survival)
- ABI (on either platform) offers modest effectiveness (very scenario dependent) without additional sensor support
  - unless large numbers of platforms are deployed or superb area delimitation is achieved
- External sensors would enable much more effective ABI
  - also supports cruise missile defense, combat identification and fratricide avoidance, and other TBMD including new architectures for MEADS

Off-board airborne radar sensors would greatly enhance ABI effectiveness.

Without them, the performance of ABI on fighters will be limited by the small "search light" surveillance patterns of on-board radars. Likewise, without them, the performance of ABI on UAVs with IR surveillance sensors will be very dependent on weather conditions. Off-board radar sensors, by eliminating ABI's dependence on the small search light surveillance patterns or clear weather, can increase the all weather area coverage (the launch area that a single ABI platform can defend against) by a factor of 25 - 50 or more. Thus, the area covered per platform, instead of being less than a few thousand km^2 (limited by the on-board sensor), could be as much as 50,000 km^2 (depending on interceptor velocity and threat type).

The number of platforms required to provide high levels of effectiveness in all scenarios would be prohibitive. Rather than asking how many are "required" for coverage, a more useful question is: what capabilities can be achieved with affordable quantities? Analyses indicate that substantial effectiveness can be achieved in many scenarios with aircraft resources on the order of, or even less than, that assigned to SCUD hunting, during the Gulf War.

The timelines for boost phase kinetic intercept are stressful (representative TBMs complete booster burn within 60 - 90 seconds). Furthermore, platforms must overfly hostile territory to achieve substantial effectiveness in most scenarios. However, preliminary modeling and simulation efforts indicate that the short timelines are not a show stopper and that the requisite detection, track, and launch functions can be accomplished in sufficient time to support useful intercept ranges.

Higher interceptor velocities compensate to some extent for the short timelines. Very high velocities (e.g., 5 km/sec) could even increase standoff sufficiently to allow some BPI capability without having to fly over hostile territory (especially against relatively small size countries like North Korea). However, limiting ABI to only such a standoff mode would severely, and unnecessarily, limit its effectiveness. Furthermore, the advantages of very high velocity may be outweighed by its price: fewer missiles per platform, reduced deployment flexibility due to fewer types of platforms that can carry the ABI and delayed availability due to the greater development challenges (e.g., window cooling).

A capability for post-boost (ascent phase) as well as boost phase intercepts also helps deal with the stressful timelines and would substantially increase the coverage and robustness of ABI concepts.

The opportunity costs of the fighter-based ABI might be substantially reduced if this mission can be made compatible with other air missions rather than dedicating a sizable number of aircraft exclusively to BPI. Some missions, SEAD, for example, may not be good multi-mission candidates. Defensive counter-air (DCA) and other air superiority missions as well as transporter-erector-launcher (TEL) hunting (aircraft need to be in the same neighborhood for both BPI and counter-TEL missions) offer more potential for multi-mission compatibility. We did not find evidence of a serious attempt to explore multi-mission opportunities and we recommend that such an effort be made.

The value of fighter-based systems would also be enhanced if both Air Force and Navy aircraft (which may be the first on the scene) can be equipped to carry out the ABI mission.

Successful pursuit of ABI needs a warfighter sponsor and committed developer, neither of which exists today. We believe that fighter-based ABI offers the earliest available BPI capability and a program can be configured to support later carriage on UAVs. However, given the Air Force's apparent lack of interest in such use of fighters, an initial focus on UAV-based ABI concepts may be more bureaucratically practical.

Boost Phase Intercept Systems — Recommendations

For the UAV option, we recommend:

- a careful look at the US funded, Israeli boost phase intercept program to identify opportunities to leverage their effort
- a detailed examination of the survivability of alternative UAVs (recognizing that considerably higher attrition of these platforms than piloted aircraft can be accepted)
- modifying (or exploiting) the Advanced Interceptor Technology (AIT) kill vehicle program to support ABI carriage on UAVs (the current AIT appears too heavy for UAV carriage)
- early and heavy emphasis on CONOPS and BM/C^3
- consideration of the role of external sensors

We realize that there are questions about ABI feasibility. There are strong advocates for both the ABL (the Air Force) and SBL (within BMDO). On the other hand, there appears to be little advocacy for ABI (the proposed ABI ACTD collapsed in part due to lack of Air Force interest).

Still, there remains a real danger of rapidly emerging countermeasures to descent phase TBMD and land attack cruise missile threats. ABR helps with both ballistic and cruise missile threats, ABL and SBL likely won't, while ABI offers the least costly, earliest available path to achieve at least some BPI capability. Far less than perfect BPI capabilities could be important in future conflicts with TBM wielding adversaries.

Advanced Airborne RADAR Sensors

Advanced Airborne Radar Systems, currently an ARPA technology program, can be a major contributor to TMD (especially as part of a CEC-type network)

- detects low-observable CMs
- fire control for surface-based missiles allows intercepts out to their kinematic limits rather than the local radar horizon
  - — increases defended area per SAM site as much as 100-fold
  - — extends defensive range of ship-based SAMs inland
- improved situation awareness and high-resolution capabilities important for combat identification and fratricide avoidance
- enhances fighter-based BPI and supports other TBMD

We examined the role of an Aerostat as a platform for these advanced sensors and reviewed a proposed ACTD for an Aerostat surveillance system. Could an Aerostat substitute for an aircraft, thus avoiding the need for aircraft? If the aircraft is needed, would the Aerostat provide sufficient additional value to warrant the additional cost?

Compared to manned aircraft, the Aerostat offers the potential of lower cost, longer time on station, no air crew at risk, and a shorter time to operational capability.

A suitable Aerostat should be able to operate above 20K feet both to rise above the most turbulent conditions and to achieve adequate coverage. Since the estimated payload is about 25K pounds, a large Aerostat is required. The largest existing Aerostats are about 71 meters in length. ARPA estimates that a 91 meter Aerostat would be needed to satisfy requirements.

A substantial ground facility is required to inflate and manage the Aerostat on the ground and to provide for the ground crew and operations. The ground facility, as well as the Aerostat itself, is subject to attack. Although the Aerostat would presumably be well behind the expanded danger zone and protected by SAMs and fighter aircraft, it is unable to duck or fly away and could be vulnerable to a determined enemy.

Aerostats have limited mobility. A ground site must be prepared consisting of a mooring tower, a vehicle of some sort to hold the tail, and enough space to allow the mooring vehicle to move, keeping the Aerostat facing into the wind. If not already there, these would have to be moved to the theater and set up, requiring some days as well as a safe place far enough from the enemy to be protected. Moving the ground site to keep up with troop movements also takes time, requiring several Aerostats to maintain continual coverage.

Advanced Airborne RADAR Sensors (CONT')

In our opinion, an Aerostat is not an adequate substitute for an aircraft and thus an aircraft is needed in any event

- aircraft provides deployability, flexibility, and survivability advantages
- aircraft can fly higher altitudes providing either greater coverage into enemy territory or greater safety depending on position

The best role for the Aerostat would be to provide coverage before hostilities begin and under benign conditions, saving wear and tear on aircraft and crews, and either reducing the number of aircraft needed or improving their staying power

- surveillance aircraft are expensive to build and operate; thus a fleet of Aerostats could be a money-saving augmentation

The Aerostat should be viewed as a complement, not a substitute, for aircraft:

- unfortunately, the development costs for the two systems are largely additive and would occur in the next few years while the savings accrue in the future
- if there is only money for one, we believe it should be the aircraft

The proposed Aerostat ACTD briefed to the Task Force was directed toward developing and demonstrating a war-fighting capability (including size, altitude, both surveillance and fire control radars, low down time, and rapid mobility). This capability would be costly and involve a number of parallel developments with considerable risk of meeting schedule and budget.

There does not appear to be much work on improving Aerostats

- more effort should be invested toward this end than currently planned. There may well be other uses for Aerostats which would be helped by a much more thorough understanding of shaping, materials, and handling

- We recommend that the advanced airborne radar systems program in ARPA be made more ACTD-like to expedite deployment on fixed winged aircraft (unmanned A/C could be a later option). Emphasis should be first to provide airborne surveillance and fire control (for both fighters and SAMs) against moderate cruise missile threats, with capabilities against VLO threats to come later.

- Since we believe that an Aerostat would be an adjunct to an aircraft system, we also recommend:
  - a wider exploration of the use of existing and improved Aerostats for many military purposes including Electronic Surveillance Measures (ESM), VHF surveillance, and communications relay.
  - in parallel, a substantial effort to develop larger Aerostats using improved technology that could carry larger payloads to higher altitudes.
  - later, light-weight, fire-control/surveillance radar(s) could be developed. The result would be a set of components which could be put together in various ways depending on how each of the component developments came out. A plan of this sort would be less dependent on everything going well.

Joint Theater Missile Defense C^4

- Some progress in TBMD
  - BMDO-led effort to develop Joint Tactical Information Distribution System (JTIDS)-based C^2, disseminate Defense Satellite Program (DSP) data
- The overall JTMD C^4 effort remains sluggish
  - in spite of repeated calls for more attention and some organizational initiatives
  - Service stovepipes an obstacle
- We recommend that USD(A&T) task the Air Force, Army, Navy and BMDO to conduct a comprehensive analysis of the costs and benefits of alternative ways to extend CEC-like capabilities into the JTMD arena

Architecture goal for JTMD should be CEC-like capability
- fuses measurements from distributed sensors
- provides common high-quality, fire-control picture of battle space to distributed shooters

Offers substantial advantages for JTMD
- supports both CM and BM defense
- allows weapons to be fired from remote sensors
- extends coverage
- is more robust against countermeasures
- helps combat identification and fratricide avoidance
- has more deployment flexibility

CEC-like, rather than CEC, because not every participant in the network needs or can afford a full CEC capability
- can have several different levels of participation
- need to develop architecture and implementation plan to extend CEC-like capabilities into the joint arena

Although we note some interest by the other Services in CEC-like capabilities, e.g., the Air Force for AWACs, we saw little evidence of a serious commitment to extend this capability into JTMD.

Passive Defense

- **Comprises many disparate functions**
  - warning, movement, signature control, hardening and dispersal, protection and medical treatment of personnel, redundancy and reconstitution
- **Can be viewed as the foundation for TMD**
  - enables affordable active defense
  - generally provides protection independent of delivery means
- **Remains underexploited**
  - despite its potential for high-cost effectiveness
  - few spokespersons for passive defense

There are many passive defense avenues to pursue; we highlight three of these:

Improve the readiness of reserve forces to operate in CBW environment

- many unprepared for Desert Shield
- anecdotal evidence of continuing problem (e.g., in Roving Sands)
- important Combat Service Support (CSS) role (e.g., as drivers, stevedores) if contract support unwilling to work in face of CBW threat or use

Devote more attention to operating air and sea PODs in face of CBW attack

- conduct field exercises to gather data and evaluate procedures and materiel
- introduce CBW threat into war games to increase awareness
- task Strategic Mobility Joint Warfighting Capability Assessment (JWCA) to address the effects of missile attacks on PODs and points of embarkation (POEs)
- identify options to provide CBW protection to contract/host nation support (part of a much more general problem of protection for allies)

Pursue new ways to deploy and project force to theaters without creating targets like the huge logistics nodes of Desert Shield

- like the Marine's "operational maneuver from the sea" and other concepts such as "pulse" or "just-in-time" logistics

Attack Operations

- Dismal wartime experience against mobile TMs
  - no confirmed kills in thousands of sorties
- Major problem is finding and discriminating
  - significantly better sensors and sensor fusion necessary
  - intelligence preparation of the battlefield is critical. The intelligence community also needs better data and information fusion
- Considerable current activity
  - multi-JWCA, Roving Sands, Joint Test & Evaluation TMD Attack Operations effort, War Breaker and other ARPA and Service programs
- But no integrating mechanism to pull together the various relevant projects, programs and activities into a comprehensive attack operations program

By comprehensive, we mean including SOF, as well as air operations, to locate and attack:

- infrastructure
- TELs in transit to launch location
- TELs preparing to launch
- post-launch TELs fleeing launch site
- the missile during its boost and ascent phase (although Pentagon considers BPI part of active defense, airborne BPI has more in common with attack and related air operations)

Cruise missiles deny or reduce some of these opportunities (e.g., they can be launched from “warehouses”).

Attack Operations (cont.)

Given the dismal past performance, what are the expectations for future improvements?

- Finding and destroying mobile missiles (pre-launch) will remain a formidable challenge even with much improved wide area surveillance
  - large operating areas, use of camouflage, concealment and deception (CCD), and small footprints (e.g., compared to a tank battalion)
    - — difficult to quantify effectiveness, let alone guarantee success
    - — very dependent on adversaries' tactics and use of CCD
- Observable and unambiguous launch signatures offer opportunities for successful attacks against post-boost TBM launchers
  - may drive adversaries to expendable launchers
- Major effect may be suppressive rather than kill
  - make adversaries devote considerable energy to survive and thus make it more difficult to launch salvos in large numbers
- Mobile cruise missiles will be even more elusive targets than ballistic missiles
  - reduced operational and launch signatures

In summary, attack operations can be an important adjunct but cannot replace the need for active defense. But, if the US faces missile attacks in future conflicts, we will undoubtedly again devote substantial resources to TMD attack operations

- **we must learn how to do better; if we expect to capitalize on our enormous theater air investment to support TMD**

Attack Operations — Recommendations

- Develop a comprehensive architecture and implementation plan for operational and technological enhancements to TMD attack operations: i.e., how to do better
  - exploit improved capabilities being fielded for other reasons
  - include the role for IPB to improve operational area delimitation (also important for BPI) and gather lessons learned from Roving Sands and other relevant exercises
  - follow on to the JWCA effort on TMD attack operations and the recent Lincoln Lab study for OSD
  - sponsor this effort through the OSD, Joint Staff and USACOM
  - include intelligence, warfighter, and technology personnel
  - emphasize individual experience and expertise, not just organizational participation
  - creative rather than evaluative exercise (one good idea is worth many evaluations)
  - provide sufficient time (e.g., 9 months) to produce this study plan
- After the study provides a road map, then decide on the appropriate management arrangement and responsibilities

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Summary of Findings and Recommendations

We found substantial progress in the TMD program since the Gulf War (also since the last DSB/DPB TMD Task Force in 1991). The progress includes enhancement to fielded capabilities, investment in major new development programs and technology efforts, greater involvement by the CINCs, more joint exercises and the publication of doctrine for JTMD. We also found some problems and deficiencies which are highlighted in the following two pages along with our primary recommendations.

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Summary Of Findings And Recommendations

Threat projections and the Acquisition Process

We found over emphasis on evidence based projections and recommend that:

- USD(A&T) and the Director, DIA provide resources and increase the role for Red Teaming and threat modeling within a disciplined process to characterize threat options
- USD(A&T) direct BMDO to add cruise missiles to the ballistic missile threats it is already examining in its Red Team and Countermeasure Skunk Works activities
- BMDO prepare an annual report to USD(A&T) on the TMD Red Team results, characterizing possible threats and countermeasures according to effectiveness and difficulty and describing the strategy to deal with these threats

The ABM Treaty and TMD

We found TMD capabilities being constrained by the Treaty demarcation path the US had been pursuing and recommend a different approach:

- based on demonstrated — and NTM verifiable — capabilities, achieved by not testing TMD systems against missile targets in excess of 5 km/sec and 3,000 - 3,500 km range
- consistent with the May 1995 Clinton/Yeltsin Summit Statement
- pursuing confidence building measures and cooperative efforts with the Russians and subsequently the Chinese

Organizing for JTMD

We found a comprehensive vision of JTMD promulgated by the Joint Staff, but no Joint CONOPS nor complementary comprehensive approach on the developers' side. To organize more effectively for JTMD, we recommend several steps including:

- assigning USACOM the responsibility for the overall JTMD architecture
- combining land-based cruise and ballistic active theater missile defense development under BMDO

TMD Program and Activities

There are reasonable rationales for each of the six TBMD programs. However, substantially increased budgets for TBMD will be required to produce and deploy all of these systems. We are concerned that the massive Capstone TMD COEA effort will not produce the desired illumination of critical investment decisions.

We conclude that very low leakage, while desirable, is unlikely to be a practical TMD goal except against very small attacks. Raising the price to an adversary, while clearly not as satisfactory as denying delivery, is a worthy and practical objective for today's investment decisions.

There is insufficient attention to architectures based on distributed sensors supporting several interceptor systems.

- the advanced airborne radar sensors being developed by ARPA are crucial for defense against land attack cruise missiles and can also make important contributions to TBMD (including BPI and MEADS). We concluded that Aerostat basing could be an important complement to fixed wing A/C and recommend more effort on Aerostat design as well as moving the airborne radar technology closer to a fielded capability in order to hedge against rapid emergence of the land attack cruise missile threat.
- we recommend more aggressive pursuit of CEC-like capabilities for JTMD.

We are concerned about the fragility of hit-to-kill systems in combat and recommend more testing in realistic environments and more intelligence data collection against real targets.

We are concerned about countermeasures to descent phase TBMD and recommend more attention to boost phase intercept, with the highest priority to airborne intercept concepts.

We did not find a coherent, integrated effort to improve attack operations against mobile theater missiles. While we remain skeptical about achieving sufficient effectiveness to substitute for active defense, there are opportunities to improve on dismal past performances. We recommend the development of a comprehensive attack operations architecture and implementation road map that makes better use of new surveillance and C^3 capabilities being fielded for other purposes.

We find that passive defenses continue to be undervalued and suggest several areas for additional attention.

Appendices

APPENDIX A

MEMBERSHIP

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Defense Science Board/Defense Policy Board
Joint Task Force
on
Theater Missile Defense

Members

Chairmen

Dr. Ted Gold and Admiral David Jeremiah, USN (Ret)

Rear Admiral Thomas Brooks, USN (Ret)
Robert Everett
Daniel Fink
Dr. William Graham
General Larry Welch, USAF (Ret)

Hon Sidney Graybeal
Stephen Hadley
General Glenn Otis, USA (Ret)
John Steinbruner

Executive Secretary
Glenn Lamartin
Maj Tim Linehan

DSB Secretariat
Lt Col Keith Larson

DPB Secretariat
Lt Col Clay Stewart

USDP POC
Dr. Frank Dellermann

Advisors

Col Roger Graves
Peter Hoag
COL William Knox
LTC Michael Lloyd
Thomas Perdue
Col Tony Ryan
Maj Michael Vela

COL Alan Hammond
CAPT John Kelly
CDR Craig Langman
Marion Oliver
Dr. Bruce Pierce
Paul Scheurich
Dr. David Whelan

Support

Ed Burke
Andrew Hutchins

Hilton Hanson
Denise Strother

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APPENDIX B

TERMS OF REFERENCE

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OFFICE OF THE SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD
CHAIRMAN, DEFENSE POLICY BOARD

SUBJECT: Terms of Reference--Defense Science Board/Defense Policy Board Task Force on Theater Missile Defense (TMD)

You are requested to form a joint Defense Science Board/Defense Policy Board Task Force to review the purposes of the U.S. theater missile defense effort, including the nature of the threat (types and quantities of missiles and payloads); how it might evolve; the degree of defense we should seek; what we should defend; under what circumstances; and to what levels.

The Task Force evaluation should also include, but is not limited to the following issues:

- An assessment of current TMD capabilities, plans and programs (including active and passive defense and counterforce).

  -- Do the programs and proposed architectures provide a balanced approach consistent with the purposes?

  -- How should theater missile defense activities relate to counterproliferation and associated efforts?

- A review of the implications of the TMD programs and options for the ABM treaty.

  -- What are the significance of alternative ABM treaty derived constraints to TMD effectiveness?

- A determination of the relationship of TMD to national missile defense from several perspectives including operational, programmatic, organizational, policy, and political. The Task Force is not being asked to make recommendations about national missile defense.

The Assistant Secretary of Defense for International Security Policy and the Director, Strategic and Tactical Systems, OUSD(A&T) will co-sponsor this Task Force and provide the necessary funding and support contractor arrangements as may be necessary. Dr. Theodore S. Gold and Admiral David Jeremiah, USN (Ret.) will serve as co-chairmen of the Task Force. Mr. Glenn Lamartin, OUSD(A&T), will serve as Executive Secretary, and Dr. Frank Dellermann, OASD(ISP) will serve as the point of contact and representative from OASD(ISP). Lieutenant Colonel Keith Larson, USAF, will serve as the Defense Science Board Secretariat representative and Lieutenant Colonel Clay Stewart, USAF, will serve as the Defense Policy Board Secretariat representative.

It is not anticipated that this Task Force will need to go into any "particular matters" within the meaning of Section 208 of Title 18, U.S. Code, nor will it cause any member to be placed in the position of acting as a procurement official. The Task Force should submit an interim report by early April, and a final report in September 1995.

Paul G Kaminski
USD(A&T)
FEB 0 6 1995

W. Cobb, acting
USD(P)
JAN 28

APPENDIX C

ACRONYMS

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ABBREVIATIONS	MEANING
A&T	Acquisition & Technology
A/C	Aircraft
AADC	Area Air Defense Commander
ABI	Airborne Intercept
ABL	Air Borne Laser
ABR	Airborne Radar
ABM	Anti-Ballistic Missile
ACTD	Advanced Concept Technology Demonstration
ADSAM	Air Defense Surface to Air Missile
AIT	Advanced Interceptor Technology
AO	Area of Operations
API	Ascent Phase Intercept
ARPA	Advanced Research Projects Agency
ASD	Assistant Secretary of Defense
AWAC	Airborne Warning & Control
BM	Ballistic Missile
BMDO	Ballistic Missile Defense Organization
BPI	Boost Phase Intercept
BW	Biological Warfare
C^2	Command and Control
C^3	Command, Control and Communications
C^3I	Command, Control, Communications, and Intelligence
C^4	Command, Control, Communications, Computers
C^4I	Command, Control, Communications, Computers and Intelligence
CBW	Chemical/Biological Warfare
CCD	Camouflage, Concealment & Deception
CEC	Cooperative Engagement Capability
CENTCOM	Central Command
CID	Combat Identification
CINC	Commander in Chief
CJCS	Chairman, Joint Chiefs of Staff
CM	Cruise Missile
COEA	Cost and Operational Effectiveness Analysis
CONOPS	Concept of Operations
CONUS	Continental United States
CSS	Combat Service Support
DCA	Defensive Counterair
DepSecDef	Deputy Secretary of Defense
DIA	Defense Intelligence Agency
DoD	Department of Defense
DPB	Defense Policy Board
DSB	Defense Science Board
DSP	Defense Satellite Program
ESM	Electronic Surveillance Measures
EUCOM	European Command

IPB	Intelligence Preparation of the Battlefield
IPT	Integrated Process Team
JCS	Joint Chiefs of Staff
JFACC	Joint Force Air Component Commander
JFC	Joint Force Commander
JTC	Joint Theater Commander
JTF	Joint Task Force
JTIDS	Joint Tactical Information Distribution System
JTMD	Joint Theater Missile Defense
JWCA	Joint Warfighting Capability Assessment
KKV	Kinetic Kill Vehicle
LEAP	Light Exo-Atmospheric Projectile
LO	Low Observable
MASINT	Measurement and Signature Intelligence
MEADS	Medium Extended Air Defense System
NBC	Nuclear/Biological/Chemical
NTM	National Technical Means
OSD	Office of the Secretary of Defense
PAC-2	Patriot Advanced Capability-2
PAC-3	Patriot Advanced Capability-3
PM	Program Manager
POD	Point of Debarkation
POE	Point of Embarkation
Pub	Publication
RCS	Radar Cross Section
RSTA	Reconnaissance, Surveillance Target Acquisition
S&T	Science and Technology
SAM	Surface to Air Missile
SBL	Spaced Based Laser
SCC	Standing Consultative Commission
SecDef	Secretary of Defense
SM-2 BLK IV A	Standard Missile 2 Block IV A
SOF	Special Operations Forces
STAR	System Threat Assessment Report
T&E	Test and Evaluation
TBMD	Theater Ballistic Missile Defense
TEL	Transporter, Erector, Launcher
THAAD	Theater High Altitude Area Defense
TM	Theater Missile
TMD	Theater Missile Defense
UAV	Unmanned Air Vehicle
UOES	User Operational Evaluation System
USACOM	United States Atlantic Command
V-1	German WW II Cruise Missile
V-2	German WW II Ballistic Missile

VHF	Very High Frequency
VLO	Very Low Observable
WMD	Weapons of Mass Destruction

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