REPORT TO CONGRESS
ON
THE STRATEGIC DEFENSE SYSTEM ARCHITECTURE

JANUARY 1988

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LIST OF ACRONYMS

ABM	Antiballistic Missile
ALS	Advanced Launch System
AOS	Airborne Optical Sensor
ASAT	Antisatellite
BM/C3	Battle Management/Command, Control, and Communications
BSTS	Boost Surveillance and Tracking System
C3	Command, Control, and Communications
CINC-SD	Commander in Chief-Strategic Defense
CONUS	Continental United States
CSOC	Consolidated Space Operations Center
CV	Carrier Vehicle
DAB	Defense Acquisition Board
DEFCON	Defense Condition
DEM/VAL	Demonstration/Validation
ECM	Electronic Countermeasures
ERIS	Exoatmospheric Reentry Vehicle Interceptor System
EW	Electronic Warfare
GBL	Ground Based Laser
GBR	Ground Based Radar
GSTS	Ground Based Surveillance and Tracking System
HEDI	High Endoatmospheric Defense Interceptor
HVG	Hypervelocity Gun
ICBM	Intercontinental Ballistic Missile
JCS	Joint Chiefs of Staff
LCC	Life Cycle Cost
MWIR	Medium Wavelength Infrared
NCA	National Command Authorities
NMCS	National Military Command System
NPB	Neutral Particle Beam
NTB	National Test Bed
NTF	National Test Facility
OMV	Orbital Maneuvering Vehicle
OTV	Orbital Transfer Vehicle
PBV	Post Boost Vehicle
PENAIDS	Penetration Aids
P3I	Preplanned Product Improvement
ROC	Regional Operations Center
RV	Reentry Vehicle
SASS	Space Assets Support System
SATKA	Surveillance, Acquisition, Tracking and Kill Assessment
SBI	Space Based Interceptor
SBKKV	Space Based Kinetic Kill Vehicle
SBL	Space Based Laser
SBSP	Space Based Support Platforms
SCP	System Concept Paper
SDIAE	SDI Acquisition Executive

LIST OF ACRONYMS (Con't)

SDIO	Strategic Defense Initiative Organization
SDS	Strategic Defense System
SDS-CC	Strategic Defense System - Command Center
SDS-OC	Strategic Defense System - Operations Center
SLBM	Sea Launched Ballistic Missile
SSTS	Space Surveillance and Tracking System
SWIR	Short Wavelength Infrared
TBM	Tactical Ballistic Missile
TW/AA	Tactical Warning and Attack Assessment
WWMCCS	World Wide Military Command and Control System

CHAPTER I

INTRODUCTION

A. PURPOSE OF REPORT

This is an interim report on the Phase I and follow-on Strategic Defense System (SDS), prepared for the Committees on Appropriations of the United States Senate and House of Representatives persuant to Section 125 of the fiscal year 1988 Military Construction Appropriations Act, HJ Res 395, P.L. 100-202.

B. STRATEGIC DEFENSE SYSTEM ARCHITECTURE CONCEPT

The Strategic Defense System (SDS) Phase I Architecture concept was presented to the Defense Acquisition Board (DAB) Milestone I Review for transition into the Demonstration/Validation phase of development. This architecture will continue to be evaluated throughout the Dem/Val phase to ensure that it is the optimum architecture for Phase I of the SDS. The architecture for the SDS follow-on phases is addressed in a more general way, since the configuration of the follow-on will continue to evolve and ultimately be determined based on the changing threat and technology development.

The Phase I System, as currently conceived, would contain two tiers of defense. The first, which would be space-based and would engage ballistic missiles during their Boost and Post-Boost phases of flight, and a second which would be primarily ground-based and would engage ballistic missiles in their mid-course phase of flight. The Boost/Post-Boost tier elements would include a Boost Surveillance and Tracking Satellite which would be in near geosynchronous orbit and a constellation of Space Based Interceptors. The mid-course tier elements would include exoatmospheric interceptors launched from the ground, which may be supplemented by space-based interceptors, and target acquisition/tracking capabilities, which may be provided by multiple elements. Candidate target acquisition/tracking elements are the subject of an intensive SDIO study which will be concluded over the Winter of 1987-88.

The defensive tiers would be under positive man-in-the-loop command and control from designated centers in the United States, and all the elements would be linked through a comprehensive communications network. The combination of the Battle Management/Command, Control, and Communications (BM/C3) has been designated as a separate element of the Phase I SDS, for descriptive purposes.

CHAPTER II

STRATEGIC DEFENSE SYSTEM DESCRIPTION

A. OVERVIEW

The goal of United States national security policy is the protection of the people, institutions, and territory of the US and its Allies. Deterrence of the Soviet Union is currently based on the threat of assured nuclear retaliation in the event of attack. The most significant threat to the safety and security of the US and its Allies is the Soviet ballistic missile force which is increasing in both numbers of warheads and warhead accuracy. This force could be used in a limited strike against specific US and Allied targets or in a massive attack against all elements of our society. The Soviet strategic doctrine is to neutralize US and Allied assured retaliatory capability against such attacks by eliminating the National Command Authorities (NCA); the Command, Control, and Communications (C^3) structure; and the US and Allied retaliatory forces.

The Soviet strategic missile force, especially the heavy throwweight, highly accurate SS-18 intercontinental ballistic missile (ICBM), is a direct challenge to our policy of deterrence based on assured retaliation. In peacetime, it is a challenge to our determination to deter aggression across the full spectrum of conflict, not just conflict at the level of homeland exchanges. During each period of heightened tension between the US and the USSR, concerns are raised about stability and the successful management and resolution of crises. In the event deterrence should fail, the Soviet ballistic missile force could compromise our capability to employ our retaliatory forces in a controlled, deliberate, and flexible manner. As a result, the Soviet ballistic missile force threatens our ability to limit crisis escalation and to terminate conflict at the earliest opportunity on terms favorable to the US and its Allies.

At the same time, the Soviet Union has continued to pursue strategic advantage through the development and improvement of active defenses. These active defenses provide the Soviet Union a steadily increasing capability to counter U.S. retaliatory forces and those of our allies, especially if our forces were to be degraded by a Soviet first strike. Even today, Soviet active defenses are extensive. For example, the Soviet Union possesses the world's only currently deployed antiballistic missile system, deployed to protect Moscow. The Soviet Union is currently improving all elements of this system. It also has the world's only deployed antisatellite (ASAT) capability. It has an extensive air defense network, and it is aggressively improving the quality of its radars, interceptor aircraft, and surface-to-air missiles. It also has a very extensive network of ballistic missile early warning radars. All of these elements provide the Soviets an area of relative advantage in strategic defense today and, with logical evolutionary improvements, could provide the foundation of decisive advantage in the future. The trends in the development of Soviet strategic offensive and defensive forces, as well as the growing pattern of Soviet deception and of noncompliance with existing agreements, if permitted to continue unchecked over the long term, would undermine the essential military balance and the mutuality of vulnerability on which deterrence theory has rested.

In response to the increasing threat posed by Soviet offensive and defensive force developments, President Reagan chartered the Strategic Defense Initiative in 1983. By the President's directive, the purpose of the initiative is to determine the feasibility of eliminating the threat posed by strategic nuclear missiles to the US and its allies. A defensive system capable of defeating ballistic missile attacks would serve three objectives. It would advance our national security goal of protecting our populations from attack by such weapons. It would counter the trends which threaten the erosion of our deterrent. And it would lay the foundation for a policy of deterrence that would no longer "rely solely on offensive retaliation" (President Reagan, 23 March 1983) as the basis for our security and safety and that of our Allies.

B. PHASED DEPLOYMENT

The phased deployment of the Strategic Defense System (SDS) has been conceived as the most reasonable means to achieve the levels of defense contemplated by the President's 1983 direction. Each phase of the SDS would contribute significantly to deterring a Soviet nuclear attack on the US and its Allies. Each defensive tier of the SDS (boost, post-boost, midcourse, and terminal) would have sensors, weapons, and battle management structured to engage an offensive ballistic missile in one or more phases of its trajectory.

The phased deployment approach considers four key factors: *time, technology, defensive missions*, and *responsive threats*. It recognizes that some efforts and technologies will mature faster than others. The approach accepts the fact that the deployment of a defense, regardless of the first deployment date of its elements, must take place over time. It posits that as the defense elements are deployed, they could effectively defend against the threat that is anticipated for their employment period. As other technologies mature through a vigorous research program and are deployed, they would improve the capability of the initial system and provide additional capability to perform new and more demanding missions. Finally, the continuously expanding technical capability of the defense would block Soviet countermeasures and responsive threats and in conjunction with the ability to perform increasingly difficult defense missions, provide significant arms control leverage.

The basic purpose of the defense, beginning with the first deployment, would be to reduce Soviet confidence in the military utility of its ballistic missile force. The deployment process itself would demonstrate our intention to expand an initial defense steadily, in a flexible and responsive manner. The phasing of the deployments would provide the defense with opportunities to exploit existing weaknesses, while simultaneously imposing new technical and operational constraints on Soviet ballistic missile forces. Phasing deployments thus would provide defensive capability against the existing threat, and leave the Soviet offensive planner uncertain of how to recover former effectiveness or how to prevent further degeneration of the utility of ballistic missiles.

The extent to which we would have to follow such a phased deployment approach would depend in large part on the Soviet response. SDI is not a bargaining chip, but the mere development of the option for phased deployment of strategic defense can help motivate Soviet acceptance of US arms reduction proposals. With such acceptance, phased deployment plans could be modified accordingly. If they respond favorably, a deployed system could function as an insurance system and would require more limited quantitative upgrading over time. If they do not respond favorably, full deployments could be initiated.

C. PHASE I

Each SDS deployment phase would have three objectives. The first would be to perform the required defensive mission. The second would be to compel favorable changes–operational or technical–in the Soviet ballistic missile force. The third would be to lay the foundation for the improved, follow-on deployment phases.

The military objective of Phase I would be to enhance the US deterrence posture by being able to deny the Soviets their objectives in an initial ballistic missile attack. Achieving the Phase I SDS objective would enhance deterrence in two ways. One, *it would decrease the Soviet confidence that the objectives of its initial attack would be met.*

Two, *it would increase the likelihood that the US and its allies would be able to respond to aggression effectively.*

The deployment of the Phase I SDS would compel Soviet operational adjustments and compromises by reducing the confidence of Soviet planners in a favorable outcome of a Soviet ballistic missile attack. The defense would leave Soviet planners uncertain of the number of warheads to apply to a single target, or to a target set, to achieve a specified level of damage. It would force them to reallocate weapons from one target set to another in an effort to restore confidence. It would impose the necessity to adjust their preferred launch sequence to compensate for the defense and potentially to compel an off-load of weapon capability, to allow volume and weight on post-boost vehicles (PBVs) for countermeasures.

Initial defenses would be able to maintain their capability more easily than those countermeasures could be taken to defeat them, and thus would contribute significantly to deterrence. Follow-on defensive deployments would provide for robust defenses that were fully effective over the long term, even in the face of Soviet countermeasures.

The initial defense must be able to operate in the boost and post-boost stages of the ballistic missile trajectory, constraining the use (for deployment of warheads and countermeasures) of this initial phase of the battle space and breaking up the structure of the Soviet attack. This requires a capability to detect launches, track boosters and PBVs, select for attack the highest priority boosters and PBVs, and intercept the targets in a systematic manner. The defense also must engage single RVs in the midcourse portion of the flight trajectory. This requires the capability to acquire, track, identify, and discriminate RVs and predict aimpoints so that intercepts can be made in accordance with preferential and adaptive defense strategies.

The SDS elements proposed for Phase I would be deployed in two tiers, boost/post-boost and late midcourse. The Phase I architecture includes: sensors in high earth orbit to detect the launch and track offensive missiles, space-based interceptors effective in boost and post-boost, midcourse sensors to track and discriminate reentry vehicles (RVs), and ground-launched late midcourse interceptors. As a support adjunct, a new heavy-lift, low-cost space launch element would be required in the first phase of SDS to deploy space-based assets.

With the combination of boost/post-boost interceptors breaking up the structure of an attack and midcourse interceptors enforcing preferential and adaptive defense, Phase I would provide US military planners a range of options for preserving mission effectiveness and expanding the level of protection afforded the nation. Phase I creates opportunities for pursuing the most cost-and mission-effective path to achieve the ultimate objective of the defense. The number and capability of elements in existing tiers of the defense system could be increased and enhanced, and more advanced technologies could be deployed in new elements. Depending on the state of a follow-on element's demonstration and validation, it may be appropriate to accelerate its development and deployment to block a Soviet response to the SDS deployment (e.g., using early or prototype directed energy elements for interactive discrimination).

The defense system envisioned for Phase I would satisfy the objective of setting the stage for the follow-on deployment. It would provide an initial capability for protection against ICBM attacks and substantial enhancement of deterrence, and a foundation on which the next phases could build and efficiently expand. It would establish US defensive capability in the most critical portions of the ballistic trajectory in the first deployment. It would also put in place and organize the military infrastructure and provide valuable training and operational experience.

D. DESCRIPTION OF SELECTED ARCHITECTURE FOR PHASE I

The six elements described in this section are expected to form the Phase I SDS. Follow-on elements will continue to be developed to keep open all options and new, innovative concepts will continue to be explored.

1. BATTLE MANAGEMENT/COMMAND, CONTROL, AND COMMUNICATIONS (BM/C3)

The BM/C^3 element would be the mechanism for employing all SDS assets (weapons, sensors, etc.). The element would support the coordinated operation of strategic defense with other strategic and tactical military forces and national diplomatic and intelligence operations. It would provide for continuous positive, responsive control of the SDS through the Strategic Defense System Commander-in-Chief (CINC-SD) at the SDS Command Center (SDS-CC). Battle management would provide the automated support to implement commanded system employment actions. The mechanism for this implementation would be a distributed information processing network of battle managers at every SDS host asset. These battle managers would process data and instructions to implement the commanded battle management functions. The BM/C^3 element would support the required interaction between offense and defense and support preferential utilization of defensive interceptors. This would allow the exchange of vital intelligence information between SDS and the strategic offensive forces during any situation to mutually enhance their performance. Figure A-3 of Annex A depicts the key requirements and functions of the Phase I BM/C3 element.

2. BOOST SURVEILLANCE AND TRACKING SYSTEM (BSTS)

The BSTS element will be a missile launch warning satellite in geosynchronous or higher orbit. In follow-on phases, enhancements would provide for improved sensor resolution and sensitivity to detect fainter boosters and PBVs. The boost and post-boost segments of the system must detect and track the missiles, perform a threat evaluation, assign and launch weapons, and control the intercept. Figure A-4 of Annex A depicts the key requirements and functions of the Phase I BSTS element.

3. SPACED BASED INTERCEPTOR (SBI)

The SBI element would be a low earth orbit, hit-to-kill system having on-board sensors and multiple interceptors on each carrier vehicle (CV). Follow-on CVs might not continue to have onboard sensors but could rely on sensor platforms, e.g., space surveillance and tracking system (SSTS) in a higher orbit. The Phase I SBI could provide a significant capability against SLBMs as well as ICBMs. With the interaction of the SBI orbits and the rotation of the earth, the SBI-CVs would be able to engage follow-on waves of ICBM or SLBM launches. The constellation of SBI-CVs needed to assure first phase mission capability would provide global coverage of all potential launch sites. Figure A-5 of Annex A depicts the key requirements and functions of the Phase I SBI element.

4. MIDCOURSE SENSOR ELEMENT(S)

Midcourse sensor element(s) functions would be to acquire and track PBVs, RVs, decoys, and ASATs and to predict RV state vectors and aimpoints. Three midcourse sensor concepts are being considered for Phase I: SSTS, a ground-launched GSTS, and sensors on the SBI-CV. Figure A-6 of Annex A depicts the key requirements and functions of the Phase I Midcourse Surveillance element.

Space Surveillance Tracking System (SSTS) – A satellite-borne electro-optic tracking and surveillance system in medium earth orbit. The satellites would track targets from medium earth orbits against a cold space background and near the earth limb. Individual object's state vectors would be generated from correlated information from two or more sensors.

Ground Surveillance Tracking System (GSTS) – This ground-launched suborbital rocket surveillance system would use sensors to perform tracking and discrimination of midcourse objects. Signal processing would be performed onboard and transmitted to the ground where correlation and target-weapon assignments would be made. The element would provide the capability to examine high-threat corridors in detail and to be placed in areas where very high resolution may be warranted.

SBI-CV - Sensors placed on the SBI carrier vehicle would allow viewing of threat tubes. This option would give the carrier vehicles greater mass and complexity.

5. EXOATMOSPHERIC REENTRY VEHICLE INTERCEPTOR SYTEM (ERIS)

A ground-based, multistage missile that would use hit-to-kill to destroy incoming warheads in late midcourse. The interceptor would be launched to a target "basket" based on acquisition and discrimination data provided by midcourse sensors. Figure A-7 of Annex A depicts the key requirements and functions of the Phase I ERIS element.

6. ADVANCED LAUNCH SYSTEM (ALS)

While current launch systems can begin SDS Phase I deployment, an ALS will be required for a cost-efficient, timely and complete SDS Phase I deployment. SDS would require lifting several million kilograms of payload to space, necessitating a flexible, relatively low cost launch system. The ALS will be a national system meeting both civil and security space launch requirements.

E. FOLLOW-ON PHASES

Specific architecture work for follow-on phases will evolve as research into SDI technology programs continues. The follow-on phases of deployment would augment the late-midcourse and boost tier with space surveillance sensors and upgraded BM/C^3.

Improved surveillance sensors of these systems, would provide coverage of the missiles' entire flight. These sensors would provide an interim interactive discrimination capability against RVs and decoys. Increasing numbers of Space Based Kinetic Kill Vehicles (SBKKVs) would provide the space-based tiers with additional self-defense capabilities against Soviet anti-satellites (ASATs). Later phases of deployment would endow the architecture with full strategic defensive capabilities against ballistic missiles throughout their flight trajectory. As with the previous systems, these elements would utilize highly advanced technologies developed in parallel with deployment of earlier systems. Suitable systems for this phase are advanced versions of the boost-phase sensor, improved SBKKV, advanced Space Surveillance Systems, Airborne Optical Sensors, High Endoatmospheric Defense Interceptors, BM/C^3, and directed energy weapons for interactive discrimination of decoys and the destruction of ballistic missiles in flight. Potential candidates for follow-on SDS deployment are briefly described in the following paragraphs.

AIRBORNE OPTICAL SENSOR. The Airborne Optical Sensor (AOS) element would be deployed in follow-on phases of the SDS to provide surveillance, acquisition, track and kill assessment (SATKA) for the interception of RVs. This element would include airborne sensor platforms with bases and command components on the ground. It would perform precommit functions for both late midcourse and terminal ground-based interceptor elements. The preferred concept for AOS would involve the development of a common platform/sensor suite to support both midcourse and high-endoatmospheric (terminal) interceptors.

GROUND BASED RADAR. The Ground-Based Radar (GBR) would provide search, track, and discrimination capabilities to meet the requirements of high endo-atmospheric and low exoatmospheric regional defense for the follow-on SDS.

HYPERVELOCITY GUN. A Hypervelocity Gun (HVG) is a device that can accelerate projectiles by converting electric energy or thermal energy into kinetic energy. In a simple electromagnetic gun, an electric current flowing between two rails creates a magnetic field which exerts a force on a projectile to propel it down the gun bore. In the more complex Reconnection Electromagnetic Gun, multiple coils physically displaced along the gun bore apply progressive electromagnetic pulses to propel a projectile.

HIGH ENDOATMOSPHERIC DEFENSE INTERCEPTOR. The High Endoatmospheric Defense Interceptor (HEDI) is a ground-based interceptor capable of intercepting ballistic missiles within the atmosphere. This capability would provide an effective underlay to the boost and midcourse SDS elements. The greater density of air within the atmosphere would improve discrimination performance and enhance identification of threatening objects missed in the upper tiers by other SDS elements. HEDI would provide the atmospheric interceptor capability necessary to engage and destroy these RVs.

GROUND-BASED LASER. The Ground-Based Laser (GBL) element of the SDS would employ ground stations which generate intense beams of visible or near-visible radiation for transmission through the atmosphere to be relayed and focused by orbiting mirrors to an array of targets. The GBL conceptual designs are conceived as frontline weapons capable of evolutionary growth from early adjuncts to the Space-Based Interceptor (SBI) to one capable of stand-alone boost-phase intercept. Such a weapon could provide interactive discrimination in midcourse by destroying simple decoys (e.g., balloons), thermally tagging heavier objects, and imparting a velocity change to heavy decoys. The GBL's greatest potential as an antiballistic missile (ABM) system element is in a synergistic mix of SBI and GBL.

SPACE-BASED RADAR. As SDS was deployed and its mission objectives expanded, it can be anticipated that the ICBM threat would evolve to the point where passive Surveillance, Acquisition, Tracking, and Kill Assessment (SATKA) sensors alone would not be capable of supporting the SDS tracking and discrimination requirements. For that reason, it is currently planned to develop space-based active sensors for deployment as an SDS follow-on deployment element. As "bus watchers," these sensors would implement active discrimination techniques capable of discriminating RVs from advanced decoys as they are released from the PBV. These sensors also might be used for midcourse discrimination as the sensor component of interactive discrimination systems deployed as SDS follow-on elements.

SPACED-BASED LASER. The Space-Based Laser (SBL) element would employ orbiting high power lasers which are conceived as front line weapons capable of evolutionary growth from early adjuncts to the SBI to weapons capable of stand-alone boost-phase intercept. Such a weapon could also supply interactive discrimination in midcourse by destroying simple decoys (e.g., balloons), thermally tagging heavier objects, and imparting a velocity change to heavy decoys. The SBL's greatest potential as an antiballistic missile (ABM) system is in a synergistic mix of SBI and SBL.

NEUTRAL PARTICLE BEAM. The Neutral Particle Beam (NPB) element would employ orbiting particle accelerator platforms which could direct beams of atomic particles at targets in space. The NPB could function as a weapon to disrupt or destroy targets or it could be used, with a network of orbiting sensors, to interact with targets to discriminate warheads from decoys.

SPACE ASSETS SUPPORT SYSTEM. The Space Assets Support System (SASS) would be an on-orbit element of unmanned support platforms planned to provide cost-effective maintenance, servicing, and preplanned product improvement (P^3I) for the space assets of the SDS. The SASS would include Space-Based Support Platforms (SBSP), Telerobotic Services, Orbital Maneuvering Vehicles (OMV) and Fluid Transfer Sub-systems. The use of an Orbital Transfer Vehicle (OTV) also may be required. This space-based support concept is expected to provide significant life-cycle cost (LCC) savings and mission effectiveness improvement for the large constellations of satellites typical of the SDS.

CHAPTER III

STRATEGIC DEFENSE SYSTEM PHASE I

The goals of defense deployments are: (1) deny the Soviets confidence in the military effectiveness and political utility of a ballistic missile attack; (2) secure significant military capability for the US and its allies to deter aggression and support their mutual strategy in the event deterrence should fail; and (3) secure a defense-dominated strategic environment in which the US and its allies can deny to any aggressor the military utility of a ballistic missile attack.

It has become clear that these goals can best be reached through the phased deployment of defenses, and that incremental deployment of defenses is the only likely means of deployment. Each phase of deployment would be sized and given sufficient capability to achieve specific military and policy objectives and lay the groundwork for the deployment of subsequent phases.

The first phase would serve an intermediate military purpose by denying the predictability of a Soviet attack outcome and by imposing on the Soviets significant costs to restore their attack confidence. This first phase could severely restrict Soviet attack timing by denying them cross-targeting flexibility, imposing launch window constraints, and confounding weapon-to-targeting assignments, particularly of their hard-target kill capable weapons. Such results could substantially enhance the deterrence of Soviet aggression.

The first deployment phase would use kinetic energy weapon and sensor system technologies to concentrate on the boost, post-boost, and late midcourse intercept layers. The boost and post-boost layers would consist of space-based kinetic-kill interceptors combined with surveillance and targeting satellite sensors in geosynchronous orbit. The late midcourse phase intercept layer would consist of ground-launched interceptors combined with ground-launched surveillance probes and could be used to destroy nuclear weapons that are not destroyed in the boost or post-boost layer defense.

A. STRATEGIC DEFENSE MISSION

The Phase I SDS would contribute to the performance of missions traditionally assigned to US and Allied strategic forces. The mission areas to which it would contribute include *denial of Soviet war aims, damage limitation, space control, and tactical warning and attack assessment (TW/AA).*

The first phase SDS would assist other US and allied strategic forces in this mission through the capability of the boost-phase and midcourse interceptors to destroy the ballistic missiles and RVs. The Phase I space-based interceptor would have the capability to destroy a significant number of SLBM as well as ICBM boosters and post-boost vehicles.

Midcourse interceptors (ground- or space-based) would enhance the effectiveness of the defense in either the counterforce or the damage-limitation mission area. Both types would be capable of flexible and adaptive defense. The extent of that enhancement would be primarily a function of the number of interceptors available for the engagement. Thus, for a given inventory of midcourse interceptors, the specific contribution made by the midcourse interceptors to one mission area or the other would be subject to determination by the military and political authorities.

Space control operations are conducted to achieve and maintain freedom of action in space. The SDS would contribute to space control during peace, crisis, and conflict to assure the US and its Allies access to space and safeguard their rights, legal and customary, to conduct activities in space during peacetime.

The purpose of TW/AA is to provide timely, reliable, and unambiguous warning of strategic attack on the US, its Allies, and interests worldwide. A variety of sensors and systems are employed to ensure adequate warning is provided by the Joint Chiefs of Staff to the NCA and subordinate commanders for strategic decisionmaking, force survival, and force management actions. Phase I would contribute to this mission through the operation of its surveillance & tracking sensor platforms.

B. SYSTEM CHARACTERISTICS

OPERATIONAL. The Phase I SDS would consist of weapons, sensors, and BM/C^3 elements balanced to satisfy the ballistic missile defense operational requirements. The Phase I SDS would provide for continuous and responsive control of the SDS through the SDS Command Center (SDS-CC). The incremental deployment of follow-on elements is planned so that the SDS would continue to satisfy operational requirements while providing increased overall strategic defense capability against the evolving threat. Figure A-1 of Annex A depicts the SDS Phase I core concept.

The SDS design incorporates the SDS-CC as part of the National Military Command System (NMCS) and the World Wide Military Command and Control System (WWMCCS). This structure provides for direct accountability of the SDS to the National Command Authorities (NCA) and for integrated operations with strategic offensive forces, and warning and intelligence organizations. The Strategic Defense System Commander-in-Chief (CINC-SD) would support the selection of the strategic offensive forces response option so that the SDS mode could be selected to support responsive offensive actions. Through the SDS-CC, the CINC-SD would command globally-distributed SDS elements using survivable communications networks.

Required system operational availability would be achieved through a systems engineering approach that would stress redundancy, component reliability, on-orbit spares, on-orbit robotic maintenance, replacement, and graceful degradation techniques for both hardware and software.

SURVIVABILITY. The survivability of the SDS is measured by the ability of the system as a whole to perform its mission in the face of direct attempts to degrade, disrupt, or destroy the various elements.

C. CONCEPT OF OPERATION

PEACETIME AND ALERT OPERATIONS. Peacetime operations would focus on system management actions necessary to establish and maintain a responsive SDS readiness state. A SDS Operations Center (SDS-OC) might be collocated with the SDS-CC to perform day-to-day actions needed to deploy and maintain the performance of all SDS elements. The SDS-OC would use the Consolidated Space Operations Center (CSOC) to manage the space-based SDS elements, and would direct multiple Regional Operations Centers (ROCs) that would be responsible for terrestrial SDS element support. The ROCs would also be designated as alternate SDS-CC, using predefined procedures for assuming the role of the SDS-CC under attrition conditions. The SDS-CC, SDS-OC, and ROCs would be integrated into the WWMCCS to ensure coordinated operations with the NCA and JCS.

Deterrence against a ballistic missile attack on the US and/or its allies would be significantly enhanced by an operational SDS. Should there be indications of a Soviet attempt to test US resolve to committing the SDS to defensive battle, the US could implement any one of numerous available SDS-related options to signal its resolve and thereby reinforce the deterrence value of the SDS. For example, when the system's operational state is upgraded, additional space-based sensors could be activated, Space-Based Interceptors (SBIs) could be activated and/or repositioned, prepositioned ground- or sea-based sensors could be launched into position, ERIS could be activated, etc. One or more of these options could be overtly implemented, concurrent with appropriate warning communicated to the Soviets.

WARTIME OPERATIONS

Boost and Post-Boost Trajectory Phases. The sensor element of the boost/post-boost tier would be the Boost Surveillance Tracking System (BSTS), which will consist of multiple satellites in near-geosynchronous orbit. These satellites would provide Tactical Warning and Attack Assessment (TW/AA) for the offensive and defensive strategic forces. The BSTS will be used to acquire and track each individual ballistic missile as soon as possible after launch. The BSTS would provide launch and related mission information to the SDS Command Center (SDS-CC) for threat evaluation and determination. During this threat analysis, the constellation would continue to collect and update sensor data to ascertain missile type, number, launch points, and other relevant data. These data would be passed to the SDS-CC as soon as they became available to further aid in threat determination.

The BSTS would provide track and booster type information to battle managers on the SBI carrier vehicles as well as to other SDS elements. Based on the nature of the attack and the operational mode selected, the battle managers would select targets for engagement. Target data would be used by the SBI-CV battle managers to point sensors on the CVs and acquire the boosters. Combining several scans of data from two BSTS satellites would result in a booster track with three-coordinate accuracy.

As soon as the CV acquired a booster track, it would begin development of range track. Passive track by the CV plus continuing tracks from the BSTS, would support the tracking of multiple targets and would provide backup for reacquisition in case of track drop caused by interference or confusion of any kind.

Midcourse Trajectory Phase. The midcourse battle environment would consist of penetration aids (penaids), decoys, RVs, interceptors, launch debris, and debris from successful intercepts. The SDS must be able to detect and track midcourse objects in this environment, and also in a potentially nuclear-perturbed environment.

If the booster or the PBV was not destroyed before deployment of the RVs, a midcourse intercept must be performed. Both the SBI-CVs that are in position and the Exoatmospheric Reentry Interceptor System (ERIS) could be used.

Terminal Trajectory Phase. There is currently no terminal defense element planned in the Phase I SDS; it would be added in follow-on phases. An option will be maintained to accelerate the development of a terminal element if Soviet responses to Phase I SDS development or deployment so warrant. The High Endoatmospheric Defense Interceptor (HEDI) could be employed in limited numbers with midcourse sensors and/or ground-based radars to provide assured survival of designated critical assets, and to complicate Soviet countermeasure efforts.

Post-Attack Reconstitution. When hostile missile launches were no longer detected and after termination of all enemy missile trajectories, the SDS and other national systems would enter the post-attack period. A surviving SDS-CC would perform damage assessment, reconfigure readily available elements, and inform the NCA of the residual SDS capability. Terrestrial SDS element communications would be reconstituted to augment space-based global connectivity. In addition, those communications would support the reestablishment of "ready" conditions for those elements that could be fixed by switching to redundant subsystems or through reprogramming.

CHAPTER IV

SDS FOLLOW-ON PHASES CONCEPT OF OPERATION

The fully capable SDS would be an integrated system of BM/C^3, sensor, and weapon elements which is designed to be survivable, effective, cost effective and responsive to command and control authorities during peace and crisis, and throughout the spectrum of conflict.

The SDS sensors, weapons, and battle management deployed in the follow-on phases would greatly enhance deterrence in peacetime by providing real-time, global coverage with diverse sensors in multiple orbits. Orbit and altitude selection, hardening, proliferation, and redundancy would provide the system passive protection and give commanders a range of options through peace, alert, crisis, and conflict. In peacetime, the day-to-day posture of this enduring, responsive force would provide enhanced TW/AA of ballistic missile attack. Orbit selection would ensure that global and space surveillance was continuously provided and that BM/C^3 and weapon elements were not all within reach of enemy systems. Active SDS elements would provide multiple tiers of capability for an *integrated and synergistic self-defense*. *Peacetime posture* would ensure against surprise attack, provide a continuous observation to provide intelligence of the adversary's test and development, and offer exercise, training, and development capabilities against real missile tests, space launches, and satellite deployments. A combination of maneuverability, hardness, proliferation, active decoys, and orbit selection would provide commanders with a survivable force that could defend passively in the face of ambiguous threats. The SDS would be immediately responsive to national command and control, providing a deterrence-enhancing presence that would not be directly threatening to any adversary but which could be rapidly raised to higher alert postures during periods of tension, crisis, and conflict. Furthermore, by its persistence, SDS would offer terrestrial systems a level of protection in standing down (recovering) from alerts, a posture which would add an element of stability to crisis resolution.

During crises, appropriate action might dictate an increased show of force. Orbital changes could be made to increase the forces available to meet the heightened threat. BSTS and midcourse sensors would continue to monitor for potentially hostile launches, and additional sensors could be added for increased redundancy and survivability. Advanced midcourse weapons and sensors that were difficult to suppress would add to a defense with high alert rates and firepower that would enhance deterrence. The wide range of passive measures available in peacetime and times of crisis would provide commanders the capability to select levels of responses to control the crisis. Ambiguous acts could be avoided, feints tested, and overt uses of force resisted; inherent self-defense capability would give the commander the option to react deliberately.

At the point of conflict, the SDS sensors would maintain continuous surveillance of all threat areas and generate tactical warning and verification of any hostile missile launch. These sensors would provide multi-band coordinated detection information to the NCA for threat assessment and appropriate response and to the SDS-CC for target assignment and weapons preparation. CINC-SD could employ appropriate rules of engagement to posture the SDS to meet the threat and seek employment authority. The firepower, responsiveness, and surveillance capabilities of the integrated system could be brought readily to bear prior to an obvious attack. In the boost and post-boost engagements, BSTS would broadcast the data to the SDS weapon systems. Release authority would direct the SDS weapons against the boosters and PBVs. The SDS sensors would continuously survey the battle providing data for assessment, discrimination, and engagement by additional interceptors.

In the midcourse phase, sensors would track and discriminate RVs, decoys, and debris. The sensors would hand over accurate boost and post-boost data to the SDS midcourse weapons. The large number of space-based sensor platforms would enable them to operate in a nuclear-enhanced environment. Figure A-2 in Annex A depicts the follow-on SDS architecture element candidates.

CHAPTER V

ACQUISITION STRATEGY

A. ACQUISITION APPROACH

The SDS acquisition strategy outlines the approach for acquiring the SDS under the direction of the SDI Acquisition Executive (SDIAE) using the existing management and technical expertise of the Services, other agencies, and SDIO. The SDS acquisition strategy is the basis for developing detailed element acquisition plans for applying resources and expending effort to execute the SDS acquisition. The SDIAE will develop plans, establish policies, program goals, objectives, and priorities, and evaluate DoD component activities under his direction. The SDIAE will serve as the Service Acquisition Executive for all SDS elements. The SDIAE will provide information on system architecture and the characteristics of its elements to support deployment decisions. The appropriate Services and agencies may be designated by the SDIAE as executive agents for development and acquisition of system elements. The SDIAE will exercise close management and retain responsibility to ensure mission effectiveness and cost-effectiveness. Functional allocation, interoperability, and integration among system elements will be ensured through overall control by the SDIO. Figure A-9 of Annex A shows the SDS acquisition process.

B. SDS ACQUISITION STRATEGY ELEMENTS

The SDS would be developed and deployed in incremental phases specifically designed to outpace any evolving threat. Each phase of the SDS would achieve a level of measurable military performance to meet the SDS mission defined by the JCS. A continuing research program will be pursued to support the evolutionary upgrades to the SDS capability. The SDS acquisition process provides the management of many diverse elements into a single, unified system that accomplishes national objectives. The SDS integration requires central control to conduct efficient element trade-offs and to make difficult decisions that cut across Service responsibility. The SDIO will define and control element, segment, and tier interfaces.

Competition and cost management are integral elements of the SDS acquisition strategy. Both will be employed to the maximum extent possible at every level in the acquisition process including: (1) choosing concepts for SDS elements to meet mission requirements; (2) choosing components and technologies that make up the elements; and (3) choosing among elements for numbers and deployment phases. Research is now being conducted to advance the state of knowledge for estimating the costs of meeting SDS performance goals, which cannot be done using just historical data bases and existing cost models. Life-cycle cost will be taken into account throughout the SDS acquisition cycle. Acquisition of the SDS will involve tailoring and streamlining the use of military standards and specifications to the maximum extent possible.

Management of cost and technical risk will be addressed through a combination of techniques: standing adversary panels (red teams), design competitions, parallel development contracts, and integrated testing. These methods will be used to develop confidence in technical, schedule, cost, manufacturing, and support concepts. Extensive use will be made of the National Test Bed (NTB) where extensive simulations will be employed to reduce costs and to replace experiments which technically lend themselves to simulation. Several alternative technological approaches will be pursued wherever practical. A vigorous, proactive design-produce-support-to-cost program will be conducted to manage the risks inherent in such a technologically advanced program. Producibility risks will be addressed by a comprehensive manufacturing investment program. Unlike traditional aerospace systems that rely on a high degree of hand assembly by skilled personnel, many SDS elements will be required in quantities that offer significant opportunities for savings through standardization, modularity, and automation. Contracting will encourage efficient and innovative manufacturing, multiyear procurements, and dual sourcing. System supportability will be a key SDS design parameter. The processes and technologies required to assure supportability will be a priority for the program. In addition the SDS will comply with security, environmental, and safety requirements.

CHAPTER VI

ISSUES

A. INTERACTION WITH INTERIM OPERATIONAL COMMAND

The development of an operationally acceptable SDS with appropriate human interface to its many automatic capabilities means that a close working relationship will be required between the potential operators and the next phase of the research program. A deployed SDS probably would have operational elements in all Services. The US Space Command is designated to perform planning for a ballistic missile defense capability, and is therefore the interim surrogate for the users which will ultimately be involved. Full interaction with the US Space Command is a necessary step toward ensuring an effective ability to fully consider SDS operational planning requirements.

B. SURVIVABILITY

The survivability of the Phase I system is being evaluated against potential responsive Soviet defense suppression efforts. These efforts consist of validated projection of Soviet capabilities and a number of possible threat excursions not explicitly in the validated threat. A broad survivability technology base and a number of passive and active protection concepts have been developed and evaluated. An optimum mix of active and passive measures would be utilized to counter evolving defense suppression threats. Trade-offs among factors such as increased weight, cost, and numbers have been made with the goal of maintaining mission effectiveness.

C. DISCRIMINATION

Developing a capability for midcourse discrimination is recognized as essential to meeting the SDS mission. Soviet responses to the SDS deployment may include the following categories of penetration aids (penaids): simulation, antisimulation, masking, stealth, and excess traffic. Discriminating these penaids from actual RVs against a possible nuclear weapon effects backgıound requires effective performance of sensors with signal and data processing. Discrimination for the Phase I elements is expected to address antisimulation and light decoys. The follow-on phases may see more sophisticated penaids and require active and interactive discrimination. Discrimination capabilities will continue to be improved during Dem/Val with close attention paid to intelligence estimates of the evolving threat.

D. AFFORDABILITY

Investments made during the next five years of the program in areas of advanced materials development, manufacturing technology, producibility, and risk reduction will yield payoffs in terms of lower costs, improved cost control, and lower technical risks for SDS and other DoD programs. Without this infusion of funds, the first phase of the SDS becomes a higher risk undertaking and future phases may be extended as a result of proceeding with research at a slower than required pace.

E. LETHALITY

The effectiveness of the SDS will depend, in part, on the RV kill methods employed. The requirement to predict the lethality of elements under a range of critical environments and operational parameters is recognized as essential. The lethality program underway includes the development of theoretical models to predict kill and validation of those models by either subscale or full-scale integrated tests. During Dem/Val, an independent agency will be used to plan, conduct, and analyze the lethality tests and to validate predictions of interceptor effectiveness. This reduces lethality uncertainties and assists in objective evaluation of system effectiveness.

F. READINESS

The SDS will be designed to be responsive, supportable, and survivable. These characteristics will be integrated into all hardware and software designs from the outset. Due to limited opportunity for servicing and maintenance, the requirement for availability, maintainability, and supportability would be met using very high reliability components, particularly in Phase I space-based systems. Follow-on phases would include unmanned support plafoms to provide cost-effective on-orbit maintenance. Support of ground-based assets would involve the traditional approach of two or three levels of maintenance with a mix of organic and contractor support. Key elements of SDS readiness include extensive use of built-in test and integrated diagnostics, modular components, standardization at the element and component levels, standardized servicing interfaces, and strict configuration control. Preplanned product improvements (P^3I) would augment deployed elements through their extended life.

G. SECURITY

Security will be a principal design driver of the SDS. Security of communications and data transfers during operational tests and system operation is vital to its effectiveness. Included in system design will be the provisions of COMSEC, COMPUSEC, TRANSEC, OPSEC, and the assurance and verification requirements necessary to protect the integrity and availability of the SDS. A comprehensive effort will ensure security through all phases of development, deployment, and operation.

H. ADVANCED LAUNCH SYSTEM

While expanded numbers of current launch vehicles and facilities could satisfy the initial Phase I deployment, it would not be cost-efficient nor would it meet the full Phase I requirement or any follow-on requirements. The SDS would require far greater launch capacity than the US has available. Primary concerns center on meeting high launch rates, designing a robust and flexible vehicle, cost reduction, and environmental and siting problems associated with ALS use. While challenging, these issues appear resolvable.

I. INDUSTRIAL BASE

Elements of the SDS will include critical components and production methods that are dependent on new designs and materials. As a result, these elements face major producibility, production capacity, schedule, and cost risks. In response, SDIO has directed an SDI Productivity Initiative using a network of Manufacturing Operations, Development, and Integration Laboratories (MODILs) as a means to optimize design, cost, and performance. Existing, modified, and new MODILs will be established that should enhance the transfer of new technologies and trained personnel to the industrial infrastructure.

J. EFFECTIVENESS IN NATURAL AND NUCLEAR-PERTURBED ENVIRONMENTS

It is recognized as essential that SDS elements must be able to operate reliably/effectively in the presence of the natural space and atmospheric environment and in the presence of the perturbed far-field environment associated with validated and excursion nuclear threats. Experiments and simulations have been undertaken and will continue to assist in design of SDS elements which can perform their functions in the presence of credible natural and perturbed environments.

CHAPTER VII

SDS ARCHITECTURE DEVELOPMENT

A. SDS STUDIES - PHASE I. The Services and SDIO are running parallel, complementary studies to evaluate sensor combinations for cost effective operation in midcourse, SDIO, in a national-level midcourse sensor study, is looking in depth at the possible contribution of the potential sensor platforms as a function of their configuration, location, and quantities. The Army is looking in detail at the contribution of GSTS probes to the Phase I system. The results of these studies are due at the end of 1987 and will be analyzed and merged so that an informed decision can be made in early 1988.

B. ARCHITECTURE ANALYSES - PHASE I. The SDIO Architecture Contractors are doing in-depth analysis of the characteristics and performance of the baseline Phase I architecture with specific assumptions regarding its elements. The purpose of their work is to refine the operational requirements of the system and get more definition of the BM/C^3. They are using both conventional and process description methodologies in their analyses and the tools they are developing will be passed on to the NTB. The Architecture Contractors are also supporting the SDIO midcourse sensor study.

C. ARCHITECTURE WORK - FOLLOW-ON. Specific architecture work for follow-on phases will evolve as research into SDI technology programs continues. The technologies to support follow-on architectures are in their milestone zero phase of continuing research. Earlier studies have shown a number of potential ways to add to a Phase I system in response to changes in the Soviet threat. A major part of our effort is to assure that Phase I can respond resiliently to threat developments as Phase I grows to a follow-on system; that is, components can be added as required without impact on the overall system BM/C^3. The analysis is parametric at this time because we do not know which direction the Soviets will take in their response to a Phase I system.

ANNEX A

FIGURES

FIGURE A-1 **SDS PHASE 1 CORE CONCEPT**

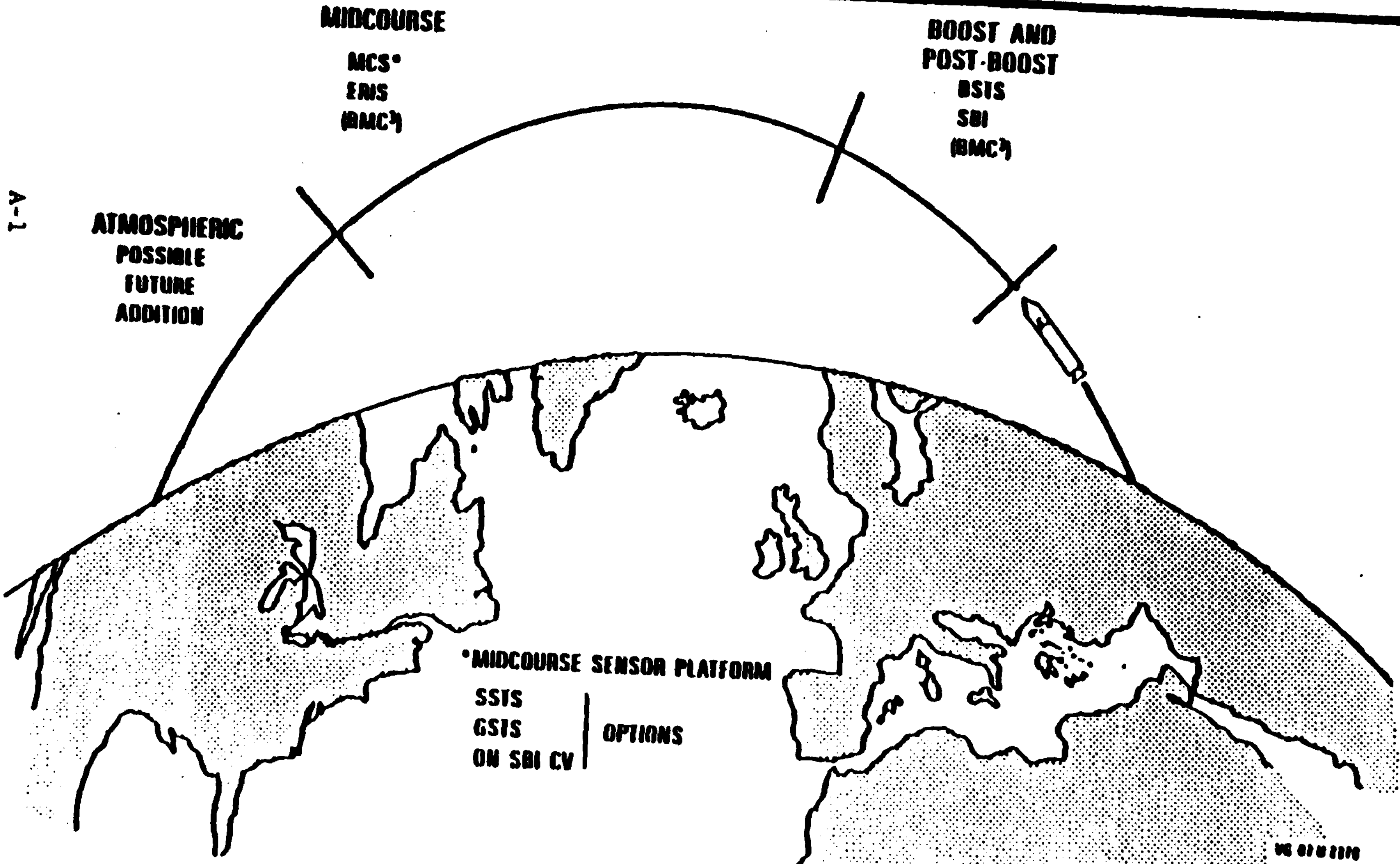


FIGURE A-2 SDS ARCHITECTURE ELEMENT CANDIDATES

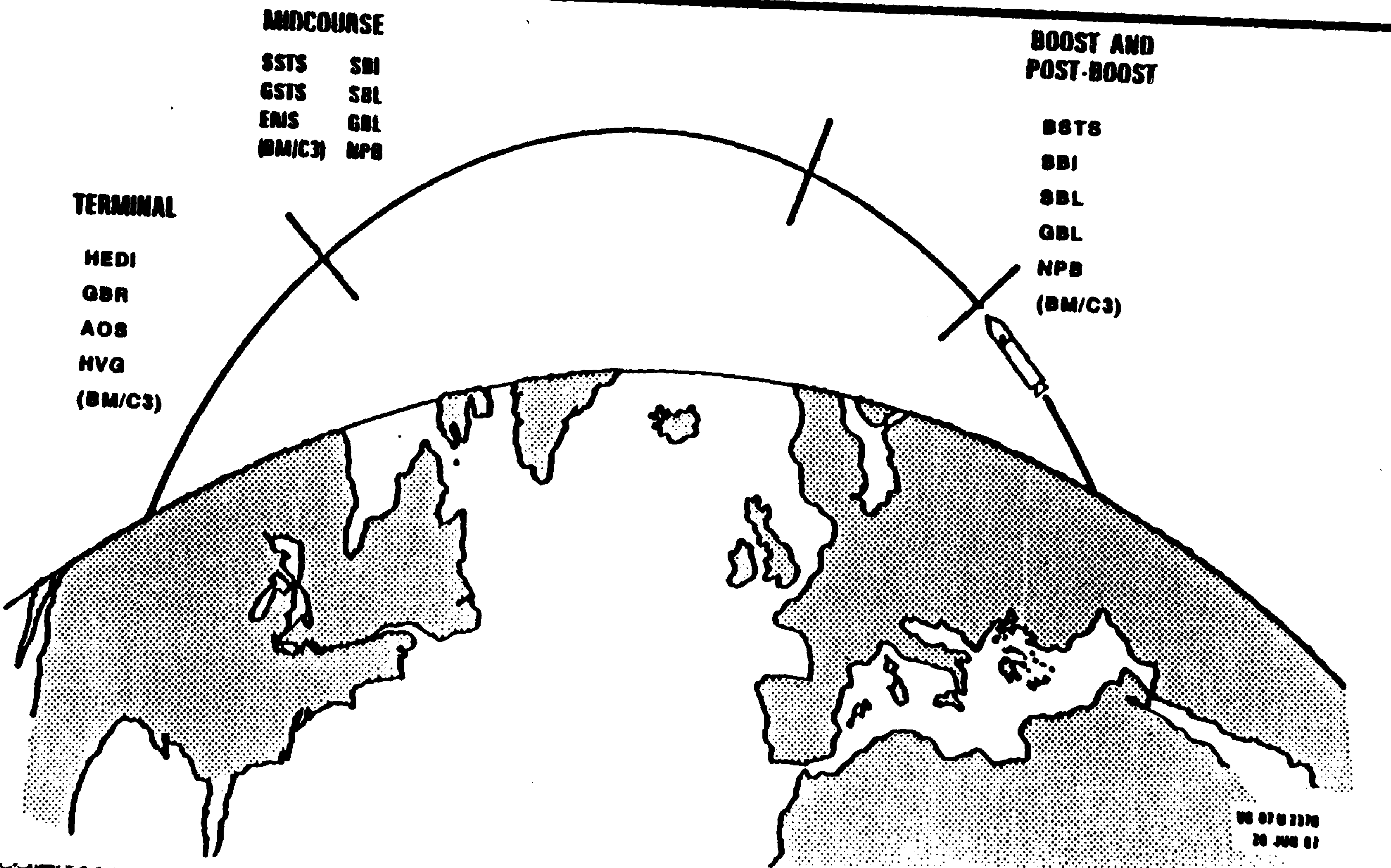
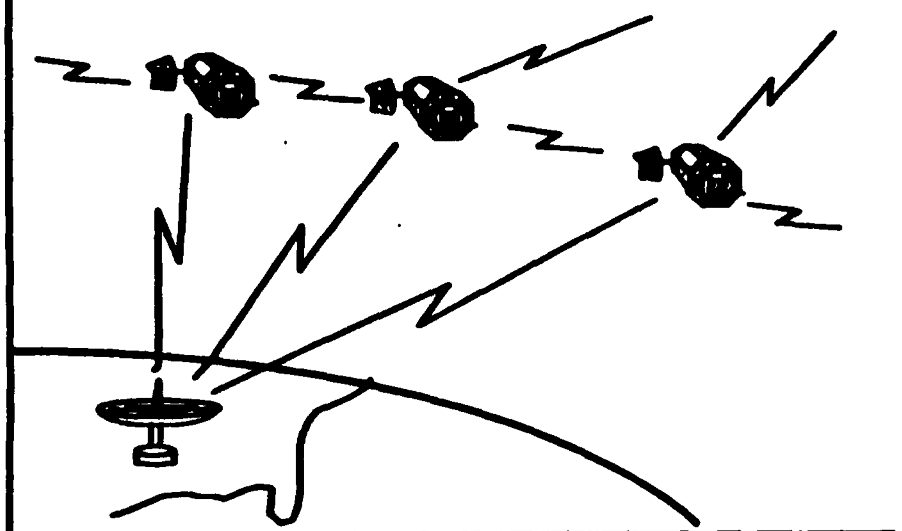


FIGURE A-3 BM/C 3 SYSTEMS DESCRIPTION



KEY REQUIREMENTS

- **Architecture**
  - Minimum Coordination
  - Rigorous + Complete Design
- **Bm/C^3 System Properties**
  - Reliable
  - Testable
  - Evolvable
  - Durable/Survivable
  - Robust
  - Secure
- **Technology Requirements**
  - High Performance Processors
  - Trusted Software
  - Validated Algorithms
  - Jam Resistant, Secure Communications

FUNCTIONS

COMMAND & CONTROL	Maintain Positive Control Assess Situation Manage Engagement
BATTLE MANAGEMENT	Establish And Maintain Tracks Assign Weapons To Targets
COMMUNICATIONS	Manage Communications Network Operate Communication Links

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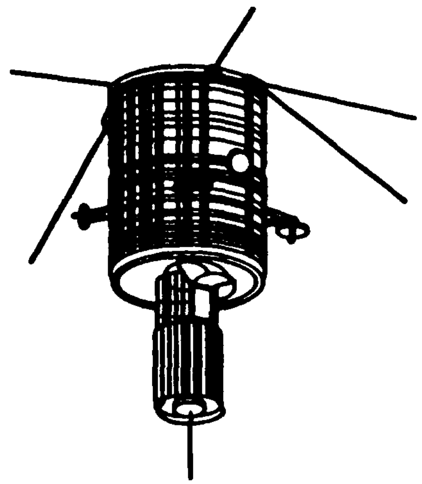
FIGURE A-4 PHASE I - BSTS ELEMENT



KEY REQUIREMENTS

Size: approx. 36x16 ft.

Bands: Multispectral

Sensor: Scanning or Staring

Power: 6-10 kW

Total Spacecraft Weight: 5000-7000 kg

FUNCTIONS

- Surveillance - Continuous Global Observation Of The Earth's Surface
- Detection - ICBMs, IRBMs, SLBMs
- Acquisition - Initiate Tracking Of Missiles
- Tracking - Compute State Vectors And Predict Future Positions
- Typing - Determine The Missile Type
- Kill Assessment - Provide Data To Weapons To Assist In Determination Of A Hit Or Kill
- Communications - Transmit Required Data To All Users
- Battle Management - As Determined By The SDI Architecture

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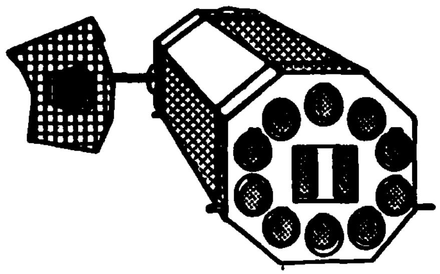
FIGURE A-5 PHASE I - SPACE BASED INTERCEPTOR ELEMENT



KEY REQUIREMENTS

Carrier Vehicle
- 3000 Kg

Interceptor
- Low Cost/Long Life

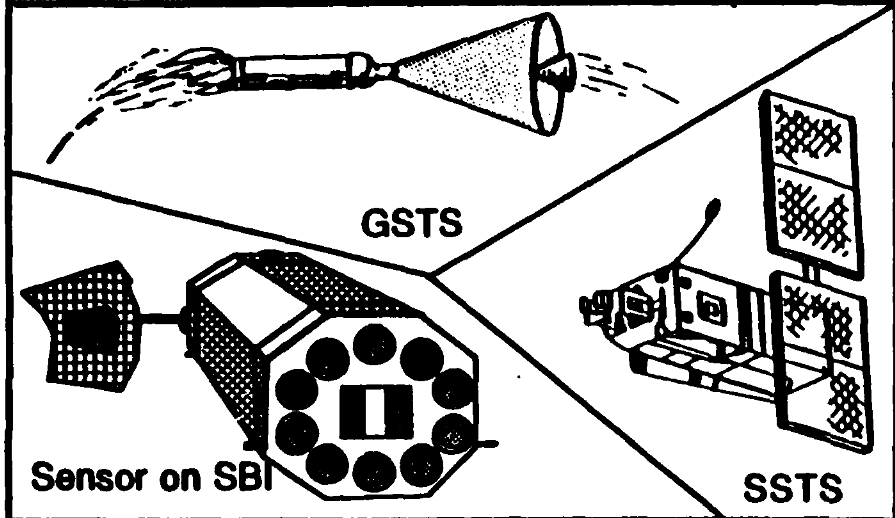
FUNCTIONS

- Intercept Boosters, PBVs, RVs, Self Defense Against Direct Ascent ASATs
- Carrier Vehicles
  - Store And Launch Interceptors
  - Assess Kill And Report Status
- Interceptor
  - Acquire, Home On & Destroy Target

TECH MATURITY AND HARDWARE DEVELOPMENT SUPPORTS FEASIBILITY

NTU A-6A(302)

FIGURE A-6 PHASE I - MIDCOURSE SURVEILLANCE ELEMENT



KEY PARAMETERS

Aperture:	< 1.5 meters
Sensor:	Scanning
Revisit Time:	< 10 sec
No. Of Detectors:	$1.0\text{-}10.0 \times 10^{6}$
Bands:	Multispectral

FUNCTIONS

Acquire and Track Cold (Non Thrusting) PBV's, RV's, Decoys, ASATS

Track Data Provided via BM/C^3 to SBI and ERIS

Discriminate Simple Balloon Decoys

Bulk Filter Debris and Keep Track of All Threatening Objects in Field of View

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FIGURE A-7 PHASE I - ERIS ELEMENT

KEY REQUIREMENTS

- Low Cost Per Rv Kill: ≤ $ 1M
- Lightweight: ~700 Kg
- Lethality Enhancer Using Impulse Kill
- "Dormant" Missile Concept

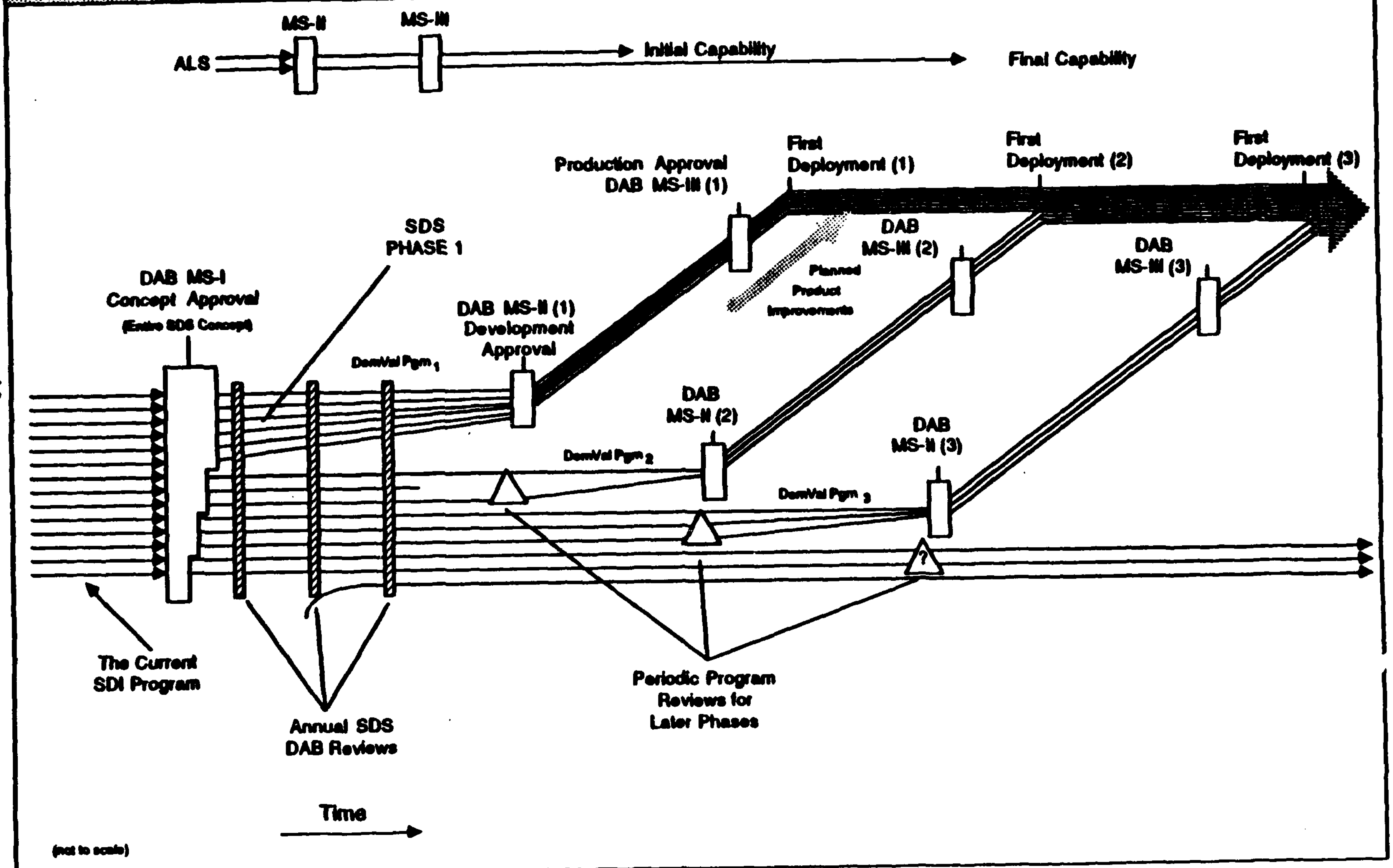
FUNCTIONS

- Accept Target State Vector Updates From Sensors (Radar, GSTS, SSTS)
- Acquire, Home On Target, Impact Rv
- Destroy Rv's In Late Midcourse (Exoatmospheric)

FEASIBILITY DEMONSTRATED (HOE) - LOW COST IS THE GOAL

NTU A-8A(301)

FIGURE A-8 SDS ACQUISITION PROCESS



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