THE RELATIONSHIP/TWAA AND BMD

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Abstract: The military missions of Tactical Warning Attack Assessment (TWAA) and ballistic missile defense (BMD), which is presently being researched under the Strategic Defense Initiative (SDI), have many similar requirements for missile launch detection and tracking. While overall BMD requirements are generally established, the assignment of requirements to each system element is not final. This paper discusses the requirements trends for both missions, alternatives for satisfying these requirements, and the plan for developing a single ballistic missile launch detection system to satisfy both sets of requirements.

Background

The Department of Defense (DoD) began development of a Early Warning System (EWS) in the late 1960's to provide warning of ballistic missile attack. This system has been modified several times since the initial deployment. The current EWS provides the needed early warning of Inter-Continental Ballistic Missile (ICBM) and Sea Launched Ballistic Missile (SLBM) attacks.

In 1979, the DoD recognized the need to begin research on a system that could satisfy early warning requirements for the 1990s. This research program was merged into the SDI research program in 1984. The current program is developing a common system to meet both TWAA and BMD requirements. This system is the Boost Surveillance and Tracking System (BSTS).

In 1987, Congress asked DoD to take a fresh look at the requirements for ballistic missile launch detection and tracking for both TWAA and BMD missions in the late 1990s. DoD organized a General Officer level steering group to perform this task. The Director, Strategic and Theater Nuclear Forces Command, Control, and Communications (S&TNFC3) within the Office of the Assistant Secretary of Defense (C3I) chaired the steering group. Other members represented the Deputy Undersecretary of Defense for Strategic and Theater Nuclear Forces, Organization of the Joint Chiefs of Staff, Strategic Defense Initiative Organization, and Secretary of the Air Force. This steering group issued a report to the Congress in June 1988. The report is summarized in the remainder of this report.

TWAA

The purpose of the SDI program has been thoroughly discussed in the public media. The purpose of TWAA has not received the same publicity.

Tactical warning provides notification that an enemy has initiated hostilities. This differs from strategic warning which identifies that a potentially hostile nation is posturing for a possible attack. Attack assessment determines the nature (what forces are being used) and the likely targets of the attack.

Providing as much warning time as possible is a critical aspect of TWAA. The National Command Authorities (NCA), the President and Secretary of Defense or their duly authorized deputies and successors, use this warning time to decide how the US will respond and to communicate that decision to the forces. The time also allows the bomber portion of the strategic triad to get airborne where they are less vulnerable. The warning time also allows for the implementation of "continuity of command" plans, such as activating alternate command posts.

TWAA is thus a very broad mission. TWAA must warn of ballistic missile and air (bomber/cruise missile) attacks on the United States and Allies. It must also warn of attacks on all the space systems that support TWAA and the strategic retaliatory forces. It must employ intelligence indicators and real time warning sensors. It must process raw sensor data into information and communicate the information to central processing and display systems. The central system must communicate with the NCA and the forces.

The common ground between TWAA and BMD is the area of ballistic missile launch detection and tracking. The remainder of this paper will discuss this common area.

Ballistic Missile Warning

Both TWAA and BMD require detection of a ballistic missile launch event and tracking of the missile during flight. It is obvious that detecting the launch at the earliest moment provides the most warning time. This is why the US has turned to space systems for the early warning role. Tracking of the ballistic missile is needed to determine the probable target of the missile for attack assessment. The tracking data are also needed by BMD for weapons targeting.

Placing the space based surveillance sensor in high earth orbit provides the required early launch detection. A passive system, using infrared detectors, can detect a ballistic missile as soon as it breaks cloud cover. A passive infrared sensor may also be the least costly method for detecting launch events.

The next section will show that the TWAA and BMD requirements for a ballistic missile launch detection system are similar. Where the requirements differ, in most cases, the BMD requirements are the more challenging. However, the BMD system architecture is still maturing. Many of these challenging requirements could be assigned to other elements, such as the mid-course tracking system.

Requirements

Similarities

Both TWAA and BMD require timely detection of all ballistic missile launches. TWAA needs to maximize the time for NCA notification and decision. Maximizing the time available for retaliatory force survival actions (e.g. bomber/tanker takeoff) also increases the deterrent value of those forces. BMD needs to maximize the time available to destroy the booster. It is during boost phase that the defense can destroy the most re-entry vehicles with the fewest weapons. Thus, the timeliness requirements are similar for both TWAA and BMD.

To assess the attack, the US needs to know how many missiles were launched, where they came from and their trajectory. These factors aid the NCA in determining the response the US will make. The response could be much different to a launch of two hundred missiles than to a launch of two. Identifying the missile launch sites provides an indicator of the type of missile. This, in turn, enables an estimation of the number of re-entry vehicles and the destructive power of each re-entry vehicle. The trajectory indicates which parts of North America are under attack.

BMD needs the same information. The number of missiles launched and the launch location enable the battle management system to concentrate attacks on the missiles carrying the most re-entry vehicles. This minimizes damage to the US. Trajectory data are needed by the weapons to target the missile for destruction.

Differences

Where TWAA and BMD requirements are different, BMD's are the more stringent. The differences are, in general, of degree, not kind.

BMD needs the launch and track data processed faster than TWAA. This time is needed to maximize the number of attacks possible during the boost phase. Not only can the fewest weapons destroy the most re-entry vehicles during this phase, but the missile is a larger target. During this phase there are no decoys, so all tracks should be real targets.

Another difference is that BMD needs more precise tracking of the missile than does TWAA. The precise tracking is needed for pointing of the target acquisition systems on the weapons platforms. Precise tracking involves both position of the missile and the sample rate of the track data. These two factors prevent confusion as to which missile came from which launch site if the trajectories cross.

Both TWAA and BMD need low false alarm rates. Because of the BMD mission, a lower rate is needed so weapons are not needlessly expended.

BMD must continue to attack surviving missiles through all phases of the flight. Thus, BMD needs to see targets which have a lower infrared signature than do the first and second states of the missile. What has not been determined is whether the launch detection system or some other element of the BMD system will detect these lower intensity targets.

Both TWAA and BMD launch detection systems must advise ground based command elements of the launch, launch location, and trajectory. The BMD system must also provide its data to the battle management

system and to the weapons platforms. This could require a larger number of communications links and more on-board power generation equipment.

Survivability

The space and ground segments of any ballistic missile launch detection system must survive long enough to accomplish the mission. This requirement is the same for both TWAA and BMD. However, a system capable of supporting both TWAA and BMD may be a higher value target to an attacker than a system that satisfies only TWAA requirements. Thus it would be prudent to build into a system that is doing both missions the ability to survive a more determined attack.

Trends

Looking back at the TWAA requirements of the 1960s and comparing them to the requirements for the 1990s, certain trends become evident. These trends seem unaffected by the advent of a BMD system.

Ballistic missile tracking requirements are tending to both longer and more accurate tracks. Missile technology has evolved by providing more flexibility to the attacker. The number of re-entry vehicles carried has increased, more energy is available to modify the trajectory in flight, and more sophisticated guidance systems allow for some vehicle maneuver. To counter this missile evolution, TWAA has required the launch detection system to follow the missile through second stage burn and accurately define the trajectory.

TWAA has also needed the ability to detect increasingly dimmer targets. The initial requirement was to detect ICBM launches, which are very bright. Then came SLBMs which radiate less energy. As even dimmer tactical ballistic missiles became available, the TWAA system was asked to detect them in support of the theater commanders. BMD takes this process to its conclusion by tracking the missile throughout its flight. (Note that systems other than the launch detection system may meet part of this requirement).

The TWAA system must have a low false alarm rate to preserve its credibility. The requirement to detect dimmer objects with more trajectory flexibility makes maintaining a low false alarm rate difficult. Data processing algorithms need to be evolved to solve this problem. A quantified false alarm level is stated as a TWAA requirement on the missile launch detection system for the first time. This requirement is only slightly less stringent than for the BMD system.

The threats to a launch detection system are also growing, prompting a trend toward greater survivability. Since the ground system is the most vulnerable component today, the trend has been to evolve the space segment to be more autonomous. It should be able to continue operation for longer periods without needing direction from the ground. More on-board data processing simplifies ground processing stations and allows for their proliferation. The goal is to eliminate the need for these ground stations at all and directly broadcast the launch event data from the satellite to the user.

Satellites that must send data to the ground for processing are vulnerable to jamming of the down links. Communications from the ground station to the user are also jamable. The trend is to

require that the satellites communicate to each other so only one needs to find an unjammed ground link. Since at least one satellite will always be near North America, this satellite should be able to communicate to the users.

Geosynchronous orbits are too high for the current generation of Anti-Satellite (ASAT) systems. Future ASAT systems may be a threat at this orbit. If a future space system is to provide a warning, the satellite must survive an attack. This requirement will evolve as the threat evolves.

Alternative Systems to Meet Evolving Requirements

There are three alternative systems that could meet the TWAA requirements of the late 1990s. These systems are: an evolved version of the current EWS, the BSTS, and a less capable version of the BSTS. Of these three systems, only the full BSTS satisfies all BMD requirements.

Evolved EWS

This alternative builds on over 20 years of experience with the current system. It also takes advantage of the current ground system to reduce cost. The evolved system adds detectors to increase the effective scan rate and increases the sensitivity. The system contains a larger field of view and additional processing. The evolved design proposes to use new power generation technology. The producibility of this power generation equipment in the quantity needed is a risk area.

This modification will meet some, but not all, TWAA requirements for the late 1990s. It will not satisfy BMD requirements. Still more detectors (of a new material), active cooling, additional processing, and redundant hardware (for endurance/autonomy) are required to meet BMD requirements. This much change to the current system results in a new and very high risk design. Modifying EWS to meet BMD requirements is not a viable option.

BSTS

The BSTS program is funding two contractor teams, each developing a unique design. The spacecraft is being designed to satisfy all TWAA and BMD requirements of the late 1990s. Both designs are stressing complete on-board data processing. One approach uses step staring and the other a straight staring approach. Both concepts allow for less complex data processing than the scanning approach used by EWS. The staring approach also allows for longer signal integration times improving detection and tracking of very dim targets.

Survivability is a major design feature of the BSTS. It does not require any ground processing of its data. It provides direct broadcast to users and can employ satellite-to-satellite relay to work around jamming and other communications problems. The satellite incorporates techniques to reduce the probability of success of a direct attack. These techniques will significantly enhance the ability of the satellites to survive to complete both the TWAA and BMD missions.

The BSTS designs exist only on paper. Hardware demonstrations of the most critical components will be conducted in 1989 before the critical design review. After reviewing the design and the hardware demonstrations, one contract team will be chosen to

build the BSTS. The high technology content of the of the program makes this the highest risk of the three alternatives. It is also the highest cost alternative.

Less Capable BSTS

The BSTS design meets all TWAA and BMD requirements. Since some of the BMD requirements are the more stressing, DoD could build a less capable BSTS to meet only TWAA requirements. Fewer detectors and less on-board processing is needed. Such a system would be less expensive than a full BSTS and the development risk would be lower. If this system were in production when a decision is made to deploy a BMD system, the features needed to produce a full BSTS could be added. A new development program would not be needed. Assessments of the cost to develop a less capable BSTS and evolving the EWS indicate very small differences. These differences are well within the uncertainty of projecting development costs before completion of preliminary design reviews of either system. Thus the costs for the evolved EWS and the less capable BSTS are considered equal.

Conclusion

TWAA requirements are well defined. They show an evolving trend toward tracking further into the flight, increasing accuracy of tracking, detecting dimmer targets, lower false alarm rates and increased survivability. Satisfying these requirements requires development of capabilities beyond those in the current EWS.

BMD requirements are also defined. The architecture is still maturing so the allocation of requirements to systems could change. The full set of BMD requirements now allocated to the launch detection system is similar to, but more stressing than, the TWAA requirements. BSTS is the only alternative that can satisfy these requirements.

A less capable BSTS could result from the BSTS technology program. Such a less capable system would satisfy the TWAA requirements at a cost about the same as further evolving the current EWS. Unlike the evolved EWS, the less capable BSTS could grow to meet the BMD requirements.

Given these factors, the best solution is to continue the currently planned BSTS program through critical design review. At that time, the DoD will choose to build a BSTS or a less capable BSTS depending on BMD maturity. If the less capable BSTS is chosen, upgrade to a full BSTS when needed for BMD. The DoD report to the Congress contains this plan.