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MEMORANDUM
RM-5037-PR
JULY 1966

FUTURE THREATS TO SATELLITES AND POSSIBLE REACTIONS (U)

T. M. Parker and J. H. Rosen

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PREFACE

This Memorandum is the text of a talk for presentation at the Satellite Survivability Session of the Eleventh Symposium on Space and Ballistic Missile Technology at the U.S. Air Force Academy, Colorado Springs on July 6-8, 1966. It explores a range of possible conflict situations from cold war to general war in which incidents of space warfare might occur and suggests some implications for future space operations and satellite survivability planning.

This Memorandum draws upon The RAND Corporation's continuing studies of military space operations and space warfare.

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SUMMARY

In the current political-military relationship between the United States and the Soviet Union, each nation seems willing to tolerate the other's space activities in order to preserve its own freedom of operation in space. This situation could change quite suddenly in the future. Incidents of space warfare could occur in connection with escalation of limited wars and crises, changes in national space policies, the resumption of nuclear weapon testing in space, and the development and deployment of space systems for general war operations, especially any containing nuclear weapons. These possibilities have many implications for future space operations and policy.

In situations short of general war, a variety of measures could be taken to protect space systems. In some situations, hardening and decoys might be effective. In others, satellite survival may depend on indirect measures such as deterrence and coercion. To react quickly requires good technical intelligence information on Soviet space activities and anti-satellite capabilities. Also needed are contingency plans for limited space warfare, including provision for the assessment of the threat (tactical intelligence), for the employment and improvisation of various countermeasures, and for measures to maintain secure space operations.

Space systems with general war missions could face very difficult survival problems prior to and at war outbreak. Although the destruction of the Soviets' anti-satellite system at war outbreak could help to ensure the survival of some systems in orbit during general war, a great deal of space warfare could occur in a crisis prior to war initiation. Satellite survival in this period may depend on the effectiveness of such countermeasures as attack warning, maneuvers, and decoys, which must be included in the design of the satellite system. Some systems might be kept on the ground for launch in a crisis or at war outbreak. While this procedure would avoid some space survival problems, these systems could be destroyed on the ground prior to launch or during launch.

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The range of threats to be considered for general war space operations includes various ground-based and space-based anti-satellite systems, boost-phase intercept systems, and the destruction of ground support facilities. Effective reactions to these threats may require the integrated use of many systems, including strategic offense, anti-satellite, surveillance, and intelligence, in addition to the direct use of various satellite survivability measures.

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CONTENTS

Approved for Release: 2017/01/25 C05096402

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DISCUSSION

Levels of conflict in which space systems might be involved provide a context for considering future threats to satellites and possible reactions. This talk is intended to explore possible conflict situations ranging from cold war to general war, and to suggest some implications for space operations and satellite survivability planning.

THE CURRENT SPACE ENVIRONMENT

Space operations to date have encompassed many activities--lunar and planetary exploration, manned spaceflight, space research, commercial communications, military support, etc. Other than the Starfish incident in 1962, there have been no satellite survivability problems. Incidents of space warfare have not occurred even though both the United States and the Soviet Union presumably have anti-satellite capabilities. At this time, there is a mutual toleration of each other's space operations and a mutual deterrence of interference. When general war is an unlikely prospect, as it is at present, the potential political-military gains from initiating space warfare are highly questionable.

The apparent similarity between the U.S. and Soviet space programs suggests a basic reason for mutual toleration. On the military side, both have emphasized observation and other support operations. Both have agreed not to station nuclear weapons in space, although future space weapon systems are presumably being considered. While the operations of some systems are important factors in maintaining the strategic balance, they are generally regarded as peacetime operations and not as "threats" to be eliminated.

In addition to their unmanned military programs, both the United States and the Soviet Union have huge investments in manned spaceflight programs. The military or national security aspects and potentials of the latter programs are widely known. The possibility that a space warfare incident might involve these programs would seem to be a strong deterrent to anti-satellite actions. Furthermore, in some situations

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it may not be possible to differentiate between military and other space activities.

Although the United States and the Soviet Union dominate current space activities, other nations are beginning both national and multinational space programs. Many nations already share in the ownership of COMSAT. Other joint commercial ventures may follow. Thus, the preservation of free access to space and of noninterference with space activities is of growing concern to many nations and antisatellite actions would have a worldwide effect.

The present situation does not imply that there will be no satellite survivability problems. Many aspects of the current space environment could change, short of general war, and give rise to various incidents of space warfare. Some possibilities will be discussed in the next section.

SATELLITE SURVIVABILITY IN SITUATIONS SHORT OF GENERAL WAR

The world situation today includes a war in Vietnam, growing apprehension of a future Chinese nuclear threat, and strained relations with the Soviet Union. Space systems could be involved in future confrontations, limited wars, and crises short of general war. National defense objectives and space policy may change; the role of space systems in support of defense objectives may expand, and space systems may be deployed to perform vital strategic missions. Nuclear weapons may be tested and stationed in space. If military space activities expand, space surveillance and intelligence operations will also expand. Systems may be deployed in space to monitor enemy space activities. These possibilities have many implications for space operations and satellite survivability.

Space Operations and Limited Conflicts

Space systems could provide various support capabilities for limited conflicts. In fact, communication satellites currently link Vietnam and the United States. Tactical communications, weather observation, and navigation satellite systems may be used in the

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future. As long as the Soviet Union is engaged in space activities, it should be possible to deter attacks on such U.S. satellites by the threat of retaliation against Soviet satellites. In addition, most support missions can also be performed by non-space systems, so that destruction of a satellite or an entire satellite system probably would not stop the support mission. Communications can be routed by HF and cables, conventional navigation systems can be used, etc. Such backup capabilities would presumably be available. Furthermore, in a limited conflict the enemy may gain more by intercepting and using the readout of space systems than by interfering with them. There is the obvious example of communications; but in addition, weather pictures transmitted to a theater command could be equally useful to the enemy. Such interception or "leakage" could be of greater concern to space-system planners and operators than satellite survivability.

Nuclear Weapon Testing in Space

The current test ban treaty may be broken or nations that are not party to it, e.g., China, may test in space. If the United States resumed testing in space, various measures could be taken to minimize the chances of collateral damage to its satellites. In addition to careful placement of bursts to avoid satellites, both satellite design and component selection could significantly decrease the range at which satellites may be damaged by direct nuclear effects. Cumulative nuclear effects could be minimized by using orbits that avoid the radiation belts.

Little can be done to protect a satellite from a test detonation nearby. The Soviet Union might be deterred from such deliberate placement by the U.S. capability to respond in kind; however, a sequence of incidents could occur under the guise of nuclear testing. Probably only unmanned satellites would be involved. If such "tests" or attacks were not halted by diplomatic means,* various countermeasures could be employed (if provisions for their use had been incorporated

*In some situations, a diplomatic protest may not be wise since it would provide damage assessment information to the Soviet Union.

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in the system design). [redacted] Knowledge of the kind of space surveillance and missile systems used in the "test" program would provide a basis for the selection of the best counter-measure. A very difficult low altitude survival problem would arise if the Soviet Union were testing an exo-atmospheric anti-ballistic missile (ABM) system, using the acquisition radars to detect the U.S. target satellite and the ABM interceptor to loft the warhead. In this case, [redacted] some missions could be suspended when tests are expected. 50X1

In the case of a satellite kill by a Chinese nuclear test, a response in kind may not be available--the Chinese may have no satellites in orbit. Other responses would be needed to deter further attacks.

Nuclear Weapon Deployment in Space

The United States and the Soviet Union have agreed not to station nuclear weapons in space. If this agreement were broken, the whole character of space operations could change. All spacecraft large enough to carry weapons might be considered hostile until known to be otherwise. The activities of large, manned space stations would be of special concern. The nation deploying the weapons, even if only for environmental testing, would try to prevent the other side from knowing about its activities and interfering with them. The other would be trying, perhaps with special spacecraft, to determine the nature of the weapon deployment. These activities could lead to attacks on the satellites involved. Consider the following situation:

> A is testing military systems in a manned space station. B sends up a manned interceptor to rendezvous with the space station and keep it under surveillance. The interceptor closes to within a mile of the space station and then sends a remote maneuvering unit with a TV camera and ELINT receiver to orbit the space station at a distance of a few feet. The interceptor returns to earth but leaves the remote maneuvering unit to keep the space station under continuous surveillance. Pictures and ELINT are transmitted from the remote maneuvering unit to the ground.

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Does A tolerate the surveillance? How close should B send the remote maneuvering unit? What if it collides with the space station? Answers to such questions have many implications for survivability of both space station and interceptor. An incident between the two could also lead to attacks on other satellites.

The deployment of nuclear weapons could also lead to a reevaluation of space policy. Should "freedom in space" also cover weapon-carrying spacecraft? In addition to threat assessment, surveillance, and gathering intelligence information, should anti-satellite activities be initiated? Certainly the nation deploying the weapons would have contingency reaction plans. It might threaten retaliation against other satellites to deter direct interference. Of course, if the United States were to initiate anti-satellite actions, it must be prepared for possible retaliatory attacks against its own satellites. This has obvious implications for satellite survivability.

If strategic systems are deployed in space, the best course may be simply to observe their operation and to plan for their destruction when the outbreak of general war appears imminent.

Space Systems Designed for Use in General War*

The maintenance of an assured destruction capability in order to deter a deliberate nuclear attack is currently a prime basis for structuring general war forces. Accordingly, the United States has deployed forces to make such an attack highly unlikely. If future planning were to emphasize other general war contingencies such as the escalation of a limited war, small attacks, and extended counter-force operations, the potential capabilities of space systems would receive more attention. In wars that develop slowly and do not suddenly escalate to a spasm exchange, satellites could be used for a variety of important operations: launch-point determination,

*A general war is defined here as one that involves the use of nuclear weapons against the U.S. or Soviet homeland.

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missile trajectory prediction, bomb damage assessment, mobile target detection, aircraft location, communications, boost-phase interception of missiles, satellite interception, space surveillance, and weapon basing. In many of these operations, space systems would complement other systems; in some, they would provide unique capabilities.

When, in times of crisis, the outbreak of general war appears imminent, the vulnerability of space systems with general war missions would perhaps be even more critical than in an extended general war wherein it may be possible to destroy the Soviets' anti-satellite system. Systems that are maintained in orbit could be vulnerable to attack because the enemy would have had an opportunity to observe their operation and to prepare means for attacking them. Systems maintained other ways might have a better chance of being available when needed at war outbreak. For example, some satellites could be kept on ground alert for launch during a crisis or at war initiation.

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In the event satellites are attacked during a crisis, survivability measures could be used, if provision for them had been incorporated in the satellite design. Their effectiveness would depend on the kind of anti-satellite system used against them and the duration of the crisis. In a grave crisis, either side may be willing to pay a very high price to eliminate a particular space system. The fact that the cost to destroy a satellite may be much greater than the cost to deploy the satellite may not be relevant when general war outbreak is imminent, and the satellite has a vital mission to perform.

If survivability measures are not effective in protecting satellites, there are a variety of other actions short of initiating general war. If elements of a Soviet anti-satellite system were based outside of the USSR, they could be destroyed. A nonnuclear attack on key anti-satellite system elements in the Soviet Union might be carried out. Although such attacks could lead to further escalation, they might be the only way to ensure the survival of some space systems.

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Attacks on U.S. satellites in a crisis could trigger reactions other than those just discussed. For example, if satellite reconnaissance flights were not possible, high-performance aircraft might be used. If weapon-carrying spacecraft were attacked, the United States might retaliate with ASW operations against Soviet missile-carrying submarines. Also, Soviet spacecraft could be attacked in retaliation. Of course, a corollary implication is that if the United States initiates space warfare in a crisis, it must be prepared for retaliatory attacks against its satellites and also for possible attacks against other forces, especially those not based in its homeland.

If a crisis were to escalate to general war, i.e., nuclear weapons used against the U.S. or Soviet homeland, nuclear attacks could be launched against the Soviet anti-satellite system. This possibility will be discussed in the next section, which considers satellite survivability in general war.

SATELLITE SURVIVABILITY IN GENERAL WAR

Since incidents of space warfare may well precede war outbreak, as discussed previously, much of the discussion in this section also applies to satellite survivability in times of crisis prior to war outbreak. Except for the outbreak characterized by a sudden, massive nuclear attack, transition into general war could include many military confrontations and incidents, some of which could involve space systems. Space is a likely environment for such actions since it is far removed from the U.S. and Soviet homelands. This section considers a range of future threats to satellites (including their ground support facilities) and discusses some possible reactions.

Destruction of Ground Support Facilities

The survivability of satellite ground support facilities can be just as important as that of the satellites. The tracking, readout, and control stations presently in operation are very vulnerable to direct nonnuclear attack. Island facilities may be destroyed prior to war outbreak. The destruction of facilities in the United States could be expected in a general war.

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Mobile or redundant facilities could be deployed in the United States to sustain space operations during general war. Some satellites might carry on-board navigation systems to remove their dependence on ground tracking facilities. Of course, secure command and control must be maintained.

Some space systems for general war operation might be kept on ground alert for launch in times of crisis or at war initiation. These could be deployed on soft sites in the United States. While they would be very vulnerable to attack, the enemy might be deterred from such attacks in the early stages of a crisis. Other systems might be deployed in hardened shelters for post-attack launch. These must have a good chance of surviving an enemy first strike, although in some situations they could be launched on warning. The hardened shelters could be mixed in with ICBM sites to prevent selective targeting.

Boost-phase Interception

Boost-phase interception is a possible threat to satellite launchings in times of crisis or at war initiation. It could be very effective when many satellites are carried on a single booster. Also, it might be the best way to kill satellites that would otherwise be difficult to find or intercept after they reach orbit. Overwater launchings from the Eastern and Western Test Ranges would be especially vulnerable to attack during boost. The Titan III booster travels about 2000 n mi downrange during its nominal 15 min powered flight. Sea- or space-based interceptors could be used. Launch detection and boost-phase tracking could be performed from high altitude surveillance satellites or ships.

To counter this special anti-satellite system, prior information of Soviet capabilities must be obtained. If ships were used, they could be kept under surveillance and destroyed if they attempted to interfere with any satellite launchings. At the first use of space-based interceptors, the remaining interceptor-carrying satellites could be attacked by short-burning, anti-satellite interceptors to remove that threat to subsequent launchings. Such reactions to a

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boost-phase intercept threat illustrate the need for integration of certain naval, anti-satellite, intelligence, and surveillance systems with satellite launch operations.

Satellite Interception

If the Soviet anti-satellite system consists of a few soft space surveillance sensors and interceptor sites, these elements could easily be knocked out by a nuclear missile attack. While such a system could easily be designed to kill an entire satellite population in a few hours, its usefulness at the start of a general war could be greatly limited if the United States detected the launch of the interceptors, maneuvered satellites subject to attack, and then destroyed the anti-satellite system. The interceptors could be tracked by high altitude surveillance satellites. All satellites that might be attacked could be warned to change orbits. Satellites at synchronous altitude would receive at least an hour's warning. Most of those at low altitudes would receive at least fifteen minutes warning. However, those over or near the Soviet Union probably would be killed in this attack.

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A missile attack could destroy the remainder of the anti-satellite system so that the satellites surviving in orbit could not be attacked for the duration of the war.

If in the future the Soviet Union deploys an area ABM system consisting of a number of hardened radars and many hardened interceptor sites, such a system might have a first-pass intercept capability against satellites that overfly the Soviet Union at altitudes up to a few hundred miles. Hardened ICBMs having an anti-satellite capability could raise the intercept altitude to a few thousand miles. This kind of anti-satellite system could defend itself against a missile attack. If it were to survive and operate in a general war, satellites would need to avoid it or to penetrate it; both options may be difficult. While high altitude satellites may be beyond the reach of the interceptors and low altitude satellites in low inclined orbits may not come within detection range of the

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radars and thus avoid interception, missions that require many low altitude overflights of the Soviet Union may be difficult to perform if faced with such an anti-satellite system.

It was suggested previously that satellites could survive at war outbreak if they were able to maneuver on warning of interceptor launchings and also that they could survive during a general war if the enemy's anti-satellite system could be destroyed. One way the Soviets could decrease the available warning time would be to preposition interceptors in space near U.S. satellites. These space-based interceptors might also be able to survive and operate during general war if a space surveillance capability also survives. Space-based interceptors could pose a difficult threat to the survival of a satellite system at the start of general war. Once an interceptor is launched from the satellite, there may be little that can be done to save the target satellite, especially if a nuclear warhead is used. To plan countermeasures and actions prior to attack, knowledge of the anti-satellite satellite's characteristics and mode of operation would be needed. This would be a space intelligence mission. Actions against these satellites would be a mission for a U.S. anti-satellite system. This possible threat illustrates the need for an integration of satellite, space intelligence, and anti-satellite operations.

Some Implications for Satellite Survivability in General War

Basic future threats to space system operations in general war are likely to be

- o destruction of ground-support facilities
- o interceptor versions of ballistic missiles and space boosters
- o area defense deployment of an ABM system.

In anticipation of these threats, various countermeasures and reactions can now be planned.

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included in the satellite design; it is not easily improvised. If the Soviet anti-satellite system has vital elements that are soft, their destruction after war outbreak could be planned to ensure the survivability of remaining U.S. satellites. [redacted] could be developed for other satellites if the anti-satellite system is difficult to destroy, as an ABM system might be.

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Some reactions to and countermeasures against space-based interceptors and boost-phase intercept systems would require prior knowledge of the systems. Observation of the development and testing of such systems is desirable if not essential to provide sufficient lead time to develop these reactions and countermeasures. Some of them probably would involve the use of the U.S. anti-satellite system, which is presumed to have a variety of capabilities for general war operations.

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CONCLUDING REMARKS

This talk has explored some of the contextual factors that I feel must be considered to place the technical aspects of satellite survivability in perspective. It also emphasizes the need for considering how other military forces would operate in support of space operations.

In the current political-military environment, direct interference with U.S. military support systems appears unlikely. Mutual interest in preserving freedom of operation in space implies a toleration of such activities. However, the space environment could change quite suddenly in the future. Incidents of "limited space warfare" could occur in connection with nuclear weapon testing in space, development and deployment of space systems for general war operations, limited conflicts, and crises short of general war. Of prime importance in reacting quickly to possible future incidents is good technical intelligence information on Soviet space activities and anti-satellite capabilities and good tactical intelligence on the nature of possible incidents. A corollary implication is the need for secure space operations on the part of the United States.

Survivability considerations should be a central part of planning for space operations in times of crisis and general war. While the destruction of the Soviets' anti-satellite system may ensure the survival of some space systems during general war, satellite survivability in the crisis period prior to general war outbreak will depend on the effectiveness of countermeasures [redacted] 50X1 [redacted] These must be considered in the satellite design. It is here that I feel most of the technical work on satellite survivability is most applicable.

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