6.0 Conclusions and Recommendations

A general assessment of the future world environment and technological developments leads to conclusions and related recommendations for action by the United States Air Force. The recommendations are provided in the context and on the assumption that the Air Force will be the executive agent for DoD space matters and that the Air Force is prepared to assume the responsibility of supporting all military customers and national needs as required by the National Command Authority.

The overarching conclusions are:

- Successful integration of space with our information based warfare capabilities will be critical to maintaining information dominance of the battle space and winning at information warfare;
- The proliferation of commercial space systems gives our adversaries unprecedented access to militarily significant capabilities that will reduce the information advantage our forces presently enjoy;
- The Air Force must welcome and capitalize on capability growth and technological advances in commercial space in the fielding of militarily useful systems;
- The need to disrupt, deny and influence the enemy's perception of the battle space while assuring our use for information based warfare is essential, and thus space control takes on new significance in this environment;
- In the long term space systems will be well suited to project force from space to targets anywhere on earth;
- Some near term program activities could limit efficient implementation of the future options envisioned in this report, and the Air Force should establish roadmaps to correct this situation.

The Space Application Panel arrived at the following specific conclusions and recommendations:

Information Warfare

With the proliferation of commercial information sources the management of information and influence of the enemy's perception of the battle space through information warfare will be the dominant factor in deterring and winning future wars. Collection, fusion, analysis, disruption, disablement, denial and tactical and strategic deception of battlefield awareness are warfighter functions that must be integrated into our joint warfare operations to attain and maintain information dominance.

Recommendations

1. The Air Force should support integrated but dispersed processing and fusing of intelligence and battlefield awareness data to provide our forces the advantage of faster and more expert use of available information.

2. The Air Force should advocate the creation of a joint warfare information function to be in charge of all information that influences the outcome of the battle.

3. The Air Force should take the lead to define the space system requirements to support offensive and defensive information warfare.

Commercialization

Capability growth and technological advances in commercial space, especially communications, positioning, environmental monitoring and reconnaissance will far outpace government efforts in many areas. Customers, including individuals, corporations and nations, will have unprecedented access to militarily significant data that will reduce the "information advantage" our forces enjoy presently. These systems will be comparatively robust, secure and accessible as unique military systems.

Recommendations

1. The Air Force should develop specific road maps for the exploitation of commercial communications, positioning, environmental and reconnaissance systems that assure availability of these assets from day to day peacetime operations through major regional conflicts.

2. The DoD must develop, document and implement an approach to positively incentivize commercial providers of space-based goods and services to do business with the government and to add military-unique functionality to their commercial systems to give the DoD incremental advantage at lowest costs. The key is to establish relationships with commercial providers early in their development cycle.

3. The Air Force representing DoD should establish an integrated product team to: a) maintain a continuous assessment capability of commercial space systems and their supporting communications and ground infrastructures which may be potentially useful or threatening to the United Sates; b) act, or enable a clear path to higher authority to recommend action, as a result of these assessments; and c) infuse commercial technology/operational capability awareness throughout the relevant planning, acquisition and operational elements of the USAF.

4. The Air Force, representing the DoD, should establish much more effective mechanisms to promote regular dialog, alliances, and investment to interact/participate with US commercial space enterprises in the areas of: a) standards definition, b) bandwidth/frequency allocation, c) joint specifications definition, d) joint development, especially for low-demand but cutting-edge technologies important to the US government, and e) operational control/access/privileges during times of declared national emergency.

Distributed Satellite Systems

Advances in computers, sensors, and materials permit establishment of large constellations of interlinked satellites, whose integrated output will give global, real-time coverage. Reducing range to target and constellation altitude reduces satellite size and cost of coverage. The advantages of such systems have already been embraced by the commercial space industry as the way ahead.

Recommendations

1. The Air Force should create a road map which recognizes the twin realities of inexpensive, single-sensor, small satellites and distributed processing and communications enables a significant advance in reconnaissance, surveillance and battle awareness.

2. The Air Force should begin development of a suite of small satellites to complement the evolving national sensors for timely battle field reconnaissance.

3. The Air Force should focus, where appropriate, on hybridized, distributed architectures, employing on-board processing, storage and cross-linking now being incorporated in commercial distributed space system designs.

Communications

Future multimedia communications systems will provide broadband communications to any person and to any point on the globe. These universal capabilities, whose transmission media and routing will be transparent to the users, will be available commercially and will provide reliability, flexibility, capacity, security and quality of service that will be difficult to match with government owned systems. Connections to other elements of the information systems may be more limiting than the communications systems themselves. Rapid expansion of use of available bandwidth due to advances in processing and antenna technology will significantly improve communications available to mobile users.

Recommendations

1. The Air Force should develop and implement a global terrestrial and satellite communications architecture whose infrastructure would be built upon both DoD and commercial capabilities.

2. Published standards should be established for future communications architectures to be distributed, flexible, scaleable, fault-tolerant, reconfigurable, and transparent to the users.

3. The Air Force should advocate the practice that DoD users who can reside on fiber optic arteries should be required to do so, and the warfighters given priority for satellite communications for mobile and tactical users.

4. Truly unique military survivable and enduring satellite communications requirements should be identified and implemented through a combination of unique military space systems, complemented with appropriate non-military systems and technologies.

Global Positioning , Time Transfer And Mapping

The current Global Positioning System (GPS) using the P(Y) code meets the basic requirements of the military for precise position location and time transfer. The GPS employs the Defense Mapping Agency WGS 84 world wide grid permitting maps and data, such as derived from reconnaissance, to be expressed in a common position language for use as needed by the warfighter. The GPS user receivers when properly designed and integrated with Inertial Measurement Units provide highly accurate navigation in three dimensions to fast moving vehicles. Such military receivers are resistant to jamming especially when equipped with self-nulling antennas. The C/A code is available to all GPS user receivers. It thus can be used by potential enemies unless jammed in the battle area. The use of the Selective Availability concept has reduced international acceptance of the GPS for such civilian uses as commercial air navigation and proliferation of differential GPS has diminished its usefulness.

Recommendations

1. The use by the DoD of selective availability (S/A) to reduce the accuracy of the C/A code position location should be discontinued.

2. Methods and systems should be developed to assure U. S. and allied forces positioning information over limited battle areas while denying similar quality support to the enemy forces without seriously affecting essential out of area civil and commercial operations.

3. In the long term the Air Force should aggressively support advanced technology using space systems leading to consistent positioning and mapping accuracies on the order of 30 centimeters. Such space systems should support relative position accuracies in the centimeter range.

4. Time transfer to accuracies of a nanosecond or less should be an integral part of any global positioning system to provide synchronization in future communications and information systems. The highly accurate temporal and spatial information should be assigned eventually to all information and serve as the basis for the storage and retrieval of this information.

Observation And Battlefield Awareness

The information that can be obtained from space-based sensors integrated with airborne systems and geopositioning capabilities offer the potential for revolutionary changes in the combat environment and employment of forces. Future U. S. commanders must have near real-time, all weather information on the location and status of friendly and hostile forces; locations of moving ground, sea and airborne vehicles, and space objects; current and future projections on terrain and weather; nearly instantaneous threat warnings; and the ability to share this information with all levels of command.

Recommendations

1. In order to exploit fully the available technology to the warfighter's advantage, the Air Force should be a full participant in planning, developing, acquiring, launching, and operating of U. S. military and intelligence space reconnaissance assets.

2. Aggressive investment should be continued on methods and technologies to extract information from data at all points of the process. The focus should be on rapid, smart systems to reduce the dependency on humans wherever appropriate.

3. A user-needs driven attitude should prevail within the information acquisition community and a seamless interface should be established with the intelligence community to ensure sharing of data bases, and commonality of objectives. System, and architecture definition and implementation with full warfighter input, recognizing the need for balance among all users, technology and attendant costs should be pursued.

Space Control

Because of the general recognition of the importance of space systems to successful combat, we must assume our space systems will be threatened and it will be necessary to limit an adversary's access to space capabilities. Survivability requirements and techniques,

against both hostile and natural threats, are as important for space system acquisition and operations as for terrestrial systems. A spectrum of offensive capabilities ranging from temporary disruption of hostile ground operations to satellite negation should be available to our forces. Local control of an enemy's environment, through disruption of his communications and information infrastructure, without global disruption will be an important tactic.

Recommendations

1. The Air Force must ensure that its most valuable space assets are safe against attack by third world nations, rogue groups and major powers.

2. The Air Force must develop and field a capability to deny, degrade, disrupt, exploit and, if necessary, destroy the use of space assets by others, globally or in a local region.

3. The Air Force should continue to study the potential threat posed by space debris and the necessary techniques for its surveillance, mitigation and removal, if necessary.

Force Projection

Future space systems will be well suited to project force against air, land and sea-based targets anywhere on earth. Precise delivery of munitions, directed energy or electronic warfare on virtually any target, heavily defended or not, within minutes or hours of tasking and with minimal risk to U. S. forces could have a decisive impact at all levels of conflict.

Recommendations

1. The Air Force should broaden the use of space to include direct force projection against surface, airborne, and space targets.

2. The Air Force should define and develop microwave and laser space-based weapons for tactical and strategic applications

3. The Air Force should develop space munitions capable of precision strikes against surface and airborne targets.

Access To Space

A number of commercial projects are underway to develop small and medium launch vehicles and there is strong competition from the international providers of large vehicles. Full integration of space capabilities into routine military operations will only be realized when launch is no longer a significant operational constraint. Although expendable vehicles may continue to provide limited, unique services, over time, dramatic improvements in cost and capability will come through an operational reusable system for all orbital regimes. The same technologies and operational concepts needed for reusable space launch will support transatmospheric systems that could provide presence anywhere on the globe in under two hours. Military human roles in space may evolve in time for on-orbit support of complex systems.

Recommendations

1. Continue to support the NASA reusable space launch technology efforts within the Air Force laboratories including the X-33 technology efforts but emphasize operability and reliability.

2. Continue to support a hypersonic technology development program with the objective of readying the technology base to support the development of future transatmospheric vehicles.

3. In conjunction with NASA continue to investigate the utility of humans in space for military operations.

4. Place emphasis on developing high specific impulse, high thrust propulsion technology to support development of future launch and orbital transfer vehicles.

Modeling, Simulation, And Analysis

Modern and future tools for connecting widely distributed centers of MS&A excellence and the explosive growth of virtual reality concepts and technologies will make it possible to conceive ideas and test them with technology, hardware and humans in the loop and then smoothly transition these experiments, demonstrations, and exercises into operations with unprecedented speed at heretofore unrealizably low costs. This is particularly true for the utilization of space systems. The Air Force should exploit these opportunities and the substantial investments in the National Test Bed to underwrite the development of doctrine, lower the costs of modernization, and train the joint warfighter.

Recommendations

1. The Air Force should quickly press ahead with a joint implementation of a DoD "virtual test bed" for space technical concepts and warfighting conops.

2. The DoD must eliminate the boundaries between MS&A for modernization support and MS&A for operations support. A seamless process which includes the joint warfighter in acquisition MS&A and the acquirer in operations support MS&A will be essential for rapid and cost effective reconfiguration of systems of space systems.

3. The Air Force, in conjunction with the Army, Navy, Marines, and others, should exploit virtual reality implementations to make space support more readily understandable to the political decision maker and the warfighter by allowing individuals to immerse themselves in the space-terrestrial operations continuum.