OPERATIONAL CAPABILITIES AND LEGAL IMPLICATIONS OF A MILITARY SPACE PLANE

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ABSTRACT

The potential challenges for the United States military in this upcoming century may require new types of capabilities only achievable through the application of new technologies. One of these potential capabilities includes a Military Space Plane (MSP). An MSP is a concept to use reusable launch vehicle (RLV) technologies in a system to provide the military global access and reach in a timely fashion that could be operational within a decade. New awareness is evident from both recent federal commission reports and activities in Afghanistan of the military's possible need of such capabilities to provide asymmetric advantages. The MSP may eventually become part of a new spaceforce that coordinates the broad range of defensive and offensive space assets. In addition, a new emphasis is being placed upon NASA and the U.S. Air Force to coordinate activity on such a space plane/RLV development. The interaction of civilian and defense agencies for such a program has ramifications, not just in terms of the requirements on a final operational vehicle, but also on the legal charters of both entities. This examination presents operational scenarios for a military space plane in order to derive various legal implications.

NOMENCLATURE

ABM	Anti Ballistic Missile
ASAT	Anti-Satellite
CAV	Common Aero Vehicle
CONOPS	Concept of Operations
CONUS	Continental United States
DoD	Department of Defense
GATT	General Agreement on Trade and Tariffs
GEO	Geostationary Orbit
ISR	Information, Sensors, and Reconnaissance
ISS	International Space Station
KKV	Kinetic Kill Vehicle
LEO	Low Earth Orbit
MSP	Military Space Plane
NASA	National Aeronautics and Space Administration
NMD	National Mission Defense
OTV	Orbital Transfer Vehicle
RBCC	Rocket Based Combined Cycle
RLV	Reusable Launch Vehicle
SLI	Space Launch Initiative
SOV	Space Operations Vehicle
SMV	Space Maneuver Vehicle
TAT	Turnaround Time
TSTO	Two Stage To Orbit
UAV	Unmanned Aerial Vehicle
UCAV	Uninhabited Combat Aerial Vehicle
USAF	United States Air Force
WMD	Weapons of Mass Destruction
WTO	World Trade Organization

INTRODUCTION

Over the last decades outer space has gained an amplified importance given the increased interconnectivity of societies through telecommunications. The ever increasing ratio of commercial space launches to government-sponsored space launches is an indication of the importance of outer space as both a corridor of transport and location of resources.

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ratio of civilian to military outer space launches was nominally at 5:4 relationship[12]. However, offensive and defensive capacities have not yet emerged. The weaponization of space does not yet exist. However, societies are at a nexus where the motive for such weaponization can be satisfied by the capabilities enabled by new technologies.

Any such MSP will have dual-use capability to service civil and commercial space launch markets. A new MSP will assist in general RLV technology development and operational experience. Technological investment for such a system will be synergistic with those required for commercial RLV development. Investment from the government for a MSP offsets some portion of the commercial risk associated with new RLV ventures. These complicate matters of limiting government offsets to private industry in light of international agreements such as the World Trade Organization (WTO).

This examination attempts to provide some clarity as to what is meant by the most recent incarnation of the U.S. Air Force's military space plane. A review of both concepts and missions is given. From these operational capabilities more insight can be obtained as to any legal implications of the system.

MSP CONCEPT OVERVIEW

A Military Space Plane (MSP) is in essence an atmospheric/space delivery architecture that can consist of multiple stages to deliver payloads into space and onto the surface of earth. The MSP is a delivery mechanism to enable space transportation. A MSP is a version of a reusable launch vehicle (RLV) that has specific abilities required for military users.

Heritage

The United States military, and specifically the United States Air Force (USAF), has a history of programs to investigate technologies and concepts for MSPs. Some of the earliest research involved the Aerospaceplane program and X-planes, which gave the military experience into supersonic flight conditions. Such vehicles included the X-1, Douglas D-558-I, X-15, X-23, and X-24. Subsequent Air Force design efforts included the mid 1950s Bomber Missile (BoMi), the Hypersonic Weapons and Research Development Supporting Program (HYWARDS), the early 1960s Boeing X-20 Dyna-Soar, and the Ballistic Missile Defense Organization's DC-X[13]. The U.S. Air Force was also involved in planning, requirements formulation, and obtaining congressional support for the development of NASA's Space Shuttle.

Recent activity by the United States includes the NASA's X-33, X-34, X-37, and X-40A/B programs. The Air Force Research Laboratory's Military Spaceplane System Technology Office at Kirtland Air Force Base, New Mexico, directs the Space Maneuver Vehicle (SMV) program. Current development programs focus on both short term and long term MSP architectures. The shorter-term programs entail using conventional rocket engines. Long-term technology programs such as the X-43 series of Rocket-Based-Combined Cycle (RBCC) propulsion test beds are designed for operational use at least two decades from today.

MSP Architecture Elements

Current perceptions of the first MSP entail development and Initial Operating Capability (IOC) sometime in the 2010-2015 timeframe. This imagined MSP consists of multiple elements coupled together to provide the war fighter with a flexibility of response. The core component of the architecture is a reusable first stage vehicle known as the Space Operations Vehicle (SOV). The SOV will have the capability of carrying multiple payloads with turnaround times (TATs) measured in hours instead of the current months for the U.S. Space Shuttle. U.S. military scenarios entail building up both a useful demonstrator and full-scale version of the MSP. Concepts within a 5-15 year time horizon most likely will entail some type of Two-Stage-To-Orbit (TSTO) system[10].

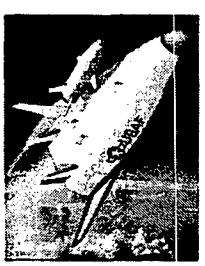

Figure 1. Notional Military Space Plane (MSP)

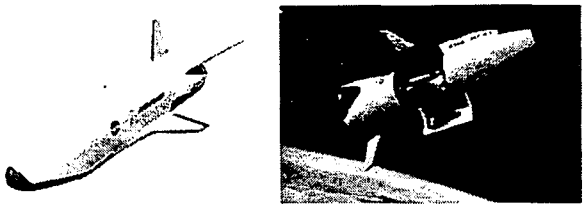

Figure 2. Space Maneuver Vehicle (SMV)

The second stage would consist either of reusable or expendable stages. Reusable stages are referred to as Space Maneuver Vehicles (SMVs). The SMV could itself hold a third/upper stage to carry payloads to higher orbits. Expendable stages are referred to as a Modular Insertion Stage (MIS) that can transport payloads to different orbits. Additional add-on components to the architecture include the Common Aero Vehicle (CAV) that consists of a maneuvering reentry vehicle and an Orbital Transfer Vehicle (OTV) that can move payloads from one orbit to another.

Nominally, the MSP shall be capable of the following[14]:

a. The SOV shall be capable of supporting space control, force application, force enhancement, and force support missions by providing low cost, high ops tempo launches of SMV, CAV, and MIS payloads to mission orbits or trajectories.
b. Orbit-capable and sub-orbital SOVs shall be capable of executing sub-orbital, pop-up profiles that allow safe launch and recovery from U.S. bases.
c. The MSP System shall be capable of autonomous, virtually commanded, or crewed operations depending on future requirements evolution.
d. The MSP System shall provide aircraft-like levels of operability and maintainability to allow high sortie rates.
e. Orbit-capable SOVs shall be capable of supporting once around missions while returning to their launch site.

Table 1 lists sample requirements for a sub-orbital type SOV MSP that can carry a SMV. The sorties requirements are some of the most critical since current turn times for the Space Shuttle are on the order of months.

Table 1. Sample Requirements Matrix for Space Operations Vehicles (Sub-Orbital)[4]

Requirement	Range
Sortie Utilization Rates	
Emergency surge	3-4 sorties/24 hrs.
Turn Times	
Emergency surge	2-8 hours
System Availability	
Mission Capable Rate	75-95 percent
Cross Range	
CONUS pop-up cross range @1200nm	250-400 nm
Mission Duration	
On-orbit time	24–72 hours
Alert Hold	
Hold Mission Capable	15 days
Design Life	
Primary Structure	250-500 sorties
Engine life	100-250 sorties
External Payload Weight	
Carriage Capacity	15,000-20,000 lb
Payload Capability	
Pop-up MIS payload east	2,000 –4,000 lb
Pop-up MIS payload polar	1,000 – 4,000 lb
Maintenance and Support	
Maintenance man hours/sorties	50-100 hours

Notional concepts of the MSP include a phased development cycle wherein a sub-orbital capable MSP could lead to development of an initial capability[11] (see Figures 4 and 5). The sub-orbital architecture assists in technology risk reduction and would be used in an operational mode, not relegated solely to testing. The larger orbital MSP to be built later would enable the use of an OTV. The follow-on orbital vehicle would have a higher cross range capability, pop-up range, and payload capability (15,000-20,000 lbs due east) than the sub-orbital version (2,000 lb due east).

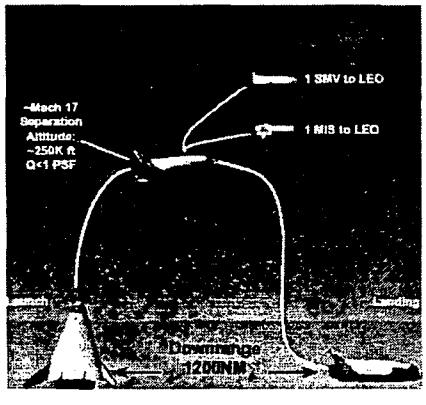

Figure 4. Pop-Up Flight Profile of Notional Sub-Orbital Military Space Plane (MSP)[11]

stages and orbital transfer stages that can be used to carry additional payloads to other destinations. These type of capabilities are just being developed. The weapons area includes offensive and defensive military capabilities such as ASAT, nuclear, and ground capabilities. Thus some payloads represent the current paradigm of space use whereas others represent a fundamental shift in the conception of space into an actual offensive battleground.

Table 3. Sample Payloads for MSP SOV

Type	Detail
Sensors and Telecommunications	Hyper-spectral Imaging
	Radar
	SIGNIT
	Meteorological Systems
	GPS
	MILSATCOM
Vehicles (Can also carry payloads)	SMV
	MIS
	CAV
	Micro-satellites
	OTV
Weapons	Precision Munitions (Ground)
	Anti-Satellite (ASAT)
	Electronic Warfare
	Nuclear
	National Missile Defense

Concept of Operations (CONOPS)

There are many components to the operation of a MSP. Figure 7 illustrates a typical timeline of various mission segments of a MSP, from launch to deployment to landing and refurbishment. Launch and landing do not necessarily have to occur at the same location. Keys for the operation of such a system include rapid payload integration, rapid checkout, standard interfaces, and operations flexibility. A sample future scenario for operations for such a vehicle would include an operational fleet of six TSTO systems, with a flight rate of 25 sorties per year, and operational life of 20 years[16]. The baseline mission could consist of the SOV carrying a 15,000 lb payload from Eglin Air Force Base (AFB) in Florida (32 degrees latitude) to an orbit of 140 nmi by 35 nmi. Previous analyses have shown that using conventional rocket engines based upon NASA's SLI program, the configuration sized to 1.5 Mlb gross weight/150 Klb dry weight vehicle (versus 4.5 Mlb gross weight/510 Klb dry weight for the Space Shuttle)[16].

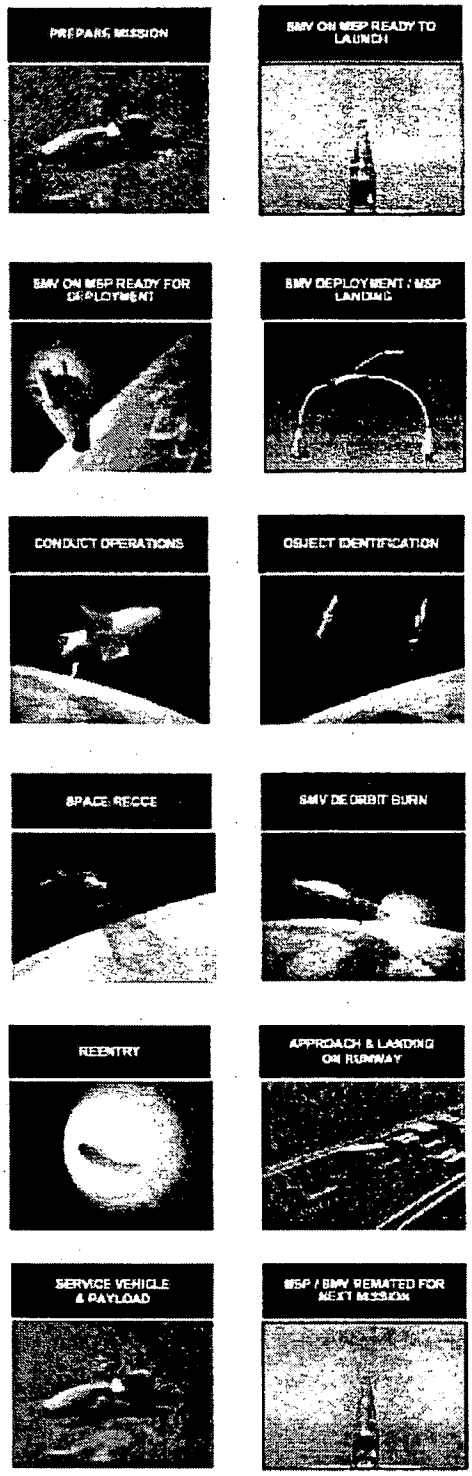

Figure 7. MSP Mission Breakout[11]

LEGAL IMPLICATIONS

There are no specific treaties or regulations that address a MSP in particular. Multiple sets of treaties do discuss various locations of space weaponry and associated military delivery systems. Both customary law and conventions are the two main sources used to obtain clarity as to the relation of space law to the MSP. Conventions, treaties or acts relevant in one degree or another to the legal issues surrounding a MSP include:

- National Aeronautics and Space Act of 1958[17]
- United Nations Charter, Article 51 (1945)[18]
- Nuclear Test Ban Treaty of 1968[19]
- The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (the "Outer Space Treaty", 1967)[20]
- The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (the "Rescue Agreement", 1968)[21]
- The Convention on International Liability for Damage Caused by Space Objects (the "Liability Convention", 1972)[22]
- The Convention on Registration of Objects Launched into Outer Space (the "Registration Convention", 1976)[23]
- The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (the "Moon Agreement", 1984)[24]
- Treaty between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems (the "ABM Treaty", 1972)[25]
- Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Elimination of Their Intermediate-Range and Shorter-Range Missiles (the "INF Treaty", 1988)[26]
- Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (1976)[17]

Since the current Bush administration in the United States is negotiating with Russia to remove applicability of the ABM Treaty, that treaty will not be extensively covered in this examination. Subsequent issues of whether payloads on the SMV constitute development or deployment of National Missile Defense (NMD) infrastructure will not be covered. In addition, only some of the five United Nations treaties and agreements on space law will be covered.

Military Self Defense

International agreements give justification for military use in self-defense. Article 51 of the United Nations charter states:

> Nothing in the present Charter shall impair the inherent right of individual or collective self-defence if an armed attack occurs against a Member of the United Nations, until the Security Council has taken measures necessary to maintain international peace and security. Measures taken by Members in the exercise of this right of self-defence shall be immediately reported to the Security Council and shall not in any way affect the authority and responsibility of the Security Council under the present Charter to take at any time such action as it deems necessary in order to maintain or restore international peace and security[18].

Thus each nation has this freedom for self-defense if the necessary conditions are met. This would not apply in the case of offensive space assets to be used for a first strike capability. This would also seem to generally preclude preemptive military action. However, an issue to be considered for a MSP, given the role of recent terrorist actions on the American homeland, is the role of preemptive first strike against terrorist targets. The administration of George W. Bush has have promulgated such justification in response to potential Weapons of Mass Destruction (WMD) threats. An operational MSP would become one of the tops assets considered for use in a first strike.

The National Aeronautics and Space Act of 1958 (as amended) explicitly states the civilian agency in charge of aeronautics and space shall have authority except for "activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States (including the research and development necessary to make effective provision for the defense of the United States) shall be the responsibility of,

and shall be directed by. the Department of Defense."[17] Thus the military is given freedom to conduct research and deployment of system related to aeronautics and space. This international law allows self-defense while U.S. custom allows the military to investigate and develop space technologies.

Legality of Payloads

The MSP concept essentiality consists of combinations of components to deliver payloads for various missions. A MSP without a payload would most likely not be construed as an illegal military application. Only when a payload is applied to the architecture do tactical and legal issues arise. The payload determines the ultimate nature of this transportation system. Application of a payload can change the nature of the destination orbit as well as the duration of the SMV in orbit. The SMV itself is more important when it comes to the issue of legality. The SMV, carried by the booster SOV (which delivers the SMV in nominal Air Force scenarios) can become co-orbit capable, rebuild a constellation, or even perform orbital fly-bys of LEO satellites.

The type of payload is critical to whether such architectures could be in violation of international agreements or conventions. For instance, Article IV of the Outer Space Treaty indicates that state parties cannot place in orbit or station nuclear weapons or WMD. Unlike an intercontinental ballistic missile, a SMV can either directly send its arsenal to a territorial destination or stay in orbit with a weapon. Thus if the arsenal includes WMD material then there may be an issue with the SMV operating for extended periods of time during peacetime "on-station" in orbit.

The issue of payload legality becomes less obvious when it relates to the nature of non-WMD offensive assets. Examples include in-space based kinetic kill vehicles (KKVs) that do damage only to targeted orbiting enemy satellites. The definition of the payload itself is also important. A defensive payload in space could conceivably be reconfigured for offensive purposes. These offensive weapons may have unintended collateral damage in space. Such manipulations of the space environment may violate terms of the 1976 Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques[27]. Generally non-WMD offensive space assets (not restricted by the ABM Treaty) should follow the paradigm of terrestrial weapons and place an emphasis on precision strike.

Uncrewed Nature of the MSP

Notional concepts of the MSP have them being both autonomous and piloted. Uninhabited combat aerial vehicles (UCAVs) and such uncrewed RLVs share similar legal issues. One particular legal issue arises of the classification of cruise missiles in the 1988 INF Treaty. The treaty prohibited the United States and Soviet Union from deploying ground launched cruise missiles with ranges between 500 km and 5.500 km[28]. Some have speculated that UCAVs could be considered such cruises missiles since they are similar to definition in the treaty. In the treaty cruise missiles are defined as unmanned atmospheric vehicles. UCAVs and some variations of the MSP architecture have similar properties: ground launched, uncrewed launch vehicles that have expendable arsenals on board. Future generations of MSPs that have Rocket Based Combined Cycle (RBCC) propulsion systems would more likely fall under these definitions since those systems do use the atmosphere for part of the flight (in place of on-board oxidizer as on conventional rockets systems for near term MSPs). However, the arming of predator UAVs with Hellfire missiles in early 2002 during the U.S. engagements in Afghanistan have shown the military's willingness to rethink the limitations of the INF treaty.

Over-flight Issues

The U.S. military's recent retrenchment when it relates to forward basing of military assets makes the MSP a more viable option for global strike missions. Continental U.S. (CONUS) operations of B-2 bombers in the Kosovo and Afghanistan campaigns demonstrate the attractiveness of such options. MSPs enable CONUS operations that allow for global strike missions. Thus a MSP enables avoidance of international territorial disputes in regards to flying rights over countries on the path towards the terrestrial target.

Coordinated Civil and Military RLV Development

In the United States there has been some recent coordinated movement by both civil and military space leaders to jointly determine if there are potential synergies in development of a RLV. The

recent OneTeam/120 Day Study is an example of such coordination between NASA and USAF[29]. Specific architecture requirements of each organization differ. NASA would prefer large payloads that can go to the International Space Station (ISS) orbit whereas the military would prefer a smaller payload class vehicle that can be turned around after landing within a few hours. The military's use of such RLVs would not be as the primary launch service for its satellites (expendable rockets would services these missions).

Given the enormous costs, government assistance is projected to be extensive for any RLV development. Specifically associated with these government efforts may be military subsidies to launch vehicle providers. American, European, Russian, Chinese, Indian, and Japanese launch services receive some type of government support (guaranteed launches, anchor tenancy, facilities development, research and development). World Trade Organization (WTO) conventions discourage governmental subsidies to commercial sectors but exclude military offsets. Specifically this refers to the General Agreement on Trades and Tariffs (GATT) Article XXI, referred to as the "security exception" wherein it allows:

> Governments free reign for trade-related actions taken in the name of national security. The rule states that a country cannot be stopped from taking any such action it deems necessary to protect its essential security interests, or any action "relating to the traffic in arms, ammunition and implements of war."...Article XXI is often called the most powerful exception for WTO member-nations, because governments are allowed to define their "essential security interests" for themselves, and protect their industries while couching their actions in terms of national security[30].

Such items, referred to as non-tariff barriers to trade, are exemplified by Canadian Technology Partnerships that a 1999 WTO dispute panel ruled against. These arrangements assisted Canadian airplane manufacturer Bombardier Aerospace to export regional jet aircraft. These rulings may have an effect of biasing governmental assistance towards military rather than civilian offsets.

Future global launch market forecasts project more commercial than government launches on an annual basis. Any future RLV endeavor (whether civilian or military) will most certainly have a role to play in the commercial launch industry. Possibly unlike previous military funded programs to enhance technologies, these RLV programs seek development of vehicles that could immediately be used to service the commercial marketplace. Given current launch forecasts, commercial utilization may outweigh military. Foreign governments could charge a military RLV-enabled country as being anti-competitive, as some European governments have charged with respect to American expendable launch vehicles. The level of involvement of civilian space agencies with military counterparts in development of such new capabilities may have to be monitored.

CONCLUSION

Since the beginning of exploration of outer space, a myriad of concepts have been explored for civil, commercial, and military purpose. As one of those concepts, the MSP should more appropriately be thought of as a delivery mechanism than an actual weapon. Subsequently, the legality of a MSP is inherent upon the payload it carries.

Various MSP configurations exist, both defensive and offensive with easy interchangeability between either. The SOV portion of the architecture may not be capable by itself of positioning weapons in space. However, additional add-on components like the SMV and CAV could be used for offensive space purposes. On-orbit, sustained operations available through use of such upper stages attached to the SOV entail more legal issues than the SOV by itself. The employment of such a system and associated on-board payloads determines the applicability of international legal conventions and treaties.

MSPs should not be dismissed based upon legal grounds since they similar to existing launch vehicles. MSPs enable much faster response times and global access. MSPs have the capability to provide asymmetric capabilities to upset the reaction times of adversaries. However, the capabilities of the SOV/SMV may not enable revolutionary classes of payloads but can deliver existing or evolutionary payloads in differing manners.

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