Department of Foreign Affairs and International Trade
Ministère des Affaires étrangères et du Commerce international

Canada

LOAC and the Neutralization of Satellites or Ius in Bello Satellitis

MICHEL BOURBONNIÈRE

ISROP
INTERNATIONAL SECURITY RESEARCH AND OUTREACH PROGRAMME

PRISI
PROGRAMME DE RECHERCHE ET D'INFORMATION DANS LE DOMAINE DE LA SÉCURITÉ INTERNATIONALE

LOAC and the Neutralization of Satellites or IUS in Bello Satellitis

Michel Bourbonnière

Prepared for the

International Security Research and Outreach Programme
International Security Bureau

May 2003

Table of Content

Preface

The views and positions in this paper are solely those of the author and do not necessarily reflect the views and positions of the Department of Foreign Affairs and International Trade or of the Government of Canada.

The International Security Research and Outreach Programme (ISROP) of the International Security Bureau has financially supported the writing of this paper.

The Department of Foreign Affairs and International Trade wishes to thank the author of this study: Mr. Michel Bourbonnière. Please note that the original text was submitted on March 2003.

Department of Foreign Affairs and International Trade
125 Sussex Drive
Ottawa, Ontario, Canada

May 2003

Sommaire

La présente étude analyse l'utilisation de la force contre les satellites en se basant sur le droit des conflits armés. Il est intéressant de noter l'ironie linguistique de la situation. Le mot satellite puise ses origines dans le mot latin *satellitis* signifiant "garde du corps". Alors qu'à l'origine le mot satellite reflétait l'image de protection et de sécurité, il a aujourd'hui une connotation beaucoup plus scientifique. Tout en conservant un certain rôle de sécurité, les satellites nécessitent l'attention en vue de leur protection.

Le droit des conflits armés est tout d'abord brièvement présenter, suivi par une description du système de l'espace et des capacités anti-satellite. La dernière partie porte sur la possibilité de cibler les satellites et leurs architectures correspondantes (liens radio, orbites, base terrestre de contrôle, etc.) en cas de conflit armé.

L'Article 52.2 du Protocole additionnel aux Conventions de Genève du 12 août 1949 relatif à la protection des victimes des conflits armés internationaux (Protocole I) stipule que:

> *Les attaques doivent être strictement limitées aux objectifs militaires. En ce qui concerne les biens, les objectifs militaires sont limités aux biens qui, par leur nature, leur emplacement, leur destination ou leur utilisation apportent une contribution effective à l'action militaire et dont la destruction totale ou partielle, la capture ou la neutralisation offre en l'occurrence un avantage militaire précis.*

Certains satellites - ceux militaires particulièrement - peuvent répondre aux principes posés par le Protocole I et ainsi être identifiés en tant que cible potentielle lors d'un conflit armé. Cette étude présente une avenue intéressante pour protéger l'espace extra-atmosphérique d'une telle éventualité: classifier les orbites comme un environnement naturel au lieu d'un simple emplacement. Ainsi classées, les orbites - et par conséquent les satellites qui y circulent - bénéficieraient de protection étendue sous le régime de protection de l'environnement.

Introduction

In analysing the use of force against satellites a fundamental irony of linguistics appears. The etymology of the word "satellite" shows the Latin origin of the word, namely *satellitis,* which in its incipient use in antiquity meant "garde du corps" or bodyguard. The use of this word to describe an object orbiting much larger objects is in fact quite poetic, invoking images of protection and security. With the evolution of scientific paradigms permeating the vocabulary of our epoch, the original meaning was lost and the word developed a more scientific connotation. Meanwhile, and herein lies the beauty of the analogy, the use of satellites in fact became more akin to that of a bodyguard as artificial satellites developed an important role in the national security of states. This paper will analyse the legality of the application of force against these orbiting bodyguards. The legality of the use of force will be evaluated by applying the Law of Armed Conflicts (LOAC) to the use of anti-satellite weapons (ASAT).

The term Law of Armed Conflict will be used within this paper as referring to the normative structures within the *corpus* of international public law regulating the means and methods of conducting hostilities between states[1]. International public law judges the use of force twice[2]. Firstly international public law establishes norms, which apply to the decision to use force[3]. These rules are found primarily in the UN Charter[4]. An illegal use of force is an act of aggression. Such acts in outer space are beyond the scope of this paper. Secondly, international public law contains a set of norms that determine the manner in which force may legitimately be applied. Irrespective of the legitimacy of the decision to use force, the law regulating the means and methods of force application, or LOAC, always applies Thus *Ius in Bello* rules can be analysed irrespective of whether the decision to use force was legitimately taken or not[5].

The sources of law reviewed will be mainly conventional. The two major systems that comprise LOAC are: the Hague system and the Geneva system[6]. Both of these "systems" have received a broad accession from states[7]. Consequently the International Court of Justice (ICJ) has declared that these two systems "constitute intransgressible principles of international customary law"[8]. State practice in space military operations will not be examined, as these are often shrouded in a veil of secrecy. Nonetheless, rules of customary international law generally applicable to the use of force will be included within the study. More specifically this paper has a limited scope, focusing on the *Ius in Belo* rules applicable to military operations, which have as a goal the neutralization of satellites, satellite functions and satellite

---

[1] The Latin term for Law of Armed Conflict is *Ius in Bello.*

[2] Michael Walzer, *Just and Unjust Wars, (*New York, Basic Books, 1977) at p. 21 "War is always judged twice, first with reference to the reasons States have for fighting, secondly with reference to the means they adopt".

[3] The Latin term for the right to use force is *Ius ad Bellum.*

[4] Art 2(4) and 51 Charter of the United Nations (hereinafter referred to as "U.N. Charter").

[5] See Adam Roberts and Richard Guelff, *Documents on the Laws of War,* 3rd ed., Oxford, Oxford University Press, at p. 1 (hereinafter referred to as "Roberts & Guelff". The *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies,* 27 January 1967, 610 U.N.T.S. 205, (hereinafter referred to as either, Outer Space Treaty or OST) establishes within its preamble the principle of "peaceful purposes" for the exploration and use of outer space. An interpretative debate surrounds the concept "peaceful purposes" and its impact upon the legitimacy of military activities in outer space. See I.A. Vlasic, "The Legal Aspects of Peaceful and Non-Peaceful Uses of Outer Space" in B. Jassini, ed., *Peaceful and Non-Peaceful Uses of Space: Problems of Definition for the Prevention of an Arms Race* (New York: Taylor & Francis, 1991) 37, at 39; C.Q. Christol, *The Modern International Law of Outer Space,* (New York: Pergamon Press, 1982) at 22; Bin Cheng, *Studies in International Space Law,* (Oxford: Clarendon Press); Nandasiri Jasentuliyana, *International Space Law and the United Nations,* (The Hague: Klewer Law International) at 104, where Dr. Jasentuliyana states that the OST "...left open the possibility of the placing in outer space of weapons other than nuclear weapons and weapons of mass destruction, which are generally considered to include chemical and biological weapons. The gap thus left has recently acquired practical importance in view of the development of anti-satellite (ASAT) weapons and research into directed-energy weapons...either for anti-satellite purposes or for ballistic missile defence (BMD)". A discussion of this debate is beyond the scope of this paper.

[6] Within the *Advisory Opinion on the Legality of the Threat or Use of Nuclear Weapons,* July 8, 1996 I.C.J. rep.1 at 27, reprinted in 35 I.L.M. 809, (hereinafter referred to as the "Nuclear Weapons Case"), it is interesting to note that the ICJ prefers the term "International Humanitarian Law", which it describes as being the synthesis of "Hague Law" which governs the means and methods of warfare, and "Geneva Law" which in turn governs the protection of the victims of war. For an interesting analysis see Michael N. Schmitt, "The International Court of Justice and the Use of Nuclear Weapons" NAVAL WAR C. Rev., Spring 1998, at 91.The Geneva system is primarily composed of the following four conventions: *Geneva Convention for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field of August 12, 1949,* 75 U.N.T.S. 31 (Hereinafter referred to as GC I); *Geneva Convention for the Amelioration of the Condition of Wounded, Sick and Shipwrecked Members of Armed Forces at Sea of August 12, 1949,* 75 U.N.T.S. 85 (hereinafter referred to as GC II); *Geneva Convention Relative to the Treatment of Prisoners of War of August 12, 1949,* 75 U.N.T.S. 85 (hereinafter referred to as GC III); *Geneva Convention Relative to the Protection of Civilian Persons in Time of War of August 12, 1949,* 75 U.N.T.S. 287 (hereinafter referred to as GC IV).

[7] *Corfu Channel* case (Merits) I.C.J. Reports 1949, at 22.

[8] *Nuclear Weapons Case,* supra note 6 at para. 80.

architecture. The law of neutrality applied to space military operations will however not be analysed. Thus this paper will concentrate on the exercise of specific belligerent rights on a precise set of space assets.

The term satellite "architecture" is used within this paper as including complementary functional assets, such as ground stations, radio links, and orbital coordinates or parameters. The approach of the paper is also functional in nature dealing with various types of satellite systems. The term "neutralization" refers to military capabilities, which may destroy satellites and/or their architecture, degrade or disrupt their function, cause deception in their use, or prevent their use.

I Overview of Law of Armed Conflict[9]

I 1. Belligerent Right Not an Unlimited Right

Perhaps the first international instrument restricting the rights of belligerents is the 19th century St-Petersburg declaration, which states, "T*he only legitimate object which States should endeavour to accomplish during war is to weaken the military forces of the enemy*"[10]. Consequently, the rights of belligerents are not unlimited[11]. Means and methods of warfare designed to neutralize satellites or their architecture or to deny the use of space itself are subject to this restriction.

I 2. Military Necessity[12]

Military necessity[13] is a fundamental principle of LOAC circumscribing the use of force[14]. This principle establishes a reasonable connection between destruction and the overcoming of an enemy force. Briefly speaking, military necessity is the obligation for a belligerent to specify the imperative military advantage intended to be gained by an attack. The principle of military necessity is expressly recognised within the codified body of law of armed conflict. Thus the principle must be interpreted and applied within the limits of the law[15]. In other words, the principle cannot be used to justify violations of the law itself. Seen in this light, and stated positively, the principle of military necessity justifies operations, which are not specifically prohibited by LOAC and which are required for the success of the mission. From a practical perspective, recent doctrinal analysis argues that it is important to understand that the principle does not justify the use of force but rather acts as a restraint to the use of force. Perhaps one of the most eloquent expressions of this argument can be found in the writings of Professor Michael N. Schmitt who proffers that "*Military necessity operates within this paradigm to prohibit acts that are not militarily necessary; it is a principle of limitation, not authorization. In its legal sense, military necessity justifies nothing*".[16]

The corollary of military necessity is the principle of unnecessary suffering. The over-extensive destruction by belligerents in violation of the principle of military necessity is a grave breach to the Geneva Conventions[17].

I 3. Distinction

The principle was initially conventionally articulated within the preamble of the St-Petersburg Declaration, asserting that war is to be conducted only against enemy military forces.[18]. A recent codified

---

[9] According to the ICJ, " these principles and rules of humanitarian law are part of *jus cogens* as defined in Article 53 of the Vienna Convention on the Law of Treaties of 23 May 1969" see *Nuclear Weapons Case,* supra note 6 at para.83.

[10] Reprinted in Roberts & Guelff, supra note 5, at 55.

[11] Hague IV Annexed Regulations, Convention Respecting.the Laws and Customs of War on Land, Oct 18 1907, reprinted in Roberts & Guelff, (hereinafter referred to as Hague IV) supra note 5; Article 35(1) of the Protocol Additional to the Geneva Conventions Relating to the Protection of Victims of International Armed Conflict, June 8, 1977, U.N. Doc. A/32/144, 16 I.L.M. 1391 (Hereinafter referred to as either API, or Protocol Additional I); Preamble of the Convention on the Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May be Deemed to be Excessively Injurious or to Have Indiscriminate Effects, Oct 10, 1980, 1342 U.N.T.S., 7, 19 I.L.M. 1523. Adam Roberts and Adam Guelff point out that this principle was incorporated in the 1874 Brussels Declaration and in the 1880 Oxford Manual. In supra note 5 at p. 9.

[12] Although these four principles are generally recognized as being the fundamental concepts of LOAC doctrinal works often debates different degrees of relations between them. For example Michael N. Schmitt, a prolific publicist, subordinates distinction to proportionality and argues for chivalry as a distinct principle see Michael N. Schmitt, "Green war; An Assessment of the Environmental Law of International Armed Conflict" 22 (1997) Yale J. Int'l L. at 52. (hereinafter referred to as "Green War"). For an excellent analysis of the origins of the principle see B.M. Carnahan, "Lincoln, Lieber and the Laws of War: The Origins and Limits of the principle of Military Necessity" (1998) 92:2 A.J.I.L., at 213.

[13] Expressions such as "necessity of military operations", "military exigencies, motives and reasons", reasons of war", and "security reasons" are synonyms of "military necessity", see *Dictionary of the International Law of armed Conflict*, Geneva, ICRC, p. 75.

[14] See H. McCouberey, "The Nature of the Modern Doctrine of Military Necessity'(1991)30 Revue de Droit Militaire et de Droit de la Guerre at 215.

[15] Specific dispositions allowing military necessity to derogate are Hague IV art. 23 supra note 11; GC I art. 33; GC IV art 53, supra note 6; H. CP, 4,11 and AP I arts. 54, 62, supra note 11.

[16] Green War, supra note 12 at 54.

[17] GC IV art 147, supra note 6.

[18] Reprinted in Roberts & Guelff, supra note 5 at 53. *"That the only legitimate object which States should endeavour to accomplish during war is to weaken the military forces of the enemy"*

expression of this norm is found within Article 48 of Additional Protocol I to the Geneva Conventions[19]. The principle obliges the belligerents to distinguish at all times between non-combatants and combatants, as well as between civilian property and military objectives. Consequently military operations may only be directed against military objectives[20]. From the principle of distinction flows a duty of care, which is imposed upon those who plan military operations. In planning an attack everything feasible must be done to verify that the objective to be attacked is neither civilians nor a civilian object but is in fact a legitimate military objective. This is an obligation of means and not an obligation of results. If there is a doubt that a civilian object is being used to make an effective contribution to military action, it must be presumed not to be so used and must not be attacked[21]. Consequently, civilians may not take part in hostilities. At this point it is important to note that LOAC establishes a difference between civilians who are taking a direct part in hostilities thus losing their protection and those who are only making a contribution in the war effort and who do not lose their protection.[22].

The corollary of the principle of distinction is that attacks must not be indiscriminate. An indiscriminate attack is defined as being one which[23]:

- Is not directed at a specific military objective;
- Employs a method or means of combat which cannot be directed at a specific military objective; or
- Employs a method or means of combat the effects of which cannot be limited as required by AP I.

Furthermore civilians and civilian objects may not be the object of reprisals. [24]

I 4. Proportionality

The principle limits the effects of attacks by attempting to establish a balance between the military interests and the humanitarian interests. During the conduct of military operations constant care is to be taken to spare the civilian population, civilians and civilian objects[25]. In planning and executing military operations, military planners must take all feasible and reasonable precautions in the choice of means and methods of attack in order to avoid, or at least to minimize, incidental loss of civilian life, injury to civilians and damage to civilian objects[26]. Thus military operators must refrain from deciding to launch any attack which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated[27]. Should it become apparent that the object to be attacked is not a legitimate military objective, or that the attack may be expected to cause incidental loss of civilian life or damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated, the said attack must then be cancelled[28]. Furthermore, should there exist a

---

[19] Reprinted in Roberts & Guelff supra note 5 at 419.

[20] A.P. I art. 48. It is interesting to note the following comment in the Unites States, Department of Defense Report to Congress on the Conduct of the Persian Gulf War, Appendix on the Role of the Law of War (hereinafter referred to as "The Gulf War Report") reprinted at 31 I.L.M. 612 (1992), "Article 48 API "states that attack means acts of violence against the adversary, whether in offence or defence. The use of the word attack in this manner is etymologically inconsistent with its customary use. The word attack historically has referred to and today refers to offensive operations only... "The language of art 48 and 49(1) (except for the erroneous use of the word attack) is generally regarded as a codification of the customary practice of nations, and therefore binding on all". At p. 625.

[21] AP I Art. 52.3, supra note 11. It is interesting to note that, within the Gulf War Report, this disposition is criticized as not reflecting customary international laws as it "shifts the burden for determining the precise use of an object from the party controlling that object (and therefore in possession of the facts as to its use) to the party lacking such control and facts...This imbalance ignores the realities of war in demanding a degree of certainty of an attacker that seldom exists in combat." supra note 20, at 627.

[22] According to A.P.V. Rogers "Taking a direct part in hostilities must be more narrowly construed than making a contribution to the war effort, and it would not include taking part in arms production or military engineering works or military transport.", *Law on the Battlefield*, (Manchester University Press, Manchester et New York, 1996) at 8.

[23] AP I art 51.4. The principle was reaffirmed by the ICJ in the Nuclear Weapons Case "*States must never make civilians the object of attack and must consequently never use weapons that are incapable of distinguishing between civilian and military targets*". supra note 6, para. 78, supra note 11.

[24] A.P. I art. 51 para. 6, art 52 para 1, art. 53 para c, art 54, para 4, art 55, para 2, art 56 para 4, supra note 11.

[25] A.P. I, art. 57.1, supra note 11.

[26] A.P. I art. 57.2 (a) ii) and art 57.4, supra note 11.

[27] A.P. I art. 57.2 (a) iii), supra note 11.

[28] A.P. I art. 2(b), supra note 11.

choice of military objectives in the planning of a mission, the objective chosen must be that which may be expected to cause the least danger to civilian lives and to civilian objects[29].

In establishing the calculus of proportionality, examples of variables which must be factored into the equation are: the military importance of the target, density of the civilian population in the target area, proximity of civilian objects including infrastructures, likely incidental effects of the attack such as the release of hazardous substances, type of weapon available, accuracy of the weapon, method and trajectory of delivery, rights of neutral countries, etc.[30]

It is interesting to note that the scope of applicability of A.P. I is defined within Article 49.2 stating that:

> *49.2 The provisions of this protocol with respect to attacks apply to all attacks in whatever territory conducted, including the national territory belonging to a Party to the conflict but under the control of an adverse Party.*
>
> *49.3 The provisions of this Section apply to any land, air or sea warfare, which may affect the civilian population, individual civilians or civilian objects on land. They further apply to all attacks from the sea or from the air against objectives on land but do not otherwise affect the rules of international law applicable in armed conflict at sea or in the air.*

Through a literal and restrictive interpretation of Article 49.2 one can argue that the scope of applicability excludes the application of the text to military operations in outer space. Such a restrictive interpretation can probably be held to be unreasonable. An expansive interpretation, which would enlarge the scope of applicability to include military operations in outer space, is probably more reasonable. Despite this interpretative debate, military operations that aim to neutralize satellite architecture, located either on land or at sea or which are within the air medium would certainly be encompassed within the scope of applicability of the Protocol.

Perhaps, the key to understanding the concept of proportionality is the frame of reference, which is to be used since "proportionality" is by definition a relative concept. The frame of reference is to be taken from a strategic reference point and not from a narrow tactical perspective.[31]

I 5. Humanity

Conventional origins of the principle of humanity may also be found in the preamble of the St-Petersburg Declaration[32]. Evidence of the importance of this principle is found in the fact that it is also one of the seven Fundamental Principles of the Red Cross and Red Crescent Movement. This principle is based upon the desire to maintain human dignity during military operations by the respect of the human being[33]. The goal of this principle is to reduce and alleviate suffering caused by war. This principle completes the others. As professor Schmitt cogently argues, " *suffering is useless it is militarily unnecessary and, because it offers no direct and concrete military advantage, disproportionate*"[34]. Perhaps one of the most important conventional expressions of this principle is to be found in the text of the so-called "Martens Clause" which first appeared within the preamble to the Hague Convention IV of 1907.[35]

> *Until a more complete code of the laws of war has been issued, the high contracting parties deem it expedient to declare that, in cases not included in the Regulations adopted by them, the inhabitants and the belligerents remain under the protection and the*

---

[29] A.P. I art. 57 .3, supra note 11.

[30] Rogers, *Law on the Battlefield.* supra note 22 at 19.

[31] Professor Michael N. Schmitt articulates three manners in which the principle of proportionality is most often violated. These are: 1) a lack of full knowledge as to what is being hit; 2) the inability to surgically craft the amount of force being applied to the target; and 3) the inability to ensure the weapon strikes precisely the point. In "Bellum Americanum: The U.S. View of Twenty-First Century War and its Possible Implications for the Law of Armed Conflict" (1998) 19 Michigan Journal of International Law at 1080 (hereinafter referred to as "Bellum Americanum").

[32] "...Uselessly aggravate the sufferings of disabled men, or render their death inevitable" Reprinted in Roberts & Guelff supra note 20.

[33] As stated by the ICJ "A great many rules of humanitarian law applicable in armed conflict are so fundamental to the respect of the human person and "elementary considerations of humanity". Nuclear Weapons Case, supra note 6 para. 80.

[34] Bellum Americanum, supra note 31 at1084.

[35] Reprinted in Roberts & Guelff supra note 5 at 67 and 70.

rule of the principles of the law of nations, as they result from the usages established among civilized peoples, from the laws of humanity and the dictates of the public conscience.

The Martens Clause predates the general principle of public international law resulting from the *Steamship Lotus case*[36]. The effect of the Martens clause is twofold and limited to international agreements that deal with the law of armed conflict. Firstly, in areas where LOAC treaties are silent, customary international law governs the situation. Secondly, during the conduct of hostilities what is not specifically prohibited is not necessarily permitted. Different versions of the Martens Clause appear throughout the *corpus* of LOAC[37]. The Martens Clause is of particular importance to new military technologies such as ASAT capabilities. In fact, within the Nuclear Weapons Case the ICJ referred to the Martens Clause stating that it "*has proved to be an effective means of addressing the rapid evolution of military technology*"[38]. The most recent expression of this clause reads as follows:

"In cases not covered by this Protocol or by other international agreements, civilians and combatants remain under the protection and authority of the principles of international law derived from established custom, from the principles of humanity and from the dictates of public conscience."[39]

[36] *Lotus Case* (1927) PCIJ Ser. A N10 what is not specifically prohibited is permitted.
[37] GCI art 63; GCII art 62; GC III art 142; GC IV art 158 supra note 6; API art I, supra note 11 .
[38] Nuclear Weapons Case supra note 6 para. 78.
[39] AP I art 1.2, supra note 11.

II Space Systems and Anti-Satellite Capabilities

II 1. Space Systems

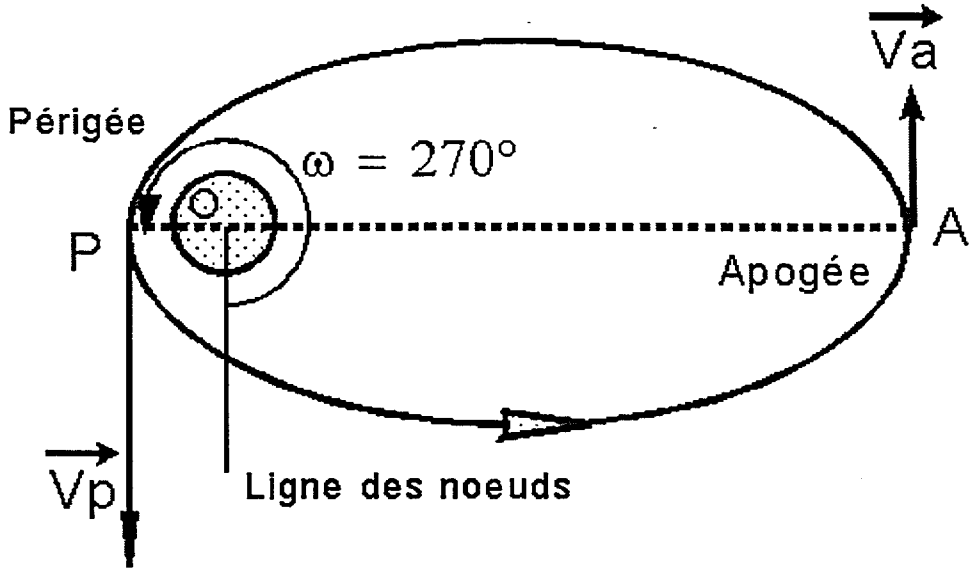
Satellites vary greatly in their architecture. For the purpose of this analysis satellites are divided into the following functions, namely: communications, remote sensing, meteorological, navigational, and military satellites. These systems have different attributes, which may affect the manner in which they may legitimately be neutralized.

II 1.1 Communications Satellite Systems

The vast majority of telecommunication satellites are located in geostationary orbit at an altitude of 36,000 kilometres above the equator. The International Telecommunication Union (ITU) regulates the geostationary orbit ensuring separation between satellites and establishes rights against harmful interference in the allocation of the radio frequency spectrum[40]. The later ITU criterion applies to all satellites for their uplinks and downlinks. However the ITU management of orbital coordinates is limited to the satellites in geostationary orbit. The concept of orbital coordinates only applies to satellites that are in geostationary orbit, as other satellites do not have fixed coordinates, but rather orbital parameters.

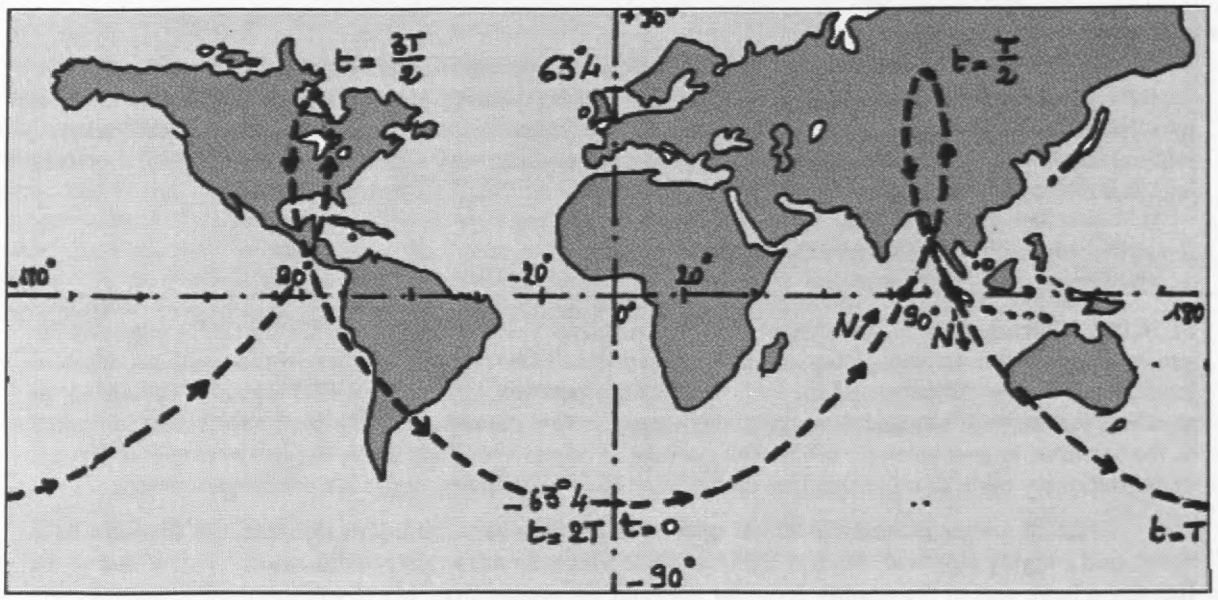
Not all communications satellites operate in geostationary orbit. For example, the Russians have developed a highly elliptical Molnya Orbit for their telecommunications satellite needs. This is due to the fact that a large part of the country is too far north for the ground trace of geostationary telecommunication satellites to be effective.

MOLNYA ORBIT[41]



[40] It is interesting to note that ITU regulations define a satellite as " a body for which the motion around another body is determined primarily and permanently by the force of attraction (Regulations S1.179 and S1.284).
[41] http://artemmis.univ-mrs.fr/cybermeca/Formcont/mecaspa/EXERCICE/SATELLIT/MOLNYA/MOLNYA.HTM.

MOLNYA ORBIT GROUND TRACE[42]



Another exception is seen in satellite phones, which use a constellation of satellites in a Low Earth Orbit (LEO)[43]. These satellites are smaller and closer to the earth than their geostationary counterparts. Consequently, satellites in LEO communicate with smaller terminals.

II1.2 Meteorological Satellite Systems

Meteorological satellites also vary as to their orbits and functions. Some are placed in geostationary orbit examples of these are: The American GEO-EAST and GEO-WEST[44] satellites, ESA owns the Meteosat[45], which is operated by EUMETSAT, Japan the Himawari[46], and India the Insat[47]. Other meteorological satellites operate in lower polar orbits.

---

[42] IBID.

[43] An example of this is the Globalstar constellation. The Globalstar constellation consists of 48 LEO (low-Earth-orbiting) satellites, plus an additional four satellites in orbit as spares. Each consists of an antenna, a trapezoidal body, two solar arrays and a magnetometer, and operates at an altitude of 1414km (876 miles).
The satellites are placed in eight orbital planes of six satellites each, inclined at 52 degrees to provide service on Earth from 70 degrees North latitude to 70 degrees South. Because of this configuration, the polar regions are not covered, including most of Greenland, small parts of Alaska, Canada, Scandinavia, Siberia, and regions in the Southern Hemisphere, such as Antarctica and parts of South America. See http://www.qualcomm.com/globalstar/about/satellites.html .

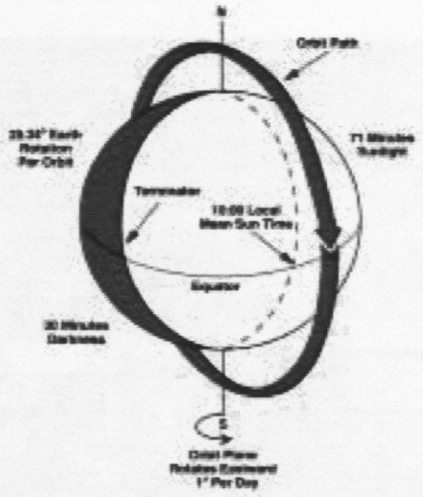
[44] http://spacelink.nasa.gov/NASA.Projects/Earth.Science/Atmosphere/GOES/

[45] http://www.esa.int/export/esaMI/MSG/.

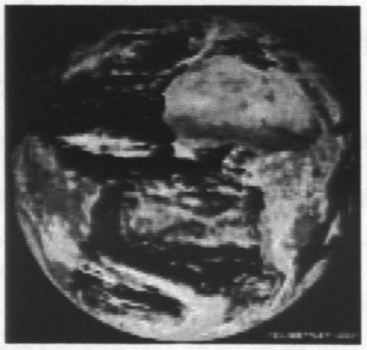
[46] http:// www.nasda.go.jp/projects/sat/gms/index_e.html.

[47] http://www.isro.org/programmes.html.

POLAR ORBIT METEOROLOGICAL SATELLITE[48]



Meteorological satellites have lower resolution capability than remote sensing satellites.



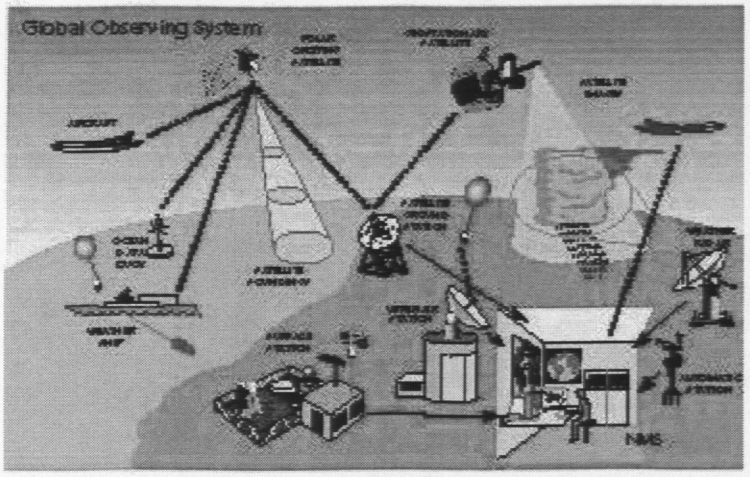
First image, MSG-1, 28 November 2002[49]

The WMO operates a Global Observation System[50] with five operational near-polar-orbiting satellites and five operational geostationary environmental observation satellites that are owned by different countries. Satellites operating in different orbits also have different capacities.

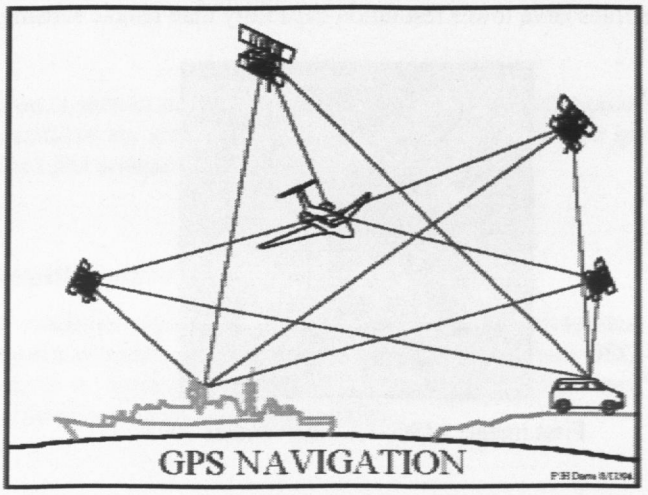
> "*Polar orbiting and geostationary satellites are normally equipped with visible and infra-red imagers and sounders, from which one can derive many meteorological parameters. Several of the polar-orbiting satellites are equipped with sounders instruments that can provide vertical profiles of temperature and humidity in cloud free areas. Geostationary satellites can be used to measure wind velocity in the tropics by tracking clouds and water vapour*"[51].

[48] http://www.gsfc.nasa.gov/gsfc/earth/pictures/noaam/High%20Resolution/Orbit_hi.jpg.
[49] http://www.esa.int/export/esaMI/MSG/.
[50] http://www.wmo.ch/web/www/OSY/GOS.html
[51] http://www.wmo.ch/web/www/OSY/GOS.html

The ground architecture of such a system is extremely complex and exchanges a large amount of data.[52]



II 1.3 Navigational Satellite Systems[53]



There are two functional constellations of navigational satellites. These are:

- Global Positioning System (GPS)[54],
- The Global Orbiting Navigation Satellite System (GLONASS),

---

[52] The backbone of the surface-based sub-system continues to be about 10,000 stations on land making observations at or near the Earth's surface, at least every three hours and often hourly, of meteorological parameters such as atmospheric pressure, wind speed and direction, air temperature and relative humidity. Some 4000 of these stations comprise the Regional Basic Synoptic Networks (RBSNs) drawn up by the six WMO Regional Associations. Data from these stations are exchanged globally in real time

[53] http://www.colorado.edu/geography/gcraft/notes/gps/gps_f.html.

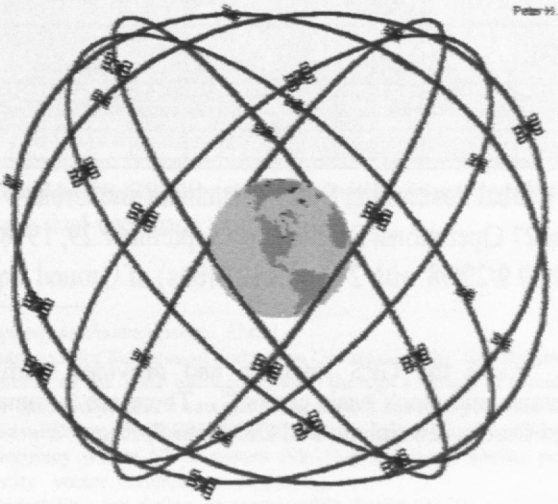
[54] "The system gained fame during Desert Storm by providing unprecedented navigational accuracy for allied air and ground forces, but it is rapidly being integrated into a wide variety of civilian uses as well" according to Maj. Gen Robert S. Dickman, director of Space Programs in the Office of the Assistant
Secretary of the Air Force for Acquisition. "GPS is a model for dual-use' systems…It's both a force multiplier for the war fighter and a boon to the civilian sector." http://www.colorado.edu/geography/gcraft/notes/gps/gps_f.html .

The Global Positioning System is owned and operated by the United States Air Force[55]. The system is composed of three parts. These are

- Space segment
- Control segment
- User segment

The space segment consists of a constellation of 24 NAVSTAR satellites within six orbital planes.[56] GPS satellites transmit two codes. Firstly there is the P-code designed for military applications[57]. Secondly there is a civilian or non/military code called the C/A-code[58].

GPS CONSTELLATION DIAGRAM[59]



GPS Nominal Constellation
24 Satellites in 6 Orbital Planes
4 Satellites in each Plane
20,200 km Altitudes, 55 Degree Inclination

[55] The GPS navigational system is operated by the 2nd Space Operation Squadron of the 50th Space Wing at Falcon Air Force Base, Colo., IBID.

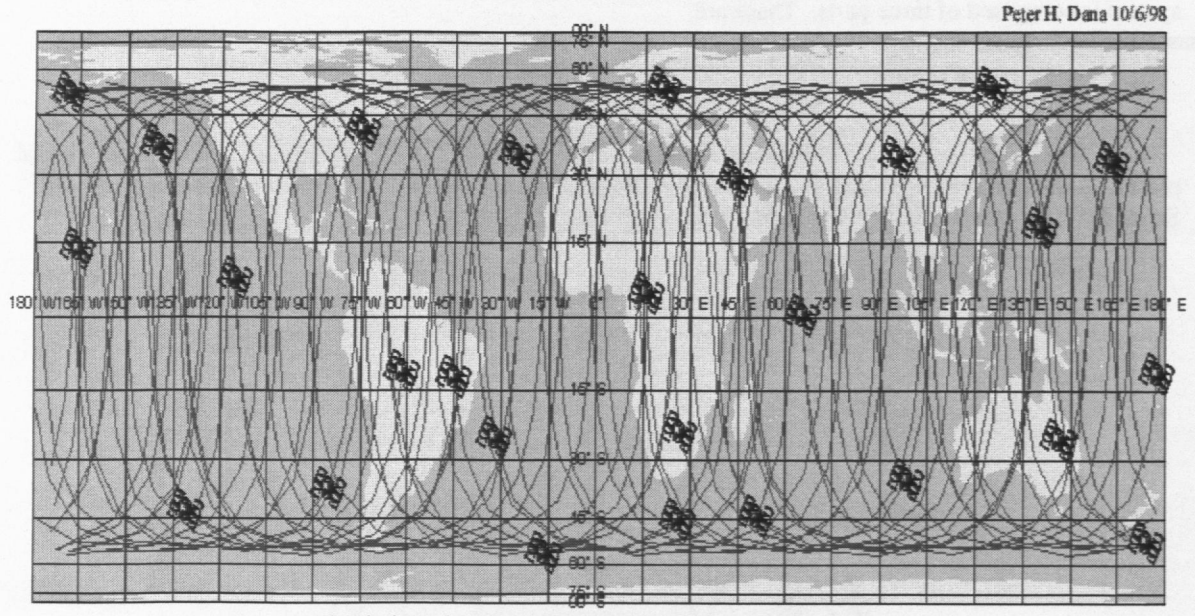
[56] "The satellites orbit the earth with a period of 12 hours in circular 10,900 n. mi. orbits at an inclination of 55 degrees with respect to the equator. Each satellite passes over the same location on earth about once every day (or every 23 hours and 56 minutes). The spacing of the satellites in orbit is arranged so that a minimum of five satellites are in view to users worldwide with a Position dilution of precision of six or less" Scott Pace et. Al. *The Global Positioning System, Assessing National Policies, (*Washington *RAND,* at. 218.

[57] A p-code is "a week-long pseudorandom number (PRN) sequence, approximately 6 x 10 to the 12th power bits long, with a bandwidth of 10.23 MHz. The long length of the code makes it harder to acquire and more difficult to spoof, or to jam than the civilian signal because of its bandwidth. The signal is further protected by encryption". IBID at 219.

[58] This is a 1023-bit Gold Code with a bandwidth of 1.023 MHz. It is less accurate and easier to tamper with. IBID at 219.

[59] http://www.colorado.edu/geography/gcraft/notes/gps/gps_f.html.

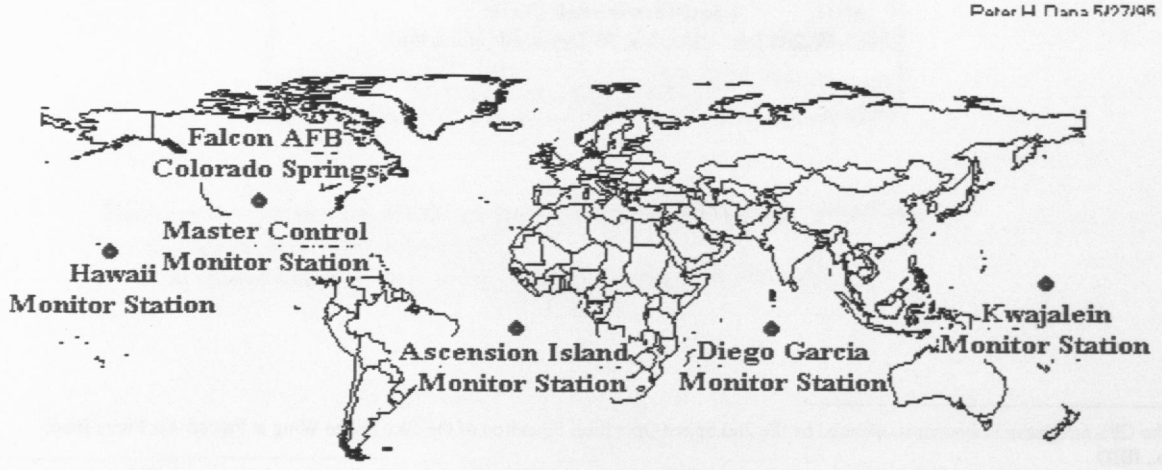
GPS GROUND TRACKS[60]



Global Positioning System Satellites and Orbits
for 27 Operational Satellites on September 29, 1998
Satellite Positions at 00:00:00 9/29/98 with 24 hours (2 orbits) of Ground Tracks to 00:00:00 9/30/98

The control segment "tracks the GPS satellites and provides them with periodic updates, correcting their ephemeris constants and clock basis errors"[61]. There are 5 unmanned stations located at: Hawaii, Ascension Island, Diego Garcia, Kwajalein; and Colorado Springs.

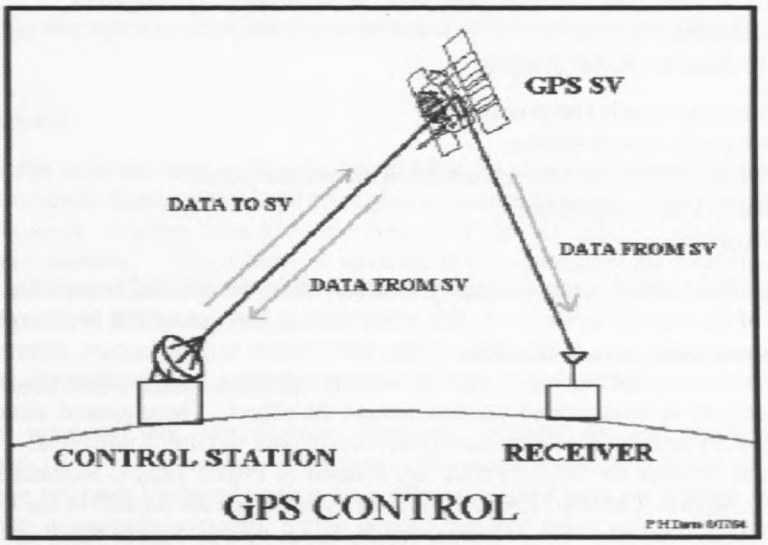
GPS GROUNDSTATIONS[62]



Global Positioning System (GPS) Master Control and Monitor Station Network

[60] http://www.colorado.edu/geography/gcraft/notes/gps/gps_f.html
[61] IBIDEM, p. 222.
[62] http://www.colorado.edu/geography/gcraft/notes/gps/gps_f.html.

GPS USER SEGMENT[63]



The GLONASS constellation is owned and operated by the Russian Federation[64]and has a similar tripartite functional architecture to the GPS constellation with a space segment,[65], a ground segment[66], and receivers. GLONASS is also a dual use space asset.[67]

---

[63] http://www.colorado.edu/geography/gcraft/notes/gps/gps_f.html.

[64] The GLONASS system is managed for the Russian Federation Government by the Russian Space Forces, system operator, providing significant benefits to the civil users community through a variety of applications. The GLONASS system has two types of navigation signal: standard precision navigation signal (SP) and high precision navigation signal (HP). SP positioning and timing services are available to all GLONASS civil users on a continuous, worldwide basis and provide the capability to obtain horizontal positioning accuracy within 57-70 meters (99.7% probability), vertical positioning accuracy within 70 meters (99.7% probability), velocity vector components measuring accuracy within 15 cm/s (99.7% probability) and timing accuracy within 1 mks (99.7% probability). These characteristics may be significantly increased using differential mode of navigation and special methods of measurements (e.g. carrier phase etc.) see http://www.rssi.ru/SFCSIC/english.html.

[65] Fully deployed GLONASS Constellation is composed of 24 satellites in three orbital planes whose ascending nodes are 120 degrees apart. 8 satellites are equally spaced in each plane with argument of latitude displacement of 45 degrees. Besides the planes themselves have 15 degrees argument of latitude displacement. Each GLONASS satellite operates in circular 19,100 km orbits at an inclination angle of 64.8 degrees and each satellite completes an orbit in approximately 11 hours 15 minutes. The spacing of satellites in orbits is arranged so that a minimum of 5 satellites are in view to users world-wide, with adequate geometry, i.e. GLONASS Constellation allows to provide continuous and global navigation coverage for performing of successful navigation observations. Each GLONASS satellite transmits radio frequency navigation signal containing navigation message for users http://www.rssi.ru/SFCSIC/english.html.

[66] GROUND-BASED CONTROL COMPLEX

The GLONASS Constellation is operated by Ground-based Control Complex (GCS). It consists of the System Control Center (Golitsyno-2, Moscow region) and a several Command Tracking Stations (CTS) are placed over a wide area of Russia. The CTSs track the GLONASS satellites in view and accumulate ranging data and telemetry from the satellites signals. The information from CTSs is processed at the SCC to determine satellite clock and orbit states and to update the navigation message of each satellite. This updated information is transmitted to the satellites via the CTSs, which also used for transmitting of control information. The CTSs ranging data is periodically calibrated using a laser ranging devices at the Quantum Optical Tracking Stations which are within GCS. Each GLONASS satellite specially carries laser reflectors for this purpose.

The synchronization of all the processes in the GLONASS system is very important for its proper operability. There is the Central Synchronizer within GCS to meet this requirement. The Central Synchronizer is high-precise hydrogen atomic clock which forms the GLONASS system time scale. The onboard time scales (on a basis of satellite cesium atomic clocks) of all the GLONASS satellites are synchronized with the State Etalon UTC(CIS) in Mendeleevo, Moscow region, through the GLONASS System Time scale. http://www.rssi.ru/SFCSIC/english.html.

[67] See Decree pf the President of the Russian Federation at http://www.rssi.ru/SFCSIC/english.html. GLONASS is used for Air and naval traffic management, safety increasing; Geodesy and cartography; Ground transport monitoring;

- Time scale synchronization of the remote from each other objects;
- Ecological monitoring, search and riscue operation organization. See http://www.rssi.ru/SFCSIC/english.html

II 1.4 Remote Sensing Satellite Systems

Space-based Earth imaging can be divided into two technological categories

- Optical Imaging
- Synthetic Aperture Radar imaging

A remote sensing system is composed of

- A telemetry and control station;
- Several ground receiving stations scattered around the planet;
- A satellite in Low Earth Orbit;
- Data interpretation centre.

The telemetry and control centre is usually located within the national boundaries of the state that licences the operator of the satellite system. At this point there is both an uplink to control the space asset and a downlink to receive data. It is at this point where the satellite tasking occurs, determining what will be sensed. Due to operational contingencies remote sensing satellites have a relatively small capacity to store data, thus the need for several ground stations around the planet. These ground stations typically do not have an uplink capacity and are used exclusively to receive data through a downlink. For example, the North American ground stations for RADARSAT are located in Prince Albert, Saskatchewan, Gatineau, Quebec, and Fairbanks Alaska. Certified RADARSAT foreign stations are located in the United Kingdom, Norway, Singapore, China, Australia, South Korea, Japan, Saudi Arabia, Puerto Rico, and Thailand. The telemetry and control for RADARSAT is located at the Canadian Space Agency in St-Hubert, Quebec. It is important to note that ground-receiving stations need not be fixed. For example, during the Maritime Combined Operational Training (MARCOT) – UNIFIED SPIRIT 1998, a large NATO training exercise, a mobile ground receiving station was used to receive and process RADARSAT data for military use in real time.

Remote sensing satellites are placed in polar Low Earth Orbits. For example, RADARSAT is in a near-polar sun-synchronous orbit at an altitude of 798 km with an orbital plane inclination of 98.6 degrees. RADARSAT completes 14 orbits every 24 hours, each orbit lasting approximately 100.7 minutes. RADARSAT can obtain 28 minutes of data per orbit.

II 1.5 Military Satellite Systems

Military satellites have a similar architecture to that of civilian satellites, namely a ground segment, a space segment and the uplink-downlink segment. The space segment may differ in that the satellite is most probably hardened against electro-magnetic pulse weapons. The applications are the same although the vocabulary may change. Military telecommunications satellites may be also referred to as command and control; remote-sensing satellites may be referred to as reconnaissance, espionage, or intelligence satellites[68]. Examples of military space products include high-resolution earth imagery, target indicators, maps and Digital Terrain Elevation Data (DTED)[69]. It is important to note that the GPS is a military asset, being the property of the USAFA. Furthermore, in the United States, a 1994 Presidential Decision Directive converged existing Air Force, NASA, and NOAA polar orbiting satellites into an integrated national program[70].

II 2. Anti-Satellite Capabilities (ASAT)

There are no reported cases of use of ASAT weapons during international conflict[71]. Nonetheless ASAT technology has been tested. On September 13th 1985, USAF pilot Major Doug Pearson made military history. From his F-15A flying at Mach1.22 200 miles west of Vandenberg AFB, he executed a 3.8 g 65 degree climb to launch a missile, which destroyed a satellite called P78-1[72]. The target satellite

[68] These may also include Signals Intelligence satellites which detect transmissions www.fas SIGINT overview.
[69] See Department of defense Space Technology Guide FY 2000-01 available at http://fas.org/spp/military/myer.pdf, p. 56.
[70] PRESIDENTIAL DECISION DIRECTIVE/NSTC-2. See http://www.ipo.noaa.gov/About/NSTC-2.html
[71] See I.A. Vlasic, "Space Law and the Military Application of Space Technology" in *Perspectives on International Law* (London: Klewer Law International 1995) at 397-98.
[72] www.edwards.af.mil/moments/docs, 'The ASAT missile was nearly 18 feet in length and weighed 2700 lbs.... The delivery aircraft was launched into an area below the path of the oncoming target satellite. Pulling up into a deep climb, the F-15 would release the weapon into a small launch window...the homing vehicle would vector itself directly into the target's path and destroy it by smashing directly into it. At the extremely high closing speed of the two objects, no explosives would be necessary."

was orbiting at 345 miles above the Pacific Ocean. The target satellite was kinetically destroyed, shattered into space debris.

Although the test was a success, there is a spectrum of technologies available to neutralize satellite systems.

II 2.1 Kinetic Weapons

Kinetic energy weapons such as the one described in the case involving the USAF F-15 do not use explosives. These weapons shatter their target through a high-speed impact. This concept may be referred to as a "hard kill" weapon. Another form of such a weapon is the "KE ASAT" which uses a Mylar shroud to impact the targeted satellite[73]. This system is intended to hit and impair the satellite but not to destroy the satellite. Thus unlike the unlike the case of hard kill weapon systems, space debris is minimised. This may be referred to as a "soft kill" weapon system.

II 2.2 Electromagnetic and Radiation Weapons

These are weapons that can destroy electronic circuitry by the creation or emission of electromagnetic pulse (EMP) or radiation. A nuclear explosion creates both and can effectively neutralize satellites, which have not been hardened against such effects[74]. EMP lasts for a small fraction of a second but causes damage to unprotected circuitry within several hundred miles radius of the blast. Following a nuclear explosion, the resulting beta particles and gamma rays can also create havoc in space assets affecting both radio waves and radar waves. According to General Kenneth Hagemann, director of the Defence Nuclear Agency, a 50-kiloton nuclear weapon exploded at 62 miles above the earth would pump up the Van Allen radiation belt[75] to the extent that increased exposure "would cause satellites to die in hours, days, or weeks"[76]. General Hagemann also points out that miniaturized electronics which make satellites lighter and smaller increases the vulnerability of satellites since they require less power and are consequently susceptible to smaller disruptions.

II 2..3 Directed Energy Weapons (DEW)

Directed Energy Weapons "include laser, radio frequency[77]" weapons. A laser weapon produces a concentrated beam, which can be projected from earth towards space assets. An example of such a system is the Mid-Infrared Advanced Chemical Laser (MIRACL). On October 17, 1997, the MIRACL laser successfully illuminated a satellite. Another program is the airborne laser (ABL) onboard a Boeing 747 aircraft. Laser weapons can be used to either physically harm the satellite or simply to" blind" the satellite sensors. Satellites in LEO are easier to target with earth-based lasers than those in geostationary orbit, which are much farther away[78].

II 2.4 Signals Weapons

Electronic weapons are used to interfere with satellite uplinks and downlinks by either spoofing or jamming these links. For example a GPS signal is spoofed if *"a receiver processes fake signals as if they were the desired signals. Users of GPS which are spoofed can be made to believe that they are on course when they could actually be very far from their desired position"*[79]. Jamming on the other hand is the rendering of radio transmissions unintelligible by causing interference. According to Rear Admiral Robert Nutwell, Deputy Assistant Defense Secretary for C3I Reconnaissance, Surveillance and Space Systems: "the vulnerability of GPS to jamming is pretty well recognized ...because it is...a weak signal and it is not

---

[73] See www.fas.org/spp/military/program/asat/ke_asat.htm

[74] The U.S. had initially developed an ASAT system called Program 437 which used a nuclear warhead launched atop a Thor missile with a 1 megaton yield and a kill radius of 5 miles. See High Frontier pp. 62-65.

[75] James A. Van Allen is credited with the discovery of the belt of high-energy particles that surround the Earth. The discovery resulted from experiments originally designed to use captured German V2 rockets. See www.sspi.org/orbiter/Dec-Jan03/anniver2.html.

[76] www.globalsecurity.org/space/library/news/1995/at_950504.htm. Can be referred to as a Van Allen Attack

[77] Major William L. Spacy II, "Does the United States Need Space-Based Weapons?" CADRE Paper, Air University Press, Maxwell AFB, Alabama, September 1999 at p.10; www.maxwell.af.mil/au/aul/aupress/CADRE_Papers/PDF_Bin/spacy.pdf.

[78] IBID p.18.

[79] Scott Pace, *The Global Positioning System Assessing National Policies,* supra note 56 at 219.

protected as military-unique satellites."[80] Furthermore to make matters worse GPS jammers are commercially available[81]. There are two ways to interfere with GPS signals. The first and the simplest method is that of using a continuous wave jammer. A filter can easily protect a GPS receiver against such an apparatus. The second, and this is the most dangerous method, is the use of a broadband jammer. A broadband jammer alternates in a highly unpredictably manner around various frequencies[82]. The unpredictable operation of such a system makes it a very effective weapon and difficult to defend against[83]. The range of effect of these jammers can be considerable, reaching easily over 20 kilometres[84].

[80] www.nationaldefensemagazine.org/article.cfm?Id=5 at p. 3.

[81] "During an air show in Russia in 1997, for example a $4,000.00 jamming transmitter was on display and its manufacturers claimed the device foils the ability of GPS receivers to provide correct geographic coordinates" IBID.

[82] IBID at 3.

[83] From a technical perspective "it is difficult to find a mathematical algorithm that allows you to anticipate what the jammer is going to do. IBID at 3.

[84] 'Tests show that a one watt jammer can drive a commercial GPS receiver haywire at a distance of twenty-two kilometers and a large number of small jammers can be hard to find and destroy. Even a 1,000 watt jammer can be miniature enough to be man-portable. See Peter Grier *Journal of the Air Force Association April 1996, Vol. 79, No.4* www.afa.org/magazine/April1996/0496gpsin_print.html at p. 4.

III Targeting Satellites and Satellite Architecture

III 1. Military Objective

The first process in legally using a weapon is that of targeting. The initial legal consideration in the targeting process is the determination of what is a legitimate military objective. This process is the application of the principle of distinction. The use of force in military operations can only be directed towards legitimate military objectives. Space assets are not an exception to this important principle. Legitimate military objectives are defined as objects which by *"their nature, location, purpose or use make an effective contribution to military action and whose total or partial destruction, capture or neutralization, in the circumstances ruling at the time, offers a definite military advantage"*[85]

It is important to note that the text imposes two cumulative conditions for the existence of a legitimate military target.

Firstly, the object must by its *nature, location, purpose or use make an effective contribution to military action,* and

Secondly, its *total or partial destruction, capture or neutralization, in the circumstances ruling at the time, offers a definite military advantage.*

Once these two conditions are united, the object may be attacked. However a complete parsing and deconstruction of the text is required to fully grasp the amplitude of the norm.

III 1.1 Nature

The word "nature" includes all objects that are used directly by armed forces[86]. Thus military satellites (command and control, GPS, intelligence, etc), including their architecture, are legitimate military objectives and may be attacked. Consequently States must avoid placing military ground stations near densely populated areas[87]. Similarly, military satellites should not be placed near civilian satellites or in an orbit that would be considered to be "near" the International Space Station (ISS).

III 1.2 Location

The word "location" offers an interesting interpretive challenge when confronted with the paradigms of space assets. The accepted and standard interpretation of the word has two dimensions. Firstly, the word refers to objects which are not by nature military, but which in virtue of their location contribute to military action. Examples of these are bridges or other such constructions[88]. A tall construction offering a view of the opposing belligerent forces can easily be conceived as being a legitimate military objective. Seen in this light, a civilian remote sensing satellite or a civilian telecommunication satellite and their respective architecture may arguably be considered as legitimate targets. Secondly, the word "location" can also be interpreted as referring to an area that may be attacked. In this sense the use of the area may legitimately be denied to the enemy. An example of this is a mountaintop or a ridge from which an enemy could observe an opposing force. It is at this point where the textual interpretation of applying the concept of "location" to space increases in difficulty. In attempting to apply this norm to the space paradigm the question is whether space itself or an orbit can be interpreted as being a "location". If the answer is "yes" then space or orbits may then be the objects of attack in order to deny the ultimate "high ground" to an enemy belligerent force. The word "location" is defined within the Oxford dictionary as either a particular place or position and even includes the action or process of locating[89]. Thus, it is logical to deduct that a specific orbital coordinates within the geostationary orbit, can be attacked in order to deny its use by belligerent forces for command and control, or telecommunications satellites. Considering that the word can also be construed as encompassing "the action or process of locating" transfer orbits which are used to place satellites in specific orbital coordinates may, according to

---

[85] AP I Art 52.2 *in fine.*

[86] Claude Pilloud et. al., ed., *Commentary on the Additional Protocols of June 8 1977 to the Geneva Conventions of 12 August 1949* (Norwell, MA, M.Nijhoff Publishers, 1987) para. 2020 (hereinafter referred to as « Commentary ».

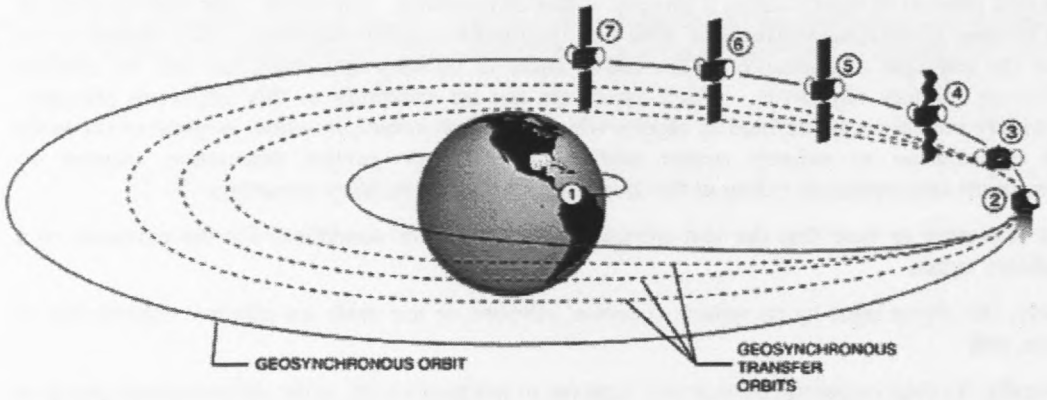
[87] API art. 58(b) supra note 11.

[88] Commentary, supra note 86, Para. 2021.

[89] Concise Oxford Dictionary, tenth edition, p.833.

this interpretation, also be the object of attack. An expansive interpretation would also permit the attack of orbital parameters as these define specific orbits.

TRANSFER ORBIT[90]



Consequently it appears that since a "location" may be attacked, it can be argued that an orbit may be the object of attack in order to deny an enemy force the use of the "location"[91].

As interesting and easy as it can be to place orbits and orbital coordinates within the concept of "location", the certainty of this interpretation is not a foregone conclusion. In fact the concept of space and orbits suffers from a cognitive dissonance in LOAC terms of reference. Thus, depending on how orbits are defined, other dispositions may apply. The cognitive dissonance occurs in the second level of the targeting process, which will be analysed later on.

III 1.3 Purpose or Use

To conclude the textual deconstruction of a military objective, the word "purpose" must now be analysed. The word "purpose" refers to dual-use objects. Dual-use objects are those which may initially be civil but which can be also used to the benefit of armed forces. Again, civilian satellites, which provide services to armed forces, such as telecommunication, command and control, earth imagery, or intelligence, along with their respective architecture, fall into this classification and may be the object of attack. In this case, it is important to note that when planning an attack on a dual use objective, an additional obligation lies upon the commander of a belligerent force. Although the object may be attacked, a military commander must, when planning such an attack, determine a location and time of attack, along with the anticipated military advantage to be gained, in such a manner as to minimize the damage to civilians and civilian objects. For example, assuming that a ground station has become a legitimate military objective and can be attacked, the attack should be planed so as to minimize loss of civilian lives. Thus, if possible, an attack should be planned to take place when there will be a minimum of civilians within the ground station, or in its immediate vicinity. Nonetheless, there may be situations where the ground station is of such high importance to enemy operations that the ground station must be destroyed immediately. In such a scenario, the commander's decision to attack will be based on the principle of proportionality. Thus, if the ground station is a military target and a commander needs to destroy it immediately, either to accomplish an important mission that is either occurring, or is about to occur, or to save the lives of his soldiers, then the ground station may be attacked and the commander need not wait until there are fewer civilians either within the ground station or its immediate vicinity. In other words, the commander may not have the luxury of waiting. In an effort to further protect civilians, the Protocol Additional I impose an obligation upon commanders to give an effective advanced warning of attacks, which may affect the

[90] http://www.telesat.ca/eng/international_operations.htm.

[91] " Une aire précise peut, en raison de son emplacement et des circonstances, constituer un objectif militaire légitime, RFA, Canada, E.U., Pays-Bas, Commentary supra note 86 Para. 2025.

civilian population, unless circumstances do not permit[92]. The position of customary international law on this issue is less clear.

III 2. Military Advantage

The second cumulative element of a military objective is that of a *definite military advantage.* In establishing a military advantage, the frame of reference is the key to properly interpreting the norm[93]. Furthermore, the definite military advantage gained must be concrete and not purely hypothetical. Thus, the calculus must be made from a strategic perspective and not from a narrow tactical point of view. Furthermore, the norm imposes an obligation of means. That is, those who plan such an attack must have the necessary information enabling them to respect the norm. Should there be a doubt as to the definite military advantage to be gained, the attack must be called off. The principle of military necessity circumscribes the definition of a legitimate target in space.

Professor Michael N. Schmitt points out a doctrinal debate on what he refers to as the degree of nexus between the object and individual attacked and military operations[94]. This debate centers upon a difference of opinion between ICRC, which propounds a restrictive approach and the less restrictive American view. In his argument, Professor Schmitt refers to U.S. military manuals, for example *The Commander's Handbook on the Law of Naval Operations,* which states, "*economic targets that indirectly but effectively support and sustain the enemy's war-fighting capability may ... be attacked*"[95].

Consequently, satellites and their architecture can be perceived as legitimate military targets and become the object of attacks. In fact, considering the economic importance of space assets within an information-based economy, the argument contained within the Commander's Handbook increases the justification for targeting satellites and their architecture.

III 3. Legitimate Means and Methods

To classify satellites and their architecture as legitimate military objectives is certainly interesting but in itself insufficient to launch an attack against these assets. Any use of force must respect the principles described here.

III 3.1 Application of the Principles

The use of force must be proportional. On this point, it is interesting to note both the similarity and difference in terms when comparing A.P. I Art 52.2, which uses the term "military necessity" with A.P. I Art. 57.2 (a) (iii), (proportionality) which, uses the term "direct military advantage anticipated". For the rule of A.P.I Art. 52.2 to be respected, each military objective must have an articulated, precise military advantage. On the other hand the rule of A.P.I Art 57.2(a)(iii), which deals with the precautions in attack, adds another variable into the equation, namely that of the loss of civilian lives which could result from the attack. Furthermore A.P.I Art 57.2(a)(iii) adds another dimension to the concept of definite military advantage, which must also be direct. The difficulty of the calculus is compounded by the realities of space, namely orbits. The calculus of proportionality when using conventional arms on earth is a static concept. Collateral damage occurs immediately and remains static in time. Space debris resulting from a hard kill remains in orbit[96].

Another consideration in the targeting of satellites and their architecture is found in Article 27 of the Annex to Hague IV[97], which offers protection from intentional attack to buildings dedicated to science

---

[92] A.P.I Art. 57.2(c).

[93] Commentary, supra note 86, para. 2218.

[94] See Bellum Americanum, supra note 31 at 1076.

[95] Bellum Americanum, supra, note 31, at 1076.

[96] On this point it is interesting to note that the OST establishes within its Article IX two concepts which may have an impact upon the creation of space debris through a hard kill. Firstly, Art IX creates an obligation of "due regard to corresponding interests of all other States Parties to the Treaty"" upon the conduct of the space activities by states. Secondly Art. IX states that States are to "pursue studies of outer space...and conduct exploration...so as to avoid ...harmful contamination". This second obligation may arguably have an impact upon the testing of new ASAT technology.

[97] Reprinted in Roberts & Guelff, supra note 5, at 73, 78. It is important to note that "The Nuremberg International Military Tribunal had already found in 1945 that the humanitarian rules included in the Regulations annexed to the Hague Convention IV of 1907 "were recognized by all civilized nations and were regarded as being declaratory of the laws and customs of war" (International Military

provided they are not being used at the time for military purposes. Article 27 of the Annex to Hague IV appears to offer additional protection to purely scientific satellites and their architecture. Furthermore this article creates an obligation for the belligerent State controlling such scientific buildings to indicate these by the use of visible signs and to notify the enemy beforehand. Thus satellites and their architecture, which are used for science and not for military purposes, must be properly identified in order to benefit from their protected status.

III 3.2 Orbits, Environment and Cognitive Dissonance

The legitimacy of the means and methods used to attack a legitimate military objective completes the targeting process. It is at this point that an alternative manner, i.e. the cognitive dissonance occurs, of perceiving orbits through LOAC paradigms.

An alternative manner of perceiving orbits is to classify them as part of the environment, as a natural resource. Orbits as part of the environment would be subject to greater protection than if they were perceived as areas. Doctrine recognizes the importance of environmental considerations in the planning and execution of military operations[98]. In dealing with the issue of environmental protection during times of armed conflict, the ICJ stated that it does not consider that the treaties protecting the environment could have intended to deprive a State of the exercise of its right of self-defense under international law because of its obligations to protect the environment. Nonetheless, the International Court of Justice did emphasize the importance of environmental considerations in the planning and conduct of military activities, stating that:

> *States must take environmental considerations into account when assessing what is necessary and proportionate in the pursuit of legitimate military objectives. Respect for the environment is one of the elements that go to assessing whether an action is in conformity with the principles of necessity and proportionality.*[99]

In support of its position the ICJ cited Principle 24 of the Rio Declaration

> *"Warfare is inherently destructive of sustainable development. States shall therefore respect international law providing protection for the environment in times of armed conflict and cooperate in its further development, as necessary."*

The ICJ arguments also included references to General Assembly resolution 47/37 of 25 November 1992 on the Protection of the Environment in Times of Armed Conflict, which the ICJ believes to be of interest in the context of nuclear weapons[100]. UNGA resolution 47/37 states that the "destruction of the environment, not justified by military necessity and carried out wantonly, is clearly contrary to existing international law". The ICJ also referred in its arguments to its recent Order in the *Request for an Examination of the Situation in Accordance with Paragraph 63 of the Court's Judgment of 20 December 1974 in the* Nuclear Tests (New Zealand *v.* France) *Case*, where the ICJ stated that its conclusion was "without prejudice to the obligations of States to respect and protect the natural environment" (*Order of 22 September 1995, I.C.J. Reports 1995*, p. 306, para. 64). "Although that statement was made in the context of nuclear testing, it naturally also applies to the actual use of nuclear weapons in armed conflict"[101]. The ICJ clearly stated the fundamental problem with nuclear weapons is that "the destructive power of nuclear weapons cannot be contained in either space or time."[102] Despite this lacunae the ICJ acknowledged that the " proportionality principle may ... not in itself exclude the use of nuclear weapons in self-defense in all circumstances".[103]

More precisely, article 35 of AP I outlines fundamental rules applicable to the methods and means of warfare[104]. Thus AP IArt 35 .3 edicts that *"it is prohibited to employ methods or means of warfare*

Tribunal, *Trial of the Major War Criminals*, 14 November 1945 (1 October 1946, Nuremberg, 1947, Vol. 1, p. 254)." Nuclear Weapons Case supra note 6 para. 80.

[98] See Michael N. Schmitt "War and the Environment Fault Lines in the Prescriptive Landscape" (1999) 37 Archive Des Volkerrechts, at 25. Also from the same Author see Green War supra note 12.

[99] Nuclear Weapons Case, supra, note 6, para. 30.

[100] IBID para. 32.

[101] IBID.

[102] IBID.

[103] IBID.

[104] API arts. 35 .2 and .2 supra note 11, represents customary international law Commentary supra note 86 para. 1403.

which are intended or may be expected to cause widespread, long-term and severe damage to the natural environment". Within AP I Art. 35, the natural environment is itself the object of protection. A few preliminary observations, firstly, the disposition is eloquent in its silence. The term "natural environment" is used and not "human environment". Secondly AP I Art. 35 addresses the consequences of the use of any weapon whatsoever, be it a kinetic or directed energy weapon. Furthermore, the conditions that result from the use of the weapon are expressed within API as being cumulative. In other words the damage to the natural environment must be at the same time widespread, long-term and severe. The term "long-term" is interpreted to mean lasting decades[105]. In this sense ASAT weapons, which cause such damage, would be prohibited. Considering the effect of space debris that would result from hard kill of a satellite, such a weapon could arguably be considered in violation of this disposition. The use of a nuclear blast is more problematical. Article 35 was accepted by consensus. The United States and the United Kingdom made a declaration to the effect that this disposition does not apply to nuclear weapons[106]. However an ASAT weapon, which would create an EMP without a nuclear explosion, could conceivably not be perceived as a nuclear weapon and fall within the ambit of article 35.3 AP I. However EMP emissions might escape from the time requirement of the norm. The problem with EMP weapons lies with another issue, namely that of distinction.

An ASAT weapon must not have indiscriminate effects. An attack is considered indiscriminate if either it is not directed at a specific military objective[107], or the method or means cannot be directed at a specific military objective[108]. This may be problematical for an EMP weapon, as is the case if the effects of the means and methods cannot be limited as required by the protocol. Thus an EMP weapon would have to be directed at the target satellite in an efficient manner. It is this last condition of an indiscriminate attack, which is also most problematical in the case of a hard kill of a satellite, which causes space debris. In this case the targeting of a satellite within a crowded geostationary orbit becomes more problematical. On the other hand a telecommunication satellite within a less cluttered orbit such as a molnya orbit is less problematical. However, the targeting of telecommunication satellites within the LEO orbit also becomes problematical as this orbit is shared by many nations.

Furthermore, recent developments in space colonization, namely the creation of a permanently orbiting space station have changed the possible application of article 55API to the use of force in space. API Article 55 edicts that care is to be taken to protect the natural environment against widespread, long-term and severe damage, including means and methods which are intended or expected to cause prejudice to the health or survival of the population. Again a semantic analysis helps clarify the application of Article 55 to the use of force in space. The ICRC commentaries proffer that a broad interpretation must be given to "natural environment"[109], encompassing the biosphere. Although space is a hostile environment to human life the concept of "environment" can be interpreted to include the orbits within which there is a human presence. Which brings up the second definitional issue. The word "population" is not defined within the Additional Protocol. The word "population", within its plain and ordinary meaning, refers to the inhabitants of a particular place, or even the action of populating an area. The word can conceivably be applied to the astronauts occupying the space station. Furthermore, does the word "population" presuppose a minimum human presence? In the case of the application of API there does not appear to be a minimum required for humanitarian protection. Thus, if broadly interpreted, Art 55 API could prohibit the use of ASAT weapons which imperil the lives of the inhabitants of the ISS by affecting the orbit within which the space station orbits the earth, or which would prevent supplies from being brought to the space station. On the other hand the ISS could conceivably become a military target should it be used for military purposes. Furthermore, although military satellites should not be stationed near non-military objectives, a commander could employ a proportionality analysis in determining whether to attack a military target that has been located near civilian objects, and as a result of such an analysis the attack may be lawful. In short the LOAC does not give special protection to the ISS.

It is important to grasp the difference in application between AP I art. 35 and 55. API art. 35 deals with environmental issues through a perspective of the means and methods of force application. On

[105] Commentary, supra, note 86, para. 1453.
[106] Commentary, supra, note 86, para. 1403.
[107] API art 51.4 (a), supra note 11.
[108] API art. 51.4 (b), supra note 11.
[109] Commentary supra note 86 para. 2127.

the other hand API Art 55 deals with the survival of the population. Granted there may be an overlap. Nonetheless their difference in perspective is important.

The Convention on the Prohibition of Military or any Other Hostile Use of Environmental Modification Techniques [110] is applicable to certain ASAT weapons. Each Party to the ENMOD convention undertakes not to engage in military or hostile use of environmental modification. Environmental modification in turn includes the deliberate manipulation of the natural process, namely the dynamics, composition, or structure of ...outer space[111]. Furthermore, according to Professor Eric David, Article IV of ENMOD makes the violation of ENMOD a war crime[112]. Could a Van Allen attack be a violation of ENMOD, perhaps so if the attack has widespread, long-lasting or severe effects as articulated in Article I of ENMOD. It is interesting to note that the ENMOD convention does not contain a definition of outer space. The OST defines outer space as being a complete orbit. Considering that Article II of ENMOD refers to the "dynamics" of the environment, it is reasonable to interpret "outer space" within the ENMOD as encompassing orbits. Thus establishing orbits as a natural environment would increase their protection under international law from certain ASAT weapons.

Therefore, depending upon the cognitive perception of the physical phenomenon of an orbit by the LOAC, the result of the targeting analysis is differs. Is an orbit an area to be attacked or is it a natural environment to be protected?

III 3.3 Debris

The creation of space debris must be factored into the proportionality calculus of ASAT weapons. What is important in applying the proportionality principle to space is the environment and vicinage within which the consequences occur. A collateral damage assessment in its' usual application, is a concept which is limited in time and space. However, in space, collateral damage has a greater physical and temporal dimension. Its physical amplitude is magnified by the fact that the resulting effects orbit the planet. Its temporal amplitude is amplified in that the orbiting particles can remain in orbit for a prolonged period. Thus even if orbital parameters and coordinates may be attacked, a similar calculus to that created within arts 35 and 55 API results. However the complexity of the calculus is increased due to the increased variables of the components of the equation.

Furthermore, if the resulting affects of an ASAT weapon cause harm to other satellites of other nations, which are not involved in the conflict, be they civil or military, other legal issues arise. In this scenario the issues to be dealt with are compounded, namely the effects on civil objects and on the rights of neutral States. Damages caused by space debris to military satellites of neutral States are, strictly speaking, not part of the calculus of proportionality but enters in the violations of the rights of neutral States. Space debris is however not only the concern of attacking forces. States must refrain from placing military assets near civilian objects. Thus a military satellite which has the potential to be attacked must not be stationed in the vicinity of civilian satellites.

III 3.4 Jamming and Signals Modifications

To be effective against GPS guided munitions, the jamming of GPS signals must be done over a specified area and not directed against a specific military target. GPS jamming weapons therefore may, depending on the circumstances in which they are used, have difficulty respecting the principle of distinction. Furthermore, the use of GPS jammers may breach other LOAC principles. For instance if GPS jammers are used in a populated area by a defending force, the jamming device may place the civilian population at risk by causing the ordnance to fall uncontrollably off target. On this issue, it is to be noted that defending forces have an obligation to take all necessary precautions to protect the civilian population from the dangers resulting from military operations[113]. It is to say the least, very difficult to reconcile this

---

[110] 1977, 1108 U.N.T.S. 151, Reprinted in Roberts & Guelff, supra, note 5, at 409 (hereinafter referred to as ENMOD).
[111] IBID art. 2.
[112] Eric David *Principes de Droit des Conflits Armes,* (Bruylant Bruxelles 1999), at 581.
[113] API art. 58(c), supra note 11.

obligation with the jamming of GPS signals in an urban area. Furthermore jamming of GPS signals is not necessarily effective against cruise missiles, which are equipped with DETD technology[114].

III 3.5 Perfidy and Ruses of War

It is important to note that an attack on satellite signals that would alter the content of the communication must not mislead the enemy as to his legal status, as this could be considered an act of perfidy. Perfidy is the hostile use of a belligerent's obligation to respect LOAC in order to kill, wound or capture him[115]. An act of perfidy must not be confused with a legitimate ruse of war.

III 3.6 New Weapons

The development of ASAT weapons presupposes much research, development and testing. API Art 36 imposes certain rules pertaining to the development of new weapons. In the development of new weapons a state determines whether their employment would, in some or all circumstances, be prohibited by the Protocol or by any other rule of international law. Thus the testing of weapons in space causes an interesting problem. There are two perspectives on the legitimacy of testing weapons, which would result in the closure of large areas of the ocean[116]. Some argue that such tests are an exercise in freedom of the seas; others argue that it is a denial of the freedom. This debate can easily be transported to outer space. Brownlie argues that this is a debate of reasonableness and mutuality[117] and that these principles apply in times of war as well as in times of peace[118]. In any case the principle of "due regard" applies in outer space. Article IX of the OST edicts that "State Parties...shall conduct their activities...with due regard to the corresponding interests of all other State Parties to the Treaty". This would apply to the conduct of hostilities in outer space. Furthermore nuclear weapon testing in space has been banned[119] which would apply to the testing of nuclear ASAT technologies.

III 3.7 Low Tech ASAT Weapons

Attempts to neutralize the use of satellites do not necessarily presuppose high tech weaponry. During the Gulf War an estimated 600 Kuwaiti oil wells were set on fire[120]. The result was a covering of black smoke over a large territory. During the present American led military operation in Iraq, there have been reports of fires in and around Baghdad, probably in an attempt to cause a smoke screen over the Iraqi capital. Visual and electro-optical devises, optical imaging satellites cannot function through dense clouds of smoke. Radar imaging satellites can however see through clouds of smoke[121]. Although such tactics may perhaps have some utility against certain imaging satellites they are ineffective against GPS guided munitions.

---

[114] "Precise DTED of target areas can be uploaded to cruise missiles and correlated with an on-board altimeter for highly accurate all-weather mid-course and terminal guidance, which is autonomous and thereby resistant to both GPS jamming and covert techniques» Department of Defense Space Technology Guide FY 2000-01, available at http://fas.org/spp/military/myer.pdf p. 56.

[115] Hague IV, supra, note 11, art 36, API, supra, note 11art 37.

[116] I. Brownlie Principles of Public International Law. (Oxford, Oxford University Press) at 239

[117] IBID.

[118] IBID p. 240.

[119] *Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water*, Aug, 5 1963, 14 U.N.T.S. 43, 2 I.L.M. 889; See also various UNGA declarations on the use of nuclear weapons: *Declaration on the Prohibition of the Use of Nuclear and Thermo-Nuclear Weapons*, U.N.G.A. Res. 1653, U.N. GAOR, Supp. No. 17 at 4, U.N. Doc. A/5100 (1961); *Resolution on the Non-Use of Force in International Relations and Permanent Prohibition of the Use of Nuclear Weapons*, U.N.G.A. res. 2936, U.N. GAOR, Supp. No. 30, at 5 U.N. Doc A/8730 (1972); *Resolution on the Non-Use of Nuclear Weapons and Prevention of Nuclear War*, UNGA Res. 35/152D, U.N. GAOR, Supp. No. 48, at 69, U.N. Doc.A/35/48 (1980).

[120] UNSC Resolution 687 dated April 3 1991 affirmed that Iraq was liable for environmental damage and depletion of natural resources. See http://www.un.org/Docs/scres/1991/scres91.htm.

[121] According to the Gulf War Report it is not clear why the oil wells were set ablaze by Iraq as these fires were created with the maximum of damage to the oil wells themselves. As the Gulf War Report points out ,"Had the purpose of the fires been to create an obscurant, oil wells in that field on each side of the border undoubtedly would have been set ablaze; Iraqi destruction was limited to the oil wells on the Kuwaiti side only, supra, note 20, at 637.

Conclusion

The use of ASAT weapons during times of international armed conflict is subject to the rules of law of armed conflict. Satellites and their architecture are, under certain circumstances legitimate military objectives. Belligerents may target such satellites and their architecture through certain legitimate means and methods. Conversely defending belligerents also have certain obligations in identifying and locating space assets and architecture. A cognitive dissonance occurs within the law of armed conflict on the classification of orbits as either a location, which may be targeted, or a natural environment that is subject to a protection regime. Nonetheless, at the very least, the long-lasting effects of ASAT weapons make their use under existing treaties questionable. The clarification within international legal instruments applicable to the conduct of hostilities during international armed conflict as to the protection of outer space as a natural environment would be a positive step towards the establishment of a strong legal regime restricting weapons in outer space. However, international law is the "art of the practical". It is doubtful countries that have ASAT weapons would easily accept placing legal restrictions upon their use. However, in the interim, a cogent argument can be made under existing treaties, that states have an obligation to choose means and methods of conducting hostilities that accomplish the mission while doing as little damage as possible to the environment, including outer space. Within the context of this paper, this would mean that when deciding to neutralize a space asset, a commander could legitimately decide to attack a ground station if such an attack would deny the enemy the ability to communicate with a satellite, instead of attacking the satellite itself or use an ASAT which will deny the use of the satellite without creating space debris. Countries that use outer space for military and civilian purposes have a vested interest in acting thusly since their future use of outer space could be adversely affected by the creation of space debris. In short, although legal scholars might differ in opinion on whether or not the space debris resulting from the use of a hard kill ASAT weapon violates international law, most would probably agree that belligerents have a legal obligation to, and a vested interest in using means and methods of warfare that denies the enemy his space-based capabilities while protecting and preserving outer space.

ISROP
INTERNATIONAL SECURITY RESEARCH AND
OUTREACH PROGRAMME

Non-Proliferation, Arms Control and Disarmament Division
Lester B. Pearson Building
125 Sussex Drive
Ottawa, Ontario
K1A 0G2

FAX: (613) 944-3105

E-MAIL: isrop-prisi@dfait-maeci.gc.ca

WEBSITE: http://www.dfait-maeci.gc.ca/
foreign_policy/arms/security-en.asp

PRISI
PROGRAMME DE RECHERCHE ET D'INFORMATION
DANS LE DOMAINE DE LA SÉCURITÉ INTERNATIONALE

Direction de la non-prolifération, du contrôle
des armements et du désarmement
Édifice Lester B. Pearson
125 promenade Sussex
Ottawa, Ontario
K1A 0G2

FAX : (613) 944-3105

COURRIEL : isrop-prisi@dfait-maeci.gc.ca

SITE WEB : http://www.dfait-maeci.gc.ca/
foreign_policy/arms/security-fr.asp