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FROM ALLIANCE TO DEPENDENCE

CANADIAN-AMERICAN DEFENCE COOPERATION THROUGH SPACE, 1945-1999

BY

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF ARTS IN WAR STUDIES
AT THE ROYAL MILITARY COLLEGE OF CANADA
KINGSTON, ONTARIO

APRIL 1999

ABSTRACT

Canadian-American defence cooperation since the end of the Second World War has received much attention from both historians and political scientists alike, but few have dared to venture into the subject of bilateral defence and outer space. Considering the paramount importance placed on the deterrence of a Soviet attack on North America and the grandiosity of the American space program between 1945 and 1999, one cannot overlook the importance of the cooperative militarization of space in any analysis.

This thesis examines the evolution and devolution of Canadian-American defence cooperation through space from 1945 to the end of the century. It argues, that after an initial brief interest in militarizing space as a fully ally of the United States, Canada quickly allowed its military space capability to wane to the point that in today it is all but dependent on the Americans for space-related defence support. This thesis does not seek to argue that Canada failed to achieve an adequate space-related defence capability. Rather, through reasoned logic Canada was neither able or required to maintain its own military space capability at a level equal with that of the United States, who sought to provide for both the deterrence of attack against North America and the military control of space itself. However, the modern foreign and defence policy of Canada has demonstrated that it can no longer satisfy itself with simply "easy riding" on the back of the United States. Increased joint operations with other space capable allies and multiple Canadian force deployments across the globe have created an imperative for Canada to both reevaluate and modernize its own military space capability. Such needed improvements will depend heavily on continued cooperation with the United States well into the next century.

This work is respectfully dedicated to

Kelly

Who on my darkest nights was a true shining star.

FROM ALLIANCE TO DEPENDENCE CANADIAN-AMERICAN DEFENCE COOPERATION THROUGH SPACE, 1945-1999

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

All too often a Master's Thesis is the culmination of countless hours of research, reading, arguing, writing, and sleepless nights. Combined with quick meals in pubs and gallons of coffee the student strives to complete what is most likely the first major achievement of his academic career. Like all students such an achievement is never made in exclusivity but rather is the product of sage advice from supervisors, colleagues, friends, antagonizing clowns, and the like. Though the final work carries a single name, it is seldom the sole efforts of that individual.

This work would not have been possible without the generous support of the Department of National Defence Security and Defence Forum which made it possible for a young ambitious reserve officer to chase off after that which piqued his and his nation's curiosity. A great deal of gratitude must also go to my thesis supervisor, Dr. Joel J. Sokolsky, undoubtedly an expert in the field of Canadian-American relations and the driving force behind my efforts. I could simply not have had a better opportunity than to work under his guidance on this project.

The Directorate of Space Development has been not only friendly and cooperative but also very supportive of this work. I must thank Major Gavin Liddy who served with D Space D in 1997-98 for sitting down and explaining in tremendous detail the fiscal realities of space defence cooperation. His help in clarifying many of the issues regarding funding and procurement as well as the aims of D Space D was tremendous. I also wish to thank Phil Somers, who has gone out of his way and busy schedule to assist me in my research. At the Canadian Forces School of Aerospace Studies I must thank Mr. Steve James, Major S. Delory, and Captain R. Trinkle, USAF. These three gentlemen taught me more about space operations in a week than I could have learned on my own in six months. Attending the Basic Space Indoctrination Course at CFSAS Winnipeg was a key to the successful completion of this thesis.

The Royal Military College and in particular, the War Studies Department, is as comfortable a home as a graduate student could hope to be in. I want to thank several people who have both challenged and assisted me in my two-year journey through its halls. First and foremost I must thank Dr. Ronald G. Haycock and Dr. Brian McKercher, both of whom have greatly helped develop my skills as an academic. The War Studies program can be both difficult and hard, but as I have written elsewhere I liked it because it was hard and found the reward well worth the effort. I must also acknowledge Dr. John M. Treddenick, whose nutty bar models and problems gave me new insight into defence economics and procurement. Lieutenant Colonel David Bashow, a fellow author, provided me with both his personal experiences as a NORAD officer and his academic analysis of present CF defence and security policy. Finally, Dr. Michael Henessy was a tremendous help in the analysis of modern CF operations involving space assets.

There are countless others to thank as well, all of whom in some small way or other made my Hobbs-like existence as a post grad a little easier. They are: Captain

Doug Handforth, Sergeant Dave Lucas, and Corporal Michelle Todd of the Office of Continuing Studies. Lieutenant Colonel David A. Paterson and Captain Denise Kingsbury at CFLCSC have been most forgiving. My fellow classmates Robert Boyer, Todd Fitzgerald, Louie Rouillard, Dan Sanford, Shaye Friesen, BJ Brister, Ian Wood, John Mooney, Rob Watts, Bill Peters, Nikki Harrack, and Bernd Horn were all kind to me and my little "pigs in space project". Outside the box I must thank my publisher Norm Christie who inadvertently made writing a thesis not such a frightening big deal after helping me write my first book.

Finally I must thank my family who have always been there for me, in particular my mother Carol who never ceases to be amazed by my work and at the same time seldom looks surprised that her son did this. When I was young she would often look at me and sigh, "what have you done this time?" Well here it is, and thank you for letting me get away with it again.

GLOSSARY OF TERMS

ABCS	Army Battle Command System
ABM	Anti-Ballistic Missile
ADC	Aerospace Defence Center
AFB	Air Force Base
ALCM	Air Launched Cruise Missile
AOR	area of responsibility
ARSPACE	Army Space Command
ASAT	anti-satellite
ASEDP	Army Space Exploitation Demonstration Program
ASI	additional skill identifier
AWACS	Advanced Warning and Air Control Systems
AWE	Advanced Warfighting Experiment
BDA	battle damage assessment
BLOS	beyond line of sight
BMC4I	Battle Management Command, Control, Communications, Computers and Intelligence
BMD	Ballistic Missile Defense
BMDO	Ballistic Missile Defense Office
BMEWS	Ballistic Missile Early Warning System
BOS	battlefield operation systems
C2	command and control
C3I	command, control, communications, and intelligence
C4	command, control, communications, and computers
C4I	command, control, communications, computers, and intelligence
CADIN-Pinetree	Continental Air Defence Integrated North – Pinetree Line
CANUS	Canadian-United Sates
CARDE	Canadian Armament Research and Development Establishment
CC	Capability Component
CCIR	commanders critical information requirement
CDS	Chief of Defence Staff
CF	Canadian Forces
CFB	Canadian Forces Base
CFSAS	Canadian Forces School of Aerospace Studies
CGS	Chief of the General Staff
CINC	Commander in Chief
CIS	Commonwealth of Independent States
CJCS	Chairman Joint Chiefs of Staff
CNN	Cable News Network
CONUS	continental United States
COS	Chief of Staff
COSPAS	Search and Rescue Satellite (Russian acronym)
COTS	commercial off the shelf
CRAD	Chief Research and Development
CRR	Churchill Research Range
CRS	Chief of Review Services
CSA	Canadian Space Agency
DAMA	Demand Assigned Multiple Access satellite communications
DCDS	Deputy Chief of Defence Staff
DECCO	Defense Commercial Communications Office
DEW	Distant Early Warning Line
DISA	Defense Information Systems Agency
DMSP	Defence Meteorological Satellite Program

DND	Department of National Defence
DOC	Department of Communications
DOC-CRC	Department of Communications – Communications Research Center
DoD	Department of Defense
DPG	Defence Planning Guidance
DRB	Defence Research Board
DREO	Defence Research Establishment Ottawa
DSAT	Defensive Satellite
D Space D	Directorate of Space Development
DSP	Defence Support Program or Defence Services Program
DTLOMS	doctrine, training, leader development, organizations, materiel, and soldiers
ELT	Emergency Locator Transmitter
ELV	Expendable Launch Vehicle
EMP	Electro-Magnetic Pulse
EMR	department of Energy Mines and Resources
EW	Electronic Warfare
FLEETSAT	US Navy Fleet Satellite
FM	field manual
FSU	Former Soviet Union
GCCS	Global Command and Control System
GEO	Geosynchronous orbit
GMTI	Ground Moving Target Indication technology
GPS	Global Positioning System
GTN	global transportation network
HARP	High Altitude Research Project
HMCS	Her Majesty's Canadian Ship
HSI	hyperspectral imagery
HQ	headquarters
IA	Implementing Arrangement
ICBM	Intercontinental Ballistic Missile
ICS	Interdepartmental Committee on Space
INMARSAT	International Maritime (communications) Satellite
INT	Intelligence
IPB	intelligence preparation of the battlefield
IO	information operations
IR	infrared
ISIS	International Satellites for Ionospheric Studies
ITV	intransit visibility
IW	information warfare
J2	Joint Staff Headquarters Grade 2 (intelligence)
J3	Joint Staff Headquarters Grade 3 (operations)
JC^2IS	Joint Command and Control Information System
JCS	Joint Chief of Staff
JFHQ	Joint Force deployable Headquarters
JSAT	Joint Staff Action Team
JSP	Joint Space Project
JSST	Joint Space Support Team
JSTARS	
JTF	Joint Task Force
LEO	Low Earth Orbit
LORAN	Land Oriented Ranging and Navigation
MACOM	major Army command
MAD	Mutually Assured Destruction
MCC	Military Cooperation Committee
MCL	Mid-Canada Line
METT-T	mission, enemy, troops, terrain and weather, and time available

MILSATCOM	military satellite communications
MIT	Massachusetts Institute of Technology
MOC	Military Occupation Code
MOU	Memorandum of Understanding
MRs	Miscellaneous Requirements
MSAT	Mobile Satellite communications
MSI	multispectral imagery
MTOE	modified table of organization and equipment
NAVSPASUR	US Navy Space Surveillance
NCA	National Command Authority
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NDHQ	National Defence Headquarters
NDI	non-developmental item
NMD	National Missile Defence
NOAA	National Oceanic Atmospheric Administration
NORAD	North American Aerospace Defence
NMS	National Military Strategy
NRC	National Research Council
NSDD	National Security Directive Decision
NWO	New World Order
NWS	North Warning System
OAS	Organization of American States
OCR	operational capability requirement
OGD	Other Government Departments
OOTW	operations other than war
O&M	Operations and Maintenance
PCO	Privy Council Office
PGM	Precision Guided Munitions
PJBD	Permanent Joint Board on Defence
POM	program objective memorandum
POS/NAV	position and navigation
PY	Person Years
R&D	Research and Development
RAND	Research and Development Corporation
RISTA	reconnaissance, intelligence, surveillance and target acquisition
RMC	Royal Military College of Canada
RMS	Remote Manipulator System
RPV	remotely piloted vehicle
SAR	Search and Rescue or Synthetic Aperture Radar
SARSAT	Search and Rescue Satellite
SATCOM	satellite communications
SBR	Space-based radar
SCC	Science Council of Canada
SCWG	ad hoc Space Cooperation Working Group
SDI	Strategic Defence Initiative
SDWG	Space Defence Working Group
SLBM	Submarine Launched Ballistic Missile
SPADATS	Space Detection and Tracking System
SRB	Solid Rocket Booster
SSN	Space Surveillance Network
S&T	science and technology
STG	Space Task Group
STS	Space Transportation System
SWE	Salary Wage Envelope
TACSAT	Tactical Satellite

TADSS	training aids, devices, simulators, and simulations
TAV	total asset visibility
TBM	theater/tactical ballistic missile
TDA	table of distribution and allowances
TENCAP	Tactical Exploitation of National Capabilities
TIBS	US Tactical Information Broadcast System
TMD	Theater/Tactical Missile Defense
TMW	Theater Missile Warning
TOE	table of organization and equipment
TRADOC	U.S. Army Training and Doctrine Command
TT&C	telemetry, tracking and commanding
TT&P	tactics, techniques, and procedures
UAV	unmanned aerial vehicle
UN	United Nations
US/USA	United States of America
USAF	United States Air Force
USCENTCOM	United States Central Command
USSPACECOM	U.S. Space Command
USSR	Union of Soviet Socialist Republics
VLF	Very Low Frequency
WMD	Weapons of Mass Destruction

LIST OF FIGURES

INTRODUCTION
SPACE COOPERATION AND NATIONAL SECURITY

Co-operation often implies two or more people or groups or organizations collaborating to achieve a common aim. The Canadian-American defence relationship has been one of co-operation for over fifty years now, in both North American and global security. This bond, forged with the United States in a hot war and solidified in a cold one, has directed most Canadian defence policy. In North America, this security relationship has been defined in many ways, most notably however, by the North American Aerospace Defence agreement, first signed in 1958 and renewed in 1968, 1973, 1980-81, 1986, 1991 and 1996. Over the thirty years, the nature of the NORAD defence system has evolved from ground-based radar to space-based assets and in this respect the US has clearly taken the lead. This thesis aims to examine the devolution of Canadian space-related defence and its decline from ally to dependent in the collective defence of North America.

In the international arena, a state's power was often measured by its military capability. During the Cold War this usually meant the number of times a country could destroy the world with its nuclear arsenal. In the New World Order the nuclear yardstick still holds true, but there is also a more modern gauge. Today, a state's power will also be measured in terms of its space capability and space control, that is, the ability of that state to launch, support, and maintain freedom of manoeuvre in outer space, and when necessary, defend its space assets and deny space to others. While today there are only seven states that can truly exert some measure of space control, it can be expected that this number is likely to increase.

Unlike military capability, a state's space capability is generated by both military and civilian sectors. In fact, as we progress into the next millennium there will be almost five times as many civilian and commercial satellites in orbit as military ones. France, for example, is a powerful space capable state, but this status has been achieved through its commercial industry, not its military capability. Such trends are likely to continue, having a considerable impact on the international balance of power as more states acquire access to orbit.

Canada clearly began the co-operative defence of North America as a full ally. At the end of the Second World War, its geographic position between the United States and the Soviet Union suddenly became strategically significant. The Americans began to think about continental defence and came to the conclusion that it could either participate in a bilateral defence of North America with Canada or defend the continent without help. Canada knew that if it did not adopt the former solution with the United States, the Americans would in any case choose the latter alternative. This gave rise to serious questions of Canadian sovereignty infringement and loss of control of Canadian airspace. Therefore participation in North American air defence at the start of the Cold War was of paramount importance to the Canadian government in ensuring a measure of sovereignty protection.

When it signed the NORAD agreement in 1958, Canada was capable of fielding an impressive airforce and air defence component. It had top-line jets in service, the F-86 Sabre and the CF-100, and the Arrow project was well under way. A number of early warning radar lines had also been deployed in the far north. Canadian ability to participate as an ally in aerospace defence quickly dissolved however, when John F.

Kennedy announced to his own country, "We choose to go to the moon", and committed the United States of America to beating the Soviet Union in a race to land a man there. Canada's foreign and domestic policy made no requirement for a similar effort in its own space capability development, but as a result the rapidly progressing American and Soviet space capabilities quickly overshadowed it. The strategic benefits of space access and control were obvious to the Americans however, and soon after, space power superceded ground-based radars as the main form of early warning and surveillance of a Soviet missile attack on North America. Though aircraft and missiles would remain the tools used to defend Canadian-American airspace, the direction in any such emergency would come from space assets. As space became vital to Canadian-American defence co-operation, the USA easily had the advantage of a more developed space infrastructure and superior space capability. Canada slipped from the position of ally in the defence of North America to dependent, and by the 1980s, was almost entirely reliant on its partner for North American security against a missile threat.

Canada's sporadic development as a space power resulted from many factors. Both politically and economically, Canada was increasingly dependent on the United States to provide the first line of defence. Canadian defence policy has been molded over the past forty-five years by the "involuntary American guarantee" of the security of Canadian soil.[1] Logic dictated that Canada would not duplicate the American process of deploying missile warning satellites if the United States had already done so (and did). Strategic space-related threats were continuously addressed directly by the United States, and therefore Canada was apt to let the Americans take on most of the burden in meeting those threats.[2]

Specifically, Canada realised that whatever its commitment to North American defence may be, the United States has no choice but to defend Canadian soil from Soviet attack if it was to protect itself. Both the ends of the Cold War and the dramatic and continual evolution in space technology have changed that requirement. Unlike air defence and nuclear attack, which once required an involuntary co-operation with Canada to be successful, United States could now easily choose to defend its own borders and space assets independently and give only limited access to its space resources without any need to consider Canadian needs or actions. At least in theory, through the use of satellites and its other space assets, the United States could effectively protect its own soil from ICBM attack without having to consider the immediate physical protection of the territory beyond its borders.[3]

The Canadian misperception that militarization of space equalled weaponization of space contributed to the confusion of both foreign and domestic policy decisions regarding space-based defence. It further caused a complete injunction on the formation of a national space program and infrastructure, rather causing the government to break it up into privatized civilian niche industries, making it all but impossible to participate on an equal level with the Americans in defending North America through space.

The recent revolution in space technology and its rapid proliferation has had some impact on national security and space-based defence in Canada. Since 1986 Canada has slowly developed within the armed forces a central infrastructure and some schools to deal with issues in and through space, but these organizations are few and still in their infancy. Meanwhile, the United States continues to invest time and resources in space defence at an increased rate, and the technology-capability gap between the two countries

continues to widen. Whereas in the past the United States demonstrated a serious concern for Canadian space defence development, in the future it may show no interest at all.

The first chapter of this thesis is designed to explain the theory and mechanics of warfare in and through space. This chapter examines the tools and geography of space, how we get there, what happens once we are in orbit, and why it is strategically important. As well, the chapter provides details on the history of the militarization of space, and the various ways in which space was and is used for non-weapon and weapon based defence.

The second chapter looks at the history of the Canadian-American space defence relationship up to 1986. Centred for the most part on the activities of NORAD and the defence of North America, this chapter examines the rise of the American dominated space defence relationship of the two countries. After a brief initial interest in space-related defence cooperation, Canada quickly slipped from the position of ally to that of dependent in bilateral space-related defence. As the Americans increased their space program dramatically during the 1960s and 1970s, Canada decentralised its space effort, demilitarised its space program, and sought to publicly distance itself from the inevitable militarization of outer space. While on the surface it appeared that Canada had failed to grasp the potential of military space capability, analysis of the subject has revealed two important factors. First, given the fiscal realities of Canada's defence commitments in the late 1960s and 1970s, it was unlikely that it would forego acquiring much needed terrestrial capital in order to procure expensive space assets. Second, despite the appearance of aversion towards militarising space, in fact Canada was heavily involved

in the affair through its activities in both NORAD and NATO. By 1986, when the NORAD renewal issue was politically highlighted due to the American SDI proposal, Canada came out of the shadows and formalised its position that a military space strategy for Canada was needed.

Chapter three examines the contemporary issues in the current relationship in space defence between Canada and the United States. The dramatic transformation in global geopolitics in the last decade of the twentieth century have brought serious changes to the foreign and defence policies of western states, and have forced both Canada and the United States to re-examine their roles on the world stage. Combined with the rapid increase in space technology and access, the relationship will evolve in completely new directions. It is this present state of expansion and flux that will force Canada to take a more active role in space defence or suffer being ostracised altogether from the arena. The onus on Canada to reassert itself is doubly applied due to the increased need for space support as a force multiplier. Where once NORAD was the sole focus of Canadian military space activities, now all operations at home and abroad require space-related attention. More and more often Canadian forces are being deployed to dangerous theatres of operations where low and medium level conflicts are taking place. The need for adequate space support has become imperative.

The final chapter of this thesis argues that Canada must take advantage of its present position as a dependent of an inviting American partner if it is to ever restore the balance in the defence relationship of North America. The advantages to adopting such a policy range from the technological to the economic as well as the political. As the

number of nations with access to space assets and products continues to grow, Canada must assert itself in this field today if it is to live in security tomorrow.

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[1] R. J. Sutherland, "Canada's Long Term Strategic Situation," *International Journal* 17, no.3 (Summer 1962): 199. Cited from Jockel, J. T. *Security to the North: Canada-U.S. Defence Relations in the 1990s*. (Michigan, 1991), p.36.

[2] In the last fifteen years at least the threat of missile attack on North America has significantly lessened, therefore the requirement for Canadian participation in space-related defence in this area has been even further reduced. Instead, the focus has shifted to space support and force enhancement requirements.

[3] This is not to argue that in any way a direct hit on Toronto, for example, by a Soviet ICBM would not have any after-effects on nearby U.S. states in terms of blast, radiation, or fall-out damage. The fact of the matter is that eventually the Americans could ensure that missiles do not land directly on Detroit.

CHAPTER ONE
THE NEW OCEAN
THE THEORY AND MECHANICS OF SPACE POWER

"The planet is the cradle of intelligence, but it is impossible to live forever in the cradle"
- Konstantin Tsiolkovsky

The twentieth century has been witness to many significant revolutions in military technologies, which have redefined the way nations wage war against one another. From the tank, to the jet aircraft, to the nuclear bomb, leaps in military capability have affected not only the operations and tactics right down to the individual soldier and his weapon, but also the theory and doctrine of war fighting right up to the strategic and political level. With the appearance of weapons of mass destruction (WMD) in the arsenals of "the big five" after the end of the Second World War, many military theorists prophesized that the conduct of war and operations other than war (OOTW) had forever been defined.[1] This however, was not to be the case. In the latter half of the twentieth century the human species has moved the potential battleground beyond the realm of its own world and outward into space. Where once it was decided that WMD were the end all of military conflict, military exploitation of outer space has shown strategic thinkers that there is indeed a new vital ground to be considered. For more than 35 years outer space has been an element in the security of the major powers of the world, and has become an area of concerted interest to others. Its inclusion as a factor in security and defence policy has had a revolutionary effect on the concepts of military doctrine, and as such, the realm of outer space as a sphere of operations can no longer be ignored. Space power has become central to the achievement and maintenance of global reach for

countries like the United States of America (USA) and Former Soviet Union (FSU), and will assume as decisive a role in future high-level conflict as air power has done in the present day.[2]

Space has had a significant impact on military thinking and the making of modern strategy. However, for the most part nations are still infants in the use of military space assets, and recent conflicts such as the Falklands, in Afghanistan, and the Gulf War are but an inkling of things to come. With the interminable development of space capabilities, the potential for space assets as a force multiplier in conflict is virtually unlimited.

The theory of space flight and its exploitation by humans can be traced back to three distinct thinkers, Konstantin Tsiolkovsky (1857-1935), Robert Goddard (1882-1945), and Hermann Oberth (1894-1989).[3] Though many historians and strategists inaccurately connect the first development of space rocketry to the aftermath of the German V-rocket program of the Second World War, the above-mentioned individuals had in fact approached the subject long before then. Both Tsiolkovsky and Goddard published works during the first two decades of the twentieth century that concluded that not only was space flight possible, but that rockets containing liquid-fuel engines were to be the suitable vehicles to achieve orbit. Furthermore, they both argued that the basic formula for engine performance and vehicle trajectory could be specified, which would give the essential basics for putting objects and humans into space. Oberth incorporated his own similar theory of space flight into his doctoral dissertation before publishing it as a book in the 1920s.[4] It was his book which inspired a later generation of German rocket experimenters who went on to form the nucleus of the Nazi military rocket program.

In 1927 a small group of German physicists gathered together and formed the *Verein fur Raumschiffahrt* (VFR) known in English as the German Rocket Society. Their initial goal was to solve the engineering problems that challenged man's ability to fly into space, but the devastating depression of the 1930s collapsed this and many other rocket societies in Germany. Among the members of the VFR was a young army officer named Walter Dornberger. He could see no way that the VFR would receive monetary support from the German government for merely solving the mysteries of space flight. However when the Nazis came to power in the mid 1930s, Dornberger fostered what author W.S. Bainbridge has coined "the military detour" in space flight which so rapidly accelerated its development.[5]

Under the guidance of Dornberger, the German military sought to make use of rocketry as a weapon for its army. The highly restrictive Treaty of Versailles left the Germans with little room to develop their armed forces during the 1920s and 1930s. One way of circumventing the treaty however, was to develop substitutes for weapons which the Germans were banned from possessing. The rocket was one such device not covered in the treaty. In 1932 Dornberger hired a young and intelligent student member of the VFR, Wernher von Braun, to assist the army in developing long range rockets.[6] Ben Finney argued that this was the beginning of a "Faustian Bargain", the implications of which, forever changed the nature of space flight and its relationship with the human species.[7] The rocket engineers and scientists agreed to join the military programs of their respective countries during the war, developing rockets as weapons in order to gain all the support and funding needed in order to realize their true dream, the achievement of space flight. Von Braun did more than just provide the Germans with the first ballistic

missiles, he and his scientist colleagues instigated the idea that outer space itself could eventually be used for military purposes and defence. Dornberger and his German weapons program were merely the beginning.[8] Fortunately, Nazi Germany fell before it could fully develop its rocket program, and the militarization of space was postponed.

The end of the war did not end the threat of missile weapons, instead it provided the Soviets and the Western allies with the equipment and the scientists to pursue their own missile programs. Using captured German technology and scientists combined with their own national efforts, both the USA and the Union of Soviet Socialist Republics (USSR) raced to dominate this new realm of technology. Each side feared the other greatly, for both felt that one would attack the other as soon as it thought it could win the next war. By September 30th, 1947, the USA had recruited and contracted 457 German scientists and technicians who helped put America in space faster than might otherwise have been possible. By contrast, the Soviets had captured fewer scientists but managed to seize most of the German V-rocket missile sites and equipment, thereby accelerating their own missile-space program.

For the next three decades the USA and USSR were the only real players in the militarization of space. However, both superpowers readily accepted that missile and space assets combined with nuclear weapons would have a serious impact on the future of warfare as a whole, and each country adjusted its national policies and military doctrines to incorporate this new type of warfare. In the USA, military space doctrine appeared as early as 1948, when General Hoyt S. Vandenberg of the United States Air Force (USAF) stated, "the USAF, as the service dealing primarily with air weapons, especially strategic, has logical responsibility for the satellite."[9] Though the military

value of satellites had not yet been fully recognized, the USAF brought their policy into effect by authorizing RAND corporation to do research and to let subcontracts in the field.[10] The Soviet airforce was equally swift in adopting doctrine to deal with space issues. Indeed the air minister was reminded by a Stalin associate during a Kremlin meeting in April 1947, "We are not going to fight a war with Poland. We have to remember that there are vast oceans between ourselves and our potential enemy."[11] First missiles, and eventually satellites, would become part of the Soviet airforce arsenal.

SPACE AND THE THEORY OF WAR

> Who rules circumterrestrial space commands planet Earth;
>
> Who rules the moon commands circumterrestrial space;
>
> Who rules L4 and L5 commands the Earth-Moon system.
>
> - Halford J. Mackinder's Heartland Theory applied to space[12]

Colin S. Gray recently argued, "Countries that fail to adapt soon enough or well enough to the changing character of warfare are condemned either to fail or to succeed at unnecessary cost and loss of life." Outer space may be no exception, for the military use of space is no longer just a fantasy, opinion, or theory. Rather, it has become a plainly emerging fact during the last four decades of this century.[13] Like the oceans, space only has an impact to the extent it can influence organized political communities on land. However unlike the oceans, space allows access to both indirect and direct influence over

land operations, be they maintaining a strategic balance or acting as a force multiplier in combat.

Military space planners, whose theatre of operations was completely alien to land, sea, and air, were pushed to develop new theories, concepts, assumptions, and options. First the nature of the terrain was completely foreign, and shared few, if any, characteristics with the three existing services. What missions the military expected to conduct in space also had to be determined, so that theory and doctrine could be developed. Just as important the military had to define how those missions would be executed. The three traditional services had already well developed their tools of war. Space theorists had no idea how people would live and fight in outer space or if even people would do the fighting at all. Space operations support had to be developed from scratch, though in this field much of the example was taken from the air force, as it was for the command and control of space elements.

Before delving into an analysis of the issue at hand, there are four loose categories to consider when approaching space operations and the theory of war. The first is known as space support, which encompasses launching capability, controlling space assets, and the ability to repair space assets. The second, force enhancement, includes issues relating to war fighting on land, sea, and in the air. The third area, space control, deals with space operating mobility and survivability. The fourth and last category, force application, examines space-based combat power.[14]

While there has been a considerable amount of theory relating to air, sea, and land power, space power suffers an acute shortage of focused strategic thought. The absence of effort in this field is due to the fact that most people, military professionals included,

lack any real understanding of what space power encompasses exactly, and what are its possibilities. Those who have approached the subject, such as Steven Lambakis and Colin Gray, readily admit that space theory has been developed piecemeal with little or no examination of the broader subjects. While one can easily find literature on policy, technology, and arms control, one has a much more difficult time revealing publications discussing the theory of space warfare or the definition of space power.[15] While Lambakis has pursued a threat-analysis approach focusing on the issue of space control (see below), Gray has chosen to borrow from earlier theorists such as Von Clauswitz and Alfred Theyer Mahan and to apply their rules to the space environment. The results are at times mixed but they do achieve a base from which further arguments can be made.[16] Also, space warfare theory has yet to be solidified in definitive terms due to the fact that there have been few opportunities to put theory into practice. Space theory development tends to be driven by two factors over which the military has little control. First, rapid and continual changes in technology appearing in the civilian sector have a direct effect on the building and operating of space assets. Second, the military is not the largest employer of space assets and information. That title goes to the civilian space agencies.

The development of space theory can be first improved with a better understanding of the environment. When assessing any conflict, one must consider which areas constitute key terrain, because whoever dominates key terrain will have an influence on the outcome of a battle or war. Modern strategic thinkers have identified six significant pieces of key terrain related to space warfare, upon which national security policy and targeting policies are usually based.[17] They include:

- Critical space installations on Earth;
- (theoretically) Critical economic and military enterprises on the moon;
- Critical military bases and (theoretically) civilian colonies in orbit;
- Geostationary and other equatorial earth orbits;
- Polar earth orbits; and,
- Lunar libration points.

While the first three are man-made the remaining three are natural points. At present libration points (see below) have yet to take on strategic value and lunar bases have yet to exist, but both will potentially play a role in future politics. The unorthodox critical list above is based upon an area of geography quite removed from that which military commanders are used to, therefore some examination of the nature of the terrain should be made.

Geography, or rather cosmography, must be taken into account, due to the significant influence it has on the development of strategy, doctrine, tactics and logistics. Whereas the Earth is defined by land forms, water, and natural resources, space is defined by cosmic radiation, solar winds, lack of gravity, micrometeorites, and near total vacuum. In space there is no north, east, south, or west. Direction is defined by measurements of right ascension and declination. There is no day-night cycle. Space has neither shape nor substance, making it almost limitless in maneuvering room. Electromagnetic radiation travels relatively freely in space, unlike through water which naturally denies radio and radar signals.[18] Likewise acoustics plays no part is space, for sound cannot travel in a vacuum.

The immediate area of concern to military space planners is the Earth-moon system, divided into four separate regions (see figure 1.1). Region one – Earth and its atmosphere, is still the dominating region of space. This is because all support for military (and civilian) space operations is located on Earth. At some future date humans may have bases in orbit (i.e. space stations) or on the moon, which in time of war may be able to provide the required support for space operations, though at present no nation possesses such a capability.[19] Since all transit into space originates on Earth, the atmosphere, gravity, and rotation of the planet act as influence on all space operations.

Region two – circumterrestrial space, begins about 60 miles above the surface out to about 50,000 miles. The majority of Earth's present space activity takes place within this region, with objects operating in four roughly defined orbits about the planet (see figure 1.2). The importance of each type of orbit to each type of man-made craft requires complex explanation, and is well outside the scope of this paper's argument. However, the majority of military related space vehicles operate either in the Low Earth Orbit (LEO) or Geosynchronous orbit (GEO).

Region three – Moon and environs, ranging from 50,000 to 360,000 miles, has yet to play a strategic role in military space operations, but various points in this region may have an influence on future conflicts. There are five nodes known as libration points (see figure 1.1), where the gravitational fields of the Earth and the moon are in balance. What makes these points key terrain is the fact that free-floating objects at these points resist drift, therefore theoretically spacecraft could linger at these points for extended periods without expending valuable fuel resources. Points L1 through L3 are, however, considered somewhat unstable due to gravitational influences of the sun, but points L4

and L5 are considered very stable. In terms of strategy, vehicles or stations could be positioned at these points, controlling routes of travel to the moon. The moon itself also presents a hazardous battlefield. With a surface roughly the size of Africa, it has gravity equal to one-sixth that of Earth and has no atmosphere of any kind. Temperatures range from 260 degrees Fahrenheit to –245 degrees Fahrenheit. The moon has no sea level, therefore making it impossible to define elevations and depths the way we do on Earth.

Region four – outer envelope, arbitrarily terminates at twice the distance from the moon. However, since the moon travels in an elliptical orbit around the Earth, this region can range from 240,000 to 600,000 miles. Beyond this range the influences of the Earth-moon system are negligible, and therefore outside the present scope of strategic thinking. Again, however, future generations will give consideration to this and further regions as our population of the solar system begins.

CONSIDERING THE THREAT

Simply knowing the terrain of space does not alleviate the complications of assessing potential threats to space assets. Threats to security are often exacerbated by the fact that many traditional indications are inapplicable. For example, due to the vast openness of space, deception operations are greatly simplified in orbit, while the deployment of photo-reconnaissance satellites in that same orbit make similar deception operations increasingly difficult on the planet surface. Other aspects such as ascertaining present and projected capabilities, and future intentions, of belligerent nations also pose special problems. During the early years of the space race, when America's own

knowledge of space flight was still limited, the USA essentially had no ability to assess what space capabilities the USSR had, and what threat impact any such capabilities would have on American national security. Former Air Force Chief of Staff General Thomas D. White in 1962 adequately reflected the thinking on this at the time when he proposed that, "We should be racing towards a new potential in warfare. The future military value of space power may transcend that of air power today. There are military requirements in space, which this nation can fail to fulfill at its grave peril. Control of the universe, including our own Earth, is a stake."[20] Analyst Nicholas L. Johnson has identified this threat perception as a sort of "Pearl Harbor complex. At the heart of this psychosis is the fear of being taken by surprise either militarily, technologically, or politically..."[21]. The Pearl Harbor syndrome manifested itself in the American fixation with so-called gaps: the missile gap, the laser gap, and eventually the space gap, to name but a few.

By comparison the Soviets suffered their own psychosis, predictably coined the Stalingrad complex. Traditionally the Russians have nurtured a severe distrust of outsiders, having been continually invaded during the last two centuries. The old slogan of Stalingrad's Commissar of Defence, "Not a step backward!" has transformed into a never again attitude that has had significant influence on Soviet military strategy in space.[22] In an effort not to be outdone ever again, the Soviets concentrated a lot of their early space efforts on achieving "firsts". Though it armed Soviet Secretary General Nikita Krushchev with plenty of political ammunition to belittle the Americans with, the narrow-mindedness of the Soviet effort was to foreshadow their undoing in the space race. Sputnik 1 was the first man-made object successfully launched into space, but it

was little more than a lawnmower-sized tape recorder that emitted a "beep-beep" for twenty-one days. By contrast, the first American satellite into space, Explorer 1, discovered the existence of the Van Allen radiation belts.[23] The USA's follow-up satellite, Vanguard 1, orbited for more than six years and returned valuable geographical data on the true shape of the Earth. Meanwhile, none of the dozen Soviet satellites that followed after *Sputnik* 1 were devoted to any sort of vital applications research.[24] While the Soviets continued to one-up the Americans by sending the first man, then the first woman, into space, conducting the first dual launch and orbit, flying the first multiple crew, and conducting the first space walk, for example, the Americans were developing communications, reconnaissance, meteorological, and navigation satellites. By the end of the 1960s the Soviets had achieved almost every first possible except the one that truly counted in the eyes of the world. The first men on the moon planted the flag of the stars and stripes, not the hammer and sickle.

Threats to space assets currently originate from two sources, the surface of the Earth and from other objects already in orbit. With the exception of the USA, the FSU, and China perhaps, most countries rely on terrestrial capabilities to project their space power. Any state possessing the capability to launch intermediate or long-range surface-to-surface missiles, or payloads into orbit, has the basics of an anti-satellite (ASAT) capability. Brazil, China, India, Israel, Iraq, and Japan, for example, all possess the technology needed to build and deploy direct-ascent satellite interceptors.[25] Given the lightweight and low cost of ASAT weapons (compared to satellites and their launch vehicles), they can be produced in large quantities and easily deployed. Using the SCUD missile experience of the 1990-91 Gulf War as an example, ASAT weapons could be

fired from mobile launchers, which are difficult to locate and even more difficult to destroy. As most space missions must be conducted in low Earth orbits, valuable satellites, which could not be replaced easily, are especially vulnerable to attack from below.

Satellites could also be destroyed or crippled by other satellites. In 1971 both the Soviet Union and China began testing a co-orbital ASAT weapon that was capable of maneuvering close to its target before itself detonating and destroying its prey. Other types of orbital ASAT interceptors included a killer satellite firing a shotgun-type weapon towards its target, crippling the satellite with shrapnel travelling up to thirteen miles a second. Another option consisted of some form of guided laser weapon system.

Other threats to satellites include electronic warfare, jamming, blinding with ground-based lasers and electromagnetic pulse (EMP) emissions. For example, the American GPS satellite constellation consists of 24 satellites, of which 18 are needed at any time for precision target acquisition, direction finding, and the like. The remaining six act as spares. If seven or more of the GPS satellites are destroyed, crippled, damaged, or even jammed, the US forces could be virtually blinded and crippled on the battlefield and on the seas. Even assuming that national efforts are increased in time of war, presently it could still take months to replace the satellites. For commanders on the battlefield, where time is always a factor, such a catastrophe could lead to a defeat at the hands of one's adversary.

THE SPACE MISSION

Space missions have been defined in terms of space control and force application – essentially, broad categories of offensive and defensive operations. These missions address the issue of who can operate and how, in space, which must be considered if defence planners want to be able to derive any sort of military advantage from their space assets. [26] If space control is severely contested or lost, then all other military space systems will suffer, some critically.

Offensive operations in space will be determined by mission priorities and target preferences. To employ a Clausewitzian idea, countries have centers of gravity key to their functioning. A state or coalition's ability to wage war successfully can be negated if those centers of gravity are menaced, damaged, or taken.[27] Returning to the six pieces of key terrain mentioned above, the first three would fall under this maxim. However, in space warfare offensive operations are not without their own unique risks. Once a satellite or space platform in orbit engages a target, its position will quickly become known and thus vulnerable to a counter-attack. If crippled or destroyed the satellite cannot yet be quickly replaced. Likewise, one cannot afford to miss when dealing with vulnerable ground launch facilities, a limited supply of launch vehicles, and vulnerable logistical means of employing them. The likelihood that launch facilities will be targets of priority (as they were in the 1990-91 Gulf War) means that a state may only get an initial chance to strike before its own launch capability is neutralized. Assuming, for example, that the USA currently has space control (though arguably it does not), other states will seek methods to challenge that control by whatever means possible. The easiest method of attack on US space control in a war would be to concentrate against American immobile launch and space support facilities. Unlike Russian space

installations which are buried deep in remote regions of their country, almost all US spaceports are located on the coast, easily reached by conventional naval forces, by special forces, or even terrorists.[28] The target preference would seem obvious.

Other offensive objectives can be met through the concentration of force at key places (in this case a place may be a facility or an orbit). Looking once again to Clausewitz for an example, success in battle flows from the achievement of overwhelming strength at the decisive point. Though more difficult to achieve in space than on earth it is no less true an axiom. In fact, as most countries are only capable of conducting offensive operations due to the fact they have nothing of their own on the ground or in orbit to defend, breaking the decisive point in an opponent's space control should be the mission priority.[29] The remaining three pieces of key terrain mentioned above come under this proverb. One does not have to have assets in orbit in order to control them or deny them to other states. For example, due to the nature of orbital mechanics, a satellite launched from any point on the planet into space must pass over that exact same launch point during its first two revolutions of the Earth. Since almost all space assets are launched from fixed installations, it becomes elementary to figure out what the satellite's position will be during the first twenty-four hours of its orbital life. A keen adversary with ASAT capability could easily target these points, wait for a launch and then attack with ease. If a state does have killer satellites in orbit, then it becomes too simple to plot interception courses, shadowing the satellite before closing in on it and making the kill.

Space defence seeks to stop opposing forces from gaining space control. There are many ways to achieve this. First, attacks can be prevented if the deterrent in place is

sufficient. Sufficiency depends on preparedness and non-aggressiveness. It has been argued that nothing encourages aggressors more than opponents who are unprepared. However, one can never be sure if they are prepared enough. Military planners often ask, prepared to do what? Preparedness in space may include sufficient resources to discourage an attack, the ability to replace losses on short notice, thereby showing resolve and determination, or the ability to trade losses evenly with an adversary. Eye for an eye or a mutually assured destruction (MAD) kept the two superpowers at bay for half a century. That being said, successful deterrence must also suppress provocation, which can result from the build-up of armed force. Wars often start when real or imagined provocation convinces aggrieved parties that a clash is inevitable sooner or later. Often the party believes it has little to lose and maybe something to gain by striking first.[30] Successful deterrent strategies must include risk reduction measures and assurance that one's targeted adversary is not being threatened, just watched closely. Though by no means infallible, deterrence does have its merits as a form of defence.

If deterrence fails, space defence can deny opposing forces an easy grab at space control. Space defence must take into consideration the relative value of targets and their vulnerability, the likelihood that a target will be attacked, how long it is expected to survive, and how quickly it can be replaced.[31] Defensive operations are designed to defeat attacks against space assets and other targets on the ground and in orbit. That which needs to be protected on the ground, such as population targets, military bases, launch pads, and control facilities, are normally immobile and their locations well known. The locations and activities of objects in orbit are less easy to verify, and frustrating enemy reconnaissance and surveillance efforts is of primary importance. Defending so

many potential targets is neither easy nor inexpensive, but it can be done. Ground targets can be protected by air-defence assets or by air launched ASATs. Objects in orbit can be protected by ASATs, ground-based lasers, or other defensive satellites (DSATs). Satellites themselves can also be designed to carry active defences, or be programmed to take defensive (i.e. evasive) action. Satellites can also be designed to reduce damage and limit their potential debilitation or destruction.

During the 1980s the United States searched for an all-encompassing ballistic missile defence (BMD) system that would give the United States increased leverage against the Soviets. Strategic Arms Limitation Talks (SALT) in 1972 had achieved less than desirable results in deterring the arms race between the superpowers, leading the United States and the Soviet Union to pursue more sophisticated means of missile warning and defence. Labeled the Strategic Defence Initiative (SDI), the SDI was coined by the media and the public as "Star Wars"; its aim was to provide a single multi-purpose space-based chain of defensive platforms that could engage ground launched missiles, ASATs, and other satellites in orbit. The 1990s scaled-down version of this program is known as the National Missile Defence (NMD) project. SDI and its implications invoked a harsh reaction from the USSR and a serious political debate between the two superpowers on the militarization of space. The main Soviet concern was that SDI was not just a defensive tool being designed to stop a missile strike. In Soviet analysis SDI meant the Americans were seeking a means to deny a retaliatory strike from Russia, thereby leaving it open to conduct a first strike without fearing an effective counterstroke. While this was a plausible argument, the American government gave no direct indication that it had any intention of reducing Moscow to rubble in a pre-emptive attack.[32] Rather,

it sought to ensure that the Soviet Union would not consider a pre-emptive missile strike by taking away its ability to conduct an effective attack on North America by that means. Nor were the Soviets the underdog in the SDI race either. Though not widely known, the Soviets had engaged in an extensive space weapons program, including directed energy weapons and space battle stations, beginning in 1976. The *Mir* station came from a design originally intended to give the Soviets a space platform to provide a much broader scope of military missions than SDI was to give the Americans. By the time the American space shuttle came into service in 1981, the Soviets had already embarked on their own shuttle program to be used for servicing and replenishing battle stations in LEO.[33]

On the whole, the theory of space defence, as opposed to offence, is a more attractive yet more complicated matter. First and foremost, the concept of defensive forces rather than offensive forces appears as a justifiable and more politically rational concept. It would be difficult to convince the public of almost any democratic state that it should invest in space assets solely for the purpose of seeking out another state's major population centers and turning them into parking lots. The issue now is that space capability is proliferating into rogue states that have non-democratic belligerent foreign policies, and who perceive military space power as a valuable force multiplier in waging war.

FORCE APPLICATION

While Lambakis and Gray have argued for the need to examine the broader issues of space warfare, the fact of the matter is that fewer space systems are presently directed

towards total space control and force application. Rather, the majority of both civilian and military space assets are employed at the level of space support and force enhancement. When one discusses the issue of space warfare, however, there is a tendency to think only of the larger strategic issues of SDI, ASAT, BMD, and their impact on the survival of the human race. The fact that "star wars" was never implemented has done little to turn strategic thinkers away from pigeon-holing military space as being solely for the purpose of shooting down ICBMs and fending off other countries' satellites in orbit. The age of gigantic space platforms firing planet-killing lasers is still a part of science fiction. Instead, the present reality is that most space assets are being employed as force multipliers in terrestrial operations. This has had a revolutionary impact on the military strategy and doctrine of the three traditional armed services, and by the end of this year all three will have significantly rewritten their war doctrines to accommodate the use of space-based resources.

Though the Gulf War has been increasingly labeled as the "first satellite war", in fact space assets have acted as force multipliers in conflicts dating back to the 1960s.[34] During the Vietnam War the Americans employed both communications and remote sensing satellites in direct support of ground operations. Geostationary communications satellites were developed jointly by the Defence Department and NASA, coming into service in July 1967. Space relayed communications were slow, but it had the advantage of clarity that ground-based communications could not provide in the dense jungle. A year and a half later the first satellite designed specifically for use in counter-guerrilla warfare, called TACSAT, was launched. Once in orbit, TACSAT assisted in locating enemy movement by linking remote seismic and acoustic sensors through itself to ground

stations set up to track potential targets. Though primitive and unable to distinguish human from water buffalo, it was the first attempt by the Americans to use space as a force multiplier in combat.[35]

With the continual improvements in satellite's abilities during the Vietnam period, American space technology was moving stubbornly towards real-time operations capability. The first generation of military satellites provided information on weather forecast, communications enhancement, and limited enemy intelligence. Because the information took so long to be received, analyzed, and disseminated, it was of limited value during the Vietnam War.[36] What were of value however, were the lessons learned about the potential of military space assets. The Vietnam War had forced the United States to consider the greater aspects of military space capability and the need for operational space systems in its planning, command, and control, of air, naval, and land combat. Additionally, the immediate value of space-based warning was self-apparent, and the Americans were intent on exploiting it.

The Soviet Union had its own indoctrination to satellites as a force enhancer during its brief clash with China in 1968-69. After the first battle of the Ussuri River in late February 1969, Soviet Secretary-General Leonid Brezhnev desperately needed to ascertain the extent of Chinese military capability along the Sino-Soviet border. While Chinese air-defence could effectively repulse Soviet air reconnaissance attempts it had no way of stopping Soviet military space assets from over-flying Chinese territory. Between February 25th and April 25th, 1969 the Soviets launched more than ten surveillance satellites solely for use in this conflict. With an average life expectancy of eight days the satellites returned both high and low-resolution photographs of thousands of square

kilometers of Chinese territory.[37] The intelligence data verified that the incursion was not the precursor to an all out invasion.

The Soviets continued to launch a series of photo-reconnaissance satellites, often at short notice, which demonstrated the maturity of their military space program. Renewed fighting with the Chinese at the Amur River in the early summer of 1969 provoked the launch of fifteen additional satellites into a LEO. In 1971 further satellites were placed into orbit to monitor the Indo-Pakistani War. Two years later Russian satellites came to the aid of Soviet client states involved in the 1973 Middle East War, which had great potential for dragging both of the superpowers into the conflict.[38] The Egyptians made use of satellite imagery both in the planning and execution phases of the war. Unfortunately the additional resources did not make the difference on the ground. Every day around noon, the Soviets captured high-resolution photos of the Egyptian Army being decimated by the Israelis.

By the beginning of the 1980s the use of space assets as a force enhancer was rapidly evolving in new directions. While both communication and photo-reconnaissance satellites were already well towards becoming a staple in military operations, other non-weapon military space assets were being developed. Satellites were being designed to assist in meteorology, geodesy, navigation, targeting, search and rescue, signals intelligence, and early warning. As warfare moved towards the information age both the need and desire for improved intelligence gathering systems increased. Though space systems were not the only means available for gathering information, satellites provided a definite edge in many areas. Other abilities such as accurate navigation, early warning, and targeting could only be achieved through the use

of space assets. Overall, the pervasive influence and potential for augmenting military prowess was rather self-evident to military planners.[39] Doctrine and tactics in all the services were also modified in reaction to the emergence of space assets on the battlefield.

Given the present availability of advanced weapon systems, in particular ballistic missiles in the arsenals of some states, extensive space capabilities have become essential to early warning, detection, and the effective deployment of armed forces in any theatre of operations.[40] Enhanced satellite abilities have altered the way in which engagements were fought and will be fought in the future. Both the USA and Russia have long recognized the necessity to support a rapid and responsive military force with a wide variety of space assets. The need was reinforced during the 1990-91 Gulf War. As the 1990s draw to a close other states are moving on this issue as well.[41] For example, among the many lessons that France took home from the 1990-91 Gulf War was the indispensability of military space assets.[42] The war illustrated the importance of satellite intelligence systems to operational mobility and independence. During the conflict France felt its dependence on US space assets was flagrant, and that it denied French forces to act independently if required. Since the end of the war France has increased its military space budget by approximately 20 percent annually, and has instituted four new military space programs. By the end of the decade France should have advanced Earth imaging, infrared imaging, synthetic aperture radar, and electronic intelligence gathering means in orbit.[43]

Terrestrial forces will become increasingly adjunct to orbital assets as a result of having space-enhanced war fighting capabilities. In areas such as reconnaissance,

weather monitoring, navigation, mapping, and communications, commanders in planning and conducting operations will make full use of the space assets afforded them. Likewise they will also have to learn how to defend against an enemy's use of space assets. Consequently, the way in which warfare is conducted will be altered to exploit fully these new resources and meet these new challenges. The goal is to provide the planner of joint operations with superior information, command, and control capabilities and the military commander with information dominance on the battlefield. With an increase in battlespace (i.e. area of operations) awareness, commanders can improve their ability to maneuver and concentrate their forces, thereby increasing their chances of victory.[44]

In terms of reconnaissance, the frequently available and highly detailed digital imaging of the earth space assets can provide has resulted in augmented ground, sea, and air capability. Space reconnaissance assets have unrestricted access over any battlefield, providing early warning of attack, targeting intelligence, technical intelligence on enemy strengths, and bomb damage assessment.[45] This in turn has resulted in a clearer picture of the battlefield, more complete intelligence preparation, and more informed leader decisions. The quality of imaging that can be achieved from space-based observation is nothing short of impressive. In terms of resolution, ten countries already have systems in orbit that can image anything one meter or larger in size.[46] What that means is bridges, roads, troop units, ships, and even individual aircraft and people can not only be recognized but also identified. Many other countries such as South Korea, Pakistan, South Africa, Taiwan, Argentina, and the United Arab Emirates, have all expressed an interest in developing their own remote sensing systems. In the interim they can buy imaging through uncontrolled licensing agreements off the open market from France,

Russia, or the USA. The range of imaging is also extensive, from optical systems (including infrared, microwave, and radio) to active radar systems. The latter is more effective, being able to both penetrate cloud cover easily and operate during periods of darkness. The timeliness of image processing is also constantly improving. For example, the Australian Center for Remote Sensing can process a 20-meter resolution relief radar image of a 62-mile square area from a satellite in just 2 ½ minutes.[47] With such extensive coverage capability, also available commercially, there is little doubt that in the future all land and naval warfare will be conducted under observation.

The implications of warfare under such conditions are serious for commanders on the ground, in the air, and at sea. Potential adversaries will be able to prepare for a battle in the same way an allied commander does. Furthermore, once engaged, adversaries can easily track the commander's movement on the battlefield, greatly reducing his chances of achieving an advantage by surprise. Time becomes an increasingly important factor. In the past, air superiority ensured the safety of rear-echelon units, depots, railheads, runways, and seaports. With satellite imagery that can be updated at least bi-weekly, combined with ballistic missile capability, enemies can now track and target rear echelon activity without needing to invest in local air superiority. For commanders, that means rear units and supply nodes may have to relocate on a regular basis to avoid becoming an easy target for attack.

In order to counter the threat from above some fundamental doctrinal changes are being made. First, there is the need to accept institutionally that one's forces can be imaged from space. Second, the threat must be properly understood, and countermeasures implemented, at all levels. Countermeasures must also be applied

uniformly throughout an entire theatre of operations. Satellites know no front lines. The threat that space-based observation presents has, for example, pushed the United States to continue its trend towards high-speed maneuver land warfare and an increasing reliance on lighter forces.[48] Shorter and shorter periods in between revisits from space assets has implied that ground forces must be sufficiently agile to take significant actions during the few days or in some cases, hours, in between a satellite fly over. The United States has also given some consideration to the need for denying space-based imagery to an adversary during wartime. Not only does one have to be aware of all the available sources of information one also has to be able to deny access to those sources if necessary. One complicated issue that arose during the 1990-91 Gulf War was the fact that Iraq had uninterrupted access to U.S. weather satellite imagery because the responsible agency feared blacking out the signal would earn serious reprimands from friendly countries also affected. In the future, potentially striking and crippling commercial or neutral military space platforms outside the immediate theatre of operations may have to be considered.

The issue of weather monitoring has always played a paramount role in military operations. Admiral Halsey's ill-fated encounter with a typhoon during World War II and the critical impact of weather on the timing of the Normandy invasion are but two examples. Weather forecasting literally helps reduce the fog of war by providing an assessment of future field conditions in support of military operation planning. During the Gulf War, Lieutenant General Thomas S. Moorman, then commander of United States Air Force Space Command, noted that, "understanding the vagaries of weather became crucial to air operations", as aircraft weapons loads were optimized for weather

conditions over the target.[49] Coalition forces relied on commercial satellite systems to get accurate weather data over Iraq.[50] Since then the USA has developed the Defense Meteorological Satellite Program (DMSP) which provides the collection and dissemination of global visible and infrared cloud cover imagery and other meteorological, oceanographic, and solar-geophysical data for operational forces. For example, weather satellites could help predict the movement of chemical and biological weapons employed on the battlefield, thus giving commanders a vital opportunity to avoid high casualties through decisive and informed action. Or another example, the commander may choose to attack on a given day knowing that the poor weather conditions will mask his advance. Essentially, the data provided by space-based meteorological systems gives the commander the freedom to exploit weather conditions to his or her advantage.

The advent of accurate three-dimensional space based navigation and mapping has resolved the traditional problems of a commander knowing where he is and where he is going. The idea of space-based navigation dates back to the 1960's when the United States Navy was searching for ways to provide an accurate guiding system for its Polaris submarine fleet. During the late 1970s the Land Oriented Ranging and Navigation (LORAN) system was developed, but besides being limited to two-dimensional information it suffered from inaccuracy and spotty global coverage. However, navigational satellite constellations have recently evolved to provide more accurate all-weather, day-night, positioning, navigation, timing, and velocity data. Commonly known as the GPS, airplanes, ships, and soldiers can now know their precise location within a few meters. To the land, air, and naval commander, the ability to maneuver using GPS

means that forces can be dispersed, thereby reducing the risk of detection and attack, maneuver independently, and marry up again at pre-selected points just prior to an attack.[51] With GPS logistics and rear-echelon support can move more freely as well, decreasing their vulnerability to attack while not having the fear of failing to link up and support the front line elements. GPS allows units to maneuver easily in terrain that was traditionally very restrictive to mobility. The Gulf War was a perfect example of this. The Americans, employing GPS, were able to advance huge columns over open desert terrain with little fear of becoming separated or lost. By contrast the Iraqi forces had little or no GPS capability, and so were forced to keep to known routes. This not only restricted Iraqi movement on the battlefields, it also allowed coalition airforces to find and engage them without difficulty, knowing that Iraqi mechanized forces would be concentrated. Reserves and reinforcements had to arrive by the same predictable routes, which gave them little chance of survival against superior American air power. Again, the allies were able to employ Special Forces behind Iraqi lines for several weeks with the aid of GPS for location, targeting, and re-supply. Later in Bosnia-Herzegovina, GPS played a significant role in the recovery of a downed American fighter pilot. Even though navigation by GPS does not mean that forces will never again be lost or dazed on the battlefield, GPS has become central to military mobility, thus minimizing the potential for fog of war for all units.[52]

A military force can choose to actively or passively engage in the use of space assets as a force multiplier. What it can not choose to do is ignore the existence of space assets altogether. Many states already have space support facilities or are close to deploying them. Nearly as many states have force enhancement capability. Just about

any state has limited access to force enhancement products. Warfare has entered a new era, driven by information and enhanced by space assets that provide it. Military forces that do not keep abreast of space developments invite disaster for themselves on the battlefield. One must keep in mind, however, that space assets alone can not and do not win wars. They merely add to the resources from which a commander derives his decision. Humans still control the nature of war. Outer space has simply provided another element in which to do it.

CONCLUSION

Security goals on Earth and in space used to be exclusive of each other, but as space capabilities continued to evolve, the political-military objectives of the two realms became increasingly complimentary. Within ten years of the launch of mankind's first satellite, states began seriously to examine how space may affect national interests. Now, every nation and alliance on Earth has political, economic, military, social, and scientific interests in space. Nearly all of these interests have security implications, which if threatened, could deny a state physical security and freedom of action not only in space but on Earth as well. Traditionally one tends to think of space control in terms of the USA and USSR/CIS only, when in fact there are now many more potential players than that. In addition to the two original super powers, Brazil, Canada, Italy, Spain, and the United Kingdom, all have active military space programs (i.e. have military space applications in orbit). Meanwhile France, China, and Israel operate completely autonomous military space programs (i.e. the ability to build and launch their own

military satellites).[53] A further 143 countries are military space users in one way or another, for example, using satellite Earth imagery, secure communications, or GPS.

In examining the theory and application of space warfare some important conclusions can be made. First, the issue of whether or not space has had an impact on the conduct of war is a moot point. Undeniably, military space assets have altered the principles of war, belittling some of them and making others almost redundant.[54] Since their inception military space assets have been integrated at the strategic, operational, and tactical levels of warfare, inducing a fundamental change in the conduct of military operations in space, on land, at sea, and in the air. This revolution in the art of war will continue so long as mankind has the ability to reach into space. Second, are the direct implications that civilian space technologies, agencies, and organizations have had and will continue to have on military operations. In the past soldiers usually only had to worry about other armies, but in space issues they must be concerned with everyone. Daily civilian staples like CNN, Navstar, and Teleglobe Canada could be just as lethal to a commander as the enemy. The issue has drawn so much attention, that the US military has established a Battle Laboratory at the US Space and Missile Defence Command to specifically test potential scenarios where civilian and commercial space assets are involved in war.[55] Third, the rapid proliferation of missile and space technologies demonstrates that not only is there a concerted interest by states to get involved in space control, but also that there is a good chance future conflicts will continue to involve space, or may even be fought in space. Many analysts believe that future conflicts will consist of an opening round of attacks on and between space assets, before the engagement of terrestrial forces begins. Fourth, if and when war does move into outer

space, the nature of the terrain will have to be better understood and adapted to. Though we know much about space cosmography and astrophysics, our knowledge has shown that we do not really know that much at all. Finally, and perhaps most important, is the fact that the incredible amount of work done on doctrine and application of military space assets has resulted in little consideration for the broader issues of the theory of space warfare.

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[1] One thinks of Herman Khan and Bernard Brodie, both of whom wrote extensively on the finalty of war now that wepaons of mass destruction were in the arsenals of the superpowers.
[2] Since the end of the Cold War the Former Soviet Union (FSU) has had increasing difficulties in maintaining its military space capability. Other countries like China, India, and Israel are showing a more aggressive role in military space as their own national programs evolve.
[3] Another important founder of space rocketry was Sergei Korolev (1907-1966). He joined the Soviet program in 1927, was arrested under the Stalin terror in 1933 and forced to work as a scientific prisoner (*zek*) until 1944 when, he was released by the NKVD. After the war he was a driving force in Soviet space development until his death at 59 from heart failure.
[4] Hermann Oberth (1894-1989) submitted his doctoral dissertation on space flight to the University of Heidelberg in 1922. His dissertation was rejected. Oberth then published the work under the title, *The Rocket Into Planetary Space.*
[5] Finney, B. *Space and Society: 1996 Core Lecture Notes.* (ISU, 1996), p.15. See also Bainbridge, William Sims, *The Spacelight Revolution: A Sociological Study.* (Florida, 1983).
[6] Ibid, p.15. Von Braun was just 20 years old at the time. He worked on developing a small rocket engine, getting credit toward his PhD while fulfilling the army's mandate.
[7] In German legend, Faust made a bargain with the Devil to obtain worldly knowledge, power, and pleasures in exchange for his soul.
[8] The rate of advancement due to the war was phenomenal. Just 25 years after Von Braun got his assignment, Earth launched its first object into space, and just 12 years after that, the first humans walked on the moon.
[9] Cited from Muolo, Major M. J. *Space Handbook: A War Fighter's Guide to Space Volume One.* Alabama: Air University Press December 1993, p.55.
[10] Until 1953 the USAF was the sole service in the USA authorized to expend funds on satellite vehicle studies.
[11] Heppenheimer, T.A. *Countdown: A History of Space Flight,* (New York 1997), p.29.
[12] Collins, John M. *Military Space Forces: The Next Fifty Years,* (New York, 1989), p.1. Mackinder's Heartland Theory was originally applied to East-central Europe and Russia, known as the world island. He who rules the world island rules the world.
[13] Gray, Colin S. "The Influence of Space Power Upon History", *Comparative Strategy: An International Journal,* 15,4 (Oct-Dec 96), p.293.
[14] Lambakis, Steve. "Exploiting Space Control: It's Time to More Fully Integrate Space Into Warfighting Operations", *Armed Forces Journal International,* (June 1997), p.42.
[15] Dr. Steven Lambakis is a policy and strategy analyst specializing in defence studies at National Security Research Inc., in Fairfax, Virginia. Dr. Colin S. Gray was president of the National Institute for Public Policy before becoming the director for the Center of Security Studies at the University of Hull, United Kingdom.
[16] See bibliography for sources on Lambakis and Gray.

[17] Collins, *Military Space Forces*, p.23.
[18] Ibid, p.6.
[19] The MIR space station has no military capability, being designed only for the conduct of scientific experiments.
[20] White, General Thomas D., "The Military in Outer Space", *Newsweek*, 9 July 1962: p.16.
[21] Johnson, Nicholas L. *Soviet Military Strategy in Space*, (New York, 1987), p.12.
[22] Ibid, p.12.
[23] Van Allen radiation belts are located inside Earth's magnetosphere. The regions trap charged particles and hold them there. When a change in the solar wind occurs, the particles are dumped out and "rain" into Earth's polar regions. When they strike the upper atmosphere they cause it to glow, creating the phenomenon known as *Aurora Borealis*, or the Northern Lights. The trapped particles in the belts can have serious effects on spacecraft and satellites which pass through them.
[24] Johnson, *Soviet Military Strategy in Space*, p.20.
[25] Lambakis, Steve. "The United States in Lilliput: The Tragedy of Fleeting Space Power", *Strategic Review*, (Winter 1996), p.35.
[26]Gray, *The Influence of Space Power*, p..306.
[27] Von Clausewitz, C. *On War*, (Princeton, 1976; first published 1832), pp. 595-597.
[28] Other countries such as Denmark, France, Japan, and South Africa suffer similar security risks.
[29] Von Clausewitz, *On War*, p.204.
[30] Collins, J. *Military Space Forces*, p.61.
[31] Ibid, p.62.
[32] For Soviet perceptions of SDI see Fitzgerald, Mary C. "The Soviet Military on SDI", *Studies in Comparative Communism*, 19, 4 (Fall/Winter 1986): pp.177-191; Burant, Stephen B. "Soviet Perspectives on the Legal Regime in Outer Space: The Problem of Space Demilitarization", *Studies in Comparitive Communism*, 19, 4 (Fall/ Winter 1986): pp. 161-175; Stares, Paul B. *Space and National Security*, (Washington, 1987); Ra' Anan, Uri. "The Soviet Approach to Space: Personalities and Military Doctrine", *International Security Dimensions of Space*, (Hamden, 1984); and Hensel, Dr. H. "Soviet Politics and Space Policy", *Proceedings of the Air War College 1988 Space Issues Symposium*, (Alabama, 1990): pp.31-44.
[33] See Zaloga, Steven J. "Red Star Wars", *JANE's Intelligence Review*, (May 1997): pp.205-208.
[34] Author Arthur C. Clarke coined the Gulf War as the first satellite war in an interview with John Burgess, "Satellites' Gaze Provides New Look at War", *Washington Post*, 19 February 1991, p. A13.
[35] Manno, J. *Arming the Heavens: The Hidden Military Agenda for Space, 1945-1995*. (New York, 1984), p.128.
[36] Ibid, p.130.
[37] Johnson, *Soviet Military Strategy in Space*, pp.90-91. The Soviets set a record for consecutive space launches that year that has yet to be broken.
[38] Ibid, p.93.
[39] Gray, *The Influence of Space Power*, p.296.
[40] Hamon, D.R. "Space and Power Projection", *Military Review*, (November 1994), p.62.
[41] For an example see Bruce, James. "Israel's Missile and Space Projects", *JANE's Intelligence Review*, (1995): pp.352-354, and Clark, Phillip. "Third Successful Israeli Satellite Launch", *JANE's Intelligence Review*, (1995): pp.265-266.
[42] For an extensive review on this issue see Yost, David S. "France and the Gulf War of 1990-1991: Political-Military Lessons Learned", *The Journal of Strategic Studies*, 16, 3, (September 1993): pp.339-374.
[43] Yost, *France and the Gulf War*, pp.356-357.
[44] USA. ODUSD (Space). *Department of Defense Space Program: Executive Overview for FY 1999-2003*, (February 1998), pp.8-9.
[45] Moorer Jr., Major D. F. "Accepting and Understanding Space Capabilities", *Military Review*, (May/June 1995), p.65.
[46] Since 1994 Brazil, Canada, China, ESA, France, India, Israel, Japan, Russia, and the US had this capability.
[47] Wolf, Capt. J. R. "Implications of Space-Based Observation", *Military Review*, (April 1994), p.81.
[48] Ibid, p.84.

[49] Cited from Keethler, Gregory A. "Impact of the Soviet Union's Demise on the U.S. Military Space Program", Petrie, J. N. Ed. *Essays on Strategy XI,* (Washington, 1994),p. 380.
[50] Hamon, *Space and Power Projection,* p.64.
[51] There is also DGPS – Deferential Global Positioning System. American GPS satellites have the ability to control the degree of accuracy provided by the existing satellite constellation, so that commercial and civilian users may have position within 25-100 meters, while military forces can obtain an accuracy to within 1-5 meters. Furthermore, encryption methodologies and algorithms are designed into the satellites to block adversarial access to the Y-code on the classified military frequency, forcing potential enemies to use the civilian C/A code on L-1 which can be jammed by US Forces.
[52] For the impact of GPS on the military and civilian market see Stanton, J. "Global Positioning System is An Asset Requiring Protection", *National Defense,* (December 1997), pp.28-29.
[53] Butterworth, Robert L. "The Case Against Centralizing Military Space", *Strategic Review,* (Summer 1996), p.44.
[54] For example surprise has become difficult and in some cases impossible under satellite observed warfare.
[55] See Gregory, B. "Down to Earth: US Army Increases Attention to Space Issues and Technologies", *Armed Forces Journal International,* (December, 1997), p.12.

CHAPTER TWO
FROM ALLIANCE TO DEPENDENCE
CANADIAN-AMERICAN DEFENCE COOPERATION THROUGH SPACE
1945-1985

"...should the occasion ever arise, enemy forces should not be able to pursue their way either by land, sea, or air, to the United States across Canadian territory."
- Prime Minister W. L. Mackenzie King, 1938.

Canada has always maintained the perception that its people were of the rough and rugged stock, able to defeat any frontier that may challenge them. This was no less true of the realm of outer space, and in 1962 Canada showed the world once more its indefatigable character by becoming the third country to project a man-made object into orbit.[1] However, it was not a completely indigenous effort. Though Canadians may be rough and rugged they are also somewhat conservative and reserved, and the satellite, known as *Alouette 1*, was launched from Vandenberg Air Force Base (AFB) in California, riding atop an American built Thor-Agena B rocket. From the very beginning, Canada operated in the upper atmosphere and space as an American partner. This relationship continued to grow as keeping the Soviets in check, first through North American security then by deterrence took on paramount importance in the new Cold War.[2] Such an early inauguration into the space frontier suggested a bright future for Canada headed by the Defence Research Board (DRB), but unfortunately this was not to be the case. Within a decade of its first launch Canada's space policy was in an uncoordinated mess, as Canadian foreign policy decisions clashed with those that provided the impetus for advancing space capability. By 1970 Canada's space program had been completely demilitarized, which not only jeopardized its ability to act as a partner in Canadian-American security operations but also ensured a steady decline from

alliance with the Americans in space defence to a complete dependence on the United States for security through space. It was not until the mid 1980's when Canada finally regrouped and reorganized its efforts in space exploration and exploitation, but by then they were seriously behind their American partners. After a brief initial interest in space defence cooperation, the evolving Soviet threat combined with a series of policy misperceptions and sporadic foreign policy decision-making doomed Canada to become all but entirely dependent on the United States for space-based aspects of security.

Joint United States/Canadian commitment to cooperative defence began before the United States had even entered the Second World War, when the two countries signed a declaration of mutual agreement at Ogdensburg on August 18th, 1940. This agreement announced, among other things, plans for the establishment of a Permanent Joint Board on Defence (PJBD). Initiated the following year, the PJBD created a direct link between the President and the Prime Minister to discuss matters of defence. This was followed soon afterwards by the Hyde Park declaration on April 20th, 1941, that stated balance of payment problems would not be allowed to interfere with production for defence purposes in either country.

Canada was able to initially operate as an ally in upper atmosphere and space development with the United States due to the invaluable assets it possessed that the Americans did not. Wartime collaborative programs in pure science, electronics, and ballistics largely defined Canada's potential for space activity. Canada's National Research Council (NRC) had conducted upper atmospheric experiments since the 1920s, and in 1943 Canada participated extensively in Anglo-American ionospheric studies, that would become the basis of aircraft detection technology for the next two decades.

Throughout the war Canada had a strong corps of scientists organized to conduct research for the allies. The Americans, who sought to take advantage of the scientific ability Canada had to offer, heavily relied on their contribution. At the end of the war, Canada had strong infrastructures already in place to continue its pursuit towards space exploration, and these were amalgamated in 1947 into a single organization with the formation of the DRB. Organized and effective, Canada held its ticket to enter the American space race.

In Canada a civilian headed the DRB, though he worked in close alliance with the heads of all three military services. The Board was strong and well organized, harmonious in operation, inventive and intuitive, and respected internationally. By contrast, the civilian private sector in the space community was disorganized and fragmented, weak in influence and resources, and highly dependent on government funding, facilities, and direction.[3] Though the Canadian scientific community had increased rapidly during the war, most of these people were at the disposal of the government, not industry. Despite this apparent dichotomy, the DRB was interested in making its military research, and hence its own organization, an integrated part of Canada's industrial structure. The DRB included representatives from both civilian universities and industry, and assisted in the creation of other research institutions such as the Institute of Aerophysics at the University of Toronto.[4]

During the early post-war period the issue of defence was central to all upper atmosphere and space development in Canada and the United States, which meant that the military exerted a great amount of control over its direction. That being said, both military cooperation with the United States and space defence was limited by government

decision making, and often outright retarded by Canada's foreign policy development that sought to downplay Canada's military space role. Despite the apparent stability and growth in space research offered by the DRB, evolving political direction would soon put the military at odds with Ottawa.

Canada rose from the shadow of the Second World War with a renewed nationalistic sensitivity that both impeded and enhanced joint defence planning with the United States. Canada promulgated publicly that international understanding and cooperation could be achieved through the newly formed United Nations, and as such Canada frowned on propositions of regional or defensive alliances. Such alliances, Canada believed, were a regressive step towards the world order that existed prior to 1939, where military solutions and a balance of power were expected to maintain the peace. Instead, Canada chose to aggressively support the United Nations in hopes that its internationalism would preclude the need for bilateral or regional security arrangements. For example, Canada's desire not to weaken the UN influenced its decision to decline membership in the Organization of American States in 1948. By joining the OAS, Canada feared that the smaller states on the American continent would merely become military satellites of the United States. Such unilateral moves by Canada were made with the apparent determination of not aligning itself with the United States directly in any way.

In fact the Canadian government continuously made conscious policy decisions to get involved in bilateral defence arrangements with the United States. Robert A. Spencer, a Canadian historian, wrote in 1959 that, "Canadians would (and must) continue to be concerned at the prospects of becoming a *de facto* colony of Washington, so soon

after having successfully won *de jure* independence of London."[5] This point is true not because Canada had to protect itself from American threats to its sovereignty but rather because since 1940 Canada had been actively entering into ad hoc joint defence agreements with the Americans. By the mid 1950s there were so many bilateral agreements between the two countries that it appeared as if Canada had "Americanized" its defence policy. To a large degree it had. Furthermore, European security depended on a secure deterrent, and that deterrent was provided through NATO. Canada and the United States both were part of these regional alliances, and for the most part Canadian defence policy was in total alignment with American defence policy at this time. The logic of defence policy told close ties with the United States, though foreign policy did not always move in this direction.

Increased aggressiveness by Soviet Russia in Eastern Europe and Russia's increasingly uncooperative attitude in the United Nations in 1947 and 1948 brought Canada's foreign policy planners somewhat back to reality. It was quickly realized that the United Nations alone had no hope of being the guarantor of world stability. Canada's position was particularly precarious. The country soon found itself geographically situated between the two states most likely to go to war against one another. Worse still, the battle could very easily be fought on and over Canadian territory. Defence and deterrence through military alliance with the United States was the only option for Canada, for the threat of Soviet expansion was becoming ominous.

Canada was also moved somewhat by the general change of direction in American foreign policy. In the post-war period the United States dedicated itself to being the leading power in the western world in protecting free nations from the growing

communist threat. This American globalism was a complete departure from its pre-war isolationist attitude, and it helped facilitate acceptance by Canada that continental defence cooperation was in the interests of world stability. However, Canada was still reluctant to engage in complete cooperation for fear of American dominated influence in its defence program, and limited initial defence cooperation agreements to the consultation and planning stage.

In February 1947, after more than a year of secret meetings, the two governments publicly announced that they would plan future cooperative defence objectives through the Permanent Joint Defence Board. The PJDB initiated the framework through which all space-related defence issues were discussed, and provided the impetus for the first joint space operation between the United States and Canada. In a statement issued on February 12th, 1947, five principles upon which continental defence would be based were outlined. They were: 1) an interchange of personnel to promote better understanding; 2) cooperation and exchange of observers for military exercises and weapons tests and development; 3) standardization of arms, equipment, organization, and methods of training; 4) mutual and reciprocal availability of military, naval, and air facilities in each country; and 5) the sovereign control of each country over activities within its boundaries in all cooperative projects.[6]

With the obvious failure of the United Nations to provide a system of collective security, Canada and eleven other western nations entered into the North Atlantic Treaty Organization in 1949. Designed to counter potential attacks on the west by the Soviet Union, for Canada NATO provided a means of collective security through a multilateral arrangement that avoided tying it too closely to the United States. By including Britain

and other European countries, Ottawa ensured its own voice would not be lost in an alliance including the Americans.[7]

The nature of the threat to North America greatly influenced the direction in which Canada's space program evolved. Prior to the successful deployment of large numbers of ICBMs by the Soviet Union, the main focus of Canada and the United States in defending North America was to develop an effective early-warning umbrella that would allow allied air defences and aircraft to intercept incoming Soviet attackers. With the increased range capabilities of aircraft, by 1949 the Soviets could effectively reach American targets by flying over the North Pole. The potential threat of over-the-pole bombing by the Soviets in turn caused the USA to turn to Canada for cooperation and support in developing ground and space-based assets that could detect this type of attack. Canada had been developing an expertise in ionospheric studies since 1947, and used this knowledge to assist in the research and development of first a crude radar detection system and later a satellite constellation that could potentially give warning of inbound aircraft.[8]

Initial cooperative defence planning against a Soviet attack suggested that American troops and aircraft should be stationed on Canadian soil, but this and other potential arrangements stirred up political concern in Ottawa. The stationing of American forces in Canada was perceived by Ottawa as a direct threat against Canadian sovereignty, and the government chose other means of participating in the collective defence of North America. It possessed a considerable military air capability of its own at the end of the Second World War, and its growing knowledge is space related sciences ensured, to some extent, that it could act as a partner with the Americans rather than as a

subordinate. Instead of deploying American forces in Canada Ottawa agreed to the development and deployment of a series of early warning lines that could effectively cover all air approaches to North America. This would give American and Canadian interceptor aircraft time to respond to incursions without the need for American forces being directly based in Canada.[9]

Prior to the deployment of space assets for early-warning Canada and the United States used their collective knowledge of the ionosphere to deploy a series of overlapping radar early-warning lines that covered all air-approaches to North America. The USA was particularly concerned about Canada's participation in these early-warning lines as it was agreed that the most likely Soviet approach to attack North America would come over the North Pole. In 1951 Canada and the US agreed to extend the Continental Air Defence Integrated North (CADIN)-Pinetree Line, that had begun as a purely American system along the 50 degrees North. The Americans also agreed to absorb two-thirds of the cost to the Canadian stations. The CADIN-Pinetree Line was completed in 1954 and initially consisted of 39 manned radars that could not only provide early warning but also control interceptor aircraft as well. The Canadian air element consisted of 162 CF-100 all-weather interceptors at five Canadian bases.[10] It was a first step in countering the Soviet bomber threat.

In 1954, Canada then agreed to the deployment of two further early warning systems, the Mid-Canada Line (MCL) and the Distant Early Warning (DEW) Line. The Mid-Canada Line, a chain of ninety-eight radar stations was positioned further north of the CADIN-Pinetree Line along the 55th parallel. Designed to detect but not track any enemy bombers which crossed it, the stations were completed three years later at a cost of

$250 million (approximately $2.2 billion in 1988 dollars).[11] The chain employed McGill Fence technology, which was a highly sensitive audible alarm system that could operate unmanned. Though this seriously cut down on the operational costs of the line, improved space technology soon made the system obsolete, and the Mid-Canada line was closed in 1965. Unlike the MCL, the DEW line was a jointly conceived and planned venture, but was mostly funded and staffed by the United States. It was located north of the MCL along the 70th parallel, just 350km north of the Arctic Circle. The DEW line was completed in 1957, and cost approximately three times the amount of the Mid-Canada Line.[12]

Throughout the 1950s Canada readily adapted its own military air capability to meet the evolving Soviet air breathing threat, demonstrating that it was initially interested in improving its own aerospace power. As the subsonic CF-100 with its unguided ordnance became obsolete, Canada upgraded its air fleet with the design of the Velvet Glove guided air-to-air missile and, later, the Avro Arrow supersonic interceptor. Unfortunately the Arrow project was abandoned in 1959. Two years later Canada acquired 66 American F-101B Voodoo interceptors, and deployed them at CFB Bagotville, CFB Chatham, and and CFB Comox. In 1964 these aircraft were armed with nuclear AIR-2A Genie missiles.[13]

Canada also continued to contribute greatly to the development of space capability in the Western Hemisphere. Though the United States had quickly overtaken both Canada and the United Kingdom in space research, Canada continued its peripheral but no less important participation in contributing to the common scientific wealth of knowledge. Canada operated within its own limits, and effectively through the DRB, to

make an impact in an area of western alliance defence that was becoming increasingly paramount in the evolving Cold War between the US and USSR.

In 1956 the United States Army opened a rocket launching facility near Churchill, Manitoba, for the purpose of conducting scientific experiments for the joint benefit of American and Canadian scientists. The Churchill Research Range (CRR) site was ideal due to the fact that Churchill lies near the middle of the zone of maximum auroral activity which in turn is centered on the geomagnetic pole. Rockets launched from Churchill were able to gather valuable accurate data on the upper atmosphere and the ionosphere, which was in turn used to assist in the detection and tracking of inbound aircraft. Also, the launching of rockets necessitated a large impact area, and Churchill was appropriately located adjacent to the Hudson Bay.[14]

The CRR regularly launched nine different types of rockets. The smallest of these was the Arcas rocket, only 4.5 inches in diameter and five feet long, capable of carrying twelve pounds of experiments to fifty miles altitude. Normally carrying meteorological instruments, approximately three Arcas rockets were fired each week between 1956 and the closure of the range a decade and half later. Larger solid-fuel rockets launched from the CRR included the Nike-boosted series, the Cajun, the Apache, and the Tomahawk. Each of these was capable of carrying about a hundred pounds of payload to about 110 miles altitude. These rockets were used by various American agencies for scientific experiments. On occasion the CRR also launched the two-stage Astrobee 250 rocket, capable of carrying 400 pounds of payload to 195 miles altitude. The largest rocket fired was the four-stage Javelin rocket, which was about 48 feet long and capable of carrying 125 pounds of payload to 500 miles altitude. The only liquid fuelled rocket fired from

the CRR was the Aerobee 150 rocket, capable of carrying scientific payloads up to 300 pounds to just over a hundred miles altitude. Finally, Canadian experiments were carried up in the Black Brant series of rockets.[15]

The development of the Black Brant rocket was a considerable achievement for the fledgling Canadian space program. Initiated in 1956 by the Canadian Armament Research and Development Establishment (CARDE), the Black Brant was designed, built, and tested by Bristol Aero Industries Limited in Winnipeg, Manitoba. The Black Brant I and II were designed and tested by CARDE, while successive models were completed and tested by Bristol. The early models were used to launch nitric oxide seeding, polar-cap ionosphere and auroral experiments, while later models carried a variety of scientific experiments. Over a hundred Black Brants were launched between 1956 and 1966 (see figure 2.1), demonstrating the versatility and capability of the rocket. Few other designs at the time showed similar ability and flexibility.[16]

FIGURE 2.1 SUMMARY OF BLACK BRANT ROCKET OPERATIONS 1956-1966

VEHICLE	NOMINAL PAYLOAD	ALTITUDE	PAYLOAD VOLUME	DIAMETER	TOTAL LENGTH	NUMBER OF FLIGHTS
Black Brant I	140lbs	90mi	4.0 ft3	17.2in	24.3ft	17
Black Brant IIA	200lbs	100mi	6.0 ft3	17.2in	27.7ft	55
Black Brant III	50lbs	100mi	1.4 ft3	10.2in	18.1ft	17
Black Brant IV	40lbs	620mi	1.4 ft3	17.2in	37.2ft	4
Black Brant VA	200lbs	125mi	8.0 ft3	17.2in	26.7ft	4
Black Brant VB	200lbs	260mi	5.0 ft3	17.2in	25.3ft	5

SOURCE: CHAPMAN REPORT, OTTAWA, 1967.

The CRR also provided special facilities capable of launching temperature-sensitive instrumentation such as ionospheric experiments. Rockets were launched from

within specially designed buildings that enabled the technicians, scientists, and engineers to prepare rockets while protected from the extreme cold. As the rockets had to stand in launch attitude for several hours waiting for the occurrence of specific atmospheric phenomenon, the proper temperatures for the rockets were maintained by specially designed heat shields. Inside the enclosed shields a rocket was maintained at room temperature in spite of low ambient temperatures often below freezing. The launchers were also capable of being adjusted in azimuth as required, allowing for alterations if necessary even late in a countdown.

In addition to Black Brant rockets and specialized launchers, Canada developed a propellant manufacturing, filling, and static-test facility at Rockwood, Ontario. Opened in 1963, it was capable of producing over 2.5 million pounds of propellant annually. The seeds of an indigenous launch capability had been sown, but unfortunately Canadian space support developments ceased entirely over the next few years and the CRR was ultimately shut down and abandoned.

With the development of the atomic bomb the United States felt a potential Soviet threat to North America was becoming inevitable. After fighting a three-year war against communist North Korea, Americans watched as the Soviet Army crushed a revolt in Hungary, and tightened its grip throughout Eastern Europe. In Ottawa it was clear that any incursion by Soviet air forces into North America would be met head on by the United States Air Force, whether it was over Canadian territory or not. The "involuntary American guarantee" of the security of Canada gave rise to serious questions about the safety of Canadian sovereignty. As mentioned above, Canada refused the deployment of American ground forces in Canada (with the exception of personnel required to man the

DEW line), but it still faced issues over the sovereignty of its airspace. Though the PJBD had defined various conditions under which either country's airforces could cross the border, there were still many gaps in the issue of command and control. The obvious solution was to formally establish some method of a combined Canadian-American authority that would act as a command decision-maker in the event of a Soviet attack on North America. In considering a joint command authority for the air defence of North America, the following argument was put forth by Cynthia Cannizzo of the University of Calgary:

> The joint nature of the threat; the need for warning as far forward as possible to give time for defence mobilization; close cooperation between the United States and Canada already existed and having a formal structure with joint command would give coherence to various programs and activities; and finally, joint command would ensure a Canadian voice in enterprises which could otherwise be carried out by the U.S. regardless of Canadian wishes.[17]

The creation of the North American Air Defence (NORAD) command in 1957 could not have come at a better time. Signed on August 1st, 1957, it was a ten-year agreement for the cooperative defence of North America, amalgamating previous bi-lateral defence efforts under a single unified command.[18] Two months later on October 4th, the Soviet Union successfully launched the first man-made object into orbit, increasing (or perhaps justifying) American fears that Soviet attacks on North America could not only come from the sea and air, but now also from space as well. The advent of missiles made space-based early warning vital.[19] By the time the United States had launched its own first satellite, *Explorer 1*, almost four months later, the Soviets had already launched a second satellite carrying the first living creature from Earth into space.[20] At first it appeared that the Soviets were well ahead of the west in exploiting

space, and there was no doubt in the minds of Washington that Moscow would exploit space for military purposes wherever possible.

THE NEW FRONTIER (1959-1969)

The initial Canadian perception of space exploitation was very similar to the view held by the United States and other western allies, that space would primarily be used for military purposes, and strategic interests. However, this perception changed rapidly for Canada during the 1960s, and by the eve of its centenary the country was well on its way towards civilianizing its space program. The rapid expansion and sophistication of space programs, combined with the changing nature of Canada's role in international affairs, reduced the military bearing of its space program in favour of a more specialized and commercially oriented agenda. The positive side of this trend was that by maintaining a close but dependent alliance with its American partners Canada was able to continue with some evolution of its own space program. The negative side of the trend was that such a position was achieved at the expense of its military space capability, and later on, Canada's space independence as a whole. By being a faithful but dependent partner, Canada's influence in space security issues within the western alliance was greatly reduced by 1970.[21]

In the wake of the Soviet breakout into space Canada and the United States undertook several joint space projects in the interest of increasing North American security. Soon after the establishment on the National Aeronautics and Space Administration (NASA) in the United States, the DRB entered into a series of joint ventures designed to augment Canada's participation in space-based defence. The first

major project was the NORAD Space Detection and Tracking System (SPADATS). The mission of SPADATS was to detect, track, and identify all man-made objects in space. The Canadian component originally consisted of an Aerospace Defence Center (ADC) satellite-tracking unit at Cold Lake, Alberta. An additional two-sensor unit at St. Margarets, New Brunswick, later augmented this. Together these two systems comprised ten radars of various designs, five Baker-Nunn satellite-tracking cameras[22], and the interferometer[23] fence of the United States Navy Space Surveillance System (NAVSPASUR).

The second joint venture was the Alouette-ISIS satellite program, a project that provided Canada and the United States with the majority of its ionospheric research during the 1960s. Following a letter of agreement between NASA and the DRB in August 1959, work started at the DTRE on the design and construction of a satellite containing a topside ionosphere sounder experiment.[24] Known as *Alouette 1*, the satellite was launched on September 29th, 1962, into a 1000km LEO at an inclination of 80°. The satellite carried a total of four experiments; the sounder, a cosmic noise experiment, a very low frequency (VLF) receiver, and an energetic particle experiment. The National Research Council (NRC) provided the last experiment. The Americans financially supported and provided launch services for *Alouette 1*, while Canada designed, constructed, and operated the satellite. Canada also decided what type of experiments the satellite would conduct, and established ground controlling stations to receive the data. Once *Alouette 1* was in orbit the Canadians collected and analyzed the data, sharing the information with their American neighbours. Both countries were pleased with the

results, and it seemed for the time being at least that Canada was interested in the defence-related benefits to be had from space assets.

Following the success of *Alouette 1* Canada and the United States reached a further agreement to extend their ionosphere studies through another program called ISIS (International Satellites for Ionospheric Studies). The project called for the launching of four Canadian-built satellites known as *Alouette 2*, *ISIS-A*, *ISIS-B*, and *ISIS-C*, from Cape Kennedy at intervals during the half cycle of sunspot activity from 1964 and 1969.[25] Another joint venture, it differed from the *Alouette 1*project in that Canada's main goal with ISIS was not direct defence related benefits but rather to use ISIS as a means of developing a skilled spacecraft industry in Canada. The ISIS project was a deliberate catalyst for the justification and development of a domestic space industry, funded through a special parliamentary vote, and evolved under civilian direction.[26] The cost of such an effort was tremendous, but at the time Canada had a significant interest in expanding its space capabilities, if for no other reason than the fact that it could. More realistically, the potential benefit of a space industry in Canada meant a new market and potential trade links in Europe.

Though ground and space-based ionospheric technology was becoming the standard method of detecting enemy aircraft, the United States continued to test and deploy other space-based early warning capability. The first alternate effort made by the Americans was the MIDAS project that became operationally effective in 1963. The MIDAS satellite used long wave infrared (LWIR) sensors to detect missile launches. The following year American space defence was augmented with the deployment of SAINT, a satellite interception system using THOR missiles as boosters and Canadian SPADATS

information for tracking. The deployment of SAINT effectively added the anti-satellite role to the USAF and directly involved NORAD in the activity.[27]

Efforts were also made to educate Canadian Forces personnel on the ongoing USA space effort. In the early 1960s Canada concluded a technology exchange agreement. In 1962 a high altitude research project (HARP) was begun at McGill University with funding from the United States Army Ballistics Research Laboratory. In 1964 the Canadian Department of Industry joined the HARP program. At the Churchill Rocket Range in Manitoba, Canadian scientists and American money from the USAF Office of Aerospace Research resulted in the successful development of the Black Brant launch vehicle.[28]

While systems like SPADATS and *Alouette-ISIS* satellites were being operated, Canada continued to ascertain exactly what military advantages, if any, could be gleaned from space technology. In a speech to the graduating class of the Royal Military College (RMC) in May 1959, Prime Minister John Diefenbaker spoke of Canada's potential place in space indicating that, "military potential and civilian benefits" could both be gained.[29] Ironically, the Prime Minister's words spoke of exactly where the schism in the Canadian space program would begin. Though Canada wished to take advantage of the military benefits of space assets, it at the same time wished to express Canada's desire to keep outer space free from becoming a battle ground for future wars. As a significant middle power Canada had a stake in global stability and activity pursued both UN initiatives and collective western security to achieve that aim. When a potential military threat from space evolved those initiatives were extrapolated to cover the realm beyond its terrestrial

shield as well. Its political actions during the following decade confirmed its non-partisan attitude towards the militarization of space.

Despite any reservations about the direction in which space technology advanced in Canada there was no shortage of military funding at the time. In fact, defence spending and military management in the 1960s was vital to the survival of Canada's infant space industry. The Department of National Defence (DND) devoted large portions of its budget to fostering Canadian space science and industry development, which would have otherwise been impossible without military planning, organization and funding. Up until 1967 Canadian military sponsored space programs constituted 41 percent of Canada's total space spending. The United States military contributed another 20 percent, and joint military-civilian projects in Canada counted for another 11 percent. Thus, almost three-quarters of Canada's space spending came from military sources. In 1966, the DRB alone accounted for 46 percent of all of Canada's space expenditures, essentially funding almost half of the space program itself.[30]

During the 1950s and 1960s the DRB played an essential role the evolving Canadian space program and its policy. In addition to its massive funding of the space program the DRB provided a seat of leadership and organizational support second to none. Under the guidance of its first chairman, Dr. O.M. Solandt, the DRB connected itself firmly to the Cabinet Defence Committee, the ministers of defence and the ministers of defence science, and thus space itself. In addition, the DRB gained direct support from the NRC and the Chief of the General Staff (CGS), Charles Foulkes. Such support from external interests not only confirmed the ability of Dr. Solandt, but also reflected Canada's overall defence priorities during this period. There was a real need for

a high state of efficiency that could only be provided by space assets. Communications, early warning systems, and air defence forces could all be enhanced through the use of satellite technology. During the Cold War, space assets could provide direct defence of Canadian sovereignty, aid to the civilian power, and where applicable, international cooperation in conflict. The DRB ensured that Canadian government had a space program could meet these security requirements effectively. Unfortunately, the Canadian government felt that the DRB's connection with its space program was an act of condoning the militarization of space, and by the end of the decade ensured that it was removed from space projects completely.

Canadian foreign policy and security policy decisions in the 1960s had a definite impact on the development of any national space assets, especially those that could have served a military purpose. The largest detriment was the misperception in Ottawa that a potential militarization of space automatically included the endorsement of a weaponization of space. Throughout the Cold War, the government demonstrated a public aversion to the employment of weapons of mass destruction, and as such declined any involvement in American led anti-ballistic missile (ABM) projects. Such a position was politically precarious, as the Americans saw it as undermining the American concept of mutually assured destruction (MAD) and nuclear stability. Since Canada's only operational connection to military space at the time was through the DRB and NORAD, Canadian politicians mistakenly perceived WMD, ABM, and space as intimately intertwined. After a brief initial commitment to developing military space, in 1963 Canada joined others in signing the United Nations Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space, and Under Water. It was the first in a series of

political decisions that would ultimately strip the Department of National Defence of it space capability altogether. Ironically, while Canada surgically removed itself from the military dimension of space cooperation with the United States, it actively though less publicly endorsed all other NATO and NORAD strategy that depended on military space capability. Ottawa and the Liberal government felt it could score public opinion points by denouncing the placing of military hardware in space, when outside of the public eye it continued to pursue cooperative military space programs with the United States. The dichotomy of effort was confusing, and one could argue that Ottawa simply did more damage than good to its space program in attempting to appear as opponents of the militarization of space, when in reality it was pursuing several cooperative ventures with its American allies.

Even though the potential threat of a Soviet attack, especially after the launch of *Sputnik*, was taken seriously by Canada, it was felt that eventually North America would be indefensible against Soviet nuclear weapons. The Americans, having realized this, advanced a new strategic environment in the mid-1960s. Instead of attempting to defend North America, it advocated that it would pursue the capability of mutual assured destruction (MAD) should the Soviets launch a nuclear strike against North America.[31] MAD was based on the calculation that American strategic forces could absorb a Soviet first strike and still impose such levels of destruction on the Soviet Union as to constitute unacceptable damage, thus deterring the attacker from initiating the exchange. The concept of MAD left little or no room for continental defence, since it was essentially based on a mutual vulnerability as a basis for stability.[32] The Americans sought to tip the strategic balance of power in their favour through the employment of non-weapon

military and civilian space assets. Since Canada was only involved in the NORAD aspect of American space-related defence, its exposure to other US military space development during the 1960s was very limited.

In 1967 by Canada's endorsement of the United Nations Outer Space (UNOS) Treaty further distanced itself from the military space arena. The UNOS treaty was an agreement by the signatories to place limits on a state's use of space. Among other limitations, it prohibited military installations in orbit or on other celestial bodies, and it prohibited the placing of WMD in orbit or on other celestial bodies. Ottawa interpreted this foreign policy decision *verbatim*, and moved to rid its space program of not only any WMD potential, but also any military connection whatsoever. It was a poorly meditated decision that led to the disunity of Canada's space efforts and the demise of space power in Canada as a strategic asset.

DEMILITARIZATION AND DISUNITY (1969-1985)

In the two decades following the launch of *Alouette 1* Canada underwent a slow decline as a world space power, as it turned away from military supported development towards a completely civilianized and commercialized space policy. Scientific satellite programs were ended, indigenous launch capabilities were shelved, and communications priorities were replaced by new international space endeavours. Under the Liberal government of Pierre Trudeau, all military sponsored projects of the previous period were terminated, the Defence Research Board was abolished, and the military was deprived of the funds it needed to carry out any significant space projects. In its place, as analyst John Kirton described, "a languishing, commercially-oriented, internationally-dependent,

civilian enterprise" was formed.[33] The result of this new tangent in Canada's space policy not only proved disastrous for the DND's space assets development, but it also caused serious problems in many adjacent areas of security and defence.

The previous decade of space achievement in Canada and its cooperation with the United States had primed the country for the potential of developing a prominent civil-military space capability. However, most of its developments with the Americans took place in an ad hoc fashion without clear policy direction, and developments in Canadian foreign and security policy was turning Canada away from a militarized role in outer space. Ottawa felt a clear position was required if Canada was to continue investing millions, and in some cases billions, of dollars in space related activities.[34] In 1966 a team was assembled to conduct a comprehensive analysis and appreciation of Canada's space capability, and the results were tabled in a document delivered to the Canadian government by the Science Council of Canada (SCC) in May 1967.[35]

Dr. John Herbert Chapman had served in the Royal Canadian Air Force in the Second World War prior to joining the Canadian Defence Research Telecommunications Establishment in 1949. Having completed a doctorate in physics at McGill University in 1951, he rose quickly through the ranks of the organization becoming the deputy director general in 1959.[36] At the request of the Science Secretariat of the SCC in 1966, Dr. Chapman co-authored the document "Upper Atmosphere and Space Programs in Canada". This document (known as the Chapman Report in government) was the first to undertake a comprehensive study of Canada's space requirements. It outlined not only the state of the Canadian space program but also offered a decisive direction for government, university, and industry programs. The report also discussed international

relationships and the necessity for properly defining Canada's independence in space exploitation. The report recommended the creation of an agency similar to the National Aeronautics and Space Administration (NASA) in the United States to coordinate all Canadian space activities. However, as comprehensive and revealing the report was, the Trudeau government chose to ignore the majority of the recommendations of both the report and its Liberal predecessors, and began systematically to dissolve Canada's standing among the space faring nations.

In 1968 Canada took the first step in a series of decisions that quickly dissolved its military space capability. In determining national priorities, difficult choices were made to allocate the majority of the space budget to commercial ventures rather than military space assets. In keeping with the general principles of a non-militarized space, Canada chose to concentrate almost solely on communications satellite assets while isolating DND from space altogether. A sharp debate broke out over the contracting of a new satellite communications plan in March 1968 that gave the contracts to civilian private interests, and the outcome had a serious impact on the future role of DND in Canadian space development. The decision to isolate the military was no doubt influenced by the publication of a white paper on domestic satellite communications systems.[37] Written by C. M. (Bud) Drury, the Canadian Treasury Board president, the report simply did not cover the question of industry support and construction capability when addressing the issue of domestic satellite communications. This overlooked factor became a serious problem when the government chose to go ahead with the Anik/Telesat satellites.[38] Though the Canadian space industries had the ability to design and build the satellites, they lacked the capability to support their operation and maintenance costs.

Since Canada had almost ceased its investment in indigenous space support capability by 1968, the only solution was to rely on external assistance from the United States.

Those indigenous space programs that did proceed in Canada after 1968 were not designed with the intention of contributing to collective security but rather to meet more pressing national priorities. The Anik/Telesat satellites formed Canada and the world's first domestic communications system. Three Anik A satellites were launched between 1972 and 1975 followed up by a single Anik B satellite in 1978.[39] The Anik series of satellites represented a major investment in space by Canada, however it was a purely civilian effort headed by private industry. While this helped to develop space capability in Canada as a whole, Anik was never intended for dual civil-military use in any way and it did little to encourage bilateral space defence cooperation with the United States.

In the immediate aftermath of the first lunar landing, Canadian-American space cooperation was increasingly limited as the foreign policies of the two countries moved in opposite directions. While Canada continued to support American containment and deterrence policies there was increasing strain between the two countries in many areas of defence policy. There were similar rifts in space policy. While United States President Richard M. Nixon's Space Task Group (STG) was streamlining American military space programs, the Trudeau government was ensuring that DND was removed from space activity altogether. While the United States planned new space programs within the context of the threat, economic constraints, and national security, Canada planned its space programs in the context of industry, economic parity, and national interest. The distinct nature of each approach highlights the difference of priorities for space development between the two countries.

The Canadian government shifted its funding in 1970 from the ISIS communications science satellite cluster over to the new Department of Communications' Communications Research Center (CRC). This effectively ended the Canadian-American project in favour of pursuing an indigenous civilian venture. The CRC was then tasked to provide its own Communications Technology Satellites (the *Anik* Series). This commercial domestic communications satellite series became the exclusive focus of Canada's satellite development activity for the first half of the decade. With this project Canada increased its international dependence by involving the European Space Research Organization and requiring the Americans to provide not only the launch facilities but some of the critical electronic components as well. Dr. Solandt, then chairman of the Science Council of Canada, called the whole scheme, "complete madness".[40] Nevertheless the Federal government backed the decision to award manufacture contracts to an American company. Once more Canada forfeited the opportunity to lead a space project in favour of adopting a subservient role to American development. Though technically cooperation, again these joint ventures did not translate into a larger defence cooperation between Canada and the United States.

Though the confusion in Canadian space development was allowed to carry on, it did not do so completely unnoticed. Concerns raised in Parliament in 1974 on the state of affairs in space development, and later complaints from Canadian industry, caused the government to task the recently formed Interdepartmental Committee on Space (ICS) to define a comprehensive space policy. A working group under Mr. J. R. Whitehead from the Ministry of State for Science and Technology was formed. Their aim was to identify key problems Canadian space development and recommend solutions, define potential

applications and uses of satellites, determine what the industrial impact of space was going to be, and finally recommend government policy for future systems. Though the ICS acted as a coordinator of space policy, the committee did not have direct access to the government nor the power to direct on its own. This lack of authority to direct government activity in departments weakened the ability of the committee to influence policy in any way at all. Therefore the ICS did little to repair the institutional fragmentation of the national space program following the DRB's demise.[41]

What was needed was solid public policy decision-making. Canada had to identify its objectives, then determine the policy alternatives available to accomplish these objectives while accounting for the resources required in pursuing each alternative. The Drury Paper, for example, failed to do this. Accurate decisions taking into account both the cost and risk were not made, and as such Drury failed to maximize the outcome of his communications satellite plan. Other organizations attempting to develop space policy, such as the ICS, suffered similar problems, leading to a general demise of the Canadian program as a whole.

Canada undertook no major national satellite projects outside of communications (mentioned above) during the 1970s, developed no generic launch capability, and disallowed any military effort to explore areas where the immediate commercial benefits were not identifiable. Canada's space effort was confined to highly selective and specialized, mostly ground-based niches. In 1971 (and renewed in 1975) Canada reached an agreement with the USA to receive limited terrestrial data from American spacecraft in return for a Canadian contribution of equipment and research. Such an agreement had to be made as Canada had no independent space means of securing data about its own

country, let alone the rest of the world. The entrance of the USSR, France and Japan into space-based remote earth sensing, "ensured that these military and economic competitors of Canada also routinely had access to data about Canadian territory that Canada itself almost always lacked."[42] The new Ministry of State for Science and Technology lacked influential ministers, operational programs, and secure funding to develop such programs. The new Department of Communications (DOC) forced space programs to compete with terrestrial alternatives and ensured that what few space projects did remain, focused mainly on communications technology an nothing else. The Department of Energy, Mines, and Resources (EMR) struggled to broaden the horizons of space assets to include remote earth sensing, but had limited success. The demise of the national military and scientific satellite program forced Canada to rely on external sources for meteorological data, remote earth sensing, international communications, aircraft navigation, and even maritime navigation.[43] Also the lack of any such programs in operation weakened the case for establishing an indigenous launching facility, ensuring that Canada would continue its reliance of foreign services for its own civilian and military space program. It seemed that all Canadian success in space depended on the cooperation of other more capable space powers.

Canada's first civil-military space project since the ISIS series was initiated in 1979, when it entered into an agreement with the United States and France to design and launch SARSAT (Search and Rescue Satellite). The role of SARSAT was to simplify the means by which emergency locator transmitters (ELT) were pinpointed through the use of satellite technology. The SARSAT concept involved placing a satellite in a polar orbit at 850-1000km altitude with a receiver tuned to the international distress frequency to

intercept ELT signals and relay them back to Earth, pinpointing the location of the signal.[44] In 1980 the Soviet Union joined the SARSAT program which then became known as COSPAS-SARSAT, and launched the program's first satellite in 1982.[45] The initial unit consisted of a Soviet navigation satellite fitted with an ELT signal repeater device that was capable of covering the entire Earth's surface twice a day. Canada designed and built the local user terminals that received and retransmitted SARSAT signals, and headed the SARSAT mission control center located at CFB Trenton.

In 1984 a second SARSAT was launched from Vandenberg AFB, California, attached to a United States National Oceanic and Atmospheric Administration (NOAA) meteorological satellite using a retired Atlas ICBM as the launch vehicle.[46] Though piggybacking the SARSAT to other satellites helped get the project underway, Canada soon felt that SARSAT would only be truly successful if it was not tied to American satellites and launching schedules. Mr. Rod Hafer, who was the SARSAT project manager at Defence Research Establishment Ottawa (DREO) in 1984, commented that, "We have to launch our SARSATs on the NOAA schedule and this doesn't always conform to our schedules. It can mean that we can't always get our satellites up when we want to. This means we wouldn't get maximum value out of the SARSAT system."[47] Though SARSAT was a joint venture, it was clear that Canada wanted more independence from the United States in the conduct of the SARSAT mission. The contradictory nature of such attitudes within the Canadian government was detrimental to the Canadian-American space cooperation relationship, and unfortunate given the obvious civil-military nature of the SARSAT mission.

Though many of these civilian and commercial endeavours appeared to be successful they were in fact living off the capital of past military space investments. However, the ability of civilian companies to monopolize the space industry solely for commercial use eroded political and public support for funding military space projects of any sort. With the disbanding of the DRB the Canadian space program was left as a wanton child, without any well-established, well-supported, and focused organization in government to direct it development. Programs and initiatives were sporadic and unconnected, presenting a miserable shadow of what was once an impressive national space program. Without the support of the Chief of Defence Staff and the Canadian Forces, very little in the way of military space policy was developed. Likely this was due to the fact that there was little need for such a policy in the military anyway. As the Canadian Forces (CF) faced tighter defence budgets, it could afford to invest little in big-ticket items like space assets. What interest that remained in DND was centered around the DRB's successor, the Chief Research and Development (CRAD) branch and in particular it Director of Communications and Space. In 1974, along with the Defence Management Committee, the CRAD Branch reiterated the need for a serious interest in military space, but it was some time before their words were transformed into action.

It is difficult to comprehend the bias against military space activity in Canada during this period. Technology, strategic policy, or even defence policy did not drive the anti-sentiment feeling towards military space. In fact, the top priorities in Canada's 1971 Defence White Paper – Canadian sovereignty and North American security could easily have been facilitated by the employment of military space-based resources.[48] Canada's expanded claims to Arctic jurisdiction in 1970, for example, could have been more

successful if the country had some way of keeping surveillance on its northern territory. Even if Canada lacked the physical means on the ground to arbitrate passage in the north, it could still have the information to seek justice by other means. Space-based assets could, have cheaply and effectively assisted other Canadian concerns such as peacekeeping missions and weapon disarmament verification.

The decision to ignore blatantly the potential of space assets in attaining security and defence aims remains something of an enigma, though one could easily attribute the poor policy making in this area to the practices of the Trudeau government. As Arthur Kroeger pointed out in his retrospective on Canada, he noted that, "the various ways in which policy has been developed and decisions made in any particular period has depended, to an extraordinary degree, on who was the head of government".[49] Under the Trudeau government there was a concerted effort to adapt systematic approaches to government decision-making, by increasing the role of the Privy Council Office (PCO) in all matters. This "collective decision-making"[50] occupied much of the minister's time and left them with less time to manage their own departments. No doubt those responsible for space policy were affected. If the centralization, which to some degree was necessary, had been less cumbersome there could have been a greater chance for development in a positive direction for both space and DND. Given that all decisions made were based on prioritizing all competing demands through this centralized process the reality of the matter was that space and space defence needs met with little success compared to other national interests.

The Department of Finance also played a central role in the development of all government policy, including space policy. Regardless of whatever party platforms were

raised, whatever speeches were made, and ministerial resolutions passed, the Minister of Finance had an incredible amount of influence on what did and did not come to fruition. In the early period of post-war Canada, the government was operating at a surplus, and combined with a very mobilized armed force, was able to implement several military space projects. As Canada continuously receded from its military commitments throughout the 1960s and 1970s, mostly due to budgetary constraints, military space assets were inevitably effected. Combined with an apparent lack of desire by the Trudeau government to include the CF in the development of space, Canada's position in space security was sent to an early death.

In 1981 NORAD reemerged as an influential part of Canada-U.S. space defence cooperation. Almost from the outset, NORAD's activities had been transformed from the direct defence of North America from the Soviet bomber threat to the surveillance and early warning of bomber and missile threats. Additionally, NORAD had adopted increasing roles in the detection, tracking, and monitoring of space activities. In 1981, NORAD was renamed from 'air' to 'aerospace' to reflect these trends.[51] Other aspects of NORAD were also clearly demonstrating the evolving dichotomy between Canadian and American space capability. By the 1980s Canadian territory was no longer important for missile and space surveillance functions, and no American Ballistic Missile Early Warning System (BMEWS) radars were built in Canada. As analyst Joel J. Sokolsky noted, "Given that only about eleven percent of Soviet warheads were carried by their bomber force, the shift seemed reasonable."[52] NORAD's space functions were almost exclusively the responsibility of the evolving United States Space Command, while Canada's limited roles in this area were being phased out.[53] With the changing nature of

NORAD the last remnants of the Canadian-American space defence partnership were all but gone. NORAD was the outlet Canada had to know what American space assets were providing.

Upon taking office in 1980, Ronald Reagan and his Republican administration immediately made strategic defence a high priority. Within months the US began a serious overhaul of its military forces by initiating a series of new projects, including several new space programs. The most influential of these programs was the American Strategic Defence Initiative (SDI), a complex and comprehensive space-based weapons platform project designed to protect North America and other American interests from Soviet nuclear ballistic missile attack. The SDI was an ambitious initiative and its actual construction very unlikely, but the United States forged ahead with examining how SDI could become a feasible ballistic missile defence system. In addition to analyzing their own force capability, the Americans quickly realized that Canada's early warning capability would also require upgrading, if the umbrella over the continent were to be complete. At the time Canada was still against the deployment of BMD in Canada, even though the 1981 renewal had omitted the ABM clause from the agreement. The Right Honourable Joe Clark, then Secretary of State for External Affairs explained the removal of the clause was done, "precisely to avoid any suggestion that either Canada or the United States might take actions [that] would breach the ABM Treaty."[54] Others suggested that having no clause would not foreclose any options. As the SDI project progressed it captured an incredible amount of media attention, causing it to become popularized as "star wars" due to the conceptualization of the system as huge space stations armed with planet-killing lasers as seen in the famous science fiction film of the

same name. The concept generated a general public concern in Canada that through its collective defence arrangements with the United States it may too become involved in the potential deployment of weapons in space. Throughout its post-war history Canada had opposed involvement in both American BMD programs, violations of the ABM treaty, and the placing of weapons in space. The SDI project suggested the implementation of both these things causing a great deal of concern in Ottawa when it appeared that NORAD would be involved in some way.

The election of a new progressive conservative government in Canada in 1984 caused an abrupt halt of the swinging pendulum in Canada's declining national space program. The previous year Canada had concluded its first astronaut selection, choosing seven members to participate in upcoming missions of the Space Transportation System (STS, commonly known as the space shuttle). The first of these astronauts to fly was Marc Garneau, a Canadian naval officer. A Canadian company, SPAR Aerospace, also delivered additional Remote Manipulator Systems (RMS or Canadarm) for the growing NASA space shuttle fleet.[55] When the Conservatives came to power, evolving Canadian space industry was further encouraged through indigenous and cooperative arrangements with other countries.

In efforts to further strengthen Canadian-USA relations Prime Minister Brian Mulroney initiated a series of national space projects, which were confirmed during his first meeting with US President Ronald Reagan. These initiates were reinforced by voices raised in two government committees in 1985 calling for a renewed military space program in Canada.[56] The Senate Special Committee on National Defence hearings on air defence recommended the establishment of a solid military space program to

concentrate on early warning, surveillance, and communication tasks necessary to the protection of national security. The committee therefore concluded that DND would require eight to twelve satellites at least, and should have been allocated at least $150 million per year for five years to build and launch them.[57] Beginning in 1990 the annual allotment would have to be raised to $350 million. The government response to these recommendations, however, was slow and only slightly positive at first.

Prime Minister Mulroney also promised to the USA in 1985 that Canada would proceed with earlier plans to construct a new chain of early warning radar stations, the North Warning System (NWS), across Canada's arctic to replace the aging DEW line.[58] Given that neither Canada nor the United States had yet space based radar technology, Canada restrained its military space commitment to the ground segment only rather than taking the opportunity to advance its space support and control capabilities. However, it did convince the American government to contribute sixty percent of the funds required to update Canada's air defence infrastructure. One could argue that NORAD was providing Canada with the opportunity to meet the other recommendations of the Senate Special Committee on air defence, but realistically without its own space assets or launch and control facilities Canada was unable to produce the nucleus required for a truly space capable state. Avoiding and rejecting offers by the United States to become involved in space defence, as in the case with SDI and other related projects, only further agitated the American attitude to plan for the space future without Canadian involvement. Where the threat of sovereignty protection had often driven Canada to become involved in bilateral defence arrangements with the United States in the past, it appeared that with space defence Ottawa was content to be left out of any consideration whatsoever. By ignoring

American offers of space defence cooperation Canada was ensuring that the United States would be less likely to respect the Canadian sovereignty from space it so loudly demanded.

The 1986 NORAD renewal debate was particularly difficult due to the potential ramifications of the SDI on Canada's continued participation in the bilateral defence of North America. The United States had interpreted that article V of the ABM Treaty, signed between the Soviet Union and the United States on October 3rd, 1972, limited all SDI work to research, lab work, and tests of sub-components.[59] This limited the primary debate in the United States to what constituted a component or sub-component and what constituted research and development and employment of dual-use technologies.[60] When the United States invited the Canadian government to participate in the SDI in 1985, the debate for Canadian involvement revolved around the same issues. A special joint committee was assembled and convened in Ottawa in July 1985 to hear evidence for and against the invitation, even though the Conservative government had announced in January that it would support the research and development phase of SDI.

The SDI invitation was a particularly difficult crossroads in Canadian-American space defence cooperation for it exposed how unprepared DND was to deal with space issues and national security. The SDI's magnitude and potential implications for the bilateral defence relationship was overwhelming to the Canadian government, who since Trudeau came to power had given little serious attention to Canadian security policy.[61] Regardless of whatever outcome resulted from the Canadian decision to participate in or opt out of SDI, it was clear that the Canadian government lacked any mechanism to seriously deal with space security issues. As a result, the Minister of Defence and the

Chief of Defence Staff tabled and approved NDHQ Evaluation Directive E3/86, which led to a study Canada's future military space requirements.[62]

CONCLUSION

Though on the surface it would appear that Canada blatantly missed the opportunity to become a cooperative space power, there are many factors that must be considered in evaluating its demise between 1969 and 1985. Canada was still very much a state with an isolated population in the post-war years with many infrastructure needs, and one must sympathize with the government in its dilemma of choosing national priorities. There can be no doubt the development of communications was crucial to connecting the country from coast to coast, and that satellites offered the possibility of achieving this goal. With limited funding available for the development of space power, civilian domestic requirements were deemed more beneficial to Canada than military space assets or cooperative projects with the Americans. Also in the case of Canada, foreign policy and security policy was evolving in parallel directions, so that when defence as a priority within the government declined, so too did the desire for investing huge amounts of defence dollars in militarizing space. Unfortunately as defence spending declined in Canada, global security issues involving space evolved. The United States successfully landed men on the moon, and was rapidly developing and deploying non-weapon military space assets to counter similar Soviet efforts. Also, new players entered the race as other nations were also evolving their own indigenous space programs. Canada by contrast was lagging well behind compared to the growing programs in China, India, Israel, France, and Japan. Though it did not exclude

cooperative arrangements with the United States outright, by the mid-1980s Canadian space capability was minor in comparison to its so-called American partners.

The 1971 Canadian White Paper on Defence has often been assessed as an excuse for not spending on defence rather than being a blueprint for defence. The document clearly demonstrated that the Trudeau government chose to let defence be driven by domestic needs rather than NATO requirements, and as such the 1971 White Paper listed national sovereignty as the top defence priority over the traditional commitment to NATO. Ironically, the 1971 White Paper provided a good justification for the development of space assets without being costly over the long term. Though it fundamentally agreed with containment and deterrence, the Trudeau government was not interested in spending on military space however, and that was a missed opportunity. Space assets had the capability of meeting both domestic security requirements and foreign policy objectives, but unfortunately Canada chose not to pursue its space option unless it increased its trade links with Europe. As the most military space development took place in the United States, the Trudeau government had foregone this option in favour of products supplied by their European allies.[63]

A nation's capacity to establish its own space strategy, to deploy its own space assets, and manufacture its own space technology has often been gauged as an indicator of the degree of its sovereignty. In the early 1980s Canada was not making its own space strategy even though DND and the government were capable of doing this. It had only limited control over the deployment of its space assets, having to rely entirely on American launching schedules and tasking priorities for windows of opportunity. Nor was Canada capable of manufacturing complete space assets without the importation of

various key components. Such space dependency was the product of an advanced state of integration with the United States in terms of continental defence and defence production sharing agreements.[64]

The renewal of the 1981 NORAD agreement and the creation of the United States Space Command in 1985 demonstrated a further diminishment in Canada's role as a space partner with the United States. The Canadian government reaffirmed its role in bilateral defence, and though it concluded publicly that all was well, it quietly ignored that Canada had become entirely dependent on its American ally for space-based security. When the NORAD renewal question reemerged in 1985 at the time of SDI, there was the possibility that Canada's role in cooperative space defence would disappear altogether.[65]

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[1] The first satellite into orbit was launched by the Soviet Union, followed a few months later by the United States of America.
[2] The American deterrence strategy developed in the 1960s was known as mutually assured destruction, or MAD.
[3] Dewitt and Kirton, J. *Canada as a Principle Power.* (Toronto, 1983), p.322.
[4] Ibid, p.322.
[5] Spencer, Robert A. *Canada in World Affairs, 1946-1949.* (Toronto, 1959), p.291, cited from Hart, John E. *Canada and North American Defence, 1940-1965.* (n.p. MA 1967), p.21.
[6] Canada, Government of. *NORAD 1986: Report of the Standing Committee on External Affairs and National Defence.* (Ottawa, February 1986), p.4.
[7] Sokolsky and Haglund Ed. *The U.S.-Canada Security Relationship: The Politics, Strategy, and Technology of Defence.*
[8] The idea was to detect disturbances in the ionosphere as aircraft passed through it. The system was far from perfect, and to this day the USA is still working to develop an effective space-based radar system that could effectively detect and track aircraft and air-launched cruise missiles (ALCMs).
[9] During the 1950s the Canadian air defence element consisted of nine squadrons of CF-100 interceptors (approximately 160 aircraft). The Americans could deploy 75 interceptor squadrons (2100 aircraft) and 82 battalions of *Nike* surface-to-air (SAM) missiles (278 firing units).
[10] The bases were CFB Bagotville, CFB North Bay, CFB Ottawa, CFB St. Hubert, and CFB Comox.
[11] The MCL was built and financed solely by Canada.
[12] Canada. *NORAD 1986,* p.4.
[13] Lindsey, G. R. *The Strategic Defence of North America.* (Toronto, 1986), p.15.
[14] Chapman, J. H. *Upper Atmosphere and Space Programs in Canada.* (Ottawa, 1967), p.22.
[15] Ibid. p.23.
[16] Ibid. pp.56-57. The Black Brant rocket series was continuously updated and is still used today. See later in this study for other details.
[17] Canada. *NORAD 1986,* p.17.

[18] The NORAD agreement was signed without parliamentary approval by Canadian Prime Minister John Diefenbaker. Ironically, he broke the twenty-one year Liberal party rule of his country by playing up the Anti-America sentiment in Canada during the 1957 election campaign. He was sworn into office on June 21st, 1957, and signed the NORAD agreement five weeks later.
[19] NORAD could not stop missiles from hitting North American targets but it could provide early warning against an attack thus giving the Americans the opportunity to respond.
[20] The satellite, *Sputnik 2*, carried a Russian dog named *Laika* into orbit and returned her safely to Earth. For notes on early Soviet space activity see Johnson, , J. L. *Soviet Military Strategy in Space*, (London, 1987).
[21]Two decades later, in the age of modern information technology-based military operations, such dependence invites a precarious position of military weakness. Further still, this capitulation of capability only serves to support opinion that Canadian Forces should not become involved in their primary role, war fighting.
[22] These instruments were capable of detecting and tracking deep space objects (out to approximately 40,000 km or synchronous altitude). Most military payloads require a higher orbit in order to fulfil their desired roles.
[23] The fading of received radio signals.
[24] The letter agreement dated August 25th, 1959, was initiated by Dr. A. H. Zimmerman, Chairman of the DRB and sent to Dr. T. Keith Glennan, Administrator of NASA. Reproduced in the Chapman Report, 1967.
[25] ISIS-C was never launched.
[26] Dewitt and Kirton, *Canada as a Principle Power*, p.325.
[27] Jockel, J. T. Ed. *Fifty Years of Canadian-American Defence Cooperation*. p.259.
[28] Dewitt and Kirton, *Canada as a Principle Power*, p.325. The Black Brant series rockets have been extremely successful, evolving into five different versions capable of lifting 70-850kg of payload to 150-1500km in orbit. This rocket is still in service today.
[29] "Canada and Outer Space". *External Affairs*. (June 1959), p.115.
[30] Kirton, J. "A Renewed Opportunity: The Role of Space in Canadian Security Policy", *Canada's International Security Policy*. (Scarborough, 1995)., pp.113-114.
[31] The Mutual Assured Destruction doctrine was propounded by American secretary of defence, Robert McNamara. Studies showed that even with a capable air interceptor force, a dedicated Soviet attack on the United States could still cause 90-120 million casualties. McNamara realised that trying to defend all American population centers was both expensive and ineffective. He found an alternative with MAD.
[32] Cox, David. *Trends in Continental Defence: A Canadian Perspective*. (Ottawa, 1986), p.8. For McNamara's analysis, see "Recommended FY 1966-70 Programs for Strategic Offensive Forces, Continental Air and Missile Defence Forces, and Civil Defence", Memorandum to the President, 3 December 1964.
[33] Kirton, J. *A Renewed Opportunity*, p.115.
[34] Spruston, Lcol T. A. *Science and Politics: The Evolution of Canadian Space Policy*. (n.p. MA, RMC 1976), p.37.
[35] The actual document is titled, *Upper Atmosphere and Space Programs in Canada: Special Study No.1*. Ottawa: Queen's Printer 1967. It was co-authored by Chapman, P.A. Forsyth, P.A. Lapp, and G.N. Patterson.
[36] From *Who's Who in Canada, 1967*.
[37] Drury, C. M. *A White Paper on a Domestic Satellite Communications System for Canada*. (Ottawa, 28 March 1968).
[38] See later in this study for details.
[39] The Anik B satellite was the world's first dual-band satellite.
[40] Baxter, Clive. "Emotions Satellite High Over Who Builds Telesat", *Financial Post*. (11 July, 1970), p. 8.
[41] Spruston. *Science and Politics*, pp. 97-103.
[42] Kirton, J. *A Renewed Opportunity*, p.116.
[43] In 1976 Canada abandoned what remained of its national scientific satellite program in favour of developing the Remote Manipulator System (RMS or Canadarm), as a adjunct of the American Space Transportation System (STS or space shuttle).

[44] The international distress frequency is 121.5 MHz. See Macpherson, Lt. A. B. "The COSPAS/SARSAT Program: An Example of Successful International Cooperation", *Canadian Defence Quarterly*, (Autumn, 1984), p.40.
[45] The first satellite was designated *Cosmos 1383*.
[46] Macpherson, *The COSPAS/SARSAT Program*, p.41.
[47] Ibid. p.41.
[48] Kirton, J. *A Renewed Opportunity*, p.117.
[49] Kroeger, A. "A Retrospective on Policy Development in Ottawa". *Canadian Public Administration*, Vol.39, No.4 (winter), p.459.
[50] Ibid, p.457.
[51] Sokolsky, J. *Defending Canada: U.S.-Canadian Defense Policies*. (New York, 1989), p.7.
[52] Ibid. p.7.
[53] The Canadian Baker-Nunn space surveillance cameras were phased out of operation in 1988.
[54] Canada, Government of. *Hansard*, February 4th, 1985, p.1961.
[55] In March 1999 the science division of SPAR Aerospace was sold to an American company and with it the RMS technology that had become an icon of Canada's achievement in space. The CANADARM is Canadian no more.
[56] The first was the Senate Special Committee on National Defence in January 1985, and the second was the House of Commons Standing Committee on External Affairs and National Defence in February 1986.
[57] National Defence. CFSAS. *Space Indoctrination Handbook: 5th Ed.*. (Winnipeg, 1996), p.3-3.
[58] The NWS cost approximately US $1.2 billion.
[59] Article V essentially stated that neither the USA or the USSR could develop, test, or deploy ABM systems or components that are sea-based, space-based, or mobile land-based.
[60] United States. DOD. *Space Handbook—A Warfighter's Guide to Space, Volume 1*. (Maxwell AFB, 1993), p.33.
[61] The general consensus of many Canadian strategic thinkers is that the Liberal government maintained a tradition of defence without strategic analysis. See Byers, Hamre, and Lindsey, *Aerospace Defence: Canada's Future Role?* (CIIA, 1985); and Leyton-Brown, D. and Slack, M. Eds. *The Canadian Strategic Review, 1984*. (CISS, 1985).
[62] The results of the study were incorporated first into the 1987 White Paper on Defence then later a 1987 DND space policy paper. See Chapter 3 for details.
[63] The exception to this was the acquisition of the American F-18 fighter.
[64] Like military capability, space capability is shaped by foreign, security, and defence policy decisions. See Clarkson, S. *Canada and the Reagan Challenge: Crisis in the Canadian-American Relationship*. (Toronto, 1982), pp.245-267.
[65] At the time it should be noted that Canada did have some of its military and civilian personnel employed in the United States Air Force Space Command, outside of normal NORAD responsibilities.

CHAPTER THREE
SITUATIONAL AWARENESS
PRESENT PROBLEMS AND PROMISES AND CANADIAN-AMERICAN SPACE DEFENCE, 1986-1999

"The government is prepared to discuss cooperation in all aspects of the defence of North America. But we will not allow Canada's sovereignty to be compromised. We will be a partner with our allies and not a dependent."
- Canadian Minister of National Defence Perrin Beatty, 1987.

When the Canadian government presented its new comprehensive space program in May 1986, there was practically no mention outside the Department of National Defence of any consideration given towards issues of security and defence.[1] Rather, there was an emphasis on immediate commercial returns rather than long-term activities in space science, defence, or launcher development. All major projects revolved around the success or failure of the American space shuttle and space station programs, of which Prime Minister Brian Mulroney had promised the United States that Canada would take an active role in developing.[2] The space program, it seemed, was still exclusively civilian with no intention to develop, integrate, or even acknowledge military space requirements and potential activities. Such a decision seriously retarded any advancement in Canadian-American space cooperation, at a time when Canada had finally realized the need for indigenous space defence policy and application. During the last decade, Canadian military space development was often sporadic and uncoordinated, but at the same time reasonable and realistic given the obvious fiscal constraints within DND and Industry Canada. Should Canada proceed at its present pace, there is potential and opportunity to re-establish some sense of balance in the Canadian-American space defence partnership.

In June 1987 Canada issued its first white paper on defence in sixteen years. Titled *Challenge and Commitment: A Defence Policy for Canada,* it was the first such document to contain any reference to space as an area of strategic concern. However, the white paper was a seriously flawed document, designed in light of the increased East-West acrimony of the early 1980s, and then made superfluous by the rapidly changing situation of the Gorbachev years.[3] While the Mulroney government could not foresee the abrupt end to the Cold War, it failed to realize the dynamic strategic environment of the late 1980s. Evolving technologies and the rapid fusion of information and military operations created a range of new national security concerns. The global proliferation of space assets posed concerns to Canada's national security interests while its own space capability was still found wanting. Previous recommendations by the United States and DND to improve Canada's space-based defence fell on deaf ears, and as such space defence and space defence cooperation received little attention in the 1987 white paper.[4]

While Canada struggled to get its new national space program underway, disaster struck in the United States that brought all American space efforts to a grinding halt. On January 28, 1986, the American space shuttle *Challenger* exploded only seventy seconds into its flight because of a solid rocket booster (SRB) failure that ruptured the main propellant tank. The shuttle was completely destroyed and all seven astronauts aboard were killed. The space shuttle was carrying a $100 million NASA tracking and data relay system satellite.[5] During the same period the Americans also lost two Titan 34D expendable launch vehicles (ELV) and a Delta 3920 ELV during launches due to technical failures. The effect on the American civilian and military space programs was devastating as virtually all launch capability was crippled. Instead of attaining the

assured access to space that President Ronald Reagan once advocated, the United States was all but shut out of space completely.[6]

The American disaster clearly demonstrated the dangers of amalgamating launch capability. In 1982, President Ronald Reagan's NSDD-42 designated the STS as the primary launch vehicle for the American national security space program. In the hopes that the STS would fly twenty-five flights a year, NASA's goal was to achieve a two flight per month routine that reduced the cost of satellite launches and make the space shuttle a self sustaining venture. Though four shuttles were built and commissioned between 1981 and 1985, NASA was unable to meet its routine due to numerous technical problems and delays.[7] The Department of Defence had been given priority for payload space on all the shuttle launches, but it was unable to deploy its systems on schedule. Since NSDD-42 had directed DOD to make the shuttle its primary launch vehicle, design and production of other ELVs were stopped. When *Challenger* was destroyed, DOD was unable to redirect its payloads to other launch vehicles as production lines had closed and existing ELV stocks were being phased out. The American military was literally denied access to space for two years. In turn Canada was also denied access to space as it had come to rely completely on the United States for launch support.

In the period of Canadian strategic reawakening in the 1980s the military space component for the most part was mysteriously lacking. Canadian military space projects lurked in the shadow of being related to the publicly unpopular American SDI program, and with DND left to its own devices, it chose rather to spend what precious funds it had on terrestrial projects rather than on space assets that could not meet immediate defence requirements. Despite a DND space policy paper later released on July 13th, 1987, co-

authored by Deputy Minister of Defence D.B. Dewar and General P. D. Manson, then the Chief of Defence Staff, the lack of physical developments in the late 1980s failed to enlarge the space consciousness of the Canadian military. Recommendations from the policy report included in the 1987 White Paper did little to encourage DND to explore its space options or cooperate with the United States. Furthermore, the CF remained unimpressed by the actions of the United States to increase its own military space activity and organization especially after the *Challenger* incident, determining that Canada could meet its space defence obligations through other terrestrial means.

In 1989 Canada formalized previous political commitments and officially opened the Canadian Space Agency, its first national space organization. Headquartered in St. Hubert, Quebec, it amalgamated the space activities of the Ministry of State for Science, the Department of Communications, the Department of Energy, Mines and Resources, and the National Research Council. The CSA was made responsible for the management, planning, and policy development of the Canadian space program, including coordination of the space activities of other agencies of the federal government.[8] Among its staff were liaison officers from DND who were responsible for coordinating activities between the CSA and the military. It became evident from the outset that the majority of federal space expenditure (approximately 70%) would be accounted for by the CSA. In 1990 DND had no dedicated military space funding of its own, thus it sought to cooperate with the CSA in any way it could. The result was beneficial for DND, which a few years later would be forming its own space organization.

The new Canadian national space program focused on many non-military projects, including developing national space capability through cooperation with USA

and Western Europe, a Mobile Servicing Center for the International Space Station, and a commercial communications satellite system for mobile users (MSAT). Other projects included remote sensing, space plane development, space station user development, technology development for remote sensing, space science, and a new Canadian astronaut program. Almost all of these programs included American participation at some level, but none of them were dedicated military projects. With the exception of the remote sensing initiative, all of the projects were sub-components of larger American projects. Though this in itself constituted joint ventures, it did not translate into greater military or defence-related cooperation.

More than once Canada was deterred from potential long-range development in an attempt to satisfy immediate domestic needs or contracts that it was invited to participate in. While some of these immediate projects consisted of cooperative ventures with the United States, for the most part the near term goals Canada chose were detrimental to fruitful Canadian-American space cooperation. The overwhelming desire to satisfy short-term commercial goals was especially evident in the MSAT project. MSAT originally began in Canada with DND-sponsored field trials of a NATO program (TACSATCOM) – a military communications system using small light-weight earth terminals. Imperatives of commercialization sent the project to the Department of Communications, which designed a satellite for civilian mobile users that would be integrated with a similar USA satellite system. This decision pulled Canada's projected satellite orbit southward, closer to the USA border and away from areas of Canada's high north where the demand for additional reliable military communications was greatest. Further the entire system became dependent on the US's Federal Communication

Commissions' willingness to allocate particular frequencies for the project, thereby practically subjecting the whole effort to foreign desires and control.[9]

The Canadian government threw out the guidance recommended in the 1987 White Paper on Defence within two years of its publication. Drastic changes in the global political situation made a Cold War defence document all but obsolete, and the renewed opening between the USSR and the USA invited the possibility of a decrease in defence spending. Canada interpreted the end of the Cold War as an opportunity to conserve on defence spending and proceeded to cancel many of its procurement projects. Space-based defence in Canada had a very short life. The considerable costs involved in space assets development combined with the shift in global politics justified the decision to abandon military space development in Canada. To make matters worse, in 1989 the government replayed a ghost of the past when it disbanded the National Defence Headquarters Directorate of Space Doctrine and Operations, right when the Chief of Review Services was finalizing a report arguing to increase military activity in the space field. The Chief of Review Services (CRS) was tasked to complete a comprehensive historical analysis, which he completed and tabled on July 31st, 1989. The resulting recommendations were approved, and implementation began on July 3rd, 1990.[10]

SITUATIONAL AWARENESS (1990-1997)

The dramatic changes in world affairs at the end of the 1980s had a significant effect on the Canadian development of space for security and defence. The end of the Cold War and the short yet dramatic Persian Gulf War of 1990-91, along with other changes in the international environment, reinforced in Canadian government not only

the need for military space assets, but also the need for the security of space itself. After half a decade of struggling with the idea of a military space capability for Canada, the government reevaluated its public position on the peaceful use of outer space to meet a more realistic and increasingly dangerous multi-polar world.

The CRS report tabled in 1989 consisted of a detailed study of the rapid expansion of space activity and the use of space for military purposes by both the allies and potential adversaries. Even though the report was prepared prior to the end of the Cold War, and followed the traditional style of Canadian defence documents by making proposals more appropriate to the immediate past than the future, it adequately assessed Canadian needs in a fragmented and unpredictable world. Canada noted large changes in space activity between 1980 and 1989, and the increasing use of space assets in terrestrial military operations. The CRS report made a number of recommendations on policy, plans, projects, and management structure that were implemented by a newly established Space Defence Working Group (SDWG).[11] The first document produced by the SDWG was a Space Appreciation with the purpose, "to provide an initial CF space development framework from which subsequent policy and program planning activities may be generated."[12]

Just as the Cold War ended the United States had its military space capability fully tested in war. On August 2nd, 1990, Iraqi forces embarked on an invasion of Kuwait, and successfully conquered the tiny state in a single day. American satellites had been monitoring the Iraqi buildup since July 1990, and when it launched its attack across the border into Kuwait, the United States quickly devoted its military space capability to fighting the war. Both Keyhole-11 (KH-11) and Lacrosse satellites were employed

immediately following the attack, monitoring Iraqi movements and intentions and supplying a wealth of intelligence to General Norman C. Schwarzkopf, commander of the United States Central Command (USCENTCOM) and force commander in the impending Gulf War. As the American military buildup continued, more US space assets were brought on line to support and enhance American operations in the Gulf. By the time Operation Desert Shield (the pre-war defensive buildup) turned to Operation Desert Storm (the war to liberate Kuwait) the United States had devoted a significant amount of its space capability to supporting its operations in South West Asia.

Among the nations present in the coalition force formed against Saddam Hussein's Iraqi army was Canada, which contributed a measured force comensurate with its interests to the Gulf operation, and in the process found itself quite unprepared for the necessities of fighting a modern war. The presence of multi-national forces in theatre meant that major enhancements to Command, Control, and Communications (C^3I) were required.[13] Though the navy had experience in dealing with space-related assets of the United States Navy (USN) and NATO maritime forces, Canadian air and land forces were much less familiar with allied space support. In terms of space-related capability Canada was very unprepared to make use of the tools of force enhancement that space offered, and had to upgrade both its ships and aircraft in order to operate with its coalition allies.

All Canadian ships assigned to Operation Friction (Canada's campaign name for its activities in the Gulf War) were equipped with satellite communications (SATCOM) terminals that Canada had procured just prior to the Iraqi invasion. SATCOM was a military satellite communications system that operated within the American naval fleet

satellite communications (USN FLEETSAT) and was capable of handling secure voice and teletype communications. The Canadian SATCOM terminals were then augmented by DAMA (Demand Assigned Multiple Access Satellite Communications) programs, a system that offered the flexibility of multi-channel simultaneous transmissions. In addition to SATCOM and DAMA, a new commercial satellite communications system capable of utilizing INMARSAT (International Maritime [communications] Satellite) was also installed on Canadian ships. INMARSAT was chosen due to its compatibility with an existing ship system, STU III, which was capable of handling secure voice and facsimile communications traffic.[14]

Canadian air and land forces also required upgrades to utilize space support. Canadian Sea King helicopters, antiquated and barely operationally ready, were given a number of quick upgrades ranging from thermal imaging systems to weapons upgrades. Among the many additions was a modern GPS system that enabled the pilots to fly day and night in all weather, thus increasing range capability through increased position accuracy and conservation of fuel. Canadian ground forces personnel were also equipped with GPS and other space-related products, such as imagery intelligence and target acquisition data.[15]

For Canada, the Gulf War highlighted a number of important issues concerning space support in war. Unlike the Russians, who during the Sino-Soviet conflict of 1968-69 were able to launch several task-oriented satellites within a very short period of time, the Americans found themselves incapable of exploiting their launch capability to augment their space assets already on station before the war was over.[16] The processing time of a Titan IV rocket and payload was approximately 270 days, while the Titan II

required 140 days, the Delta rocket seventy to eighty days, and the Atlas rocket sixty to ninety days. This became a serious dilemma when both of the Americans' DMSP satellites malfunctioned. One of the satellites 'died' in September 1990, and could not be replaced until the following April, well after the Gulf War was over.[17]

The American Gulf War experience also enlightened Canada to the US concept of TENCAP (Tactical Exploitation of National Capability). TENCAP was established within the US military in 1977, roughly at same time as the American Lacrosse satellite program was initiated. The purpose of TENCAP was to bring the field commander into the user community of national space assets and products, making available much needed space intelligence at the theatre level.

Canadian space support in Operation Friction was almost entirely American originated or supported. Going to war for real after decades of practicing for it in Western Europe was a shock to the combat service support elements of the Canadian Forces, which simply lacked the necessary materials to adequately deploy a Canadian combined arms expeditionary force in theatre. Among the deficiencies was space support, a capability that Canada not only did not have but also few in its ranks understood. The quick-fix space support delivered for Operation Friction came from American sources, and Canadian Forces depended on the United States completely. Canada carried almost all its communications through American satellites, navigated using American based commercial satellites, and received a good portion of its intelligence data from American space based sources. Given the size of the Canadian force in theatre it was not a huge burden on the United States' space resources, but it was

a burden no less. Once more Canada was reliant on its American partner for space-based defence capability.

However, it was not unreasonable to expect that if Canada were lacking the space support required to successfully carry out its mission, it would be provided by one of its allies, usually the United States. Canadian participation abroad in the 1990s has almost always been at the request of the United Nations or Canada's allies (such as NATO), and often within a coalition force led by the Americans. With the Americans having the largest number of space assets, it was essentially their responsibility to ensure that the force it asked to assist it in the Gulf in 1990-91 was properly supported from above. Canada's force was no exception.

The need for indigenous effort in space-related defence planning in Canada had become paramount. The primary stimulus for a revised space policy in the late 1980s was DND's concern about its access to data from the United States in the NWS follow on system. While the existing NWS ground-based facilities located in Canada guaranteed Canadian access to American generated and controlled data and a similar replacement would also guarantee access, an American satellite-based follow on system did not carry the same guarantee. Such concerns about access to data were heightened by the 1990-1991Gulf War when the United States devoted almost its entire space capability to supporting its own forces in theatre. Other coalition allies, although supported by American space assets, received only the minimum data required to carry out their mission. Any extra space support capability was reserved for American forces.

Between 1991 and 1996 the SDWG implemented the four core items of the CRS report. In 1992 DND tabled its first comprehensive space policy, approved by the

Defence Minister and Chief of Defence Staff in June 1993. This in itself was something of an accomplishment, for the greatest hurdle that Canadian space policy planners faced was justifying the militarized use of space to the Canadian public. The new space policy was based on national sovereignty and security, the establishment of a national defence presence in space, the possession of a national capability to monitor space activities in areas of interest, and the possession of a proper mechanism to develop appropriate policy and resource responses. The new policy was virtually a conceptual revolution in military space thinking in Canada. Fortunately DND chose not to trump up the more apocalyptic threats typical of American propaganda (such as Asian rogue states firing missiles at the continental United States) to sell space defence, instead focusing to a large part on more publicly tangible national interests. Though its largest strategic concern still was guarding against the proliferation of Weapons of Mass Destruction and ballistic missile technologies, no doubt influenced by Canada's role in NORAD, many other more easily legitimized potential threats were offered to justify a military space program.[18] In its 1992 space policy document Canada identified concerns such as economic security; curbing the illegal importation of drugs and refugees, monitoring and ensuring the safety of our fishing zones, search and rescue (SAR), and economic exploitation (i.e. natural resource exploration). All of these areas were closely related to the civil-military sphere, and had a duality of purpose that the Canadian public could accept. Additionally, many of these tasks were a shared responsibility with the United States, providing a simple means for joint operations in these areas.

Using the 1992 policy directive as a base, The SDWG submitted proposals to be included in CF development plans and planning guidance documents, which advocated

the requirement for an indigenous space-based capability.[19] Within three years some of the recommendations were realized as projects. For example, the SDWG initiated the Canadian Military Satellite Communications (CANMILSATCOM) project, and the Joint Space Project (JSP), which included intelligence collection and space surveillance requirements.[20]

In the spring of 1994 Canada began hearings on defence policy through a Special Joint Committee of the House of Commons and the Senate. The hearings were part of an overall review of defence and foreign policy initiated by the newly elected Liberal government. In its publication of an updated defence white paper later that year, the government produced a reduced yet reasonable and realistic defence policy for its armed forces. The issue of space was again present, demonstrating that it had finally become a permanent fixture of Canadian defence policy making. Of the traditional roles of the CF, bilateral military cooperation (primarily through NORAD) remained a major aim. This no doubt pleased the United States which was becoming increasingly concerned about the seriousness of Canada's commitment to cooperative space defence especially after the 1991 NORAD renewal agreement.[21] The intent to share the burden was at least a start. It remained to be seen, however, to what extent Canada would be able to contribute to cooperative space defence activities given that the basis of the 1994 White Paper on Defence was often referred to as "doing less and doing with less".[22]

In 1996 the SDWG implemented the last of the CRS report requirements, management structure. Ironically, this led to the dissolution of the SDWG in December, however replaced by a newly formed Directorate of Space Development (D Space D) in 1997 under the Deputy Chief of Defence Staff (DCDS).[23] That same year the DCDS was

designated as the departmental space advocate. A Canadian military space program was finally established after ten long years and a very tenuous journey through Canadian public bureaucracy.

PRESENT PROBLEMS AND PROMISES (1997-1999)

Though the final establishment of a dedicated Canadian military space organization was achieved autonomously, there was no allusion within NDHQ that it would grow and prosper in isolation from American military space developments. D Space D immediately recognized that its focal point was not to attempt the development of an entirely indigenous military space capability but rather to capitalize on the potential benefits of dedicated cooperation with the United States.[24] The intention was made clear in the vision statement of D Space D's first level three business plans produced in 1997. Given that the organization understood its deficiencies it stated that:

> "In light of the limited resources allocated to space in the CF Long Term Capital Plan, cooperative participation in US programmes is considered a key component in the development of a modest space capability for the CF. Our partnership in NORAD will be leveraged, where practicable, to provide Canada a conduit into US space programmes and ensure an equitable contribution to burden-sharing in the future. An important enabling mechanism will be a Statement of Intent concerning defence space cooperation to be developed between DND and the US Department of Defence (US DoD)."[25]

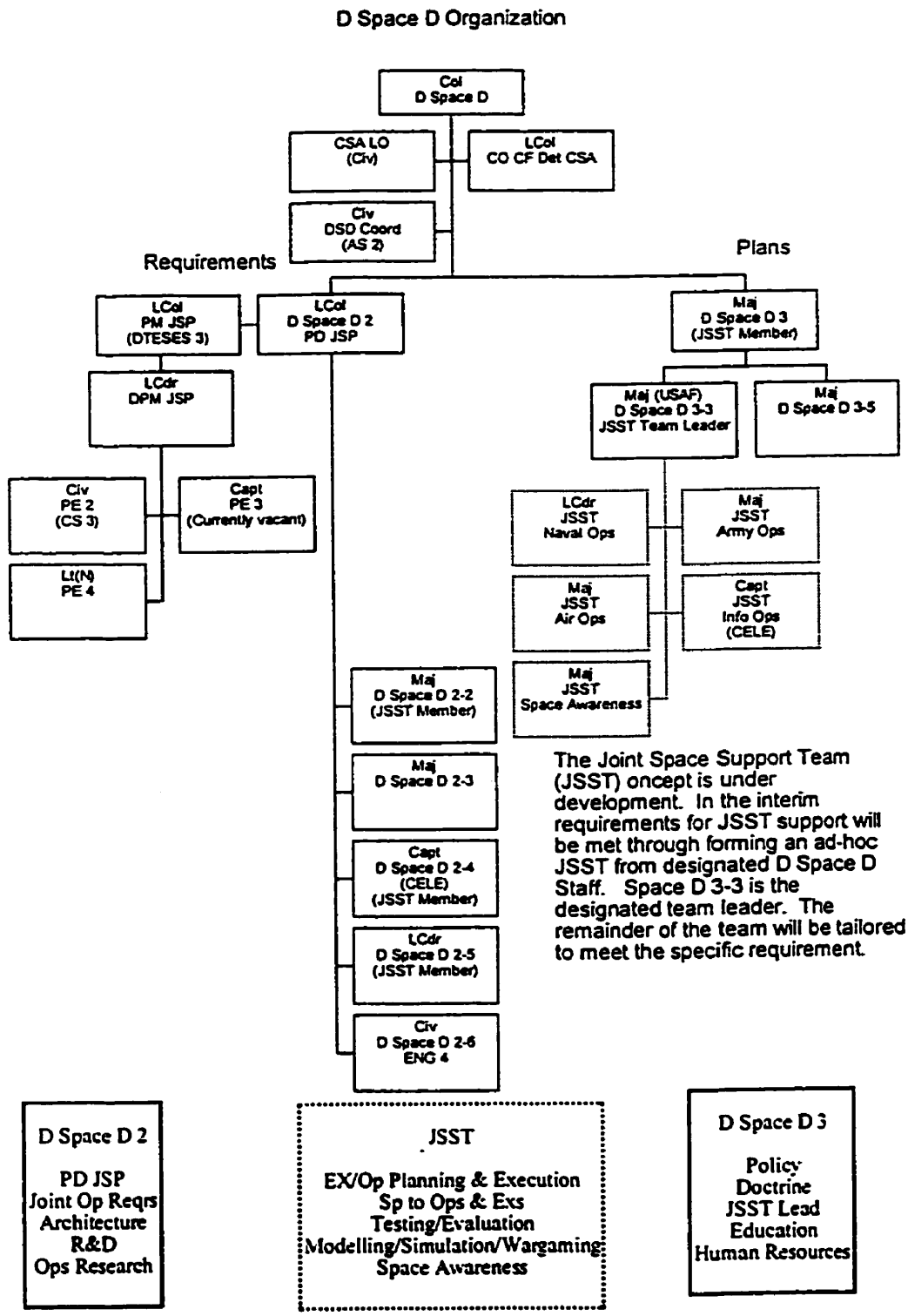
In July 1996 a Space Cooperation Ad Hoc Working Group (SCWG) was formed under the auspices of the CANUS Military Cooperation Committee (MCC) – to identify specific mutually beneficial opportunities for increased bi-national space cooperation. A number of major objectives were initiated by the SCWG including a tentative position on the future cooperation of North American defence. The final report of the group was

presented to the MCC in June 1997. The MCC then agreed to disband the SCWG and transfer oversight of future defence space cooperation to the Permanent Joint Board on Defence. The PJBD pursued several initiatives including a Statement of Intent (SOI) between the US Department of Defense and DND to establish the necessary legal and policy framework within which to harmonize the collaborative space-related defence and security efforts of both countries. In particular D Space D hoped to obtain mutual approval of a Memorandum of Understanding (MOU) concerning space defence cooperation by October 1998. Additionally, Canada sought to develop an Implementing Arrangement (IA) for the surveillance of space by June 1999.

Of the five major initiatives outlined in D Space D's first business plan, four entailed some degree of cooperation with American space programs. Additionally, an USAF officer was brought into the strategy, plans, and coordination section of D Space D to advise on American space doctrine and concepts and to coordinate NORAD issues as well as assist in the implementation of the Joint Space Support Team concept (see figure 3.1).[26] More recently American air force officers were also invited to instruct at the Canadian Forces School of Aerospace Studies (CFSAS), lending an incredible amount of experience and knowledge to the fledgling Canadian space indoctrination courses.

D Space D identified a number of capability requirements, almost all of which required cooperation with the United States Department of Defense. The key capability areas for CF consideration included space-based surveillance; weather monitoring; geomatics (mapping and charting); surveillance of space; warning and defence; navigation; intelligence support; search and rescue; and communications.

FIGURE 3.1


D Space D Organization
Col
D Space D
CSA LO
(Civ)
LCol
CO CF Det CSA
Civ
DSD Coord
(AS 2)
Requirements
Plans
LCol
PM JSP
(DTESES 3)
LCol
D Space D 2
PD JSP
Maj
D Space D 3
(JSST Member)
LCdr
DPM JSP
Maj (USAF)
D Space D 3-3
JSST Team Leader
Maj
D Space D 3-5
Civ
PE 2
(CS 3)
Capt
PE 3
(Currently vacant)
Lt(N)
PE 4
LCdr
JSST
Naval Ops
Maj
JSST
Army Ops
Maj
JSST
Air Ops
Capt
JSST
Info Ops
(CELE)
Maj
JSST
Space Awareness
Maj
D Space D 2-2
(JSST Member)
Maj
D Space D 2-3
Capt
D Space D 2-4
(CELE)
(JSST Member)
LCdr
D Space D 2-5
(JSST Member)
Civ
D Space D 2-6
ENG 4
The Joint Space Support Team (JSST) oncept is under development. In the interim requirements for JSST support will be met through forming an ad-hoc JSST from designated D Space D Staff. Space D 3-3 is the designated team leader. The remainder of the team will be tailored to meet the specific requirement.
D Space D 2
PD JSP
Joint Op Reqrs
Architecture
R&D
Ops Research
JSST
EX/Op Planning & Execution
Sp to Ops & Exs
Testing/Evaluation
Modelling/Simulation/Wargaming
Space Awareness
D Space D 3
Policy
Doctrine
JSST Lead
Education
Human Resources

Surveillance from space capability allowed for a more adequate coverage of Canadian sovereign territory. In particular, surveillance provided near real-time situational awareness in otherwise denied areas, and could alert Canadian Forces to changes in any area of operations whether it is foreign or domestic. Changes in the situation in both Rawanda and the Manitoba floods are but two examples of where near real-time situational awareness was considered mission critical. The goal was to provide real-time tasking of surveillance assets to the CF in support of any operation, and ensure that timely information reached the operators when they needed it and tailored to suit the specific needs of the force and the level of operations. Most importantly the information could not be restricted or slowed due to unnecessary security classifications. To achieve this capability requirement, D Space D initiated an omnibus project known as the Joint Space Project (JSP). Under the JSP, the aim was to provide a comprehensive space capability for DND, by addressing the capability deficiencies that presently exist within DND and the CF. The JSP included environmental observation, surveillance from space, surveillance of space, warning systems, and defence systems. In addition to exploiting the military utility of Canada's RADARSAT satellites, Canada sought to participate in the research and development phase of the American space-based radar (SBR) wide area surveillance project. Estimating that SBR will eventually replace AWACS and JSTARS, Canada has planned to invest in American SBR over the next ten to fifteen years.

A capability in weather monitoring is essential to modern day operations. Under the JSP, D Space D planned to acquire guaranteed sources of global meteorological and oceanographic information derived from commercial, allied, or other government departments' (OGD) remote sensing sources. Again the primary source for the CF was

the US Defence Meteorological Satellite Program (DMSP), through which it obtained most of its data. To ensure the continuation of access to that data, D Space D also sought to negotiate MOUs with the United States that would allow for Canadian Forces abroad to tap into up-to-date American weather sources. By the end of the century, DND hopes to have reached an agreement with DoD for assured access to DMSP classified data.[27] D Space D also planned the same for Geomatics support, thereby ensuring that current data was available for planning and operations. The original maps available to the CF for the Gulf War were over thirty years old, and those obtained for the CF deployment to Burundi-Zaire in 1996 were seriously outdated. In the absence of a dedicated system at the time, DND made use of RADARSAT to confirm the maps and rectify any deficiencies. In the future mapping capability will be developed as a routine part of planning for operations.

The acquisition of surveillance of space capability rested within the ability of D space D through the JSP to become a full partner in the US Space Surveillance Network (SSN). In 1998 the concept was put forth that Canada allow the Americans to either deploy or assist in the Canadian deployment of one or more SSN sensors on Canadian soil. By doing so, Canada would be able to demonstrate its intent to share the burden of such assets, while at the same time ensuring access to SSN data. As a first step, D Space D sought to develop some level of expertise in the area through the posting of CF officers to the Millstone Hill space surveillance radar facility at the Lincoln Laboratories of the Massachusetts Institute of Technology (MIT) near Boston. The Haystack space surveillance high frequency radar housed at Millstone Hill provides high quality accurate satellite surveillance and tracking data products that are currently unavailable through

Canadian systems. Eventually, however, Canada plans to retrofit some of its own existing assets and potentially acquire a new phased array radar system to ensure space surveillance capability in the future.[28] Additionally, Canada would seek to acquire an electro-optical surveillance system based on the American RAVEN technology.

Existing warning and defence capabilities in Canada are lacking to the point that presently the CF has no way of communicating tactical warning information to deployed forces abroad. According to DND's 1998 military space strategy document the preferred approach "is to address this deficiency through the Joint Command and Control Information Systems (JC^2IS) project. A candidate system for connection to the JC^2IS is the US Tactical Information Broadcast System (TIBS)."[29] Other aspects of warning and defence such as that against ICBMs and other WMD, are still controlled through NORAD. DND has conducted research and modelling simulation dealing with specific areas of BMD/NMD interest to DND. Additionally, DND has posted a military officer and a defence scientist to the US Joint National Test Facility where the two members participate in operations research and the development of operational concepts for missile defence.[30] Such participation would seem highly contradictory to the traditional perception of Canadian BMD and TMD abstention. The fact of the matter is, Canada is not only interested in but where politically possible actively pursues collaborative research and development activities with the United States Ballistic Missile Defence Office.[31]

In terms of navigation Canada is a user of the American built Navstar Global Positioning System. Navstar GPS consists of twenty-four fully operational orbiting commercial satellites that provide accurate navigation and positioning data to military

and civilian users. Canada owns no indigenous GPS satellites and thus relies on Navstar for data access. Canada is one of several states that rely on the Navstar constellation for navigation requirements making it unexceptional in this regard.

Other capability requirements, such as search and rescue and communications, are presently being met through joint ventures with the United States. The SARSAT project has been highly successful since its initiation and the CF plans to continue its participation by providing additional repeaters for American NOAA satellites as well as two additional receiving stations on Canadian soil. Meanwhile, Canada has also committed to two joint projects to provide satellite-based communications to the DND and CF abroad. The first project (DSP G1945) aims to gain assured access to the US Military Satellite Communications (MILSATCOM) space segment and to acquire the requisite MILSATCOM terminals and possibly a control segment as well. The second project (DSP M1713) identifies the requirement to fit Canadian ships with a permanent satellite communications capability to ensure future interoperability with USN and other allied ships. Ultimately, the RCN plans to continue using the US Fleet Satellite Communications system, again through cooperation and support from the United States.

Though limited unclassified information is available on intelligence support, one can assume with some confidence that most Canadian space-based intelligence gathering activities include some degree of cooperation with the United States. The present concern over the deployment of RADARSAT II and its follow on, RADARSAT III, has shown an unusual rift in the collaborative efforts of the two countries in intelligence gathering.

The development of the above capabilities also identified the requirement for a nucleus of qualified personnel capable of translating space support from the national level to the war fighter. Again an American method, known as the Joint Space Support Team (JSST) concept was suggested and adopted. Though still in development, eventually D Space D will provide an elemental JSST officer to assist each of the three services. Ultimately the aim is to have a dedicated MOC that will man space support teams in the field.

In essence almost the entire Canadian military space capability development plan is based on active and supportive cooperation from the United States. Such a turnaround in attitude is reflective of both the CF realization of the impact of space support on modern military operations and the advantages to be gained from cooperative military efforts with the Americans. Currently, it would be impossible for D Space D with its very limited funding to undertake any one of the above projects and attempt to adequately develop it independently. The cost of space support programs are simply too great. However, with even with limited funding and no assurance of stability within that funding, by creating and maintaining open communication and cooperation with the United States Canada has once again managed something of a "easy ride" on the back of the American military. Such an approach does have faults however. As space support provides the United States with increased independence from the necessities of gaining access to Canadian airspace and other approaches, the American government can be more rigid in how much of a free ride it wants to permit Canada. Already there are serious concerns within D Space D and DND about the possibility of being denied future access to valuable classified data that was traditionally obtained through American space

systems. Though the United States realizes that it cannot isolate Canada completely, it is quickly learning just how much or how little of its own assets it has to share and still maintain its own space aims and strategy. Once more the issue is cost, and space is still very expensive.

THE ECONOMICS OF SPACE COOPERATION

All defence planning in Canada has been subject to fiscal constraint and space development is no exception. In fact, as this study has already demonstrated, traditionally DND has preferred to invest in the upkeep of its terrestrial assets which are in constant threat of obsolescence rather than assign much needed defence dollars to costly high technology that may or may not increase force projection capability. The plight of D Space D since its inception has been to convince the three armed services that there are advantages to investing in military space, and though the benefits of force enhancement are obvious, they are no less expensive. As such, D Space D has argued that investing in space projects will facilitate access to American space assets which since the end of the Cold War have become increasingly adjunct to Canadian Forces operations abroad. It could be argued that in fact, cooperation with the United States was not simply an opportunity but, rather, a necessity for survival.

Most of D Space D's existing budget is devoted to cooperative ventures with the United States. In the business plan for the 1997-1998 fiscal year D Space D allocated approximately $838,000 of its $1,028,747 budget to joint US-Canadian ventures (see Figure 3.2).[32] These projects included the Joint Space Project (JSP), CANUS cooperation, space strategy development, and human resources. To some degree R&D

and support to CF operations also included American participation. Essentially, all fiscal efforts were being devoted to ensuring that Canada was interested in American capabilities and was making some attempt to share the cost as a demonstration of its good faith.

FIGURE 3.2 ECONOMICS OF COOPERATION IN MAJOR D SPACE D INITIATIVES, 1997-98

PROJECT	COST ($THOUSANDS CDN)	MILITARY PERSON YEARS
JOINT SPACE PROJECT	801.5	6.3
SUPPORT TO CF	108.6	0.3
CANUS COOPERATION	11.1	0.55
SPACE STRATEGY[1]	16.6	1.4
SPACE R&D	?	?
HUMAN RESOURCES	9.6	0.35

Note: (1) Includes consultation with USA on matters relating to BMD and TMD.

Source: DND. D Space D Level 3 Business Plan, 1997-98.

The JSP (designated Defence Services Program [DSP] project G2667) originated as an omnibus project that was designed to consolidate those elements of the 1992 DND Space Appreciation document that were not addressed by other DSP projects. The project originally provided an intelligence collection element as well, however in June 1997 the intelligence collection element was established as a stand-alone project (DSP project G2773), though still consolidated with the JSP for budgeting purposes. The two elements, intelligence collection and surveillance of space, required VOTE 5 funds for implementation within the first five years (1997-2002).[33] The budgeted cost of the intelligence collection element from 1997 to 1999 was $50 million. The surveillance of

space element was budgeted at $150 million for the period 1998-2005. It was proposed that D Space D receive $24 million over the next fiscal year so that it might start both projects, with the opportunity to have an intelligence capability in place within the foreseeable future. Not only did D Space D not receive the $24 million in 1997, it also lost an additional $5 million in VOTE 5 funding due to the cutbacks implemented across the entire DND that year. As such, the Miscellaneous Requirements (MRs) were met out of the existing VOTE 5 project funds (pending the required approval of the Treasury Board), while the remaining procurement projects went onto the shelf.

The environmental observation element also required secure funding commitments, but such allowance was most likely achievable through the MRs of D Space D's and DND's defence budget. The definition and implementation of capital solutions for other elements of the JSP were not currently planned to commence within the next five years due to fiscal constraint, however a cost projection to the year 2011 was made. Theoretically, D Space D wanted to devote $624 million to the JSP between 1997 and 2012.

Though funding committed to supporting CF operations did not automatically suggest American cooperation or involvement many of the existing space related DND projects have had some degree of US influence. Those procurement projects that were approved had a cost far more than the funding that existed for them. As a result the current cash phasing for procurement within DND made no allowance for significant advances in any space projects, and unless that changed it was unlikely that D Space D would be able to meet its aim of providing an adequate space capability for the CF. Those projects that were being considered or approved however, included:

- A2526 – Regional Operational Control Centre Replacement at $87.690M;
- A2542 – Integrated Tactical Warning /Attack Assessment at $3.708M;
- A2371 – Advanced Navigation System at $152.647M;
- A2040 – SARSAT/IOS Project at $64.489M;
- G2471 – High Arctic Data Communication System Mark II at $32.959M;
- M1713 – Fleet Satellite Communication (SATCOM) at $20.304M:
- L2683 – Position Determination for Land Forces Project at $68.665M:
- G1945 – Canadian Military Satellite Communications at $646.223M:
- G2667 – Joint Space Project at $589.688M; and,
- G2773 – Troodos (INT) at $48.056M.

With the exception of the JSP all of these projects are run by one of the three services.[34] Funding for these projects derives from the respective CC with D Space D providing only liaison and assistance as required.

In addition to the above mentioned projects D Space D also sought to establish a $100,000 contingency fund for the purchase of satellite imagery to support Canadian operations abroad. D Space D worked with the Chief of Staff (COS) J3 (operations) to identify the source of the funds and to establish protocols for its use, but in 1997 the funds were denied and allocated elsewhere.

Though most Canadian military space activities are already connected to participation within or cooperation with American space programs, D Space D devoted a further $11,100 in operations and maintenance funding to CANUS cooperation activities

during 1997-98. Most of this was spent on studies related to NMD and BMD cooperation, an area that continues to be politically sensitive in Canada.

D Space D devoted dedicated funding to the development of a long range coherent strategy and plan for achieving CF/DND space goals. During 1997 $16,600 in O&M funds were dedicated to this initiative with the aim of achieving three goals. First, to develop DND space strategy for approval by DCDS by April 1998. Second, to develop an updated Canadian space doctrine for publication by July 1998, and third, to consult with the United States on BMD for North America and participate in development of collaborative BMD research program by March 1999.

Of all the areas financed by D Space D, research and development has suffered the most. Investment in space R&D has declined substantially in recent years despite the obvious benefits to be had from dedicated research. During 1997-98 D Space D through the Space Team of the C^2IS R&D Working Group, developed an R&D Strategy paper, and is working actively with CRAD staff to formulate a space R&D program in support of departmental requirements as reflected in the JSP. CRAD space-related R&D funding in FY 98/99 (Excluding that related to the CANMILSATCOM project) is planned to be approximately $2.3M, and D Space D plans to devote an additional $5,400 in O&M funds to this initiative in FY 98/99. The two primary objectives are first, update the Space Systems R&D Strategy Paper by May 1998, and second, initiate a major Space-Based Surveillance R&D project by May 1998.

As detailed in the CF Space Human Resources Work Plan, management of space qualified personnel requires a more focused approach to ensure the Department benefits from the space expertise developed during postings to NORAD and other space positions.

D Space D devoted $9,600 in O&M funds to this initiative during 1997-98. Its objectives were threefold. First, develop a training and education plan by June 1998. Second, establish joint manning of NORAD space positions during 1998, 1999, and 2000, and third, examine the potential for developing a space career path within the CF by January 1999.

CONCLUSION: THE POLITICS OF SPACE SECURITY

Global trends clearly indicate that access to and freedom of maneuver in space will become an area of heightened political concern in the next decade. The United States has readily accepted that control of outer space will be contested by states and has already implemented strategy to ensure American dominance of space well into the next century. By contrast, Canada has developed a very modest program, with no independent access to and limited freedom of maneuver in space. Ultimately, Canada's space defence capability is dependent on the United States for the present, and unless the government adopts a radical alternate approach, it will continue to be dependent on the United States for some time. Challenges to present military space capability are compounded by the growing commercial space market that invites many more states to compete for space. Canada is faced with both challenges, and has increasingly let the space defence capability wane in favour of keeping its civilian space program competitive. Commercial interests and business, not defence, was considered the national imperative.

Since the mid-1980s, the role of outer space in Canadian security interests has increased rapidly. However, it is evident that the primary objective of Canada's space strategy is not to ensure the satisfactory defence of North America (The United States

already have this well in hand), but rather to augment its own abilities while making a modest contribution in sharing the burden of North American defence. Developing space policy and space assets in Canada has always been a challenge for historical, political, and economic reasons. Overcoming that challenge in order to advance its own national security interests while achieving a balance between its civilian and military roles in space has been a major problem for the country, made even more complicated by Canada's desire to continue its cooperation in this field with the United States. Since the 1986 NORAD agreement renewal Canada has sporadically developed a civilian and military space policy that is in itself both reasonable and realistic considering the limited space capability of the state. Within NDHQ, the Directorate of Space Development has become a small yet efficient space organization dedicated to monitoring and where possible improving Canada's national security interests in and through space. Though hardly equipped to go it alone in space support and control, D Space D provides a mechanism for developing a modest indigenous capability as well as acting as the main conduit into American space defence programs.

The present state of Canada's space defence capability and its reliance on American participation for its very existence clearly demonstrates the junior role that Ottawa plays in the bilateral space defence relationship. Though Canada has taken significant steps to revitalize its military space effort since 1986, the necessity of American cooperation to achieve any aim is obvious. Of all the major initiatives, only human resources do not depend heavily on help from the United States. That being said, however, there is no doubt that Canadian officers are professionally developed through their exposure to their American counterparts and partners. Essentially, the present

Canadian military space strategy is all but entirely dependent on American cooperation to be successful, and requires continued American commitment if it is expected to survive and expand at the same pace. If present efforts are maintained then Canada's recent past performance and future potential make it possible to reestablish a reasonable balance in Canadian-American space defence cooperation, however for now it is still a long road back from dependence to alliance.[35]

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[1] Kirton, *A Renewed Opportunity*, pp.117-120.
[2] With that in consideration the space shuttle challenger accident in 1986 put a full stop to all manned space flight for two years and crippled the American space launch capability at a time when it had virtually no expendable launch vehicles. Canadian civil-military space industry and astronaut development was greatly dictated by American misfortune.
[3] Sokolsky, J. *Canada, Getting it Right This Time: The 1994 Defence White Paper*, (Carlisle Barracks, 1995), pp.6-7.
[4] The first recommendation came through the Senate Special Committee on National Defence in January 1985, and the second through the House of Commons Standing Committee on External Affairs and National Defence in February 1986.
[5] United States. DOD. *Space Handbook—A Warfighter's Guide to Space, Volume 1.* (Alabama, 1993), p.36.
[6] On July 4th, 1982, American President Ronald Reagan spoke at Edwards AFB, California, at the fourth space shuttle landing. In is first speech on space policy, he advocated for "a more permanent presence in space", and that steps would be taken to provide "assured access to space". See Stares, Paul B. *The Militarization of Space: US Policy 1945-84.* (New York, 1985), p.218.
[7] *Columbia* first flew on 12 April 1981; *Challenger* on 4 April 1983, *Discovery* on 30 August 1984, and *Atlantis* on 3 October 1985.
[8] Various. *JANE's Space Directory: 1997-98.* (London, 1998), pp.6-7.
[9] Ibid. pp. 118-119.
[10] Canada, Government of, *A Canadian Military Space Strategy*, p.1.
[11] The SDWG was formed on 3 June 1991 by NDHQ instruction DCDS 2/91.
[12] Canada, Government of, *A Canadian Military Space Strategy*, p.1.
[13] Morin, J. H. *Operation Friction: The Canadian Forces in the Persian Gulf, 1990-91.* (Toronto, 1997), p.23.
[14] Ibid. p.269.
[15] Ibid. pp.23, 38, 124, and 191.
[16] In eight weeks the Soviets launched over a dozen surveillance satellites with the mission of obtaining timely photo reconnaissance on Chinese forces along the Ussuri River.
[17] Kutyna, D. J. "Space Systems in the Persian Gulf War", *Air Power History*, (Spring, 1999), pp.34-35.
[18] Canada, Department of National Defence. *Space Policy.* (Ottawa, 1992), p.1.
[19] Ibid, p.3.
[20] The JSP was designated Defence Services Program (DSP) G2667 on 17 August 1995, following Program Planning Proposal (PPP) approval. In June 1997 the Intelligence Collection element was established as a stand-alone project, named TROODOS, with DSP number G2773.
[21] For an analysis of the panel review see Hill, R. et. Al. *The NORAD Renewal Issue.* CIIPS Working Paper No.33, (Toronto, March 1991), pp.53-61.
[22] Sokolsky, J. *Canada, Getting it Right This Time*, p.8.
[23] D Space D is part of Capability Component 4 (CC4).
[24] Interview with Major G. Liddy (D Space D 3-2), March 1998.

[25] DND. *D Space D Level 3 Business Plan 1997/98*, p.4.
[26] Major Karl Mickelson, USAF, held this position (designated D Space D 3-3) during 1997-98.
[27] DND. *D Space D Level 3 Business Plan FY99/00-03/04.* p.A-1/8.
[28] Canada is considering the retrofit of a space surveillance radar into the existing Algonquin Radio Telescope.
[29] Canada, Government of, *A Canadian Military Space Strategy*, pp.8-9.
[30] Ibid. p. 8.
[31] Ibid. p. 8.
[32] This figure does not include support to CF operations budget nor the R&D budget, both of which contain joint cooperation to some degree. The figure simply illustrates the degree to which D Space D is investing in Canadian-American cooperation.
[33] Vote 5 funds are dedicated funds to DND, voted for by parliament and designated for specific DND requirements. However, DND can choose the allocation of its Vote 5 funding which means that a sub-unit or CC is not guaranteed a portion of that funding.
[34] The services are also referred to in the defence economics world as capability components (CC). CC1 is army, CC2 is navy, CC3 is airforce.
[35] Canada is perhaps no different than many other countries in NATO who depend heavily on the United States for space support.

CHAPTER FOUR
A MODEL FOR THE FUTURE
CANADIAN-AMERICAN SPACE COOPERATION IN THE 21ST CENTURY

"Everybody sub-optimizes within his own limited mandate, but nobody optimizes for the overall national good."

- Dr. George Lindsey, 1992.

In the last fifteen years Canada has struggled to find its place in the world as a space power. Though technically competent, it has sporadically developed its space strategy in attempts to both appease traditional government biases while meeting the realistic demands of the modern day strategic environment. Previously it could ignore the developments in space as they were largely confined to the United States and the Soviet Union. More recently, however, the proliferation of space technology has raised a whole new series of security issues that affect all states. Half a dozen countries have developed completely indigenous space capability (Canada is not one of them) and a dozen more have a space capability on par or better than Canada. Like the defence of North America, space has brought Canada once more into a close bilateral defence relationship with the United States. However, the rules are somewhat different this time. Where once the Americans needed Canadian participation and access to Canadian airspace to protect itself, in outer space no such bilateral arrangement is necessary. These days cooperation is just that, a sharing of the burden in accordance with one's ability to take on the responsibility. More and more, the United States has rejected Canada's limited participation and its "easy riding" on the involuntary American guarantee of protection. In the future, though unlikely, should Canada be directly threatened through or from space by a rogue state (either by an ASAT missile or by some means of satellite

interdiction), the United States is not required to jump to its aid in order to protect its own space capability. Assistance will be exactly that, and may only come provided Canada has continued to cooperate on as equal a basis as possible. Given the present reality, one must ask is a truly balanced bilateral space defence relationship possible? Could Canada re-establish some form of equality according to means in space defence?

Canada's original interest in space based defence cooperation with the United States quickly waned for a number of reasons. The difference in national priorities between Canada and the United States, both foreign and domestic, was the largest contributing factor. The Americans were fully intent on fighting the Cold War against the Soviet Union in and through space and ultimately Canada was content to let them do it in favour of meeting other more immediate domestic concerns. With a limited defence budget, Canada had to concentrate on fighting the Cold War on earth, let alone in space. Canada's own space program pursued objectives and concentrated on endeavours that were traditionally selective and specialized, oriented to terrestrially focused missions and to practical and ultimately commercially profitable purposes. Logically, they centered on needs directly related either to Canada's geography and/or political alignment, rather than the overall strategy of the western alliance.[1]

The national policy on space was never clearly defined within the Canadian context until the 1990s, and as such Canada's space policy developed in a fragmented and unfocused manner. The traditional myth that Canada's space policy development was formed on the basis of its aversion to the militarization of space is simply untrue. Though not all of its space activities translate directly into a greater space defence capability, Canada conceded that it was involved in the military dimensions of space

since it signed the original NORAD agreement in 1958. Despite the apparent demilitarization of space in Canada in the 1970s, in fact the government continued to be involved in American space defence initiatives even if it was only at the sub-unit or sub-component level.

The attachment to American led space defence cooperation had an opportunity cost. The nature of the bilateral relationship was obviously unbalanced in favour of the Americans and as such there was little possibility of a truly equal partnership. The involuntary American guarantee of protection that evolved throughout the 1950s and 1960s encouraged a certain amount of lethargy within the Canadian Department of National Defence to seek solutions to its own defence requirements. In the area of space defence, Canada was very content to let the United States become dominant and at the same time, assume a large portion of the cost. Burden sharing was almost non-existent at first and only recently has the United States become more aggressive in asking Canada to contribute more reasonably to the space partnership.

The changing nature of the threat against North America augmented the difficulty in getting Canada to contribute more readily to the defence of it. As the air-breathing threat (bombers) gave way to missiles, Canada realized perhaps more easily than the United States that North America was ultimately indefensible. When the United States began investing heavily in space assets for early warning, Canada also realized that it could more easily achieve some sense of security through participation in NORAD rather than attempting to deploy an independent space surveillance network of its own. The Americans were intent on achieving early warning capability through space and Canada was intent on buying into it with whatever it could afford.

Finally, the economic reality of the bilateral relationship as it evolved left Canada with little hope of maintaining an equal share of the cost. During the first three decades of space cooperation the majority of any costs were devoted to improving North American security through space-related defence. During the last decade and a half the proliferation of space assets, in particular in the area of non-weapon military space assets (force enhancement satellites), has forced Canada to invest in a whole new range of space defence issues, that quite frankly it can hardly afford. This issue has been made doubly difficult by the fact that Canada has experienced a major increase in the number of forces deployed abroad that require non-weapon military space support. As such the bilateral relationship has taken on a new importance as Canada seeks to maintain a rudimentary military space capability through cooperation with the United States.

Since the watershed of events in Canadian military space that were ignited by the 1986 NORAD renewal issue, Canada and DND have made a conscious attempt at building some sort of military space capability. Though the impact of space assets on modern military operations had been self-evident since the early 1980s, Canada was able to escape the need for such assets until the Gulf War. For better or worse, the war was a wake up call to both DND and the Canadian government that its forces were in dire need of modern technology if it was to project itself in modern conflicts. Space technology requirements were no exception. Forces deployed to the Gulf required extensive upgrades and while at war the outright dependency on American space support was definitely highlighted. Within a year of the end of the war Canada had formalized a basic military space policy of its own and had devoted funds to creating the necessary infrastructure to direct Canadian military space activities within DND. The next decade

proved that such an organization was essential as Canada went from a half dozen overseas force deployments to over two dozen. Between 1992-1996 Canada repeatedly deployed a force of over a thousand troops in the former Yugoslavia. At the same time it operated in Somalia, Cambodia, Rawanda, and a dozen other areas. In March 1999 Canadian CF-18s executing bombing attacks in Serbia during Operation Allied Force depended heavily on satellite GPS and target acquisition assets to deliver precision guided munitions onto their targets. The need for space support and space products was considerably augmented by continued increases in force projection abroad.

More recently Canada has formalized its military space capability through the formation of a permanent directorate and an official DND space policy. This is slowly translating into other military capability, such as the formation of the space wing at CFSAS and the absolute turnaround in attitude towards the value of cooperating with the United States in space defence issues. Though Canada has had an increase in space defence experience and activity however, there is still much work to be done. The most difficult areas to overcome remain with the government in Ottawa.

In order to facilitate the modern bilateral space defence relationship with the United States Canada needs to organize its effort along untraditional lines. A modern and competitive national space program would require the Canadian government to pool its resources and cooperate in ventures that inevitably will have some degree of technical and financial risk. Traditionally the Canadian government has been reluctant to take such risks, preferring instead to force its departments to plan activities and budgets within closely defined mandates. Additionally every department's fixed objectives are, as analyst George Lindsey noted, "fiercely policed by a central Treasury Board demanding

guarantees of success."[2] Given the nature of space technology and capability development, such guarantees are simply not possible.

The Department of National Defence, and in particular D Space D, may seek to provide a professional environment that is inviting to civilian and military interests. In the past other government departments have avoided cooperation with DND for fear there would be difficulties over security or that project costs would soar and thus quickly kill budgets. Likewise, programs once started could be cancelled without warning, which for some civilian interests, such as communications, could invite financial disaster. There is also the constant concern that the services that the civilian side would need could be preempted at any time without warning or appeal on the grounds of national security. Cooperating in such ventures with the United States would invite numerous external factors into play that could cause further legal and security issues. Though very opening in one sense it is restrictive in another.

OPTIONS FOR STRATEGY: OPTING IN OR OUT OF THE FUTURE

There are many options for Canada's future military space strategy, many of which depend on American cooperation or participation. The most influential factor of any future option is the state and direction of the Canadian Forces of the future. When Canadian defence policy was under review in 1994 the question arose on how should the Canadian Forces of the future be structured. On the one hand there were those who argued for the necessity of retaining Canada's traditional Cold War forces composition capable of engaging in classical total war scenarios. On the other hand there were those who proposed that Canada develop military capabilities especially suited to a world

increasingly characterized by regional conflicts and low-level military operations other than war.[3]

Whichever route was to be chosen, the relevance of military space was equally applicable. Since 1985, space assets were becoming increasingly adjunct to military operations. The multi-purpose combat capable force that Canada chose as its model likewise required such a military space capability. The irony of the debate was that when Canada had a significant military space potential in the late 1960s there was little need for such a force. In the 1990s, when Canada regularly has one fifth of its combat arms continually deployed throughout the world, often in dangerous places and within range of enemy missile ranges, its military space capability is neither equipped nor yet adequate to properly support its deployed forces. However, and to its credit, DND and D Space D have readily accepted the existence of this deficiency and have made every effort to identify areas where space support can be advanced. In the meantime, Canada's reliance on the United States is paramount to continued force projection and operability overseas.

The state and direction of the Canadian Forces in the 21st century clearly demonstrates that D Space D and eventually the JSST will play an active role in CF operations at home and abroad. For the present, the development of these two organizations depend on American cooperation. Though one might argue that in the future Canada may reach a level of independence in military space capability, there is nothing to suggest that it will veer away from continuing collective agreements, statements of intent and memorandums of understanding with the United States. Though Canada probably has no hope of attaining space control like the Americans have achieved

for some time, through its own efforts and with help from the United States it can at least strive to control its own near Earth orbital interests.

Opting in or out of military space cooperation with the United States is often tied to the impending future relevance of NORAD. Traditionally this may have been true, however the recent creation and expansion of D Space D has created another area where the two countries cooperate and exchange ideas and information. Still, NORAD is a major part of the bilateral space defence relationship and as such its future existence and role should be considered. Recently the Canadian government raised some concerns over whether or not Canada could afford to remain a partner in NORAD. In briefing notes to former Defence Minister David Collenette and in an official DoD memorandum on NORAD missions, the United States indicated that Canada's geography was of lessening importance to NORAD as space took on a more prominent role in providing early warning for missiles. Though Canada's position still provided some influence over the intercept of an air-breathing threat, the decline in Soviet bomber production and deployment lessened this threat significantly as well. As such the United States wanted Canada to make a more tangible contribution to NORAD in that area.[4] Any contribution has a cost, and adequate or generous funding in any area has always been a problem for Canada's stretched defence budget. In terms of contributing more to space development it would be unrealistic to suggest that DND plans to devote more funds than it already has committed to D Space D. Still, some measures have to be taken, for the SCWG has identified that NORAD's ground-based radar systems will be too expensive to maintain beyond the year 2010.[5]

Ultimately suggesting that Canada would leave NORAD or that the United States would dissolve the bilateral agreement is unrealistic. Though the United States may absorb the majority of the cost of NORAD once all of its early warning systems become space-based, it already has absorbed the majority of the cost of the present NORAD system. Any Canadian contribution to NORAD is welcomed by the United States, which would have to foot that much more of the bill of defending North America if Canada did not participate at all. Though many would argue or suggest that the involuntary American guarantee of protection is no more a fact, it is still very present, only perhaps in a modified and less prostituted form. Where once Canada could ultimately receive all the benefits of the American umbrella of defence, now the United States can be more selective of that umbrella's contents (i.e. data as opposed to actual air defence). As Canada becomes an increasingly minor player in the space defence cooperation game, the United States has more freedom to dictate exactly what is shared with Canada and what is not.

NORAD not only formalizes CANUS cooperation, that would exist anyway whether or not there was a NORAD, it to a great extent facilitates the political issues of defence cooperation rather than highlighting them if there was no cooperative arrangement. In the absence of a NORAD the United States would have to operate with Canada in the a manner similar to that which it did prior to the formation of NORAD in 1958, and it was exactly the desire to facilitate that operation that led to the cooperative agreement.

In the absence of an indigenous launch capability Canada continues to rely on the United States for assured access to space, though in this area it does have the option to go

elsewhere. To date almost all of Canadian space assets have been launched on American platforms, though in the future due to rocket technology proliferation and increased launch market competition this may change. The recent problems arising over RADARSAT II highlight the difficulty the Americans have in completely controlling Canadian access to space. They have raised concerns over the product that the new Canadian satellite will produce (see the case for strategic technology below) and as such have refused to launch the vehicle until a more concrete ruling can be decided on who would be allowed to buy its product. Canada is not unique in this treatment however. West Indian Space Limited was only allowed to proceed with a joint American-Israeli imagery satellite venture provided it would not sell images of the United States or Israel to a small group of states considered antagonistic to the two countries.[6] Despite such an obstacle, however, Canada has not been deterred from its goal, and may simply find itself another launching service to put the satellite in orbit.

Canada does have other options in terms of access to space. It could choose to continue to rely on the United States for launch services as it has done in the past. There is little cause for concern over letting the Americans have access to Canadian space defence payloads. Usually the space asset is to some degree financed or sponsored by the DoD anyway. Or Canada could choose to pursue other space capable countries for launch support. Such a move however, does come with a risk. As the Americans are currently experiencing in their space dealings with China, should Canada allow another country to launch its defence-related space assets it automatically puts the security of those assets at risk. Of the launch capable countries, perhaps only France could be considered a low risk country, though there is no guarantee of any foreign country not

conducting espionage against one's payload. Another option for Canada would be to create an indigenous launch capability of some sort. In the past, the CRR was perceived to be a plausible launch facility, but due to its northerly latitude it is only feasible for payloads entering a molniya (polar) orbit. Launching geosynchronous payloads from such remote latitude requires too many plane shifts to make it a serious contender for commercial markets. A more realistic and perhaps more profitable access to space capability could be found in a sea launch system. The Sea Launch concept is a joint venture between Boeing, Kvaerner Maritime A.S. of Norway, RSC Energia (Russia), and KB Yuzhnoye/PO Yuzhmash (Ukraine). Essentially a converted oil rig and a technical support ship, the aquatic platform can sail out into the open ocean and launch anywhere in international waters, thus putting payloads into just about any desired orbit while having plenty of range for launch safety while infringing on no territorial rights. [7] Not only is such a system technologically and financially possible for Canada, it would give it access to commercial and military markets while providing for most if not all of Canada's launch requirements. Again, however, such a move would require a dedicated commitment from the government. For the present a possible move may include involvement in the existing Sea Launch Corporation cooperative.

For the most part Canada's technological limitations and fiscal realities will deny it from ever deploying as comprehensive a space program as the United States. One might then ask are Canada's present contributions to bilateral space defence enough for the United States? Though there is a national opportunity cost every time the United States enters into an agreement with Canada, ultimately cooperation as far as the Americans are concerned is still better than opposition. The United States readily

recognizes that Canada is incapable of contributing a vast amount to space defence, though there are times such as the present when they feel Canada should be doing more than it is. On the whole, as long as Canada is supportive of American domination of space, they will accept whatever contribution, however small or large, Canada is able to make. Cooperation with Canada is still to the advantage of the United States, if for nothing other than ensuring Canada's loyalty in times of conflict.

MILITARY SPACE POLICY OBECTIVES

Canada's original military space policy recommendation was built on no indigenous foundation. The policy was based to a large extent on the existing American military space policy, designed and tweaked by the erroneous 1987 White Paper, fiscal limitations, and a general Canadian misunderstanding of the rapidity with which space capability was proliferating throughout the world. The policy had to be redefined in 1992 to meet the NWO and was again altered with the change of government in 1994. The distribution of a new White Paper the same year did little to develop space policy, it merely reiterated that having a policy was important. After the formation of D Space D, Canada received its first serious military space appreciation. The conclusion was any development that occurred would require American assistance to be successful.

Canada's current military space policy is designed to evolve DND's space capability through total cooperation with DoD. Not only is such an approach wise, continued participation in space cooperation will benefit Canadian society, i.e. space research, the application of space technology, industrial development, and education and information. Through cooperation with the United States Canada is able to play an active

role in national and international space development it would not normally have. Unlike other minor space states, Canada has become relied upon to provide certain technologies to international space ventures. On the International Space Station for example, Canada contributed the RMS that will be vital to all station operations. Canada has also contributed both science and manpower to other key projects, and has often been a central partner in certain American led civilian space initiatives. In some areas, such as remote sensing, Canada has even demonstrated a clear lead over its American partners. Sharing such technology freely could count towards the burden sharing of space defence and assist in furthering Canadian military space objectives.

Canadian space defence policy and organization can benefit from American designs which ultimately it will be cooperating with. In considering how strategic planning in Ottawa could be translated down to the war fighter it is designed to support, Canada has looked to the American TENCAP method as a possible solution. D Space D has established the need for another cell in the Canadian Joint Staff Action Team (JSAT) that would allow for an operational contingency ability to provide space assets as required. Designed around a Canadian Global Command and Control System (GCCS) a Theatre Missile Warning (TMW) cell, and a Joint Force deployable Headquarters (JFHQ), future space tasking orders originating through the GCCS could be fulfilled within 12 to 72 hours depending on resources and the nature of the mission. Though Canada presently has a National level GCCS designed to provide a common operational picture, it presently has no TMW or JFHQ capability.[8] This may change in the future however, for the army plans to make 1st Canadian Division Headquarters and Signals Regiment (1CDHQSR) into a JFHQ. Thus, future missions commanded by the JFHQ

could include a theatre support to operations cell that includes an advanced C4I systems architecture at the operational and tactical levels of conflict (i.e. space assets and products to the war fighter).[9] The benefits of such a system are that it could be applicable to Canadian-led, CF unilateral, UN peacekeeping/ peace enforcing, or US-led coalition operations.

THE CASE FOR STRATEGIC TECHNOLOGY

Canada has demonstrated the ability in the past to use its technological capabilities as a playing piece in its partnership with the United States. At the end of the Second World War, Canada's expertise in ionospheric studies made its participation in bilateral space defence invaluable to the protection of the United States. In the 1990s Canada once again is in such a position, this time with its remote sensing and photo imagery technology capabilities. However, unlike ionospheric technology which brought the two nations closer in defence, remote sensing and Canada's RADARSAT project has at times caused conflict between Canada and the United States over issues of security.

The RADARSAT project is Canada's most comprehensive and sophisticated space project to date. Consisting of a remote sensing satellite carrying Synthetic Aperture Radar (SAR), RADARSAT is capable of covering most of Canada every seventy-two hours and most of the Arctic every twenty-four hours. RADARSAT is capable of completing numerous missions. For example it can monitor and map renewable resources (e.g. forestry); fishing, shipping, and oil exploration; conduct ice, ocean, and environment monitoring; disaster management; offshore surveillance; earth observation; and high resolution photo imagery.[10] Though the existing RADARSAT is a

very powerful and versatile space asset, Canada plans to launch an augmented RADARSAT II in the near future. Its capabilities have created both interest and concern within the American space defence forum.

Currently the defence R&D branch and D Space D are co-sponsoring a SBR Ground Moving Target Indication (GMTI) technology demonstration on Canada's RADARSAT II satellite, that is scheduled for launch in November 2001. If successful, Canada will be the first country in the world to demonstrate such a capability from space, and will make GMTI and RADARSAT an invaluable asset to both Canadian and American space support.[11] Additionally, RADARSAT II will be capable of taking 1-3 meter resolution photographs available for public purchase, far more detailed than present commercially available satellite images. While the United States is very enthusiastic about the former RADARSAT II capability they are less thrilled about the prospects of the latter ability. The United States has raised concerns about public access to high resolution satellite imagery, iterating the security risks of making such accurate imagery commercially available. In a rare moment of opposition to the American space defence program, Canada disagreed and when the United States threatened not to launch RADARSAT II Canada simply stated it would find another launch service elsewhere.[12] Ultimately the United States could not blockade Canada's launch of RADARSAT II or RADARSAT III but it could exert some influence over who may get access to its space products and under what circumstances (such as war) that customers could be turned away. Though no formal agreements have been yet reached at the time of this writing it can be forecasted that Canada will agree to some of the United States' concerns in the interest of bilateral national security.

CONCLUSION: FUTURE CONSIDERATIONS

There are grounds for renewed Canadian security interests in space in the 21st century, provided that earlier displays of aloofness and indecisiveness are not repeated. The world is at a point where falling behind in space security may prove to fatal to a state's sovereignty. Already 30 countries operate satellites or use space directly, while a further 143 countries are members of international space organizations.[13] Canada must be flexible, and able to adapt to the requirements of a globe shrunken by space assets proliferation. As a nation Canada must support both its military and civilian space capability if it is to prosper and survive in a 21st century space environment.

Canadian-American defence cooperation through space in the present day carries its own problems and promises. First and foremost traditional Canadian political concerns continue to retard an unbridled advancement in space assets and technology. In some ways this is a good thing. Though one might argue that this was achieved through crafty politicking, it seems pointless to chide the nation for achieving its foreign policy goals by other means, and perhaps even hints at jealousy. Instead, one might consider that in the context of the evolution of global space trends, will Canadian politics deny it the opportunity to re-establish a sense of balance with the United States in space defence?

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[1] Kirton, *A Renewed Opportunity*,p.111.
[2] Lindsey, G. *Surveillance From Space: A Strategic Opportunity for Canada.* CIIPS Working Paper 44, (Toronto, 1992), p.20.
[3] Bland, D. L. *Canada's National Defence Volume 1: Defence Policy,* (Kingston, 1997), p.282.
[4] Pugliese, D. "NORAD's Future Hangs on Canadian Space Investment", *Defence News*, (February 1999), p.8.
[5] Ibid. p.8.

[6] Present American space policy bars U.S. satellite imaging companies from imaging Israel or the United States at a resolution of smaller than two meters. See de Selding, Peter B. "U.S.-Israeli Satellite Venture Plans Bond Offer Soon", *Defense News*, (29 March, 1999), p.20.
[7] For more information on recent developments see Smith, Bruce, "Zenit Prepared for Sea Trials", *Aviation Week and Space Technology*, (February, 1999), p.66.
[8] Notes from lecture, "CF Space Integration", given by Captain R. Trinkle, USAF, Space and Weapons Instructor, CFSAS, March 1997.
[9] Ibid. above lecture, March 1997.
[10] Government of Canada. *Canadian Space Agency: Performance Report for the Period Ending March 31st, 1997*, (Ottawa, 1997), pp.30, 71-73.
[11] DND. *D Space D Level Three Business Plan FY 99/00-03/04*. (Ottawa, 1998), p.A-6.
[12] See "Canadian Satellite Will Take Off Despite U.S. Protests: Maleny", *Ottawa Citizen*, (February 19, 1999), p.A-11.
[13] As of 1992. In the last five years at least another five countries have either launched their own satellites or have supplied direct support to space operations.

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