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Space in the 21st Century

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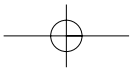

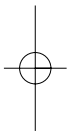

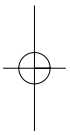

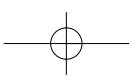

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FOREWORD

The Canadian Forces College second annual Air Symposium, conducted on 5 and 6 April 2000, focused on the Canadian Force's use of Space at the beginning of the 21st Century. As with the first symposium held in April 1999, this second symposium received the enthusiastic support of the Chief of the Air Staff in funding and promoting the symposium's programme.

The Air Symposium provided a unique opportunity for the students of Command and Staff Course 26, selected academics, and members of the Canadian air force community to gather and share their thoughts on how Canada might use space in future conflicts. The aim of this event was not to determine definitive answers on issues related to space, but rather to provide a collegial setting where the air students of the Command and Staff Course could both present the findings of their research and hear the views of noted academics and others on the subject of space.

The Canadian Forces College wishes to thank the Chief of the Air Staff, Lieutenant-General David Kinsman, for his continuing support of the symposium process, and Dr Jim Fergusson and Colonel Richard Szafranski, USAF (retired) for their scholarly contribution to the symposium's agenda.

Inquiries about this publication may be directed to the Canadian Forces College, Attention: Deputy Director Aerospace Studies.

Thinking the Unthinkable: On Revolution, Outer Space and Canadian Policy

Dr. James Fergusson, Deputy Director, Centre for Defence and Security Studies, University of Manitoba

For the moment, little public attention is being paid in Canada to developments concerning the military use of outer space. Canadian foreign policy is focussed on the Minister's human security agenda. National defence continues to concentrate on dealing with the fiscal restraints facing its goal of maintaining multi-purpose, combat capable forces, especially with the looming major modernization and new equipment programmes. This is not to suggest, however, that outer space is being entirely ignored. On the commercial side, Canadian firms are developing new technologies to exploit outer space, and in conjunction with the Canadian Space Agency are moving forward with RADARSAT II and participation in the International Space Station. Canada continues to raise the issue of the weaponization of outer space at the Conference of Disarmament. Finally, National Defence is proceeding with the development of the Joint Space Project with the US, MILSATCOM, and a contribution to the U.S. Space Surveillance Network (SSN).

Nonetheless, the *here and now* focus of Canadian Foreign and Defence policy as a whole raises significant questions about whether Canada will be prepared to deal with the dramatic security and defence implications of outer space in the future. This is most evident in the absence of any clear understanding of the way in which outer space is likely, if it has not already begun, to revolutionize thinking about war and peace, and strategy. Central to this lack of understanding is a set of uncontested assumptions or beliefs that relegate space to the margins of interest and investment. Unless closer attention is paid to space in strategic and security terms, Canada's "long-term strategic interests" may not be met.

On Revolution

Much attention over the past several years has been paid to the so-called Revolution in Military Affairs (RMA). Academics debate what is a RMA, whether a RMA is underway, and what are its implications for armed forces. Practioners tend to concentrate upon the direct implications of emerging RMA technologies for force requirements, inter-operability, and military organizational structures and procedures. Also, both academics and practioners tend to see the RMA in rather strict, technical terms surrounding the terrestrial employment of military force. However, both also tend to ignore the true nature of the revolution, and it concerns outer space. The centrality of outer space to the RMA has two key components; the first concerns the dominant

strategic paradigm of deterrence, and the second concerns outer space as the necessary condition for understanding the true nature of the RMA as debated in the literature.

Regardless of the historical debate on military revolutions, there is general agreement that the development and deployment of nuclear weapons had a revolutionary impact on the conduct of international politics and the relationship between armed force and politics. As noted by Bernard Brodie almost immediately after the use of atomic bombs against Japan, nuclear weapons changed the meaning and purpose of armed force: "Thus far the chief purpose of our military establishment has been to win wars. From now on its chief purpose must be to avert them. It can have almost no other useful purpose."[1] Nuclear weapons ushered in the era of deterrence as the dominant strategic concept as informed by the political context of the Cold War, and subsequent technological developments of which ballistic missiles in general, and long-range Inter-Continental Ballistic Missiles (ICBMs) in particular were paramount.

In the construction of the what may be labelled the Deterrence RMA, the central focus has been nuclear weapons, which, in turn, has also been expanded with reference to the other two legs of the Weapons of Mass Destruction triad, chemical and biological. Thus, the central driving feature of this RMA concerned warheads. While one cannot ignore the exponential growth in destructive power brought on by nuclear weapons, whose very nature undermined their warfighting utility, these weapons did not produce the Deterrence RMA. It was only with the development and deployment of ICBMs in the context of the American-Soviet adversarial relationship that the full meaning and implications of nuclear weapons, and thus deterrence resulted. Prior to then, the idea of defence still had some meaning, given the prospects of intercepting bombers carrying nuclear payloads, notwithstanding tactical short-range missiles. ICBMs could not be intercepted, and thus national defence for the two Superpowers came to rely strictly upon the offense, the ability to deliver an "assured destruction" second strike. The triumph of the offense married to nuclear weapons, the Deterrence RMA, was symbolically sealed politically and strategically with the negotiation and signing of the Anti-Ballistic Missile (ABM) Treaty in 1972.

Of course, this did not foreclose research and investment in strategic missile defence on the part of both the Soviet Union and the United States, nor into Anti-Satellite (ASAT) programmes. Reagan's Strategic Defence Initiative (SDI) was clearly directed at escaping from the Deterrence RMA, and part of the SDI research programme was based upon the earlier ASAT Homing Overlay Experiments. Ostensibly, the critique of SDI centred around the de-stabilizing nature of strategic defences in promoting first strike incentives and arms races, notwithstanding technological feasibility and cost questions. In reality, this critique largely masked a much deeper phenomenon - the social triumph of the Deterrence RMA, as many, if not all, of the pro-

ponents of SDI, or some limited form of missile defences, constructed their arguments around this belief system.

The Deterrence RMA also extended into the conceptualization and understanding of outer space. It became embedded in two ways. First, ballistic missiles were conceptually not part of outer space, even though Medium Range (MR) through long range ballistic missiles transited through space. The conceptual exclusion of ballistic missiles from space was legally codified in the 1967 Outer Space Treaty, in which space was defined relative to an object completing a single orbit. Certainly, the United States and the Soviet Union agreed to this definition for practical strategic reasons. But underneath these reasons was the incontestable triumph of the belief system. The implications, of course, have been, and continue to be, a de-linkage of space from the core element of the dominant strategic belief system - ballistic missiles.

Second, the way in which space was exploited for military purposes was driven by the same belief system. Notwithstanding the significant costs and technological barriers to the full exploitation of space, exploitation was driven by strategic deterrence beliefs and subsequent requirements. Once again, the decision to prohibit the deployment of WMD in space in the Outer Space Treaty was not necessarily a function of cost and technological barriers, but more of the presumed dangers such deployments posed to strategic stability considerations as defined within the belief system. Moreover, the development and deployment of satellite early warning, intelligence, surveillance and communications were also a function of the belief system. Even though both Superpowers invested in ASAT research and development for fear of the other gaining an advantage, both also logically realized that any attack on early warning assets in particular would be interpreted by the other as the precursor to a strategic attack. Thus, space evolved as a function of the Cold War informed Deterrence RMA, and its non-weaponization and current manifestation as a sanctuary from weapons is as much a function of the belief system as cost and technology. In so doing, space conceptually was moved to the background, or margin of strategic thought.

Even with the collapse of the Cold War context that informed the specific manifestation of the belief system, deterrence has remained dominant. New strategic planning, capability requirements, and new technologies have remained framed within the context of the Deterrence RMA. Any cursory examination of official national security and military documents today reveals the continued strength of the deterrence mind set. For example, the Report of the Quadrennial Defense Review states: "The third aspect of the military's key role in shaping the international security environment is deterring aggression and coercion in key regions of the world on a day-to-day basis through the peacetime deployment of US military forces abroad."[2] Most interestingly, the requirements in this document to undertake this role are the classic components of the deterrence belief system: political will; the communication of commitments/threat; and the conventional

and nuclear, including strategic, forces to carry out the threat.

Of course, these components, and a generic notion of deterrence, have been in existence throughout history, and long before the Deterrence RMA. Moreover, the use of conventional military force did not disappear during the Cold War, even for both Superpowers. However, the generic notion of deterrence is, in effect, a meaningless one because it is divorced from any specific understanding of the relationship of war to the societies that engage in it, and this relationship has changed historically. Also, the application of conventional military force during the Cold War and under the Deterrence RMA was significantly constrained by, and directly related to, the conditions emanating from the triumph of the strategic offence, such as in the case of the Vietnam War, and Superpower involvement in the October, 1973 Arab-Israeli War. Even in Europe, conventional forces were not there for classical warfighting purposes, but rather as the first rung of the seamless web of US strategic deterrence.

For most observers, the Gulf War is the central empirical case surrounding the current RMA debate. On the pro-RMA side, the Gulf War is seen as a harbinger of the revolution. On the con-RMA side, the Gulf War is seen as the product of an evolution of American military capabilities and strategies, in effect the American way-of-war, generally dated back to Vietnam. However, this debate, interesting in itself, largely misses the point. The actual revolution is the negation of the no-defence condition of the Deterrence RMA, and this is occurring not simply through the development of missile defences, such as the U.S. National Missile Defence (NMD) Programme and the various Theatre Missile Defence (TMD) Programmes. It is also occurring through key developments concerning the military use of outer space, which amount to a transformation from deterrence to a defence belief system.

Space-based assets are central to this transformation. This does not necessarily imply the deployment of space-based interceptor assets, which many fear NMD and TMD are the precursors of (the ghost of SDI). While such assets would likely create a more effective missile defence capability, the key is the development and deployment of new space-based early warning, tracking, cueing, and target discrimination capabilities (Space-Based Infrared High and Low) linked to terrestrial/air/sea-based kinetic-kill interceptors, a new generation of ground-based radars, and sophisticated command and control/battle management (C^2/BM) capabilities. Even if such defences are not perfect, as no defence ever is, their existence will alter the political calculus of nations. During the age of nuclear deterrence, the key revolutionary transformation was the impact of vulnerability (no defence) on political action. In the future, missile defences married to a new generation of these space-based assets transform and reverse this relationship, at least for the United States, and possibly for Russia as well if cooperative efforts are fully realized. Deterrence may remain the "rhetorical concept", but it will not be deterrence in the same sense as the past. At a minimum it will be a one

way street, that contains a variety of unique political-strategic conditions.

The transformation underway as a function of ballistic missile defence within the broader outer space development envelope is not simply a function of technology. It also is the product of the post-Cold War international system of US political-strategic dominance. Central to this is the explicit American goal to develop new technologies to ensure its political-strategic superiority. These new technologies, centred upon space, promise to eliminate, or at least significantly undermine, the traditional set of beliefs that underpinned the Deterrence RMA. In the future, the United States, and thus western security, will no longer exclusively rely upon national and operational vulnerability and the threat of nuclear retaliation. Instead, the United States will be able to act with a significant degree of impunity in relation to direct threats to its national territory, and national interests. National vulnerability as the extant condition of the nuclear age is being replaced by national survival: defence or the Defence RMA.

Nonetheless, the continuing influence of deterrence is evident in several ways. As ballistic missiles are conceived outside of space, so ballistic missile defence is as well. In fact, missile defence discussions, especially among academics, make no reference to its revolutionary implications. On one hand, it is apparently not part of the RMA. On the other hand, it is implicitly conceptualized as one of many components of operational support to the "warfighter". Missile defence facilitates the political will to intervene by providing protection to forces-in-the-field. In enhancing political will, hence credibility, similar to all the space-based systems and technology development programmes, missile defence is portrayed as a support for deterrence. In other words, missile defence when implicitly linked to other space-based capabilities is placed on the margins in the same manner space was during the Cold War.

At one level, the marginalization of missile defence and space may simply reflect the classical conceptualization of the strategic dominance of territory. Humans are land creatures, and war is won or lost on land. Missile defence and space, like the navy and air force, are strategic enablers for the prosecution of war on land. Missile defence and outer space as a whole are seen as support for the "warfighter". Yet more interesting within this context has been the emergence of the concept of "warfighter" in the past decade. This concept did not exist in the public lexicon at least during the Cold War, and it turns Brodie's dictum on its head.

The conjunction of missile defence, outer space, and support to the "warfighter" speak to an emerging new belief system about the relationship between armed force and politics. This system is not simply a return to the pre-deterrence system for two reasons. Social-political attitudes to war and peace, and the utility of armed force remain embedded in deterrence thought. This is most clearly evident in the assumed sensitivity of Western societies to casualties. At the same time, it also reflects the liberating nature of the end of the

Cold War for military institutions, whose cultural predispositions were directly undermined by deterrence. In other words, the defence-warfighter image of the military side of the equation must be blended with social-political attitudes towards the costs of engaging in war.

Outer Space and Strategic Thought

As noted above, missile defence is excluded from space as a product of the triumph of the Deterrence RMA as informed by technology (nuclear weapons and ICBMs) and the political context of the Cold War. At the same time, space itself, like missile defence, is conceptualized as simply an enabler for the "warfighter", and outside of the dominant conceptualization of the RMA. Yet, new generations of space-based assets, in fact the evolution of these capabilities since the 1980s, are the key to the RMA regardless of how one conceptualizes and understands the term. Eliminating the "fog" and "friction" of war, or at least significantly constraining their effect, is fundamentally dependent upon space-based assets. Full integration of these assets into strategic, theatre, and operational command, control, and battle management is the key to its realization. Real-time situational awareness of an enemy on the battlefield, combined with the ability to undertake precision strikes, thus reducing the size, and re-structuring the nature of military forces and their logistic trains, set the stage for realizing a strategic-political level transformation of war; however, they only set the stage, because the dominant belief system remains unchallenged. This is evident, as argued above in the failure to conceptualize missile defence and space outside of the deterrence belief system. It is, perhaps, most evident in the failure to develop, or least propose, an independent body of strategic thought for space.

Understanding strategy in the emerging strategic space era remains at best embryonic.[3] Whereas students of strategy and the western way of war turn to the classics of Clausewitz (land), Mahan and Corbett (sea), and Douhet (air), there is as of yet no equivalent for outer space. Certainly, the outline of such strategic thought is present, not least of all in US Space Command's Long Range Plan.[4] But within these outlines there are several factors that need to be further developed, and with them certain tensions that have to be resolved.

Generally, the starting point, usually more implicit than explicit, is that space should be understood in naval terms. This point stems primarily from two considerations. First of all, the legal status of outer space is similar to the high seas - open to all and the possession of none. In this sense, the legal differentiation between outer space and sovereign air space is analogous to the differentiation between the high seas and sovereign territorial waters. Although space is defined with reference to an orbit, rather than point in which the atmosphere transits into the vacuum of outer space, it is an issue that may emerge in the future, especially as a function of growing commercial exploitation. Here, one could potentially see reference made to "exclusive economic zones" as in law of the sea in the context of orbits and con-

stellations. One can expect further developments in international law governing outer-space, and it is possible that the law governing the "high seas" could also become the template for legally defining belligerent rights in space.

Second, this naval analogy is further reinforced by the references in the literature to space-faring nations. Popular culture has also tended to portray military force in space as a naval activity and one should not completely disregard the impact of popular images, because they do serve to frame the way societies think and act. Thus, as a strategic naval domain, it is possible to conceive of space in terms of Mahan and Corbett.

However, space is not simply portrayed in naval terms. It is also conceived in air force and army terms. In the context of air force thought, outer space has long been its domain, or at least it has dominated the domain as a natural extension of its role in the air, and its technology-dominant culture. Although elements of the other services participate in outer space activities, with their own sub-commands, US Space Command is clearly an air force command, and thinking about the impact of the air force becoming a space and air force, and its effect on air force culture, is clearly underway.[5]

More importantly, outer space strike assets hold the promise of bringing Douhet's vision to fruition: a truly independent strategic force. As many observers have recognized, the new air forces of the second World War lacked the capacity for a strategic strike that would bring quick victory independent of a ground campaign. The ability to do so was acquired with nuclear weapons, but these very weapons made war politically meaningless, the aforementioned postulate of the deterrence era. However, new strike assets, that could include a range of new technologies located in outer space constellations, hold the promise of destroying the capacity of a nation to wage war without a ground/naval campaign, and such an ability would transform the practice of international politics.

However, the air force strategic case must be balanced by the army one as well. Arguably, the army has been the least directly involved in space activity, and least technologically driven culture. But, this has begun to change, even though the idea of taking ground as the *sine qua non* of war remains. Space for the army is the ultimate high ground. Thus, from an army perspective, reinforced by current RMA related work on army activities, the strategic value of space is not inconsistent with a land strategic perspective. Even futuristic ideas of re-usable space vehicles may be seen in airborne/air mobile terms; able to appear at any point in an operational theatre to exploit the element surprise.

In many ways, all three strategic perspectives are evident in US Space Command's Long Range Plan. Despite the recognition of the need to weave a seamless web for the proper exploitation of outer space, its analysis more transfers the unstated strategic logic of each of the services, without integrating them into a new body of strategic thought. Thus, control of space draws on naval and air thought

on the army's force enhancement and on the air force's force application concepts. In addition, the emphasis is primarily technological.

Perhaps, it is much too early to expect the development of a body of new strategic thought. Until the various new technologies are actually deployed, their strategic implications will be difficult to understand and exploit fully. It was only after the initial use of the aeroplane during the First World War that a body of strategic thought about airpower emerged. Similarly, it took nearly a decade before the full strategic implications of nuclear weapons came to be understood. Until then and despite the work of Brodie and others, nuclear weapons were largely seen as just another weapon, albeit exponentially more destructive.

At the same time, it is also not surprising that each of the services conceptualizes space according to its dominant culture. Similarly, it is also not surprising that the broader political, academic, and public discourse, when it does engage space, conceptualizes it within the deterrence belief system. However, neither the services nor the broader discourse have come to grips in a meaningful way with the strategic and security implications of space in the foreseeable future. Certainly, the Long Range Plan posits that space will become an economic and military "centre-of-gravity" for the US. In so doing, the idea of space control has emerged with its traditional air and naval connotations (the surveillance of space, the negation or denial of adversarial use, and the protection or defence of one's own use. In addition, doctrinal concerns, largely dominated up to now by passive measures, are now starting to transition into the consideration of active measures as well.

However, deterrence remains a significant barrier to a full understanding of the strategic and security implications of space. Several examples are evident. First of all, the exclusion of ballistic missiles from the space envelope, and with them ballistic missile defence, has lead to two interesting views. At one level, the belief that missile defences will produce greater incentives for states to acquire larger and more sophisticated arsenals of ballistic missiles remains intact. Although this view is largely seen today in the context of Russia and China relative to NMD, it is also enunciated with regard to the proliferation as a whole; witness the regular retort that the non-proliferation regime will collapse if NMD goes ahead. Yet, missile defence is a not just part of a counter-proliferation strategy, but it is also central to a non-proliferation strategy. It affects opportunity costs for missile and WMD proliferators, and can be understood as creating a disincentive.

More directly relevant to space itself is the dominant assumption that missile proliferation is an attempt by states to obtain the ability to practice Cold War type deterrence as a means to dissuade the US/West from intervening. In so doing, the belief that such states are undeterrable reinforces this very logic by portraying their leadership as irrational and "mad" the ideal posture to create credibility. However, perhaps missile proliferation is not solely directed towards replicating deterrence.

Perhaps it is also directed towards acquiring an ability to practice space denial, and warfighting itself. By excluding missiles from space, one easily forgets that missiles are the means to access space. Moreover, the increasing exploitation of Low Earth Orbit (LEO) for military and commercial purposes is an inviting target for even rudimentary launch and warhead technology. In fact, this technology may be much less demanding and costly than that required for delivering warheads to terrestrial targets thousands of kilometres away.

To illustrate the value of breaking away from deterrence and rethinking space in strategic terms, the August 1998 North Korean three stage missile test is useful. The test is seen as a step towards acquiring the capability to threaten the continental US, and thus deter the US. Critics, in keeping with deterrence thinking, in part, argue that even North Korea would not be foolish enough to believe that the US would not retaliate if attacked. North Korea stated that the purpose of the test was to launch a satellite into orbit. From a strategic space perspective, perhaps the North Korean explanation is closer to the truth; the acquisition of a space-launch capability married to a crude nuclear warhead to interdict US space-assets in the case of war, and/or threaten US/Western commercial space assets.

Thinking about alternative explanations for long-range missile proliferation is excluded by deterrence. It is only possible when one begins to think in terms of the independent strategic world of space. A similar case is found in the old deterrence-based dichotomy between offensive and defensive weapons as enshrined in the ABM, and SALT/START agreements. Even in the Missile Technology Control Regime (MTCR) world, the issue is missiles for terrestrial purposes. When missiles are linked to space, the division is between missile defence and ASATs. Both have negative connotations because defence is "bad" and offense is "good". But from a strategic space perspective, the distinction is meaningless. In one way, missile defences are also ASATs in disguise. However, the most effective missile defence for terrestrial purposes may not be the most effective ASAT system for space defence purposes. If threats to space assets are the future, missile defence investments need to be geared more to space defence, than terrestrial defence. A strategic space perspective leads one to this type of conclusion. Certainly, the current programmes and NMD are important to break the psychological barrier with regard to missile defence. But, the current programmes remain informed by deterrence, rather than an alternative space-centric strategic one.

A final example of the problem in developing a strategic vision of space as a function of its emergence as a military and commercial "centre-of-gravity" is the idea of space as a sanctuary. Drawing on the Outer Space Treaty and the absence of weapons in space, as informed by Cold War Deterrence, political thought today assumes that space is a sanctuary, and nations concerned with future US designs seek to codify it as such. However, space is not a sanctuary and since the beginnings of the space age has never been one. It may be illegal

to deploy and test nuclear weapons in space, but it is not illegal to use them in space. Thinking that "criminalizing" the deployment of weapons in space resolves the problem, in actuality may undermine Western security. It permits all states to practice space denial, but no states to practice space defence outside of passive measures and limited dual-purpose missile defence. Strategically, it makes no sense, except as a function of deterrence which has framed the entire strategic debate, including arms control and disarmament.

In the end, there are many barriers to developing a strategic vision of space. Notwithstanding cost and technology considerations, one of the core barriers is the deterrence legacy both in terms of understanding the RMA and the way in which even advocates of space construct their own visions. Space control, as recognized by US Space Command among others, will be the key doctrinal and political battlefield of the next two decades. Already the organizational fight for jurisdiction is appearing. For many, space is a "purple" domain that includes all of the services, and a new independent Area of Operations (AOR). Even though it is organizationally dominated by the air force, notwithstanding naval and army participation, its functional value and strategic nature indicates that no single service necessarily should dominate the domain of outer space. As the Second World War would lead to the creation of the United States Air Force as a new, independent service, so outer space developments may create the preconditions for another new service. In fact, the conditions may already be in place with the growing emphasis in the last decade on "jointness" and the development of joint doctrine among the services.

However, thinking of space in independent, strategic terms is problematic relative to the way in which space continues to be conceptualized by the services as informed by their distinct cultures within the context of deterrence. Indications of a new conceptualization are indeed present, not least of all as a function of the public emergence of the concept of space control. Perhaps space does not truly hold the promise of an independent strategic role. But unless this idea is explored, opportunities may be lost. At a minimum, space holds significant strategic and security implications for all nations, and while the US strategic community is beginning to become engaged, many other nations are not.

Canada in the Past

Towards the end of the Second World War the conditions were set in place for a revolutionary transformation in Canada's approach to the outside world. Recognizing Canada's contribution to the war effort, policymakers began the process of shifting Canadian policy from isolationist to internationalist. In so doing, it was clearly recognized that Canada's long-term strategic interests resided in a free and stable Europe. This interest was further extended, particularly since the end of the Cold War, to a global basis. In effect, Canada benefited from a peaceful and stable international system. It had, and continues to have, a stake in the international order. With such an interest

and stake, it thus followed that Canada has had an obligation and responsibility to commit itself to the international order as it has evolved.

During the Cold War, this commitment primarily manifested itself in Europe through NATO, on the continent through NORAD, and globally through the UN and the practice of peacekeeping. Over this same period of time, Canada's military capabilities and investments declined. The commitments relative to declining capabilities created the conditions for the identification of the commitment-capability gap critique.[6] While on paper such a gap clearly existed, the critique failed to recognize one vital point (from the deterrence standpoint of "no defence", it was largely irrelevant. In many ways, Canadian policy-makers, sometime consciously and many times unconsciously, acted from this standpoint in making decisions about investments.

It is this very standpoint that has continued in Canadian thought since the end of the Cold War. It is perhaps most clearly evident in the current agenda of Foreign Minister Lloyd Axworthy, and the overall post-Cold War governments' failure to recognize the revolutionary changes that are underway. These changes are a combination of the new strategic environment and the emerging revolution in the relationship between armed force and politics. The former has removed the structural constraints on the utility of armed force for the defence of the West's strategic interests, and thus Canada's long-term strategic interests. The latter through the domain of outer space is resurrecting the political conditions supporting the actual employment of armed force in a socially acceptable manner.

For Canada, this revolution, whether viewed from the deterrence perspective or the current RMA debate in the literature, has direct implications for Canadian requirements to meet its fundamental commitment to the existing international order. From the former perspective, there is a need to recognize a future of deployed ballistic missile defences with space-based tracking, cueing, and target discrimination assets for the defence of North America against ICBM threats from states other than Russia and perhaps China, for the defence of Europe, and for deployed Western coalition forces in the field. All these missile defence capabilities are essential to ensure that western decision-makers are willing to deploy forces against regional adversaries, particularly under the social constraints left over from by deterrence and the unwillingness of Western societies, perceived or real, to accept high levels of casualties.[7]

The deployment of missile defences with their vital space-based assets represents the escape from deterrence under the new political environment. In so doing, capabilities to participate meaningfully in coalition campaigns become essential for Canada. Whereas in the Cold War simply being there sufficed militarily, in the emerging environment of defence, being there is not enough. It also demands making a meaningful combat contribution.

However, the nature of a meaningful contribution has to be considered. The key requirement for Canadian Forces to be inter-operable with other coalition forces, primarily

American, is changing. While the logic of combat capable forces remains in place, the specific requirements and investments necessary to be combat capable is likely to be significantly different. These are likely to require in particular the ability of Canadian Forces to integrate into the new battlefield created by emerging space-based capabilities under development in the US, as well as military structures that are emerging to exploit these new capabilities.

Both perspectives tend to indicate that Canadian elites must increase investment in defence capabilities. While there is logic to this need, current political conditions also indicate that the probability of a significant "true" increase is near zero. The public political agenda is dominated by demands to increase investment in social programmes, even within defence as demonstrated by the Quality of Life report of the Standing Committee on National Defence and Veterans Affairs (SCONDVA). Furthermore, the government's foreign policy agenda emphasis on human security with its development underpinning and emphasis on intra-state conflict largely relegates the revolution to the margins.

Of course, Canada could choose to ignore the ongoing revolution, and in so doing undertake a limited or specialized role in the international system, a role suggested by the Canada 21 Report.[8] In many ways, the Canadian Forces are already drifting in this direction. However such a limited role carries potential political costs. It is in effect a posture of limited liability, and with limited liability comes a limited political role and commitment to the international order. In other words, it potentially implies a return to a marginalised isolationist reality with an internationalist rhetoric of commitment.

More importantly, there is a dangerous belief that Canadian policy developed for the Cold War under the label of internationalism remains immune from geo-strategic and technical changes. With regard to missile defence, for example, concerns expressed by the Foreign Minister are deeply embedded in Cold War Deterrence. Canada had been able to side-step earlier US missile defence issues, ABM and SDI, largely because of the geo-strategic value of Canadian territory and existing technology. Today, Canadian territory has become strategically irrelevant by the conjunction of the end of the Cold War and emerging space-based surveillance technology. In other words, Canada is likely to pay a significant political price if it attempts to side-step US NMD.[9]

Beyond missile defence in general and NMD in particular, there are several more key issues emerging which cannot be managed by the old Cold War policy parameters. Paramount among them is the emerging issue of space control. Longstanding Canadian policy opposition to the weaponization of outer space has been politically viable under the deterrence conditions of the Cold War. Opposition was cost-free, as neither the US nor Soviet Union possessed the strategic need, or technological capability, to weaponize. In

the future, the strategic need and technological capability will likely exist, especially if space does emerge as the centre of military and commercial gravity for the US and the West. Canadian opposition in this situation will not be politically cost-free, relative to way in which Canada managed its defence interests with its arms control and disarmament ones under deterrence.

This emerging issue, which is the broader policy revolution facing Canada, also spills down into the way in which Canada has itself marginalised space. Not only is there a need to re-examine current Canadian space policy overall, and the relationship between National Defence and the Canadian Space Agency in particular in light of the ongoing revolution, but there is also a need to re-examine the way in which space is conceptualized. Briefly, National Defence continues to conceive of space as a marginal investment requirement. Selective limited contributions to US space requirements will enable the Canadian Forces to access US space systems.[10] While such an approach is understandable, not least of all for budgetary reasons, it also will predetermine Canada's response to space control. Limited, selective space investments into the American space envelope largely dictate that Canada will have no choice but to accept the outcome of the US policy debate on space control. This may be in Canada's long-term strategic interests. However, it also ends any independent debate years before it would begin. As Canada engaged too late in the debate on NMD today, the current space investment strategy unless debated today ensures that Canada will not engage in a functional manner in terms of space control.

Re-evaluating Canadian foreign and defence policy under the emerging Defence RMA is complicated. These brief examples provide only a basic indication of the tensions which exist and will continue to develop. The5.1(vide o19.Ao17w8adomi9.6(ence con-

regard to outer space, commercial and military, raise significant implications for Canada and the Canadian Forces.[11] Neither outer space nor the RMA is being completely neglected or ignored within DND, and concerns about the weaponization of outer space are evident in DFAIT. Nonetheless, the ability to understand and respond to either or both are significantly constrained. At the highest political levels, it appears that no attention is being paid to outer space whatsoever, especially given the absence of a cabinet sub-committee dealing with foreign and defence policy issues. More importantly, the *here and now* focus of DFAIT and DND under the current political conditions, especially with regard to investments, is a significant barrier to long-term strategic considerations. However, the implications for Canada of failing to move beyond the immediate horizon may be extremely significant. The political-strategic world of 2020 and beyond, and Canada's place within it, is likely to be much different from today, especially if the future, and with it outer space, is relegated to the margins in Canadian political-strategic thought and investment. The embryonic first stage of this new strategic world is the emerging with missile defence. The next stage will be space control.

Endnotes

1. Bernard Brodie, *The Absolute Weapon: Atomic Power and World Order*, (New York: Harcourt, Brace, 1946), p. 76.

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9. For details, see James Fergusson, *Deja Vu: Canada, NORAD, and NMD*, (Occasional Paper #38. Winnipeg: Centre for Defence and Security Studies, 1999).

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Aerospace and Cyberspace: The Transformation of Small Air Forces©

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Introduction

If the Air Force understood itself to be organized, not around the aging technology of flight but the nascent technology of top sight, it might be able to play the continuous roles-and-missions debate in a far more constructive manner. Like any shrewd firm, it would cast off low-information missions in favor of high-information ones, strengthen its core competence, and position itself for vigorous institutional life well into the next century, all the while contributing to fostering jointness without risking its own identity.

" . . . Or Go Down In Flame?: Toward An Airpower Manifesto for the Twenty-First Century"

This presentation advances hypotheses that are bound to aggravate some. Hence I am delighted to accept the College's promise of non-attribution. The views I will express today are my own. They do not represent the views of Toffler Associates® or of any of our customers.

Several years ago when the outlines of how information—especially space-derived information and information operations—could transform warfare became clearer, a renegade band arose whose mission remains to attempt to transform Airpower in the 21st Century. The target of transformation has been the United States Air Force (USAF), not only the world's largest, but also at present the world's most capable air force. That transformation in Airpower, when it occurs, pivots on appreciating the roots of airpower's contribution to warfare and returning to those roots in the 21st century context. Sadly, this campaign to enrich thinking in the USAF has not been successful and the mission is unfulfilled. Since I support this band, I am here today on a recruiting drive.

Why ought you join the merry band of rebels? Because, and perhaps much to the chagrin of the USAF, a "revolution in military affairs" actually *requires* critics, rebels, and revolutionaries at some point. The need for rebels is acute, because if Douhet is correct that victory smiles on those who appreciate the coming changes in warfare and anticipate them, then it is also true that victory may frown on and then elude the wrong-headed. If the USAF is wrong-headed, and I believe it may very well be, then a David is somewhere in this Goliath's future. To avoid that, would it not be far better for allies and friends to join the rebellion, undertake the transformation of their own air forces, and thereby show the USAF the possibilities? Failing that, I'm afraid that smaller air forces may become what they most fear: in the worst case they're inexpensive and trivial knock-offs, using second-rate exportable

technologies, and utterly dependent on the United States Air Force.

So, at least two things need to be avoided. First, easily allowing today's stewards of airpower to act in ways that assure the future irrelevance of airpower. And second, the trivialization of any friend's contribution to the maintenance of security in the 21st Century. Toward that end the thesis of this discourse is that small air forces can transform themselves and acquire disproportionate power by capitalizing on the advantages that competence in aerospace and cyberspace operations can bring. The revolution in airpower can begin, and most likely will begin, in a small air force. Unlike the United States Air Force (described by one of its former Chiefs as a "full service" air force), with its numerous legacy systems and massive bureaucracy, smaller air forces may be more agile in adaptation and hence more easily ready for transformation. To choose to remain miniature versions of the larger United States Air Force will doom smaller ones to irrelevance. They will become not the partners of the United States Air Force, but the hewers of its wood and the carriers of its water. The time to begin the transformation is now. Sometimes looking back is useful in helping look forward in that it illuminates where we have been.

A Simple Tale: From Whence Did "Airpower" Come?

Airpower's Roots

If one dismisses the Icarus and Dædelus fables as legends, then airpower probably began with balloons. The "hot air" balloon was an innovation whose ability to change the way in which battles were fought was clear from the beginning. So clear, that von Moltke, who also saw the potential and the pitfalls of trucks, rail, and telegraph made these comments:

> Observations should be carried on for several hours. It is absolutely necessary that the balloon be kept stationary, like a kite on a string. The technical possibilities of this must be investigated since strong and changing air currents can place the balloon at an angle that halts observation.
>
> If a balloon cannot be made stationary, its entire usefulness disappears.[2]
>
> General Helmuth Karl Bernhard von Moltke, circa 1859-1868

Von Moltke was a military genius, but his prejudices were those of a soldier. Like Wellington, the soldier's goal was to see what was occurring on the "other side of the hill" by creating a higher hill. The balloon was airpower's first artificial hill. Balloons—nascent Airpower—gave advantages to soldiers by providing information about the enemy merely by extending soldiers' lines of sight. *Let me repeat that: the genesis of airpower was in the quest for better information about the enemy.* Stationary balloons were followed by moving balloons, von Moltke's admonition notwithstanding.[3] Moving balloons went where the information about the enemy was—near the front lines—so they operated at risk. They were vulnerable to gravity, to "strong and changing air currents," and to ground fire. They also were vulnerable to technology. The mastery of the scientific principles and sciences that make flight in heavier-than-air vehicles possible[4] is more

complex than those that make lighter-than-air ballooning possible, but not so complex that someone did not break the heavier-than-air code—Santos Dumont, the Wright Brothers, some Russian, whoever. Pursuit aviation was born.

Pursuit airplanes were anti-information systems. The strategic aim, the "meta-logic" of pursuit, was to deny the enemy information by driving off and harassing those airmen who would collect it. The quest for air superiority began not as the chase for anti-ground attack capabilities, but as the search for effective anti-information capabilities. *Let me repeat that also: the roots of air superiority were in the anti-information mission.* They were not in the von Richthofen or Bong "Hey, let's all be aces!" mission or in the Harris and LeMay "bomb 'em back into the Stone Age" mission, as fond as we are of both of those missions.

Pursuit was the beginning, but technology advanced relentlessly (and, by way of warning, continues to advance). Soon flyers had the bomblets and bombs (and pilots or observers provided the hand-eye coordination) necessary to drop explosives on the enemy from on high. The notion of aerial bombardment initially was not so much a notion of using airpower to "reach"—even the artillery of the First World War had an enviable reach—as it was to use airpower *to match reach with certain knowledge:* to avoid expending ordnance stupidly. Stupidly, in this case, means dropping bombs or lobbing artillery shells where the enemy isn't.[5]

In the Second World War airpower was less able to match reach with certain knowledge in the extended theaters spanning the geography of the Pacific and Europe. And, indeed, there was a relaxation of the need for certainty. In that "total war" the only good enemy was a dead enemy and unfortunately the enemy was defined by gross geography more than precise legal status. Witness Coventry. Witness Dresden. Witness Tokyo, Hiroshima, and Nagasaki. In fact, airpower killed more civilians in Germany than *all* American and British (including Commonwealth) wartime casualties, and in "Japan more people were killed in six months of heavy aerial bombardment than in the whole United States war effort."[6]

The exigencies of that War demanded that the technologies of knowing be less important than the technologies of production. Superb generalship did not "win" the Second World War for the Allies or for its air forces. Mass production and brute force did.[7] John Ellis notes that "the prosaic arithmetic of natural resources, generating capacity, industrial plant and productivity was to be incontrovertible."[8] Airpower went down the path of industrial production to create enemy attrition, a path the institution failed to stray from until Desert Storm. Desert Storm showed the value of knowledge. The technologies glimpsed in Desert Storm will, fueled by commercial progress, begin their ascent in the next decade. There are markets for information systems. There are fewer buyers for warplanes.

Consider the proofs, that airpower always has been and always will be about acquiring superior information for the Good People and denying information to the Bad People. Technologies now exist that make matching that superior information to the weapons that can hurt an enemy, wherever and

whenever an enemy needs hurting, a "joint" job, not exclusively an air force job. Navies can strike deep with aircraft and missiles—and do. Armies, ground forces, including naval infantry, can strike the enemy's rear with artillery, missiles, and rotary wing air forces—and do. Hackers can render objects in the enemy's homeland, "deep targets" if you will, dysfunctional—and do.

Add to this our concern for our own aviators and the enemy's non-combatants and you have what will soon be an intractable set of problems for Old Airpower: the technologies of long-range precision strike are providing suitable substitutes for strike aircraft; the technologies of unmanned air vehicles (UAV) offer weight and other (cube, maneuverability, infrastructure, mobility, and footprint) advantages over manned aircraft; the numbers of new manned aircraft decrease in tandem with their cost increases; air defenses become ever more lethal; and no one is stepping up to the responsibility to be master of knowledge production. Thus, by what inexorable logic has the USAF concluded we must have the F-22. To protect friendly missiles? To kill bad UAVs or protect good UAVs? Forgive my incredulity, but were I younger I would ask "So what?"

Okay, but so what?

"So what?" is the most important question we can ask. (However, asking "So what?" outside an academic environment is often misunderstood and likely to be dangerous. Speaking truth to those in power is an acquired skill and, unfortunately, few in the military acquire it.[9]) So what do we make of these proofs from my rendering of airpower's history? I argue that what we ought to appreciate from this abbreviated history are five unchanging things that not only characterize the roots of airpower but also forecast its evolutionary or revolutionary future. They are:

1) *The vantage that Airpower provides is its principal advantage.*[10] The higher the elevation, the better the view. "Airpower" is the military power exercised in that indivisible medium of aerospace, the vertical dimension from the surface of the earth to the edge of the universe, and in all the cyberspace. Airpower provides the power of knowledge.

2) *The advantage of vantage is more or better information.*[11] The earth, after all, is round and its surface is curved. There are terrain and cultural features that obstruct the line of sight of even tall humans. Operating in the full vertical dimension offsets some of the horizontal disadvantages of the geometry of the planet. Technologies improve sensing year after year. Computing power follows Moore's law. Given the right impetus, vantage will accrue greater and greater advantages for those airpower serves.

3) *Airpower was created to satisfy the need for information.* As much as we would like to believe that our roots are in "one-v-one" or "bombs on target," the simple truth is that airpower began by serving and serves still to penetrate secrecy and resolve ignorance in the terrestrial realm. Airpower (and its included aerospace power and cyberspace power) are about *having the knowledge necessary for applying force* to the enemy's nodes, processes, webs, intersections, and unions to impede the production,

transportation, and control of enemy combat power.

4) *Airpower changes as technology provides the wherewithal to do new things or to substitute means to achieve the same ends.* Science and human creativity gave us aircraft. Science and human creativity also will give us unattended aircraft like the Unmanned Combat Air Vehicle (UCAV), superbly lethal ground-based defense against all kinds of air vehicles (including the UCAV), applications of nano-technology which will include more sophisticated missiles and other miniature air vehicles, what the Secretary of the United States Navy describes as "non-explosive weapons,"[12] next-generation radio-frequency weapons, all kinds of information warfare capabilities, and bio-technology applications and weapons that can and most assuredly will change much about warfare. Simply put, we used to employ battering rams and arrows. We still knock down walls and hurl projectiles at the enemy, but the technologies for doing this have improved.

5) *Finally, history shows that investing in the wrong things is not a problem unless others are investing in the right things.* We see this every quarter in the private sector. Applied to Airpower and said another way, some one, some group, some nation will take airpower the next competitive step function leap forward. As much as the aircraft looks unlike the balloon and the satellite unlike the aircraft, the next technologies that reify a revolution in airpower may look like the means to sluice the zeroes and one's of precise knowledge across the realm of defended cyberspace.

Taken together what I think all of these may mean is that the USAF may have taken a wrong turn with its single-minded (for itself) and potentially divisive (for its air allies and for its ground and sea partners) pursuit of the F-22. It is single-minded because apparently there is no sacrifice that the USAF is unwilling to make, no element of force structure it is unwilling to forgo, no programs it is reluctant to kill or push to the right (even including, one must suspect, the Joint Strike Fighter), and no amount of money it is unwilling to spend for the ever-more-costly F-22. When one thinks of the larger aerospace and cyberspace opportunities and the risks of neglecting them[13] one cannot but help think of the climate, the preconditions, that caused the dissatisfied United States Army Air Corps to splinter from mother Army and become a separate Air Force.

But even if the F-22 is not largely technologically obsolete by the time it is fielded, it may very well be nearing irrelevance: airpower's dreadnought, dreaded by none.[14] By the time the F-22 comes into service, it may very well be that air superiority can be assured by surface-to-air missiles, inimical lines of code, and electromagnetic energy emanating from the land, the sea, and the air. Among the more dastardly adversaries, air superiority also could be enabled by biological or chemical substances that prevent F-22 ground crews and aircrews from getting airborne. But the universe is large: perhaps we should not lament that for lack of vision an air force here or there will wither away.

On the other hand, true *aficionados* of Airpower fear that an entire air force,

at one time the best in the world, is being overtaken by its unyielding devotion to its phantasmagoric vision of "Those Magnificent Men In Their Flying Machines". What's to fear? That the air force of one country is wrongheadedly pursing this or that phantasm does not stop the right-thinking Airpower advocates of another country from taking a different course. What might that course look like?[15]

Okay, So Where Should Airpower Be Going?

To the Infosphere through Cyberspace…

Airpower is about information, so airpower should be moving into space and cyberspace. Airpower should command the "infosphere" described by Alvin and Heidi Toffler in *Powershift*. Information warfare is the great new discovery true *aficionados* of Airpower need to welcome. Military technology gave us computing machines, and computing machines gave us awareness that things in the external world could be reduced to combinations of zeroes and ones. This understanding launched the Information Age. These combinations could be transmitted electronically as data and recombined upon receipt to form the basis of information. According to the work by Arquilla and Ronfeldt, "information" is more than the content or meaning of a message. Rather, information is "any difference that makes a difference."[16] Awareness that almost everything[17] of military significance in the external world could be reduced similarly launched the age of information warfare.

Information warfare is troublesome for the established institutions to "get," because key facets of it are indirect and subtle, not direct and brutish. Information warfare is a form of conflict that attacks information systems—carbon and silicon—as a *means* to attack adversary knowledge or beliefs. Information warfare can be prosecuted as a component of a larger and more comprehensive set of hostile activities—what Arquilla and Ronfeldt call a "netwar" or cyberwar—or it can be undertaken as the sole form of hostile activity. Information warfare can occur *in* war and it can occur *outside of* war.

How easy or difficult is engaging in information warfare in and for the cyberspace? The basic requirements are easy according to experts.

> Offensive IW, in brief, uses computer intrusion techniques and other capabilities against an adversary's information-based infrastructures. The Commission [US President's Commission on Critical Infrastructure Protection] is aware of little in the way of special equipment required to launch IW attacks on our computer systems; the basic attack tools—computer, modem, telephone, and software—are essentially the same as those used by hackers and criminals. And compared to the military forces and weapons that in the past threatened our infrastructures, IW tools are cheap and readily available.[18]

Others suggest, perhaps unwittingly, that many of Airpower's old targets (power grids, transportation infrastructures, C^2 or C^3, etc.) are cyberwar's domains now. A RAND report notes that

> In the future, the possibility exists that adversaries might exploit the tools and techniques of the

> Information Revolution to hold at risk (not for destruction, but for large-scale or massive disruption) key national strategic assets such as elements of various key national infrastructure sectors, such as energy, telecommunications, transportation, and finance.[19]

This is not to say that the USAF lacks the thinking or the intellectual tools to see cyberwar in their Air Force's future. It has thought about this, developed doctrine about this, but, one must suspect that given the resources going to the F-22, done very little about this. Carefully read what USAF doctrine advances. This doctrine describes Information Warfare (IW) as:

> …information operations conducted to defend one's own information and information systems or attacking and affecting an adversary's information and information systems. The defensive aspect, defensive counterinformation, much like strategic air defense, is always operative. Conversely, the offensive aspect, offensive counterinformation, is primarily conducted during times of crisis or conflict. Information warfare involves such diverse activities as psychological operations, military deception, electronic warfare, both physical and information ("cyber") attack, and a variety of defensive activities and programs. It is important to stress that information warfare is a construct that operates across the spectrum, from peace to war, to allow the effective execution of Air Force responsibilities.[20]
>
> ***
>
> IW is information operations conducted to defend the Air Force's own information and information systems or conducted to attack and affect an adversary's information and information systems. This warfare is primarily conducted during times of crisis or conflict. However, the defensive component, much like air defense, is conducted across the spectrum from peace to war.[21]

One can forgive the unimaginative constructions and the cloned taxonomy. Note however that this relatively uncomplicated conception, new nonetheless, poorly masks a new admission—repetition reveals it—that this new kind of *warfare* and warlike operation is not restricted to *wartime.* Offensive information warfare, "offensive counter-information" as the USAF calls it, is "primarily," but not necessarily *exclusively* conducted "during times of crisis or conflict."[22] This kind of warfare is new, and the new always has been a challenge and vexation to militaries.[23] Operations in the cyberspace are harder to grapple with and concretize than F-22s, or missiles, or satellites.

Thus the future of airpower may be neither air superiority fighters, air-delivered long-range precision weaponry, nor even unmanned aerial vehicles, but a new discovery. The new discovery, the potent "new intangibles" of cyberspace operations[24] do not eliminate the old "things" of fighting past or fighting present, but they now allow old things — like air superiority fighters — to be augmented, complemented, or in some cases replaced by new things.

If the future of airpower is to command the cyberspace, then the high reaches of the aerospace must be commanded first.

Organizationally "space" in the United States is a bureaucratic jumble of organizations and acronyms, all characterized by oftentimes apparently competing aims, continuous finger-pointing, and all the normal palace intrigues of inter-

Puzzlement over or perhaps dissatisfaction with the way in which the United States Air Force superintends space has caused the United States Legislative branch to begin two inquiries and appoint two "commissions": the "Commission To Assess United States National Security Space Management and Organization" and the "National Commission For The Review Of The National Reconnaissance Office.[26]" The "Space Commission" will:

> …review the following:
>
> (1) The relationship between the intelligence and nonintelligence aspects of national security space (so-called 'white space' and 'black space'), and the potential benefits of a partial or complete merger of the programs, projects, or activities that are differentiated by the two aspects.
>
> (2) The benefits of establishing any of the following:
>
> (A) An independent military department and service dedicated to the national security space mission.
>
> (B) A corps within the Air Force dedicated to the national security space mission.
>
> (C) A position of Assistant Secretary of Defense for Space within the Office of the Secretary of Defense.
>
> (D) Any other change to the existing organizational structure of the Department of Defense for national security space management and organization.
>
> (3) The benefits of establishing a new major force program, or other budget mechanism, for managing national security space funding within the Department of Defense.

The "NRO Commission" will examine

> …the current organization, practices, and authorities of the NRO, in particular with respect to —
>
> (1) roles and mission;
> (2) organizational structure;
> (3) technical skills;
> (4) contractor relationships;
> (5) use of commercial imagery;
> (6) acquisition of launch vehicles, launch services, and launch infrastructure, and mission assurance;
> (7) acquisition authorities; and
> (8) relationships with other agencies and departments of the Federal Government.

Permit a few polite questions. Why two parallel, and indeed in some ways overlapping inquiries? Is it because the United States Senate and House of Representatives believe that the USAF[27] is doing such a great job of space stewardship that they need a statutory means to commend it? If so, then is the Space Commission examining potential benefits of "an independent military department and service" apart from the USAF or a "corps" within the USAF merely to banish these bugaboos from polite discussion for a few years? Or will the Space Commission surprise us?

I do not know what the Commissions will find. Does it matter? Not really. Most likely, the United States Air Force will "grow" space capability willingly if its budget is increased. Maybe this is the gambit? But if not given additional resources, the priority given the F-22 will be higher than the priority USAF

can or will give space. The 360-ship United States Navy cannot step up to the responsibility[28]. The revitalized United States Army cannot.

Thus the conundrum: the USAF is so locked-on to the embellishment of atmospheric airpower that it cannot embrace a larger vision of airpower, but there cannot be a larger vision for airpower unless airmen advance it. Where shall we find those airmen?

Small Air Forces Can Lead the Way

Size does count…

The hope of the future of airpower-writ-large may reside in small air forces. Size counts in a way that is counterintuitive. One would think that an air force with 360,000 people, over 2,600 fighters, and funded at $US 75 billion would have more options than an air force of 15,000 people, about 140 combat aircraft, and funded at some small fraction of $US 7 billion.[29] But such is not the case. Smaller allied air forces may have distinct advantages because they *are* small. In this category I put the dear friends of the United States—Canada, Australia, Great Britain—and to them would add Israel, the Scandinavian air forces, the Dutch, the Belgians, the Italians, and perhaps even the Germans and the Japanese.[30] Small air forces do not have to accommodate to the same levels of bureaucracy that larger air forces do. They are not, and what a blessing, headquartered in Washington DC. Small air forces are freer to innovate. They use "guile and ingenuity to solve problems" and their "chain of command is lean, unstructured and goal oriented—typical more of a start-up than a military bureaucracy."[31] Innovators and the managers of innovation know that it is always a messy process. But Howard Sherman and Ron Schultz offer this consolation and admonition:

> As information-gathering and – utilizing systems, we humans need to realize that coherent information flows within the fluid context of the complex, not in the solid walls of controlled order. The most powerful and innovative location within that realm is at the edge of chaos. At this critical juncture, just this side of the phase transition into chaos, the greatest opportunities for innovation exist. Mining along this outpost on the edge of confusion may seem dangerous, may go against every wall-building, safety-seeking instinct we have, but it is here that information thrives and the surprise of innovation is commonplace. Organizations must learn to operate along this precipice so that they neither fall into the total disorder of chaos nor are inundated by the overburdened infrastructure they have built to protect themselves.[32]

I believe that the USAF has both a "safety-seeking instinct" and an "overburdened infrastructure."[33] I have learned not to be disappointed when there is little innovation there. Although any one of the small air forces could leapfrog ahead,[34] should one expect Canada to be in the vanguard? Australian airmen assure me it will not be them. The air forces of Canada and other sovereign states must draw their own conclusions. Perhaps there are no conclusions to draw save that "the merits of joint operations and the merciless imperatives of economic efficiencies increasingly determine the agenda" of small air forces. They are *not* free to choose. Perhaps small air forces make a virtue of necessity and assert that they *want* to remain miniature versions of

the larger USAF, even if it means running the risk of irrelevance. Perhaps goodwill is more important than anything else. These are matters about which only those invited to advise should advise.

But taking Canada as an example, and hypothesizing that advice *were* sought, what would be a path to revolution? There are at least five steps. First, do the headwork before beginning the footwork. The Canadian Forces College, like the Airpower Studies Centre in Australia, can be the incubator for forward thinking, audacious thinking, about revolutionary transformations of airpower in the 21st century context. Build bridges with every Staff College and War College you can. Discuss these things openly with friends and potential adversaries alike. Take a systems approach. Think in terms of the metasystem.

Take advantage of your differentiation, too. Canada's armed forces also have the experience of what is good and bad about unification and integration—ask any naval officer—and the "happy compromises" actually required to make jointness work. In close collaboration with ground and sea forces, airpower advocates would begin the thinking that lays the foundation for future airpower concepts of operations—which must come first—and future doctrine. (I am not, by the way, persuaded that you have not begun a version of that process already.) Then test the concepts. Be open to criticism. *…but brains, cunning, and chutzpah count more!*

Next, second, and only when the initial thinking is largely done, put your friends on notice that changes may be imminent and that negotiations will follow. Get shrewd and canny business advisors to help you craft the "deals" you will have to make. Inventory what you have to offer that others cannot do without.[35] Know your trade space and the offsets you want, and trade and barter what you have for what you need for transformation.[36] If you have "spies," and I only presume that you do, trade their services for other collection technologies and systems you do not have. Be tough with the Big Players. Keep in mind that other air forces may be giant, but they are merely the instrumentality of another sovereign State, and States are equally sovereign even when they are not equivalent in size or wealth. Such is the law that binds us all.

Put the word on the street that Canada's air force intends to move away from being an atmospheric air force and migrate to an infospheric force. I would go directly — as directly as the law allows — to Boeing's Phantom Works, Lockheed Martin's Shunkworks, the Hughes Research Center, Silicon Valley's entrepreneurs, and countless others who can help envision an infospheric air force. Aerospace firms in the United States, for example, are more innovative than their Government customers. They would be delighted with deals that spark innovation and put an outside-in pressure on their Government customers. Form coalitions with other like-minded small air forces. Create a buying bloc for procurements. But what does one procure?

Third, consider that one might begin by procuring a combination of co-produced[37] sensors and unmanned aerial vehicles for the intensive maritime patrol and

coastal defense missions.[38] This is a wonderful beginning. One might then re-role planned investments in aircraft upgrades and new aircraft acquisitions to planned procurements of revolutionary knowledge systems. Simultaneously, work the challenge of networking knowledge. Work with ground and naval forces to incorporate engagement systems into the knowledge network. Work with vendors (and your small air force buying bloc) to get the deals you need.

Fourth, move into space more deeply than Canada is already in space. If the United States has goofy export restrictions[39] that affect, say, a Canadian radar satellite, perhaps another nation that also has a small air force does not have such restrictions. Be tough in negotiations and willing to trade. If Iceland, for example, plans a missile defense system that might cause unexploded ordnance or biological weapon warheads to rain down on Canada, then demand that in fair consideration Canada have a say in and a piece of the space action. Be obnoxious when Iceland says "no."

Fifth, and finally, keep the pressure up on the United States Air Force. General Kinsman, for example, is a respected friend of General Ryan. Air Marshal McCormick of the Royal Australian Air Force is a friend both to General Kinsman and General Ryan. They all can talk, air chief to air chief. The F-22 is not Canada's issue nor Australia's issue, but the future of Airpower most certainly is. The Chiefs must talk about this. Eventually, like water wearing on rock, we *can* revolutionize airpower. If not us, then who? God forbid it be the *Unrestricted Warfare* crowd. God forbid the revolution be delayed much longer.

Conclusion

If I have not yet worn out my welcome, I suspect it may be like Wellington observed about Waterloo, "A damn near run thing." I will close. My recruiting drive does not end here though; it merely goes into a strategic pause. If you and I do not take it upon ourselves to revolutionize airpower, we will be like the soldiers of the 1930s — the ones who spent good Army money on research into gas masks for horses. The choice is ours. Do we have the guts to choose and the wisdom to choose properly? The time for transformation is now.

Endnotes

1. The views expressed are those of the author.

2. Daniel J. Hughes, ed., *Moltke On the Art of War: Selected Writings* (Novato CA: Presidio Press, 1993), p. 258. Hughes notes on page 257 that "The source of this essay is uncertain. It probably is a combination of previously unpublished essays."

3. Disagreeing with soldiers seems to be in the DNA of airmen.

4. Aircraft that could hover followed aircraft that passed at "high speed" through the air by at least three decades.

5. For those who believe "denial and deception" are new, one need only turn to nature for disputation.

6. R. J. Overy, *The Air War: 1939-1945* (New York: Stein and Day, 1980), p. 267.

7. We forget that the Red Army broke the back of the Nazi army by destroying 150 divisions with only modest support from the Allies. See John Ellis, *Brute Force: Allied Strategy and Tactics in the Second World War* (New York: Viking Penguin, 1990), R. J. Overy, *The Air War: 1939-1945* (New York: Stein and Day, 1980), and Graham Lyons, ed., *The Russian Version of the Second World War: The History of the War as Taught to*

Soviet Schoolchildren (New York: Facts On File, Inc., 1976).

8. Ellis, *Brute Force*, p. *xviii*. Ellis records that

…in the last 18 months of the war the Allies put onto the battlefield 80,000 tanks to the German's 20,000, 1,100,000 trucks and lorries to 70,000, and 235,000 combat aircraft to 45,000; in these same months the U-boats sank 630,000 tons of merchant shipping whilst the Allied shipyards turned out another 20,000,000 tons; between 1942 and 1945 the Japanese built 13 aircraft carriers, the crucial component of modern naval warfare, but the Americans built 137. The Battle of Production was virtually a walkover.

9. Eliot A. Cohen and John Gooch, *Military Misfortunes: The Anatomy of Failure in War* (New York: The Free Press, 1990). The authors advise that

Military organizations should inculcate in their members a relentless empiricism, a disdain for *a priori* theorizing if they are to succeed. The "learners" in military organizations must cultivate the temperament of the historian, the detective, the journalist, rather than the theoretical bent of the social scientist or philosopher.

10. My friend and colleague, the late Carl Builder, offered this insight years ago.

11. Frank Strickland, when reviewing an earlier version of these remarks observed, "The vantage of the heights gives one an advantage in sensing. Do not equate, however, that advantage with knowing. As you well know, sensing and knowing are two related but different things." He is, of course correct, sensing is a precondition for knowing. But because one cannot "know," what is unobserved or un-sensed, except through faith, the vantage of the heights is the vantage of knowing.

12. My "Have We Not Yet Begun to Fight?: A Talk About War's Future With Secretary of the Navy Richard Danzig," *Civilization*, February/March 2000, p. 61.

13. "DOD's Strategy For Communications Improvements Called Inadequate," *Inside The Pentagon*, March 9, 2000, p. 1. If the United States Air Force is the United States Department of Defense's "executive agent" for space, then these deficiencies suggest failures in vision, funding, or execution. They at least suggest other priorities.

> The [Defense Science Board] task force found no established and verified DOD-wide database of Joint Information Exchange Requirements, which made it difficult to assess DOD needs. However, the task force derived what it termed a "conservative estimate for the peak total [communications] capacity required for two major theaters of war," measured in gigabits per second (Gbps). The task force estimated that by 2010, the military will require 35 Gbps — "almost 20 times what was used in the (uncontested) Bosnia operation in 1997."
>
> This conservative estimate, the report adds, "far exceeds the total capacities of current and planned DOD communication systems, even when projected over the next decade."
>
> Other factors complicating DOD's ability to meet future requirements include spectrum allocation issues, "Title 10 arguments about who is in charge," and a "significant lack of 'systems' perspective and independent system engineering organizations within DOD to provide the necessary studies and analyses."

14. In the last several combat engagements involving the United States and the armed forces of other States, a legitimate response to Allied Airpower has been to *not* fly. We should seriously consider the possibility that an asymmetric response to Allied fighters in the future is to not fly or to rely on surface-to-air missiles as an enemy's response to our air superiority. As an aside, I recall a cartoon in the *New Yorker* magazine during the height of the Cold War era. It showed two Red Army marshals seated at a café in Paris, sipping wine, and gazing upward at intertwined contrails. The caption read, "By the way, who *did* win the air war?"

15. In reviewing an earlier version of this paper, Dr. Alan Stephens of the Airpower Studies Centre in Australia wrote:

> I think that air forces as we know and love them will continue to serve a useful warfighting purpose, but primarily in a 'tactical' setting. Increasingly the pursuit of strategic effect will be pursued via long-range precision missiles, space-based weapons, and cyberwar. (Post-Kosovo, I will be astonished if the next rogue state/organisation which takes on the rest of the world doesn't use an all-out cyber-attack. They'll be fools if they don't.) Air forces have no special competence or preordained place in any of those activities.

Permit me to add an inflection. The goal of armed force is to combine with other kinds of force or power to achieve strategic "outcomes," not strategic "effects." The distinction between the two notions is significant, especially for airmen who like to think in terms of "weapons effects." For airmen, "strategic weapons effects" often mean "big and widespread," as opposed to "tactical," which, of course, mean "local and little." Stealing a thought from the Russian lexicon, strategic operations "alter the course or outcome" of a struggle. All force elements, Airpower included, should strive for, be designed for, and be employed with the intention of achieving strategic outcomes. The dominant outcome sought is *not* "rapid dominance" (an idea fashionable in the US Defense Department now), but rapid "resolution." Resolution may or may not require dominance since dominance may not allow for resolution.

16. John Arquilla and David Ronfeldt, "Cyberwar is Coming!" *Comparative Strategy* 2 (April-June 1993), pp 141-65.

17. But not the internal world. There are some things of military significance—intentions and hostile will, for example—that await work undone in chemistry and biochemistry before they can be decomposed into the electrochemical impulses that can be reduced to zeroes and ones. That day will come. See Robert L. Solso, *Mind and Brain Sciences in the 21st Century* (Cambridge MA: The MIT Press, 1997), John Maddox, *What Remains to be Discovered: Mapping the Secrets of the Universe, the Origins of Life, and the Future of the Human Race* (London: The Free Press, 1998), and Steve Connor, "Science finds key to beating fear," *The Times Newspapers Limited*, February 22 1998.

18. *The President's Commission on Critical Infrastructure Protection*, October 1998, p. 30. Emphasis added.

19. "Executive Summary," *Strategic Information Warfare Rising* (MR-964-OSD), p. 1.

20. United States Air Force, "Foreword," *Information Operations*, Air Force Doctrine Document 2–5, 5 August 1998, p. ii.

21. Air Force Doctrine Document 2–5, p. 2.

22. We must appreciate that careful word choices have been made before doctrine is approved for publication. The choice of the word "primarily" appears significant to me.

23. Especially in the alliance context. See Maria Seminerio, "'Infowarfare' part of NATO arsenal?" *Ziff Wire*, March 26, 1999.

24. Alvin and Heidi Toffler, "Foreword: The New Intangibles," *In Athena's Camp: Preparing for Conflict in the Information Age* (Santa Monica CA: RAND MR-880-OSD, 1997), p. *xiv*.
None of this is to suggest that tangible, material resources and technologies are going to vanish in a puff of dematerialization. Obviously, things matter, and weapons matter more than most things. Software still needs hardware. Soldiers cannot eat data. Nonetheless, the fundamental relations between the tangible and what might be called the "new intangibles" are increasingly crucial to military effectiveness, in both waging war and trying to prevent it.

25. Martin Libicki and I asserted that space was the gateway to the infosphere and that commanding the infosphere required space capabilities. We described the problem this way in " . . . *Or Go Down In Flame?: Toward*

An Airpower Manifesto for the Twenty-First Century"

> The leap from an atmospheric to an infospheric Air Force is the next logical step, as paradoxical as it may seem. Air forces have always capitalized on speed, range, freedom of maneuver, and vantage that their medium provides. Yet, nothing travels faster than information. Nothing impedes the distances that knowledge can travel. Nothing makes movement more intelligent, economical, and fruitful than information. And nothing would provide the vantage that a metasystem provides. Atmospheric solutions sufficed until technology permitted multiple solutions from any medium. The metasystem, however, demands an integration of exoatmospheric components with those provided from the air and the surface. This is not the vision or role that the Army, Navy, and Marine Corps are in a natural position to advance on—although they may lay claim to bits and pieces, thereby frustrating the larger aim. This opportunity is the Air Force's to lose. Done properly, the issue becomes not so much "What is the future of the Air Force?" but "What is the Air Force of the future?"

26. Emphasis added. See H.R.1555, Title VII, Section 701, Intelligence Authorization Act for Fiscal Year 2000 (Enrolled Bill Sent to President) and Subtitle B, Section 911, Commission To Assess United States National Security Space Management and Organization.

27. The director of the National Reconnaissance Office also is an Assistant Secretary of the United States Air Force.

28. "30-Year Shipbuilding Plan Outlines Need For A 360-Ship Navy," *Defense Daily*, March 6, 2000, p. 1. The article states

> The 360-ship force level would provide for 15 aircraft carrier battle groups and 14 amphibious ready groups. Elements of that force structure include 134 surface combatants, 68 attack submarines, four SSGN strike variants of the Ohio-class SSBN submarine, four command ships, 14 SSBNs, 40 combat logistics force ships, and 16 mine warfare ships.
>
> Senior Navy officials have recently told Congress that, from a requirements perspective, the 300-ship Navy endorsed by the 1997 Quadrennial Defense Review is not adequate to meet the service's commitments.
>
> ***
>
> The annual funding required to sustain the force level of about 306 ships—as noted in the 1997 Quadrennial Defense Review—will require on average $14 billion per year. Funding spikes are expected for full funding of aircraft carrier procurement in FY '01, '06, '11, '16 and '19. Those spikes reach as high as the $20 billion mark.

29. The comparisons here are, of course, between the air forces of the United States and those of Canada. See *The Military Balance 1999/2000*, The International Institute for Strategic Studies (London: Oxford University Press, 1999), pp. 12-29, 49-50 and *The Military Balance 1998/99*, The International Institute for Strategic Studies (London: Oxford University Press, 1998), pp. 12-27, 47-48. The 1998 issue presents the United States Air Force Total Obligation Authority in Table 5, page 16. The 1999 issue does not have a similar Table.

30. I have omitted the French from this list only because regarding their air force, as in many other things, they must be considered as unique and very special. Nations that forbid using words and phrases like "e-mail" and "start-up" in official communications are very special indeed.

31. An excellent example is provided by Israel's armed forces. See "Successful Tech Start-Ups Utilize Techniques Learned In The Army," *Wall Street Journal*, March 6, 2000, p. 1.

> That, says Mr. Kalish and many of his clients, is why Israel's high-ts Ut lesh and mane

people and fighter jocks. The Israeli military, which is as informal as it is formidable, has served as the incubator for a generation of hugely successful start-ups, many of which use derivatives of classified defense technology and now trade on the Nasdaq Stock Exchange.

Limited in size and number, the Israeli army has survived by tapping every drop of its resources. It gives enormous responsibility to relatively junior officers and encourages them to use their guile and ingenuity to solve problems. The chain of command is lean, unstructured and goal oriented-typical more of a start-up than a military bureaucracy.

"It's in the nature of the Israeli military-that 'can do' attitude," says Benny Levin, a retired intelligence officer who helped found computer-software giant Nice Systems Ltd. "In a way, Israel is a start-up country."

32. Howard Sherman and Ron Schultz, *Open Boundaries: Creating Business Innovation Through Complexity* (Reading MA: Pereus Books, 1998), p. 69. See also Ralph D. Stacey, *Managing the Unknowable: Strategic Boundaries Between Order and Chaos in Organizations* (San Francisco: Jossey-Bass Publishers, 1992, John H. Holland, *Hidden Order: How Adaptation Builds Complexity* (Amsterdam: Addison-Wesley Publishing Company, 1995), T. Irene Sanders, *Strategic Thinking and the New Science: Planning in the Midst of Chaos, Complexity, and Change* (New York: The Free Press, 1998), Peter F. Drucker *Innovation and Entrepreneurship: Practice and Principles* (New York: Harper and Row Publishers: 1985), Dan Dimancescu and Kemp Dwenger *World-Class Product Development: Benchmarking Best Practices of Agile manufacturers* (New York: American Manufacturing Association, 1996), David M. Anderson *Agile Product Development for Mass Customization* (Chicago: Irwin Professional Publishing, 1997), Clayton M. Christensen *The Innovator's Dilemma: When Technologies Cause great Firms to Fail* (Boston: Harvard Business School Press, 1997), Jeremy Hope and Tony Hope *Competing in the Third Wave: The Ten Key management Issues of the Information Age* (Boston: Harvard Business School Press, 1997).

33. There are, for example, more people assigned to the staffs of *subordinate* headquarters of the United States Air Force than there are people in Canada's air force.

34. One reviewer disagrees, noting that is small air forces "the merits of joint operations and the merciless imperatives of economic efficiencies increasingly determine the agenda." Hence, the "defence forces of smaller countries…are ineluctably moving towards the 'tactical effects' component." See note 15 above.

35. Among these are your friendship and the consanguinity of shared values, access, a well educated workforce, a commitment to fairness and social equality, vast expanses for training and testing, the NORAD agreement, and purchasing power. There are others.

36. The People's Republic of China, for example, requires creation of an "institute" or "training facility" for every deal that allows access to Chinese production capacity (and its relaxed environmental and occupational safety laws) and Chinese markets. China also requires that firms doing business in China provide the exit or migration plans that eventually lead to Chinese control. If China, why not Canada?

37. Nothing precludes "sole source" arrangements with suppliers.

38. Canada, like Australia, has a huge coastline. Imagine a Canadian-Australian partnership to procure the suites of sensors and UAVs that watch those coasts.

39. It's arguable whether the restrictions proper are goofy or not, but the way in which they are managed in the United States would, I opine, have to improve to rise to the level of "goofy."

Historical Background of Canada in Space

Syndicate 5: Major Cliff Beattie (Chair), Major Sandra Baker, Major Tom Guttormsen, Lieutenant-Colonel Slawomir Kaluzinski, Major Don Leblanc, Lieutenant-Colonel Alain Parent, Major Pierre Ruel, and Major Mary Turkington

Introduction

Canada has had a distinguished history in the realm of space. Since the beginning of the modern "space era", Canada has been a "space faring" nation.[1] Being a northerly country, phenomena such as the Aurora Borealis and magnetic anomalies associated with the Magnetic North Pole, stimulated space-oriented research very early in Canada's history. This initial research laid the foundation for studies concerning the difficulties of radio communication in the north to the development of the CANADARM for the US Space Shuttle program.

Canadian achievements in space have been marked by exemplary scientific research, satellite engineering expertise, co-operation not only with the United States but also with a host of other countries and collaboration between government and industry. The emphasis has been not only on scientific research but also in commercial applications with Canada being a leader in satellite communication systems.

Canada's interest in space has primarily been related to its use for peaceful purposes. In accordance with international law, space treaties and agreements that Canada has ratified, the policy of the Government of Canada is to oppose placing weapons in space.[2] Historically, the Canadian military has had and continues to have a role to play in Canadian space endeavours, especially as space provides a unique opportunity for the Canadian Forces (CF) to exercise control over territory, airspace and sea approaches.[3] Ongoing efforts to explore the military uses of space will assist the CF in effectively exploiting this important medium.

Early Research

Communication throughout most of Canada in the first half of the 20th Century was reliant upon radio signals reflected from the ionosphere. Unfortunately, the phenomena of the Aurora Borealis or "Northern Lights" and location of the North Magnetic Pole in northern Canada, seriously degrades this form of communication.[4] Research on studying these phenomena was started as early as 1839[5] in Canada, which set the groundwork for further studies of the ionosphere and radio communications.

Throughout the Second World War, research programs were focused on the military. In Canada, the first systematic measurements of the ionosphere were made to improve naval radio communications and surveillance of transmissions from German U-Boats.[6] Additionally, improvements were made in reconnaissance photography for the

national photographic and survey program – a program for which the RCAF was responsible since its inception. In the field of aviation medicine, there were other advancements initially developed to satisfy military requirements that were later relevant to space research. In 1939, Sir Frederic Banting oversaw the formation of the National Research Council (NRC) Associate Committee on Aviation Medical Research to support research projects involving the protection of pilots and aircrew who were about to wage aerial warfare. The focus was on the physiological effects of acceleration and decompression, oxygen equipment, motion sickness and the "G-Suit" developed by Dr. Wilbur Franks.[7]

Satellite Programmes

Most of the military research that continued after the war was conducted at the Laboratories of the Defence Research Board (DRB) which were formed in 1947. It was at these laboratories that some of the major Canadian space programs were initiated. Two of these laboratories were amalgamated to form the Defence Research Telecommunications Establishment (DRTE) and it was scientists from DRTE who responded to an invitation from the US for international participation in their scientific satellite program, not long after the launch of Sputnik I by the USSR. The DRTE proposal was to design and build a complete satellite, which would, from a high orbit, monitor the ionosphere from above. This proposal was acceptable to US National Aeronautical Space Agency (NASA) which agreed to provide the launch facilities.

The Canadian team, led by John Chapman, built a satellite from scratch with an emphasis on reliability. The resultant Alouette I was an unqualified success both scientifically and from an engineering perspective. The satellite was launched 29 September 1962 and although designed to operate for only one year in space, it "in fact operated for 10 years, vastly exceeding even the most optimistic expectations."[8] Canada became only the third nation to have built its own satellite for orbit and Alouette was the first spacecraft to be built entirely by a country other than the US or the USSR. The value of the Alouette program was not only the significant amount of scientific data it generated about the ionosphere, but also equally important were the technical competence, confidence and credibility that it gave to Canadian scientists to undertake even ambitious projects in space.

Following the success of Alouette I, the US and Canada embarked on a joint program to launch more satellites. The program was known as the International Satellites for Ionospheric Studies (ISIS) program and was managed at DRTE by David Florida, for whom the David Florida Laboratory in Ottawa was later named.[9] Individual satellites, named Alouette II, ISIS I and ISIS II, were built in Canada and were launched by NASA from 1965-1971. Several other countries also participated in this program by building ground stations.[10] Significantly, it was also during this program that the Government of Canada successfully transferred technology developed in government laboratories to industry with the intent of establishing a Canadian space-based industry with the economic benefits associated with a high-tech industry.

While activity on building satellites was focused at DRTE, another aspect of space research was being conducted in Churchill, Manitoba. In the early 1950s, American scientists were interested in probing the atmosphere near the auroral zone for comparison with data they had been collecting in New Mexico. Churchill, located in the auroral zone was ideal especially as it was accessible by rail and sea and the Defence Research Northern Laboratory and the Fort Churchill Canadian army camp were already located there. The DRB supported the US initiative and the US Army installed launch facilities for rockets. The first rockets, launched in 1955, were ground-to-air missiles fired independently by the Canadian Army as part of cold weather trials.

The launching of rockets at Churchill was conducted for more than 25 years and provided Canadians with a means of launching their own scientific payloads into the upper atmosphere. Altogether, the Americans fired 95 rockets from Churchill.[11] As the rocket program grew, the NRC eventually took over its management from the Americans and the expertise that had been developed in government laboratories was slowly transferred to Canadian industry. With the reduction of government budgets in the 1980s, the rocket program was gradually reduced and finally terminated in 1984.[12] The cancellation of this program "had a significant effect on the Space Science Program as it removed the only component of the program that had a relatively short time-frame between project initiation and launch."[13]

During the 1960s, it was evident that satellites could resolve the communications problems experienced in the north and provide other commercial services such as the delivery of television programs in both official languages. In 1967, the Government decided to refocus the emphasis of Canada's space programs from purely scientific to commercial applications. As a result, the Alouette-ISIS program was terminated and the scientific study of space in Canada seriously declined.[14]

Commercial Focus

With this refocus, Parliament passed an act on 1 September 1969 to create Telesat Canada, a government-industry corporation which would operate a satellite-based domestic communication system across the country. The first satellite of the system was designated Anik A, which was launched in November 1972. With that satellite, Canada became the first country in the world to have a satellite in geostationary orbit for domestic communications.[15] The system was successful in providing quality telephone service and television to every community in the country and in 1990, and the Anik E series of satellites became the most powerful domestic communications satellites ever launched.[16]

Teleglobe Canada, originally named the Canadian Overseas Telecommunications Corporation (COTC), is responsible for providing overseas communications. Initially using wireless radio and then cable, Teleglobe now represents Canada in Intelsat, the commercial, international satellite organization established in 1964, in which Canada has a 3 percent share.[17] Canadian stations are located in Mill Village, Nova Scotia; Weir, Quebec; and Lake Cowichan, BC. Teleglobe was also one of the founding members of

Inmarsat which provides improved maritime communications[18] and has been used extensively by the Canadian Forces on deployment and by ships at sea.

In 1967, Department of National Defence (DND) and Canadian Research Council (CRC) engineers collaborated on a project to evaluate the use of US military satellites for mobile services. The intent was to provide a mobile telephone service that would operate anywhere in Canada, using small, inexpensive terminals. A military system was not implemented in Canada; however, plans were made to offer a Mobile Communications Satellite (MSAT) on a commercial basis. The satellite was launched in April 1996 and provides cellular-like telephone service across North America including up to 400 km offshore, to portions of the Canadian Arctic, and to Central America and the Caribbean. MSAT links land mobile, aeronautical and marine phones with the terrestrial telephone network.[19]

The Hermes satellite program (also known as the Communications Technology Satellite (CTS)) was also a joint Canada-US program carried out from 1970 to 1980. The intent of the program was to develop advanced technology in high-powered satellite communications and included participation from the European Space Research Organisation (ESRO). The infrastructure investment that Canada made was the David Florida Laboratory that was designed and constructed specifically for the Hermes project.[20] Launched in 1976, Hermes was the world's most powerful communications satellite which led to powerful direct-to-home communications satellites in both the US and Canada.[21]

Specialized Programmes

Satellites were also perceived to be useful in the realm of humanitarian assistance. An international program was established to locate ships and aircraft in distress and in 1975, the feasibility of a satellite aided Search and Rescue (SAR) system was successfully demonstrated in Canada. The work was sponsored by DND and carried out at CRC. In a joint program, Canada, France and the US created SARSAT in 1979. These SARSAT partners co-operated with the USSR by incorporating the compatible Soviet system known as COSPAS into SARSAT. Canada provides some of the required SARSAT equipment including SAR repeaters developed by Spar Aerospace Ltd and the Local User Terminals (LUTs) for use in Canada and abroad, supplied by Canadian Aeronautics Ltd.[22]

Another innovation involving Canada was the Navstar Global Positioning System (GPS). Although a US developed system for primary navigation, Canada, represented by DND, signed agreements with the US to participate in research and development for the system. The Canadian Marconi Co. developed the GPS receiver for DND. Agreements were also signed with the North Atlantic Treaty Organization (NATO) countries to foster use and standardization of the system.

As early as 1969, the US invited Canada to participate in the US Space Transportation System (STS) program, more commonly known as the Space Shuttle. Canadians had previously earned credibility with NASA with their accumulated experience in space-related programs. This facilitated an agreement whereby Canada would pro-

vide the Remote Manipulator System (RMS) for the shuttle, more colloquially known as the CANADARM. The CANADARM was tested at the David Florida Laboratory and was first tested in space on the Shuttle Columbia in November 1981. The RMS is used extensively by astronauts on the shuttle to launch, retrieve and repair satellites and has proved to be extremely successful.

In 1982, 20 years after the launch of Alouette I, NASA opened the astronaut program to Canadians. Commander (later Captain) Marc Garneau, a Canadian Forces Officer, was the first Canadian to fly in space. His shuttle flight of October 1984 was of benefit to many Canadian scientists and the life-science experiments he conducted were all related to space adaptation syndrome. The Defence and Civil Institute of Environmental Medicine (DCIEM) and NRC sponsored these experiments.

RADARSAT, another joint project with the US, is used for remote sensing and has an all-weather, day/night imaging capability using synthetic aperture radar. The system has a resolution of between 8 to 100m and can provide data, which when combined with digital terrain data, will create a 3-D representation of any area of interest.[23] RADARSAT, in conjunction with the LANDSAT satellite launched by the US, provides Canada with a thriving remote-sensing industry used for natural resource surveys and studying the earth's surface.[24]

The next major project on the horizon is the International Space Station, "one of the most complex and ambitious technological undertakings ever conceived."[25] Canada was invited to participate in the project and will contribute the Mobile Servicing System (MSS). This system will assist in the construction of the space station as well as have an ongoing role to play in the maintenance of the station structure. Once again, this project will exemplify the team effort of both Government and industry.

Canadian Space Programme/ Canadian Space Agency

John Chapman, considered the "Father of the Canadian Space Program", was commissioned by the Federal Government in 1966 to prepare a report to establish the basis for a policy on space research. Known as the Chapman Report, it recommended among other things, the creation of a national space agency. This concept finally came to fruition in 1989 with the formation of the Canadian Space Agency (CSA), the centre of excellence for the Canadian Space Program.[26]

Objectives. The objectives of the Canadian Space Program are "to develop and apply space science and technology to meet Canadian needs and to foster an internationally competitive space industry."[27] To these ends, Canada has aggressively pursued satellite communications and remote sensing, space robotics and additional activities that will provide the greatest socio-economic and technological benefits.

Canadian Space Policy. The space policy framework stems from the CSA's legislated mandate "…to promote the peaceful use and development of space, to advance the knowledge of space through science, and to ensure that space science and technology provide social and economic benefits for all

Canadians."[28] The framework "confirms the strategic importance of space in Canada's transition to a knowledge-based economy and to the social, scientific, sovereignty, and foreign policy objectives of the government."[29] Canada's space vision is also derived from these objectives: to maintain and expand Canadian expertise in traditional areas of activity; to derive maximum social and economic benefit from Canada's activities in space; to foster regional development; to develop and use Canada's space infrastructure; and to private sector infrastructure.

Canada pursues a number of strategies in order to realize its mandate. These strategies, dictated by policy objectives and resource limitations, include specialization, or a niche strategy, industrial commercialization, partnerships, fostering excellence in science, and nurturing a science culture. Accordingly, the CSA has forged vital partnerships with other agencies including educational institutions, industry, defence, and international agencies such as the European Space Agency (ESA). The main areas of specialization include space robotics and automation (CANADARM), radar remote sensing (RADARSAT I and II), advanced satellite communications and space science.

New Space Program. Canada's new space program was approved in 1999 and is restructured around the following five areas of strategic importance to Canada:

a. Earth & Environment (RADARSAT 1 and 2);

b. Space Sciences (Life and Microgravity);

c. Human Presence in Space (International Space Station);

d. Satellite Communications (tele-education and -medicine); and

e. Generic/Enabling Space Technologies (miniturization of satellite payloads).

Testing and Integration. Canada is fortunate to have the world class facility of the David Florida Laboratory for testing space technologies. This facility has supported testing for the CANADARM, RADARSAT I and Canada's Mobile Servicing System for the International Space Station.

CSA and European Space Agency co-operative ventures. The history of co-operation in space-related activities between Canada and Europe predates the creation of the ESA. The co-operative venture first began in the early 1970s when the European Space Research Organization (ESRO) provided the solar cell panels and other components for the Canadian HERMES Satellite Program. The convention creating the ESA was signed in 1975 and, shortly afterwards, the first agreement between Canada and the ESA was ratified. The co-operation agreement, recently renewed for another term, establishes the framework for co-operation in the fields of space research and technology and their space applications. Areas of interest include satellite communications and remote sensing, particularly the framework for co-operation in space-related activities for exclusively peaceful purposes.

Canada's objectives for signing the co-operation agreement with the ESA included fostering collaboration

in science and technology development, pursuing synergistic benefits accrued by participating in large space projects on a cost sharing basis and fostering the competitiveness of Canadian industry. Recent studies, one of which was commissioned by the CSA, have shown that both partners have benefited not only from a technology aspect but also from an economical one.

DND and Space

The military had sponsored many of Canada's early space projects. "Prior to 1966, Canadian space projects administered by the military represented 41% of total Canadian expenditures on space." Subsequently, the program was "demilitarized" and the focus shifted to an emphasis on commercial applications. The CF has recently established a

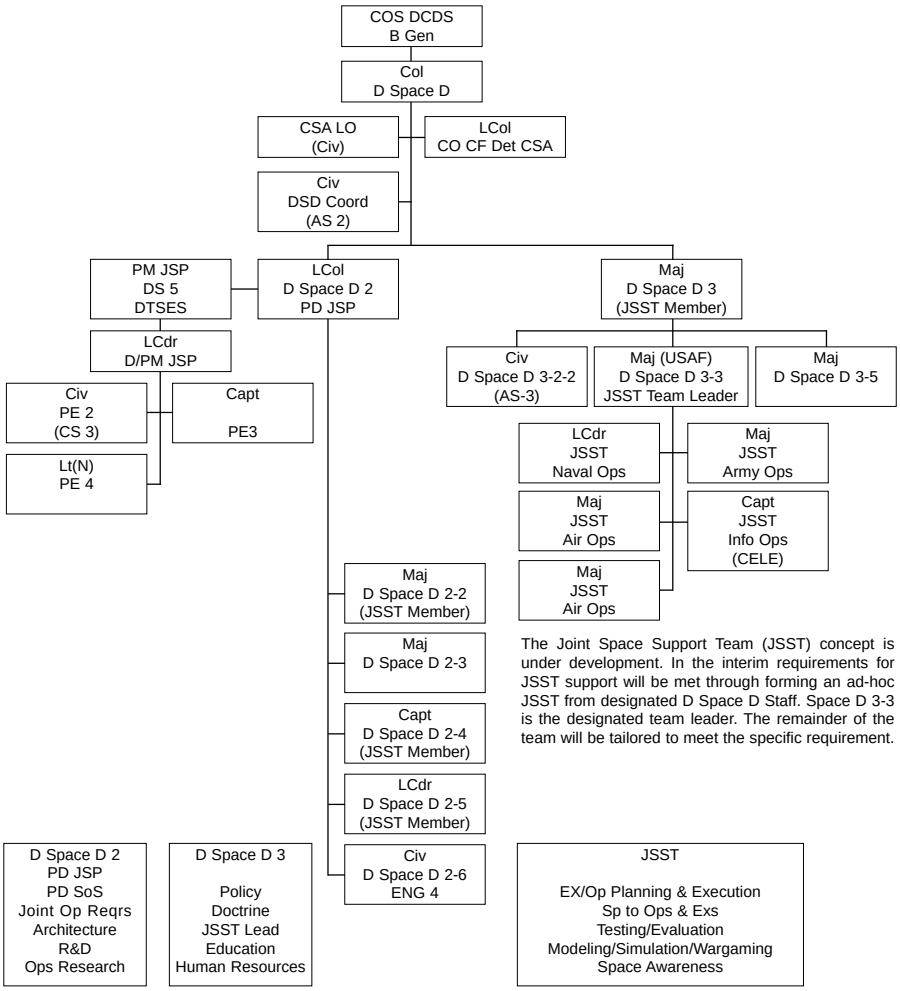

Figure 1. D Space D Organization Chart

joint Directorate of Space Development (D Space D) to coordinate all CF space activities, to develop space policies and doctrine, and to acquire a CF space capability.

The Directorate for Space Development is the focal point within the department for achieving CF goals in acquiring space capabilities necessary to support operations. This organization is responsible for providing input to CF space policy, developing a space education program and providing advice on space matters. It is currently involved in a variety of space-related projects and initiatives as well as coordinating with other organizations and government departments to ensure that the CF is appropriately prepared to make the best use of space to achieve national objectives. Currently, D Space D has a military liaison officer at CSA to facilitate co-operation between these two organizations. Additionally, CSA has a liaison position at D Space D which is not filled at present. D Space D's organization can be found at Figure 1.

Canadian Defence Policy

Canadian Defence policy is identified within the Defence White Paper, the last one of which was published in 1994, and is interpreted by DND within Defence Planning Guidance (DPG) 2000 and Strategy 2020. The White Paper, in particular, identifies that space is an increasingly important component of the global security environment and that "with the advent of missile warfare, the role of space in protecting the modern state has taken on added significance".[32] Therefore, Canada's military interest in space concerns the ability to use space, in conjunction with the other environments, to contribute to the defence mission.

Space and the use of space technologies have emerged as an increasingly important elements of Command, Control and Communications (C3) to the extent that "space activities are now key in supporting all operations in the [pursuit] of global security environment."[33] The intent of the Space Policy document promulgated in 1998 was to ensure that every aspect of Canadian military doctrine, activities, and programs relating to space accurately reflected the Canadian Government's direction. Accordingly, DND and the CF have identified three goals: to protect national security and sovereignty interests, to protect national interests from threats located in or passing through space, and to fulfil Canada's defence commitments by supporting missions and tasks using space technology wherever appropriate.[34] In addition, DND has identified that the CF will fulfil its defence commitments by using space technology wherever appropriate.

To pursue these goals, DND and the CF have identified a strategy that will:

a. use space where appropriate to project sovereignty and security, and the security of Canada's allies;

b. develop a capability to acquire and access space data of interest, and monitor activities in space in areas of national interest;

c. use space to support combat-capable, multi-purpose Canadian Forces and their world-wide development on joint and combined operations;

d. support arms control verification and security and confidence-building measures in or from space; and

e. participate in space-supported search-and-rescue systems.[35]

This strategy will be reliant upon the acquisition of space-based or space-related capabilities for success. Although limited by funding, DND's Long-Term Capital Plan (LTCP) has identified several projects that will provide the CF with appropriate capabilities. These are as follows:

a. Communication (CANMILSATCOM and Fleet SATCOM);

b. Navigation (NAVSTAR GPS, Position Determination for Land Forces);

c. Navigation Warfare (NAVWAR);

d. Search and Rescue (SARSAT/IOS project);

e. Intelligence Support (project TROODOS);

f. Weather Monitoring (under Joint Space Project (JSP));

g. Geomatics Support (under JSP);

h. Surveillance of Space (under JSP);

i. Surveillance from Space (under JSP);

j. Warning. Warning consists of the monitoring of man-made objects in space and the detection, validation, and warning of attack against North America whether by aircraft, missiles, or space vehicle;[36] and

k. Ballistic Missile Defence.[37]

DND and the CF will address space capability deficiencies through full co-operation with Other Government Departments (OGDs), Agencies and Allies. Priority will be given to the Canadian Military Satellite Communication (CMSC) project and the Joint Space Project. In light of the limited resources allocated to space in the CF LTCP, co-operative 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 ensures an equitable contribution to burden-sharing in the future. An important enabling mechanism will be a Statement of Intent concerning defence space co-operation to be developed between DND and the US Department of Defence.

Though Canada-US defence co-operation continues to serve this country's fundamental interests extremely well, certain arrangements require updating [in accordance with evolving challenges to continental security]:

a. Canada will contribute to aerospace surveillance, missile warning, and air defence capabilities at a significantly reduced level;

b. In the negotiations on the renewal of the NORAD agreement, Canada will seek to preserve its benefits and examine closely those areas that may need to change in accord with evolving challenges to continental security;

c. Canada supports ongoing discussions on the possible expan-

sion beyond North America of NORAD's missile warning function, and is interested in gaining a better understanding of missile defence through research and in consultation with like-minded nations; and

d. The possibility of developing a space-based surveillance system for North America in the next century will be explored, subject to a variety of military, financial and technological considerations.[38]

Although limited, Canada can increase its contribution, and enhance its current expertise by participating in the development of spaced-based radar (SBR) capability for NORAD. Its main role would be purely in the detection and identification of incoming threat to North America, contributing to Canadian airspace sovereignty, particularly in the Arctic. Since space-based radar is not bounded by ground-based radar conventions, the development and use by the CF of space capabilities would be in accordance with DND Space Policy. This in turn would maintain the appearance of being fully in accordance with International Law, signed Treaties and any other agreements, which Canada has ratified or supports.

In order to plan the way ahead for the development of space capabilities, a three-step approach was adopted:

a. First, a review of the current policy framework - to align it with the 1994 Defence White Paper and the 1996 renewal of the NORAD Agreement;

b. Second, acquiring appropriate space capabilities - to support our three elements, both in Canada in a national security and sovereignty sense, and in deployed operations; and

c. Third, enabling activities - supporting activities required to enable the achievement of the space capabilities. These activities include support to operations, co-operation with ODG and Agencies, collaboration with Allies, research and development, human resources and policy and doctrine development.

CSA/DND Cooperation

Canada's space program had been managed by a variety of government programs and committees and, although DND was represented by CRAD, the military had not been directly involved in Canada's efforts in space since the mid-1960s. This shortcoming was addressed in 1994 when the Canadian government directed that the CSA "pursue synergistic opportunities with DND."[39] The requirement to modernize the CF for the 21st century, and ensure interoperability with the US armed forces has further compelled Canada's venture into space to enhance capabilities in the areas of communications, navigation, intelligence, surveillance, warning, and defences.

Consequently, the DND and the CSA signed a Memorandum of Understanding (MOU) concerning space-related activities, in November 1995. This MOU is expected to be renewed this year. DND and CSA cooperative activities were initiated with the formation of a DND/CSA Space Cooperation Committee (SCC) to direct all cooperative activities between the

CSA and DND, the creation of four Ad Hoc Working Groups (AHWGs), and the establishment of Liaison Officers at the CSA and NDHQ. The SCC is co-chaired by representatives from both DND and CSA. In accordance with its Terms of Reference, the SCC is required to meet twice annually. The four AHWGs meet twice annually and report to the SCC. These four working groups are :

a. Research & Development. The objectives of this working group are to identify and pursue opportunities for joint research and development of space technology systems and capabilities, to identify and develop technical options for joint or dual-use space systems and capabilities, and to participate in strategic program planning and activity review;

b. Communications. The mandate of this working group is to provide a forum to identify common strategic goals and objectives for satellite communications and to determine how existing programs can be used to achieve these goals;

c. Earth Observation. This AHWG, originally called the RADARSAT AHWG, was formed to exploit cooperative activities regarding the use of RADARSAT I data and any follow on projects such as RADARSAT II; and

d. Education, Training & Development. The aim of this working group is to identify and exploit space related areas of common interest in this field. Activities conducted in this regard include the coordination of space awareness and indoctrination sessions and to identify joint space training and development courses.

INTERNATIONAL CONSIDERATIONS

The UN in Outer Space

The launch of the Sputnik I satellite in 1957 embarked mankind upon a journey of technological development in the quest to both explore and exploit space. The United Nations' (UN) interest in the peaceful uses of space also dates back to the launch of this first satellite.[40] In 1959, the UN exhibited a great deal of foresight when it established the General Assembly's Committee on the Peaceful Uses of Outer Space (COPUOS), along with two sub-committees, one to deal with legal issues and the other to address scientific and technological issues. The COPUOS currently has 61 members, of which Canada is one.[41] The COPUOS fosters international cooperation in those areas applicable both to the legal and to the scientific and technological aspects of space. The work of these committees has resulted in the development of five international treaties and principles that serve as the legal framework for UN member states to observe in their development and use of space technology.

The UN also established the Office for Outer Space Affairs (OOSA) which serves as the secretariat for the COPUOS and the two sub-committees. In addition, the OOSA is responsible for implementing the UN's Space Applications Programme. Common themes have emerged from the UN's interest in outer space. These themes are: the requirement for international cooperation to include developing states; that all states

should benefit from space technology; and that "space is the "province of all humankind and should therefore be used for peaceful purposes."[42]

Conference on the Exploration and Peaceful Uses of Outer Space

The UN has held three Conferences on the Exploration and Peaceful Uses of Outer Space. The first conference, convened in 1968, reviewed the progress of space based initiatives, and reiterated the requirement for international cooperation particularly for the benefit of developing countries. The efforts undertaken as a result of the conference eventually culminated in the creation of the UN Space Applications Programme, which applied space technology in the fields of communications, environmental monitoring and remote sensing. The second conference, convened in 1982, reviewed progress and focussed on the requirement for international cooperation.

The third conference, convened in 1999, was necessitated by the requirement to address both the post-Cold War world situation and the rapid advances made in space exploration and technologies. The main objectives of the conference, apart from enhancing international cooperation, were to identify methods of using space solutions to address significant regional or global problems and to enhance the ability of states to use the results of space research for socioeconomic development. Canada was a participant in this conference.

During this third conference, member states developed the framework of a strategy to meet future challenges and identified specific areas for action in the following categories:[43]

a. Protecting the earth's environment and managing its resources;

b. Using space applications for security, development and welfare;

c. Advancing scientific knowledge of space and protecting the space environment;

d. Enhancing education/public awareness;

e. Strengthening & repositioning of space activities in UN system; and

f. Promoting international co-operation.

Future Challenges. In summary, the UN has been active in promoting the peaceful uses of space. The UN has approved five international treaties, legally binding on ratifying states, and five principles, that serve as guidelines or standards. Canada has ratified four of five treaties. One of the main challenges faced by the UN is enhancing international co-operation, particularly for developing states. Another major issue that the UN will no doubt face is the increasing pressure to weaponize space. The US National Missile Defence Program may be just the beginning of such efforts.

Space Law

International Space Law has been formally established through a series of diverse treaties and agreements. The first step towards constructing this legal framework was undertaken in 1961 when the UN General Assembly Resolution 1721 (XVI) was adopted.

This resolution decreed that the UN Charter and international law applied to outer space.[44] The various resolutions that followed were subsequently formalized through the treaty process.

International UN Treaties. Since 1966, the UN has adopted five international treaties concerning the uses of outer space. These treaties not only regulate military activities in space but also stress the importance of using space for peaceful purposes for the betterment of all humankind; no state can appropriate any portion of space. These treaties prohibit the placement of nuclear weapons or other weapons of mass destruction in orbit around the Earth, on the Moon or on other celestial bodies. The treaties also prohibit the establishment of military bases, installations and fortifications on the same bodies. However, the use of military personnel in space is permitted. The treaties are legally binding upon those states that have ratified them. To date, Canada has ratified four of the five treaties; the exception is the Moon Agreement, which Canada has yet to sign.[45] The five treaties are:

a. Outer Space Treaty (1966). This treaty stipulates that the exploration of space shall be carried out for the benefit of all states, regardless of their degree of development. It also prohibits states from placing weapons of mass destruction, including nuclear weapons in space, establishing military installations in space, and/or testing weapons in space. Ninety-five states have ratified this treaty and 27 others have signed it;[46]

b. Rescue Agreement (1967). This treaty stipulates the assistance due spacecraft crews in the event of accident or emergency landing. The treaty also delineates the procedures for returning space objects to launching authorities. Eighty-five states have ratified this treaty and 26 others have signed it;[47]

c. Liability Convention (1971). This treaty stipulates, in basic terms, that launching states are liable for any damages caused by their space objects. Eighty states have ratified this treaty and 26 others have signed it;[48]

d. Registration Convention (1974). This treaty stipulates that launching states shall maintain registries of space objects and provide specific information regarding these objects to the United Nations for inclusion in a central registry. Forty states have ratified this treaty and four others have signed it;[49] and

e. Moon Agreement (1979). This treaty elaborates on the 1966 Outer Space Treaty. The treaty bans both the use of force on and the use of force from the Moon and other celestial bodies. It also establishes the basis for the future regulation of the exploration and exploitation of natural resources found on the Moon and other celestial bodies. Nine states have ratified this treaty and 5 others have signed it.[50]

Other Treaties. There are a number of other treaties, primarily bilateral agreements between the US and Russia (former Soviet Union), that supplement the treaties approved under the aus-

pices of the UN. The additional treaties include the Anti-Ballistic Missile (ABM) Treaty, the SALT I and II Treaties, the Threshold Test Ban Treaty, and the Peaceful Nuclear Explosions Treaty (PNET) to name but a few. These treaties are important because they seek to clarify the meaning of the "peaceful uses of outer space" dictum for the great powers. For example, the US views peaceful use as "non-aggressive" while Russia views it as "non-military"; distinctions that could create world tension.[51] The bilateral agreements permit the use of military satellites for arms control verification purposes. The US and Russia have also ratified agreements that permit the use of early-warning, communications, navigation and meteorological satellites. Another Treaty that can influence Canada is that pertaining to Environmental Modification.

Principles. In addition to the five treaties, the UN has adopted a number of "principles" which serve to further define the appropriate peaceful use of space. These five international principles have the legal status of General Assembly Resolutions, which means that the principles are not legally binding per se, as are the treaties. The principles serve as guidelines or standards regarding the peaceful use of outer space particularly for those states that have not signed the treaties. These principles established space as the province of all humankind, endorsed the sharing of information obtained through the use of satellites, and provided general standards regulating the safe use of nuclear power sources in outer space. The five principles are:

a. Principles Governing the Activities of States in the Exploration and Uses of Outer Space (1963). This was a precursor to the Outer Space Treaty. It established the basic components of international space law, including that exploration be carried out for the benefit of all states and that nuclear weapons be banned from space;

b. Direct Broadcasting Principles (1982). This principle recognizes the impact that international direct television broadcasting can have on other states' political, economic, social and cultural situations. Communication between the broadcasting and the receiving states is essential. Consequently, the principle endorses both consultation and the establishment of formal agreements between the states;

c. Principle Relating to the Remote Sensing of Earth From Space(1986). This principle reiterates the concept of international cooperation and using space for the benefit of all states. States must also be cognizant of other states' sovereignty and employ remote sensing accordingly;

d. Principles on the Use of Nuclear Power Sources (1992). This principle acknowledges that nuclear power sources are essential for some missions. Accordingly, the principle stipulates that these nuclear power systems should be designed so as to minimize public exposure to radiation in the event of an accident; and

e. The Declaration on International Cooperation in the

Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries (1996). This principle acknowledges the importance of international co-operation in the exploration and use of outer space for the benefit of all humankind.

Space Law and Canadian Policy

Table 1 provides a brief summary of those treaties primarily responsible for establishing International Space Law and, as such, they impact Canada.

Canada's position on the development of the Space Law regime through a series of treaties has been generally supportive. The Canadian policy has been one of strict adherence to the treaties and their intentions. This created some controversy with her southern neighbour during the 1980s. The issues of Anti-Satellite (ASAT) weapons, the Strategic Defense Initiative (SDI), and their relationship with the ABM treaty of 1972 have been the subject of challenging diplomatic and political considerations. Canada's efforts in arms control during the 1980s were not in line with the present policy of the US Government. A Canadian proposal to ban high Earth orbit ASAT systems was not well received by neither the US nor USSR at the time. An invitation from the US to join in the SDI research program was also turned down by the Canadian Government. Due to the unclear wording of the ABM Treaty, Canadian officials urged the parties to adhere to the intentions behind the

YEAR	TREATY	MAIN PRINCIPLE
1963	Limited Test Ban Treaty	Bans nuclear weapons tests in the atmosphere,on outer space, and under water.
1967	Outer Space Treaty	Space activities shall be conducted in accordance with international law, including the UN Charter
1968	Rescue and Return Agreement	Agreement on the rescue and return of astronauts and the return of objects launched into Outer Space.
1972	ABM Treaty	Prohibits development, testing, or deployment of space-based ABM systems or components (between the US & USSR)
1972	Liability Convention	A launching site is liable for damage caused by its space object to people or property on The Earth or in the atmosphere.
1974	Registration Convention	Requires a party to maintain a registry of objects it launches into Earth orbit or beyond.
1978	Environmental Modification	Prohibits military or other hostile use of environmental modification techniques as a means of destruction, damage, or injury to any other state.
1984	Moon Treaty	Agreement governing the activities of states on the Moon and other celestial bodies.

Table 1. International Space Law

agreement, namely banning all defensive systems. This was clearly a policy aimed at urging the US to limit the SDI to basic research, which is permitted within the ABM Treaty. Another Canadian initiative was taken toward the subject of verification from space. This included "peace satellites" that could be oriented towards space to space verification, and towards space to ground verifications. The initiative was part of the Canadian efforts to limit the arms race both in space and in general. Although the program never materialized as proposed, the subject of verification has been carried forward as a result of the Canadian initiative.

NATO

The use of space for military purposes has grown to the point where it is virtually inconceivable for any self-respecting force to exclude space-based resources from its overall military or strategic planning. In the past thirty years, the military use of space has generally been accepted. The next thirty years has the potential for us to witness a dramatic development - the weaponisation of space.[52]

There is no doubt that the whole question of the relationship between the military and space is about to take on new importance. If the philosophical debate of the 1960-80s was over the militarisation of space, then its successor in the 21st century will be the weaponisation of space. It is perhaps naive to think of space as entirely peaceful and non-military. After all, the use of the aircraft was initially conceived for peaceful purposes or at least not as weapons platforms; space seems to be following the same pattern. We have already seen the deployment of satellites with specific military purposes, whether for communication, navigation, reconnaissance and surveillance.[53]

This is thought of in the same way as previous generations contemplated and developed sea or air power. Indeed some would argue that the issue of the military use of space at the beginning of the 21st century is at a similar stage of development to that of air power in the early decades of this century. Many are aware of the importance air power has assumed in the past eight years. Take, for example, the current US position, which was forthrightly and explicitly stated in a Department of Defense (DoD) directive on Space Policy, issued in June. While it does not represent any significant change in policy, it does express very clearly Washington's view of the importance of space: space power is as important to the nation as land, sea and air power; and space is a medium like the land, sea and air within which military activities will be conducted to achieve US national security objectives.

Purposeful interference with US space systems will be viewed as an infringement on their sovereign rights. The US may take all appropriate self-defence measures, including, if directed by the National Command Authority, the use of force, to respond to such an infringement on their rights. Space capabilities shall be operated and employed to:

a. assure access to and use of space;

b. deter, and if necessary defend, against hostile actions;

c. ensure that hostile forces cannot prevent US use of space; and

d. counter, when directed, space

systems and services used for hostile purposes.

Given that this is Washington's policy, can other states afford to ignore not only the importance of space, but also the likelihood of its emergence as a new theatre of conflict? All states are increasingly dependent on space in one way or another. The information age and the application the increased use of technology in war fighting - the Revolution in Military Affairs (RMA) - have increased reliance on the space medium. The US is beginning to acknowledge this fact, which many have failed to recognise. The rest of the world is going to have to play a potentially risky game of catch-up.

The first thirty years of military space activity have seen its evolution from theory to practice, from the strategic to the theatre level. For example, during operations in Kosovo in 1999, satellite links permitted the redirection of aircraft to new targets while they were flying missions.[54]

In a relatively short time the integration of space and other assets will offer real-time information to individual combat units. Such a growth in the military usefulness of space will inevitably lead to increasing efforts to destroy the opponent's capability there. The advent of space power will produce demands for space superiority. At that point, it will become almost impossible to resist the weaponisation of space.[56] The US is developing space-based systems for insuring its military dominance. If these space-based systems became vulnerable, the vulnerabilities would be exploited and the US would defend itself. This situation could result in an arms race in space.

The Alliance's Strategic Concept (Washington 23 April 1999)

NATO is committed to a strong and dynamic partnership between Europe and North America in support of the values and interests they share. The security of Europe and that of North America are indivisible.[57]

The security architecture of Western Europe stems from the North Atlantic Treaty. Reliance on the US is a fundamental reason. The transatlantic partnership, which is at the heart of NATO, is the bedrock of European security, and, within the NATO framework, each of the member states contributes to the security of the others. In terms of military space capability, the US has undoubtedly, far and away the greatest panoply of space assets, and the truth is that the European members of NATO have seen little reason to duplicate such assets. With a few exceptions, the European allies have been content to assume that, when necessary, the US military space capability would suffice.[58]

NORAD

The North American Aerospace Defence Command (NORAD) has been a centrepiece of Canada-US defence relations for almost 42 years. For a relatively low investment, Canada receives great benefits and has a respected voice on defence matters related to the aerospace defence of the North American continent. NORAD started as an acronym for North American Air Defence Command. But with emerging technologies and threats, it has evolved to handle not only the threat from long range bombers but also from Inter-Continental Ballistic Missiles, which travel through space. Hence, NORAD

truly performs aerospace defence of North America, which implies missions with both an air and a space dimension.

The 1996 NORAD Agreement assigns two missions to NORAD: aerospace warning and aerospace control for North America. Aerospace Warning includes the monitoring of all man-made objects in space and the detection, validation and warning of attack against North America by aircraft, missiles or space vehicles. Aerospace control deals primarily with the air dimension of the aerospace defence of North America. It consists of the surveillance and control of the airspace of Canada and the United States.[59] Aerospace control is currently limited to the surveillance and control of air approaches to North America by air breathing vehicles only, but could be expanded to include defence against ballistic missile attacks.

NORAD evolved from an air defence organisation to an aerospace defence organisation[60] when the Command was assigned the role of supporting the American strategic deterrent and for providing unambiguous warning of a ballistic missile attack. Accordingly, the United States deployed the Defence Satellite Program (DSP) and the Ballistic Missile Early Warning System (BMEWS) and assigned them to NORAD. "NORAD's role was to determine if there was a ballistic missile attack against North America in order to ensure that the US NCA [National Command Authority] had adequate time to order, if necessary, the release of American strategic forces."[61]

In 1985, the United States formed the United States Space Command (USSPACECOM), as the single point of focus for all military space related issues. Consequently, USSPACECOM operates, through its various component commands,[62] all military space assets. In the case of NORAD's missions using space assets, NORAD is the supported command and USSPACECOM is the supporting command. For example, in the case of the ballistic missile warning mission, the DSP constellation is operated under command and control of USSPACECOM to support NORAD's Integrated Tactical Warning and Attack Assessment (ITW/AA) network. USSPACECOM provides information from space tools to NORAD where it is interpreted, validated, and assessed to ascertain whether or not North America is under attack. This information is then disseminated to the governments of Canada and the United States. The same could apply to the Space Surveillance Network as it relates to NORAD's missions.

There is a direct link built, by necessity, between NORAD and USSPACECOM. There is also a pseudo-formal link because the Commander-in-Chief of USSPACECOM, who is also the Commander-in Chief of NORAD, and the Commander of Air Force Space Command. All three commands are co-located at Peterson Air Force Base in Colorado Springs. The Deputy Commander-in Chief of NORAD is a Canadian Lieutenant-General; he also serves as the Chief of Staff of NORAD. For the purpose of maximum effectiveness, several key staff positions are dual-hatted NORAD/USSPACECOM, with Canadian personnel manning high level decision-making positions across the board. The Director of Combat Operations (N/J3) is a Canadian Major-General and, in this position, he is actively involved in the day-to-day decisions and operations of NORAD.

Canadians therefore wield considerable influence on the decision making process at NORAD and some influence with USSPACECOM due to the close relationship between the two commands. In fact, there are several MOUs between NORAD and SPACECOM that allow for Canadian personnel to serve in USSPACECOM, AFSPACECOM and ARSPACECOM positions related to the NORAD missions.

NORAD provides Canada and the United States with a mutually supporting aerospace defence for North America. The United States covers approximately ninety percent and Canada, ten percent of the operating costs.[63] For this relatively minor investment, Canada gains substantial access to several United States space assets that otherwise would be unthinkable to even consider acquiring due to the current reality of Canadian defence spending. The following are concrete examples where Canada has access to expensive and capable systems because of Canada's strategic relationship with the United States: the Defence Support Program; the Defence Satellite Communications System; the Defence Meteorological Satellite Program; the Global Positioning System; and the Space Surveillance Network and a network of intelligence space-based assets. NORAD is the centrepiece of this partnership, which has fostered trust and respect between the armed forces of Canada and the United States for close to forty-two years.

NORAD'S Vision

To ensure its future relevancy, NORAD has developed its vision for the year "2010 and beyond: Partners in protecting our homelands: deter, detect and defend against air and space threats to North America."[64] In this vision, the emphasis is on space as an enabler for four capabilities: precision tracking; precision engagement; integrated battle management; and focused logistics. These capabilities are envisioned to be achievable through information superiority, where information is being processed more and more through space satellites. Therefore, in order to protect information, space systems will also require protection.

If one accepts the assumption that present NORAD missions, which are valid today, will be valid in the future, it should also be assumed that emerging threats would require new missions for NORAD to perform, if the aerospace defence of North America is to remain credible. Arguably, North America presently and for the near-term is especially vulnerable to information operations, cruise missile and ballistic missile attacks, and thus these issues need to be addressed.

There is no known disagreement between Canada and the United States about the requirement for defence against cyber attacks and cruise missiles. Satellites carrying information will need to be protected via passive means and they will need to be controlled and monitored. The solution against cruise missile attack may be found in a space-based wide area surveillance system. The paradox for NORAD is that, although it is nearly impossible for it to detect the launch of a cruise missile unless cued by timely intelligence, there are means to shoot down the missile. In the case of a ballistic missile attack, NORAD can detect and track the incoming missile but presently has absolutely no means to prevent an impact.

Ballistic Missile Defence

Ballistic Missile Defence is potentially an issue of contention between Canada and the United States. The United States is currently working on a National Missile Defence (NMD) program and will make a decision this year regarding the deployment of an anti-ballistic missile system. The main issue for Canada is the impact of a unilateral US deployment of the NMD on the 1972 ABM Treaty between the former Soviet Union and the United States. As missile defence is an extension of the missile-warning mission, NORAD finds itself at the centre of the debate between Canada and the United States on ballistic missile defence. Additionally, most of the architecture required for the NMD Program is presently operational for the ITW/AA.

The United States government would like to place operational National Missile Defence under the command of NORAD as the supported command with USSPACECOM as the supporting command. Under this concept of operations, it is assumed that Canada would be a willing participant in the command and control of the anti-ballistic missile system.[65] In the event that Canada refused to take part, USSPACECOM would assume full command and control and NORAD's relevancy would be at stake, which would impact Canadian personnel currently working in Cheyenne Mountain.[66] Canada's refusal to participate in ballistic missile defence of North America (BMD-NA) could trigger the end of the NORAD alliance as we know it.

To participate in BMD-NA, Canada would not have to buy interceptors from the United States, put sensors on Canadian soil, or even have to provide any funding directly into the program. Canada's contribution could be negotiated with the United States and take the form of an asymmetrical contribution. For instance, the United States would like to place the system under NORAD command and, as such, requires Canadian support for the system. Additionally, Canadian support could include easing or perhaps even facilitating negotiations with Russia on amendments to the 1972 ABM Treaty. In return for the protection given to Canada by the BMD-NA architecture, Canada could offer, in exchange, participation in a space related venture such as a contribution to the Space Surveillance Network for the surveillance of man-made objects in space - a NORAD mission. This could probably be achieved through the CF Joint Space Project.

CF Joint Space Project

The main efforts of the CF Joint Space Project are intelligence collection, environmental observation, surveillance of space, surveillance from space, warning, and defence. "*The two pillars for acquiring a Canadian capability are the Surveillance of Space and from Space elements.*"[67] Space surveillance accomplishes the following:

a. Prediction of when and where a space object with a decaying orbit will re-enter the Earth's atmosphere;

b. Prevention of a returning space object from triggering a false alarm in missile-attack warning;

c. Charting the present position and anticipated orbital paths of objects;

d. Detection of new man-made objects in space;

e. Determination of which country owns a re-entering space object; and

f. Informing NASA whether or not objects may interfere with the space shuttle and the international manned space station orbits.[68]

An argument can therefore be made that space surveillance performs an essential role for the BMD-NA mission without being designed for that purpose. Politically, Canadian participation in space surveillance does not carry the baggage of the Strategic Defence Initiative (SDI) debates and has no bearing on the 1972 ABM Treaty.

Surveillance from space could become a niche for Canada to contribute to the United State's space capabilities. The technological potential for RADARSAT II, for surveying ground moving targets from space, could be used as leverage in negotiations to further bi-national defence co-operation. "The ultimate technological goal is to be able to detect and track air targets from space, asserting air sovereignty from space and detecting cruise missiles."[69] This ultimate goal undoubtedly falls within NORAD's mandate.

The Way Ahead - Space Power and the RMA

Space power essentially is not just about a revolution in military affairs. The space environment must be recognized as a geographical environment for conflicts that is, in a strategic sense, no different from the land, sea, air, and electromagnetic spectrum. However, there is a key geographical sense in which space is unlike the other bounded, terrestrial environments. Space is unique because there are no boundaries in space and although space power is a form of military power analogous to land, sea, and air power, space based platforms will definitely be more prominent in future conflicts.

Dr. Colin S. Gray, in his article in the fall 1999 *Airpower Journal*, suggests these key assumptions about space power:

a. In all strategic essentials for now, space power is akin to land power, sea power, and airpower;

b. The strategic history of space power is likely to follow the pattern already traced clearly by sea power and airpower;

c. Geographically and geophysically, space is distinctive but then so is the land, the sea, the air, and even cyberspace;

d. People have only one natural environment, the land. To function at all in any other environment, people require technological support;

e. B ecause people live only on the land and belong to security communities that are organized politically with territory domains, all military behaviour, no mater what its tactical forms, ultimately can have strategic meaning only for the course of events on land;

f. The logic of strategy is both geographically universal and temporally eternal; and

g. The unique geography of space must find expression in unique technology, operations, and tactics. That unique geography does not, however, point the way to some unique logic of strategy, let alone a unique irrelevance of strategy.[70]

Strategic considerations are just as relevant in the space environment as they are in the other environments.[71] Even though the geographical, geophysical and therefore technological and tactical details of combat are unique to each environment, there is, nonetheless, a pattern common to the development of military technology in all geographies: vision, experimentation, exploration, and correction. The technical-tactical challenges that limit the operational and strategic effect of a kind of military power (sea power, airpower, space power) can eventually overcome. The best approach to overcoming the challenges posed by the space environment from a military perspective is to:

a. Approach it as just another generator of strategic effectiveness;

b. View it as the 'latecomer on our block' that should be interpreted and moulded according to the ideas and systems which are familiar; and

c. View space as a wholly unique geographical environment that requires total respect on its own geo-strategic terms.

Space power and space warfare are both coming. It is only a question of how and when. Although space power could be regarded as an RMA, certainly as a Military-Technical Revolution (MTR), it is much more than that. Space power is an evolving physical reality; RMA and MTR are mere intellectual concepts that comprise only constructed realities.[72]

For good or ill, the era of space dependency has arrived. As space power becomes a reality, so space warfare will become an impending reality whose prospect is endorsed by history, as well as by the logic of strategy. If space power is defined as the ability in peace, crisis, and war to exert prompt and sustained influence in or from space, then the key enabler for space power has to be space control. This is well recognized and understood in USSPACECOM's Long Range Plan (LRP).

USSPACECOM Long Range Plan

The Long-Range Plan is the USSPACECOM roadmap for achieving its vision for 2020. The first premise is that space is an opportunity for the US as well as their potential adversaries.

With the end of the Cold War, the US now has a "strategic pause" in which to explore innovative war-fighting concepts and capabilities. Given the continuing dynamic nature of the space environment and the long lead times necessary to develop and field space capabilities, there is a sense of urgency to articulate future requirements today.

The increasing dependence of the US upon space capabilities, both military and economically, produces a related vulnerability that will not go unnoticed by adversaries. US interests and investments in space must be fully protected to ensure their freedom of action

in space. The USSPACECOM Vision for 2020 identifies four operational concepts:[73]

a. Control of Space- the ability to assure access to space, freedom of operations within the space medium, and an ability to deny others the use of space, if required;

b. Global Engagement- an operational concept developed by USSPACECOM which advocates an integrated, focused surveillance of space, air, and surface areas designated by combatant commanders, a defensive umbrella against missile attack, and a force application capability for certain high-priority targets;

c. Full Force Integration- the integration of space forces and space-derived information with air, land and sea forces and information; and

d. Global Partnerships- augments military space capabilities through the leveraging of civil, commercial, and international space systems.

Conclusion

Canada cannot afford by itself to enjoy the security benefits provided by space-based assets. Canada needs its Allies, and most importantly, Canada needs the US as a full partner to fulfil its defence needs. Therefore, it is in Canada's best interest and it is Canada's policy to maintain and develop its strategic relationship with the United States. This relationship needs nurturing if Canada is to have significant access to US space assets. The defence of North America is indivisible and NORAD is a centrepiece of cooperation for aerospace ventures and a natural conduit for Canadian military space activity. NORAD is still relevant today and will be relevant for the future as long as it is recognised that NORAD provides much more than air defence. NORAD's vision is space-centric and it is in Canada's best interest to embrace NORAD's vision if Canada wants to enjoy the continuous accessibility to US Space systems. The Canadian decision on NMD may be NORAD's centre of gravity for its long-term future. Canada could participate in NMD by having the JSP contribute to the US Space Surveillance Network from a ground sensor initially and perhaps from a space-based sensor in the future.

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Equipping the Canadian Forces for Space

Syndicate 6: Major Catherine Cowan (Chair), Major Faisal Al Kaabi, Lieutenant-Colonel Mivil Deschênes, Major Marc Desjardins, Squadron Leader Richard Lennon, Major Daniel Mitchell, Major Thomas Sand, Major Pierre St-Amand

"*Space forces are fundamental to our modern military operations. They are playing a central role in the ongoing revolution in warfare because of their unique capabilities for gathering, processing, and disseminating information.*"

Dr Paul Kaminski, US DoD Under Secretary of Defense for Acquisition and Technology

"*Over all of these operations, I am reminded that our space forces provide a constant umbrella … Altogether, our space-based assets provide critical global situational awareness, communications, weather, and navigation support to all warfighters.*"

Hon. Sheila Widnall, US Secretary of the Air Force

Introduction

Throughout history, armies have attempted to seize control of the high ground to gain advantage in battle. Command of the high ground expanded visibility over the battlefield, reducing what Clausewitz termed the "fog of war" as space represents the "ultimate high ground."[1] Satellites have the potential to afford a commander almost unlimited visibility of the battlespace. For this reason, the Revolution in Military Affairs (RMA), described in the US Joint Vision 2020, is defining and expanding on space capabilities as a force multiplier. The Gulf War was the first conflict in which space assets were heavily employed in support of campaign planning and execution.[2] However, it was the air war in Kosovo that made it clear that the ability to contribute in an alliance with the US in the future will be contingent upon the ability to receive, process and share space-furnished battlespace information. Thus, if Canada plans to continue to contribute to future coalition and, in particular, US-led operations, it should review its space policy to identify those space capabilities in which it should invest.

NORAD is also exploring the use of space-based assets to enhance the defence of North America. Canada gains great benefit from its participation in the NORAD agreement – in fact, it affords a gateway for Canada's access to space. With the US poised on the threshold of Ballistic Missile Defence, the extent to which Canada participates may affect her continued partnership with the US in space ventures through NORAD.

Canadian defence policy directs the Canadian Forces (CF) to provide multipurpose, combat capable forces on land, sea and in the air to meet the requirements of national security and international peace missions. In an era of reduced defence spending, the CF must take advantage of new technologies that can act as force multipliers. However, given the CF's current defence commit-

ments and the deficient state of existing conventional equipment, space capability should initially be acquired as a complement to, rather than at the expense of, more traditional equipment. Space should be seen as the means of making current assets more efficient and cost effective in the performance of their missions, thereby permitting adjustment to the acquisition ratio of space to traditional equipment as efficiencies are realized. For the CF, the key is to define a cohesive procurement programme that prioritizes the requirements for space-related equipment as integral capabilities within the replacement and upgrade needs of traditional military platforms.

In considering the CF's future participation in space, two core questions arise. The first deals with the space capabilities that the CF requires. The second concerns the portion of the defence effort that should be devoted to space capabilities. This essay outlines the key space capabilities and associated equipment that the CF needs to acquire to remain an effective combat capable force in domestic and foreign coalition operations now and in the future. It begins with an overview of Canada's military involvement in space and her intent to obtain space capability through partnership arrangements with industry and allied nations. Next, a review of current US and Canadian military space policies and the CF space strategy are presented to identify the space capabilities that the CF requires to remain a capable military force in the future. Key national factors that could constrain Canadian participation in space will then be discussed. Following this, each of the roles and associated equipment requirements will be discussed. Next, the employment of space equipment will be examined in terms of its feasibility, affordability and applicability to the CF mission. Finally, this paper will make recommendations for the acquisition of space capability designed to improve the efficiency and interoperability of CF assets in meeting its current and future tasks.

Background

Canada has played an important and leading role in space since the beginning of the space era. Canada's successes include the physiological research of Dr. Wilbur Franks; research on the ionosphere during the Second World War to improve naval communications and surveillance of transmissions from German U-boats; and the launch of the Canadian satellite, Alouette I, in 1962. These impressive successes were focussed predominantly on research for military applications. In fact, at the time that the space programme was "demilitarised" for political and commercial reasons in 1966,[4] 41 percent of Canadian space expenditure was for military projects. The first Government initiative following demilitarisation of the space programme led to the creation of Telesat Canada in 1969 to develop a "domestic communications satellite system".

Government policy allowed the Canadian space industry to become successful in the development of space; however, the same did not apply to the Department of National Defence (DND). A Senate Committee hearing on air defence in 1985 recommended the establishment of a military space programme to protect national security, and its recommendations were finally included in the form of a space policy statement in the 1987 White Paper on Defence. To support this policy, the

Space Development Working Group (SDWG) was finally established in 1991 to co-ordinate all space related issues for DND. In issuing a DND Space Policy in 1992, the SDWG sought to develop a comprehensive strategic space appreciation, to review current government space policy and to develop an executable space plan. Recently, the SDWG produced its Space Appreciation 2000, a study of today's global space development trends and the related security implications for Canada.

Strategy 2020 clearly indicates DND's intent to focus on its ability to operate in a global battlespace. In this environment, reliance on information and information management will require the CF to modernization in the areas of space, telecommunications and surveillance.[5] Limited defence spending and the expensive nature of space programmes make it clear that Canada cannot on its own afford to develop the complete realm of space capability necessary for the future battlefield. Only through alliances and industry partnerships will DND be able to acquire or gain access to those key assets necessary to remain an effective fighting force in future operations. While commercial systems are capable of meeting a number of the support requirements, there are critical gaps in their ability to meet specific national security and reliability requirements. The key to obtaining these capabilities is our alliance with the US.

DND currently acquires much of its satellite communications bandwidth from commercial companies. In addition, DND has several joint ventures with industry on projects such as RADARSAT II, a terrain analysis satellite system. Multi-national understandings are also in place that enable Canadian participation in joint programmes such as the SARSAT search and rescue system. Furthermore, an agreement between the Canadian Space Agency (CSA) and the European Space Agency (ESA) gains Canada access to technological information on European space initiatives. However, by far the greatest cooperation on space related issues has been with the United States through the NORAD agreement. As the US and Canada define their military space programmes and their future military structures, cooperation on space issues has increased. Discussions have included the renewal of NORAD, the mutual defence of North America, and the use of space in combating the emerging asymmetric threats to continental security. As indicated in Strategy 2020, these initiatives demonstrate that Canada anticipates sharing the burden for space capabilities in the areas of early warning, global sensing and telecommunications.

On the other hand, differences in Canadian and US policies on Ballistic Missile Defence (BMD) may prove a stumbling block to Canada's capability to exploit space initiatives through NORAD. The US intends to assign the BMD role to NORAD, but this requires the approval of both countries. While the US sees BMD as critical to defence "against nuclear attacks by so-called 'rogue' states,"[6] the Canadian Government's "opposition is rooted in its fears for the non-proliferation treaty."[7] Resolution of this issue may be key to Canada's continued participation in US space projects. However, for the purpose of this paper continued Canadian-US cooperation on space initiatives is assumed.

Before addressing specific areas where Canada envisions participation in the space arena, it is first necessary to

review and compare the space policies of the US and Canada. While doctrine would give greater insight into the military application of space assets, neither country has developed joint or single service space doctrine to a level that would be useful to this discussion. The following section will thus review relevant policies to identify key areas for Canadian space participation.

Space Policy

The US views space power as a vital component of operations. Joint Vision 2010 provides "the conceptual framework for how America's Armed Forces will channel the vitality and innovation of [their] people and leverage technological opportunities to achieve new levels of effectiveness in joint warfighting."[8] Joint Vision 2010 specifies that "Global positioning, ballistic missile defense, multispectral sensing, electromagnetic technology, telecommunications and fusion of all-source intelligence"[9] will provide an integrated picture for "dominant battlespace awareness and [an] order of magnitude improvement in lethality."[10] The key operational concepts emerging from this document are dominant manoeuvre, precision engagement, focused logistics, information dominance and full-dimension protection – all parts of "full spectrum dominance".[11]

In his Vision 2020, the Commander-in-Chief, United States Space Command (USSPACECOM) describes how space power will be used to support the operational concepts identified in Joint Vision 2010. It is based upon the domination of space for military operations and includes four tenets: "control of space, global engagement, full force integration, and global partnerships."[12] This recognizes that space, just like air, sea and land, is becoming another medium of warfare in the 21st century and forms the basis for current joint space policy and doctrine development.

In the US, the development of space capabilities is derived from the National Space Policy, which identifies four broad sets of guidelines: Civil, National Security, Commercial, and Intersector. The US Department of Defense (DoD) space policy, a subset of the National Security Space Guidelines, states that the primary goal of DoD in space is to "provide operational capabilities to ensure the US can meet national security objectives". It goes on to detail general, space support, force enhancement and force application policies.

The missions attributed to DoD include:

a. provision of support for the US' inherent right of self-defence and US defence commitments to allies and friends;

b. deterring, warning, and if necessary, defending against enemy attack;

c. ensuring that hostile forces cannot prevent US own use of space;

d. countering, if necessary, space systems and services used for hostile purposes;

e. enhancing operations of US and allied forces;

f. ensuring the US ability to conduct military and intelligence space-related activities;

g. satisfying military and intelli-

gence requirements during peace and crisis as well as through all levels of conflict; and

h. supporting the activities of national policy makers, the intelligence community, National Command authorities, combatant commanders and military services, federal officials and continuity of Government operations.[13]

Canadian military space policy is embodied in the Department of National Defence Space Policy document, dated 14 Sep 1998. The stated goals of the policy are to use space technology wherever appropriate in:

a. protecting national security and sovereignty interests;

b. protecting national interests from threats located in or passing through space; and

c. fulfilling Canada's defence commitments (treaty and UN obligations) by supporting existing missions and tasks.

DND is further tasked to develop a capability to:

a. acquire and assess space data;

b. monitor activities in space;

c. use space to support the Canadian Forces globally;

d. support arms control verification, and security and confidence building measures in or from space; and

e. participate in space-supported search-and-rescue systems.

While expressed in a less focused manner, the Canadian policy incorporates all aspects of the US military space policy except active (offensive) ballistic missile defence. Much of Canadian policy focuses on aerospace warning and control, as specified in the NORAD agreement.[14] Whilst Canadian policy concentrates on acquiring access to and using available space information, US policy promotes building a national capability.

Canadian Space Strategy and Capability Requirements

The policy framework described above provides the basis for the Canadian military space strategy, which defines the CF capability requirements and resultant equipment programmes. Current CF military space strategy identifies key capability requirements as:

a. Communications. Satellite communications are an integral part of military operations. "Intelligence gathering and dissemination; conferencing; information query and exchange; force and resource status and replenishment needs; deployment; mission planning, tasking and rehearsal; employment; and mission assessment are all enabled through satellite connectivity… ."[15] Satellites provide the flexibility, security (anti-jam, low probability of intercept and detection) and survivability that are essential to rapid manoeuvre warfare.[16] The CF requirements for satellite communications can be met through a combination of dedicated military satellites (where security and reliability are of concern) and leased channels on commercial satellites. As Canada does not possess its own

military communications satellite, acquisition of guaranteed bandwidth on US military satellites is planned to meet Canada's specific security requirements. However, in order to take full advantage of these facilities, the CF, as part of a coalition, will require small tactical terminals (in weapons platforms) and both small (e.g., INMARSAT) and large (e.g., MSAT) satellite ground terminals to link deployed CF units to these overhead networks.

b. Navigation. Accurate geospatial positioning and timing are critical to today's military operational environment where precision weapons delivery and zero casualty tolerance are a reality. Systems such as the US Global Positioning System (GPS) and the Russian GLOSNASS afford continuous, weather-independent, positional accuracies on a global scale, which greatly increases the effectiveness of both weapon delivery and navigation.[17] It is critical to CF operations that Canada maintains and enhances its capability to use GPS. It is inevitable that the US will continue to develop and improve its ability to deny the use of, or degrade the accuracy of, the GPS signal to reduce an adversary's potential use of this high accuracy system. In this light, Canada, in cooperation with the US, will have to consider the effects of navigation warfare in order to ensure that the CF has the means for continued GPS access during operations when access is denied to non-allied forces.[18]

c. Search and Rescue. Specialized SAR payloads on satellites have become a key part of the Search and Rescue Satellite (SARSAT) search and rescue system. From a political and public support perspective, it is essential that DND continues to participate in the SARSAT system, where our current contribution is the provision of transponders which "piggyback" on other satellites.

d. Intelligence Support. Remote sensing[19] data from a number of varied satellite systems are vital to staffs for intelligence preparation of the battlefield. An accurate picture of the terrain and weather in an area of operations is critical to mission success. By combining the data from a number of different sensors, a fairly detailed depiction of the operational environment can be provided for the operational planning process.[20] For Canada to obtain and make use of critical intelligence support information, it is vital that DND intelligence agencies have the ability to receive space-derived intelligence data at a useful reception rate. Allied sources of this information are switching to digital, soft-copy transmission of these products. It is essential that our intelligence agencies be supplied with the necessary equipment to enable reception and analysis of the information and to allow for the integration of the space intelligence product into the normal military command and control system.

e. Weather Monitoring. Commanders in modern warfare require accurate, timely weather information for operational planning and for accurate weapons employment.

Military and civilian geostationary weather satellites provide an overview of the regional weather picture every 30 minutes. By tracking weather patterns and monitoring trends, planning staffs are able to make accurate forecasts. Satellites in polar orbit provide more detailed weather information (wind, temperature and moisture content data) on a 12-hour cycle. This information is critical for the accurate employment of weapon systems.[21] Therefore, it is essential that Canada acquire the capability to receive and process near real-time access to global weather data.

f. Geomatics Support. Commercial environmental observation satellites provide a fairly detailed terrain picture. Systems such as Canada's RADARSAT, France's SPOT and the US LANDSAT provide the information needed to develop current maps of almost any region of the world to a degree previously unobtainable. By fusing the data from systems using differing sensor types, a more accurate and informative picture can be produced for operational planners. Recent experience has revealed difficulties in obtaining maps containing required information for short notice operations in regions where the CF does not traditionally operate. To redress this shortfall, the CF requires a capability to produce and update maps, at short notice, to meet the planning needs of new operations.

g. Surveillance of Space. Surveillance of space enables detection, tracking and identification of space-based objects, and is the first step in assuring space control. A global network of sensors provides rapid detection and characterization of any threats in space. In addition to ballistic missile warning, continuous surveillance of space can produce intelligence information on the orbits, coverage and overhead timings of hostile satellite systems. In times of hostilities, this information could be used to protect allied use of space while denying similar uses to the enemy.[22] As a sovereign nation, it is important that Canada is aware of those space systems capable of surveying her land mass, sea approaches and airspace, as well as threats to Canadian and allied space assets. Canadian space policy and the NORAD agreement identify surveillance of space as a capability priority. Traditionally, Canada has participated in this role under the NORAD umbrella. The importance of this capability to Canadian sovereignty protection makes it essential for Canada to continue her NORAD participation with the US Space surveillance Network (SSN).

h. Surveillance from Space. Commanders today require near real-time surveillance to provide information on enemy force disposition, strength, troop movements and the environment where combat will take place. Satellites equipped with a variety of sensors are capable of providing rapid surveillance and reconnaissance information, with image resolutions in the order of 1 to 3 metres. However, the Gulf War showed that for this information to be of use, the military must have deployable equipment capable of receiving and manipulating the

collected imagery. Experimentation with the SENTRY Ground station by Canadian naval forces in Halifax has been successful and future acquisition of systems for both the East and West Coasts is under consideration. Next generation systems may also be capable of providing tracking of moving targets on land, sea and in the air, greatly enhancing sovereignty protection and battlespace awareness.[23] Canadian policy and the NORAD agreement identify surveillance from space as a capability priority. Therefore, the CF needs to acquire sufficient surveillance and imagery processing capability to meet its requirements for sovereignty protection, joint defence of North America, and support to deployed forces.

i. Warning. Space-based ballistic missile warning sensors, operated by our allies, provide timely detection, identification, tracking and assessment of missile attack. The Gulf War pointed to a deficiency in the capability of coalition forces to provide tactical warning against modern, short burn-time, theatre ballistic missiles. The political necessity for minimum casualties places a burden on the CF to protect deployed forces. Therefore, the CF must investigate options that would rectify this deficiency.

j. Defence. Defence against ballistic missiles, both strategic and tactical, is currently a highly contentious issue. The threat to US troops deployed in theatres abroad, and the potential nuclear threat from 'rogue nations' has prompted the US to push strongly for a space and ground-based Ballistic Missile Defence (BMD) capability. However, Canada, along with a number of other nations, believes that the existing nuclear non-proliferation and anti-ballistic missile treaties specifically ban this technology. Fearing another nuclear arms race, Canada has thus far refused to endorse the US concept of BMD. However, as part of the NORAD agreement, DND is currently reviewing the US BMD programme to gain a better understanding of its capabilities and implications to support a future Canadian Government response once the US deployment decision is made.[24] Recent news articles have hinted at the political manoeuvring on this issue. However, given that the future of the NORAD arrangement may be tied to Canada's decision on BMD, Canada will soon have to make decisions on our future needs in this area.[25]

The Deputy Chief of the Defence Staff is responsible for generating Canadian military space strategy. From the identified capability requirements fall the priorities and the specific equipment programmes to be pursued in Defence Planning Guidance (DPG), along with the identification of any enabling activities.[26] The limiting factor is the amount of funding allocated to space capabilities in the CF Long Term Capital Plan.[27] With this factor in mind, DPG 98 identifies "cooperative participation in US programs … [as] a key component in the development of a modest space capability for the CF."[28]

Less than two percent of the Canadian military budget, or some $1.72 billion over the next 15 years, is earmarked for major space equipment acquisition projects to meet key capabil-

ity requirements of the CF military space strategy. The most notable of these projects include military satellite communications ($646 Million), global positioning systems for select aircraft ($152 Million), and enhancements to the SARSAT search and rescue capability ($64 Million).[29] These projects barely scratch the surface of the required capabilities. As a result, the Space Project, which will be discussed later, has been raised to address a few of the shortcomings. The point to be taken here is that funding for space projects represents an extremely small portion of the Major Equipment Acquisition Programme at a time when space exploitation is the key force multiplier for the future.

Having reviewed the military space policies of the US and Canada, and having identified the key capability requirements from the Canadian military space strategy, it is clear that Canada wants to mirror US capabilities but on a smaller scale and currently, without the inclusion of active BMD. However, from the current fiscal allocations it is evident that the current policy and strategy are highly ambitious, with little chance of coming to fruition without significant US and commercial input. Therefore, the essential and more immediate capabilities need to be identified in order to focus CF equipment acquisition efforts towards more plausible short- and long-term goals. To this end, the next section will look at factors that shape a nation's ability to equip for space.

National Factors Affecting Canada's Space Role

Equipping Canada for space is problematic. There is far more to the equipment equation than the high cost of obtaining a basic space capability. Geography, national wealth, technology, industry, intellect and politics all play important roles.[30] Many of these factors determine what a country can and cannot do in a space programme and a number of them will shape the direction that Canada should take.

Geography. Geography is important when considering launch facilities. There is an advantage to launch sites located on or near the equator as the Earth's rotational velocity is greatest, giving rockets launched to the East the biggest boost into orbit. But, most importantly for objects launched into geostationary orbit, the available payload on a rocket is greatest because the fuel required to obtain orbit is least. For example, a rocket launched from Montreal could carry only half the payload of one launched from the Equator. Canada is not well situated for developing launch facilities, therefore, Canada should not invest in this area of a space program.

National Wealth. Countries with great wealth are more likely to get involved in an expensive space program. While Canadians are considered wealthy by world standards (Canada has one of the highest GDPs per capita), the relatively small population base means Canada's absolute wealth is not great. Any sizeable investment by Canada in a space program would thus represent a significant proportion of Canada's wealth. Consequently, while the government may wish to have a space program, cost will be a limitation.

Technology. Space technology is rapidly changing and represents the cutting edge of research and development programmes. Canada, with a history of innovation and creativity in research

and development, has great potential to participate in the development of technology. To ensure maximum participation, the government should encourage and facilitate co-operation between government laboratories, private laboratories and universities.[31] Government involvement with industry on past space initiatives has been the key to Canada's successes. This is particularly true in the satellite communications arena. As such, technological innovation through government partnerships with the private sector is viewed as an effective means of achieving Canadian space goals.

Industry. The most successful manufacturers in the space industry have been smaller companies dealing in specific components.[32] These companies are able to quickly restructure their operations as technology develops and equipment requirements change. The Canadian space industry is not large. With the world's largest space customer to the south of the border, the Canadian Government should, through government contracts or financial incentives, encourage substantial growth of a Canadian space industry sector that would be competitive in the US market. A larger space industry would not only contribute export dollars to the economy, but would also increase the technology base for space applications.

Intellect. Canada already possesses a significant high-technology knowledge base in the communications, computer and robotics fields. This knowledge base lends itself well to specific niches within the space environment. Canada should ensure that there are sufficient educational institutions generating the necessary knowledge and expertise to support a Canadian space capability and industry. The population's attitude toward a space industry must be positive. And, there must be incentives to curtail the oft-quoted Canadian 'brain drain' to the US. Canada has a world class educational system. If the government wants growth in Canada's space capability, it must undertake to win the support of the business community and the population, and must in turn support the institutions that are developing the required intellectual power base.

Political Will. Space is still primarily in the realm of nation states, although participation by non-state (commercial) operators is increasing, so any capability in space requires Government commitment. Because of their national security concerns, countries such as Israel, Russia and China have overcome deficiencies in national wealth, geography and other attributes to become significant players in space - all because the political will to have a presence in space was overriding. If Canada wants more than a token presence in space, it must commit resources. To accomplish this, the support of the Canadian people is very important.

From this overview of Canada's national factors, it can be seen that, while not suited geographically for satellite launch facilities, Canada does possess the necessary technological, industrial and intellectual capacity to play an active role in the space arena. For a country with a small population, funding will always be a limitation. However, as with all government initiatives, political will and public support are key. Current government policy is highly supportive of a Canadian space programme; all that remains to be seen is the level of financial commitment the government is prepared to commit.

Equipping the CF for Space

Given that Canada has the capacity to play a role in space, and having reviewed the CF's space capability requirements, the questions of which are the essential and more immediate requirements and what would be the best method to meet them need to be answered. This section will begin to address these questions by discussing each of the capabilities and their associated equipment within the broad categories of command, control and communications, data acquisition and exploitation, and surveillance of space and defence.[33]

Command, Control and Communications

Command, control and communications (C^3) is one of the most important areas where the CF can be supported and enhanced by space-based assets. C^3 satellite systems provide secure, worldwide voice and data communications in support of command and control networks.[34] Interoperability with our allies and the capability to receive and transmit key operational and tactical data depend on a robust communications system.

Communications

As space and command and control technologies evolve, connectivity to deployed forces, information fusion, and information management must receive increased focus.[35] The development of a high speed, mobile communications capability that can support large volumes of fused data is key to the integration of all space capabilities into future theatre operations.[36] From these statements it can be inferred that the most important space capability requirement is space communications and the associated ground and weapons platform equipment.

Geography and population distributions in Canada make satellite communications a highly attractive and cost effective alternative to HF radio, microwave and landline telecommunications. For the CF, commercial communication satellites provide key links to installations and deployed forces worldwide. Recognizing this requirement, the CF Space Policy emphasized the importance of satellite communications in terms of providing global strategic and tactical secure communications for the command and control of air, land and naval forces.[37]

Unlike many of our NATO allies, Canada does not possess dedicated military communication satellites. The CF relies instead on a combination of leased capacity from commercial satellites and access to other nations' military systems to provide global communications.[38] Systems currently being used by the CF include the following:

a. Telesat Canada. Telesat Canada operates all of Canada's commercial ANIK and the upcoming mobile satellite (MSAT) communication satellites. The CF uses the Anik satellites extensively to effect communications with Alert and the North Warning System radar stations. These systems offer limited far north coverage and communications security. As a result, the CF funded a secure teletype and communications capability on the Anik E satellites. To utilise these systems, the CF operates two fixed ground stations and seven transportable terminals (MMs). These trans-

portable terminals deploy with CF contingents to provide multiple secure voice, data or video conferencing channels. However, the bandwidths that can be supported, their lift requirements, and satellite footprints limit the usefulness of these terminals. The MSAT, consisting of one Canadian and one US satellite, provides continental Canada/U.S coverage (with the exception of the far north) for mobile communications. Although more expensive than cellular communications, it is anticipated that MSAT will provide communications to small, light-weight, mobile platforms, such as vehicles, ships and aircraft, at much higher data rates than those currently available.[39]

b. INTELSAT. The International Telecommunications Satellite (INTELSAT) organization provides near global satellite communications between its 123 plus member nations through the use of INTELSAT V, VI and VII satellites positioned over the Atlantic, Indian and Pacific Oceans. Most commonly used for high volume communications, such as TV signals, this system is restricted to peaceful uses, limiting military usage to domestic operations, peacekeeping and UN sanctioned actions;[40]

c. INMARSAT. The International Maritime Satellite (INMARSAT) system is a commercial system designed to support a mobile communications interface between ships at sea and land-based telecommunications networks for the 74 member nations. Consisting of satellites over the Atlantic, Pacific and Indian Oceans, it is capable of providing near-global coverage to small portable/mobile terminals and fixed ground stations. First introduced in 1979, its initial implementation was so successful that the system was expanded to include both land- and air-based applications. Although the CF has heavily used this system at sea and on deployments both within and outside of Canada, as a commercial system INMARSAT usage is also limited to peaceful traffic. For military users, the INMARSAT system poses two additional problems: high cost ($7-$10 per minute); and the lack of a guaranteed channel (channel can be seized on demand if it is available).[41]

d. FLTSATCOM. The Fleet Satellite Communications (FLTSATCOM) system, owned by the US Navy, provides global communications for US strategic and nuclear military forces. The initial system consisted of three US DoD geostationary satellites, supplemented by LEASAT satellites leased from Hughes. Operating primarily in the UHF range, it ensures secure communications with ships and aircraft. As part of its UHF Follow-on (UFO) project, the US launched 10 satellites between 1992 and 1996 as an EMP protected replacement for the initial system. A Memorandum of Understanding affords access to CF Naval forces; however, this access is restricted to periods of joint naval operations.

e. SKYNET. SKYNET is Great Britain's military communications satellite.

f. NATO III and IV. NATO III and IV are communication satellites dedicated for use by NATO forces.

Because of the lack of a Canadian military communications satellite, the CF has relied on a combination of HF radios and commercial satellites to provide for long-range communications. With the unreliability of HF communications and the limitation of peaceful usage only applied to many of the commercial satellite systems now in use, the CF needs to acquire a guaranteed capability for military communications via satellite. The Canadian Military Satellite Communications (CANMILSATCOM) Project was raised to address this capability shortfall by obtaining guaranteed access to the US military global Advanced EHF MILSATCOM System. Highly protected, this system will provide the CF with the capability to overcome satellite communications signal jamming, interference and detection. In addition, it will provide the CF with the following capabilities: global satellite-based broadcast; mobile and interoperable satellite UHF; required UHF MILSATCOM terminals for long-range patrol aircraft, submarines, and ships; and direct interoperability with US Navy UHF communications. Strategic rear-link communications for National command and control to deployed forces will be supported through a combination of Canadian-purchased man-portable, transportable, mobile and fixed terminals. In short, the CANMILSATCOM project will ensure reliable, protected, and interoperable global communications to deployed CF elements.[42]

Communication shortfalls remaining after completion of the CANMILSATCOM project will be ground based. While the Army's Tactical Command, Control and Communications Systems (TCCCS) project addressed some of the transportable terminal replacement requirements, the DND CIO organization is addressing piecemeal fixes to bring these systems up-to-date in order to ensure transportable rear-link communications capability for the future. The recent policy decision by the CF to permit contractors into theatre means that transportable ground station equipment could be leased and operated by contractors to provide all but the most secure rear-link military communications capabilities to deployed forces. However, the CF needs to review this approach to determine the best and most economical means of meeting this strategic communications requirement. In addition, while TCCCS addressed the mobile and man-portable radio requirements for the Army, satellite communications terminals would be required to operate over the MILSATCOM system. For the tactical forces to be interoperable and capable of sending and receiving military satellite communications, the CF will have to acquire terminals to support land-based mobile communications.

Canada, as a world leader in the communications field is also ideally situated to provide ground control stations as part of its space contribution to its allies. While not a key capability requirement within the CF, development of Canadian-based ground stations would help alleviate the world-wide shortage of ground control stations.[43] A ground station contribution could be used by the CF as an offset to gain access to other satellite system capabilities.

Navigation

Space technology has provided military commanders in the field with

enhanced movement and control of forces through satellite navigation systems. The Gulf War and the air war in Kosovo amply demonstrated the advantages of, and the requirement for, accurate global positioning and timing synchronization for manoeuvre coordination and precise weapons delivery. Only two systems provide continuous global coverage today – the US Global Positioning System (GPS) and the Russian GLONASS global positioning system. Since the Gulf War, Canada has used the US GPS for all-weather land, sea and air navigation in addition to GPS weapons delivery enhancement. However, while commercial systems often provide the requisite accuracies, the spectre of Navigation Warfare (NAVWAR),[44] along with GPS integration with numerous military systems, make it essential for Canada to acquire the capability to utilize the allied military GPS signal in all conflict conditions.

The Position Determination and Location Finding (PDALF) Project was raised by the CF to address the shortfall in military GPS receivers on select military aircraft, ships and in support of land forces. The decommissioning of many radio-based navigation aids make GPS receivers essential. In addition, the ability of the CF to operate in contingency operations with the US and other allied nations depends on precise navigation and timing. Therefore, the procurement of GPS receivers across CF elements under the PDALF project must continue.

Canada does not possess any GPS satellites or control segment facilities. To ensure continued access and to gain a better understanding of the NAVWAR environment, Canada could make a valuable contribution in the area of research and further development of GPS security with the US as part of its share of space capability financing.

Command, Control and Communications Priorities

Both satellite communications and GPS navigation capabilities are vital to CF operations. When looking at the myriad of access and equipment requirements that these capabilities generate, acquisition priority should be given to obtaining secure satellite communications through the CANMILSATCOM project, followed by GPS receiver acquisition for select platforms, acquisition of strategic rear-link and tactical satellite user terminals, and leasing of commercial satellite facilities. Once these requirements have been addressed, the CF should look at making contributions to the space programme through investment in communications ground stations and navigation warfare (i.e., GPS security) research and development.

Data Acquisition and Exploitation

Data acquisition and exploitation "involves the development and deployment of space-based systems for such functions as remote sensing, spatial positioning, and surveillance and reconnaissance in support of traditional military operations."[45] While not usually considered in this category, the CF has international obligations and financial commitments to the upgrade of the SARSAT Search and Rescue system. As activities in this regard must continue, search and rescue will be covered first. Canadian sovereignty protection and our ability to gain knowledge of the battlespace environment are contingent upon the CF gaining space capabilities in the areas of sur-

veillance from space, intelligence support, geomatics support and weather monitoring. Each of these capabilities and the equipment necessary to acquire them are discussed below.

Search and Rescue

While not strictly a military activity, the Canadian public highly supports the CF's leading role in Search and Rescue (SAR). Because of the size and geography of Canada, space detection of emergency beacons is one of the few measures available to reduce the search area, thereby making better use of the limited SAR assets. As such, Canada has been committed to the international SARSAT program with Canada's contribution coming primarily from the provision of transponders and ground control facilities. The Canadian developed "piggyback" transponders have proven to be a cost-effective way of deploying space segments. The SARSAT system is currently being upgraded to provide better location information. The CF, as part of its commitment to the SARSAT upgrade project, is developing more sensitive and powerful transponders for better signal detection and rebroadcast capability. Even though there may be higher priority needs for space capabilities within the CF, international obligations and existing project investment make it necessary to continue with the SARSAT update project.

Surveillance from Space

The key to surveillance from space is the capability "… to sense the earth's surface and air without regard to boundary, sunlight, weather and, in some cases, foliage or soil … ."[46] Surveillance and reconnaissance satellites, equipped with a variety of sensors, can provide rapid coverage of areas, installations and troop movements to aid commanders in forming an accurate picture of the battlespace. Comparison of repetitive images from a combination of optical, thermal and radar sensors enables planners and intelligence staffs to highlight forthcoming problems and to make accurate operations and damage success determinations. Future advances in sensor technology are expected to enable space-borne tracking of individual targets on land, sea and in the air, greatly facilitating sovereignty protection and tactical targeting. With resolutions in the order of 1 to 3 metres, accurate intelligence information can be easily gained, especially when multiple sensors are used to cover the same area.[47]

A large number of commercial imagery satellites, such as Canada's RADARSAT, France's SPOT, and the US's LANDSAT, are currently deployed, with another 45 new systems expected to be launched before 2010. These satellites are capable of providing users with near-real time information at resolutions greater than 15 meters. Access to these commercial satellites can provide a large portion of the information required by the CF for general surveillance, reconnaissance and intelligence gathering purposes. Access to specialized systems, for more accurate, sensitive and timely information, can be obtained through shared Canadian and allied sources. One possible avenue to aid access to the required systems could be through Canadian involvement in the development of the US space-based radar programme through the NORAD arrangement. Projected efficiencies of space-based radar assets opens possibilities for the future downsizing and long-term decommissioning of parts of the North Warning System.

Canada's major contribution to surveillance from space comes through the RADARSAT programme. RADARSAT is a joint government and commercial satellite that provides a detailed picture of the earth's terrain along its orbiting route. Continuing research and development aims to achieve the ability to track ground targets and, eventually, air targets with RADARSAT II, which is due for launch shortly. The CF must be positioned to take advantage of these evolving capabilities, ensuring controlled access to these satellites as required.

Intelligence Support

In addition to national surveillance for sovereignty and environmental purposes, the CF needs to be able to quickly acquire, process, manipulate and disseminate imagery information in support of deployed operations. The importance of this capability was clearly demonstrated during the air war in Kosovo, during which aircraft were reassigned to new targets in-flight and imagery was transmitted to the pilots for target familiarization. With the exception of limited systems, such as the RADARSAT programme, the CF cannot afford to develop a nationally owned and operated global remote sensing capability that employs the complete spectrum of sensor types. However, the CF is well situated to augment its RADARSAT contribution with an imagery processing facility for allied imagery development, manipulation and dissemination.

Although space systems can provide enormous quantities of raw data, existing CF systems are only capable of receiving and processing small amounts of the information made available through US and allied sources. Given the data communications and computer expertise in Canada, the CF could become an integral and key link in the intelligence chain by developing automatic processes and capacity to receive, analyze and distribute timely intelligence data to fielded forces in a readily useable format. The development of this capability would allow continued access to other nation's space assets in exchange for sharing the processing burden. This is an area where Canada's well-established research and development capability could play a leading role.

Geomatics Support (Mapping)

Military operational experience has shown that updated mapping of an area of responsibility will often be required at little notice. Accurate and timely mapping requires access to remote sensing and cartography satellite systems employing land-use applications. To aid in this process, satellites are being launched into service as part of the Geographical Information Systems (GIS). These systems are designed to store and manipulate surface data in the form of cadastral maps, satellite photos, and contour, road and soil maps[48]. In fact Canada, as a pioneer in GIS development, holds the world's largest land resource data bank. The primary advantage of the GIS is the ready ability to overlay maps, greatly reducing the number of man-hours traditionally spent in manually preparing maps with acetate overlays. In addition, three-dimensional representations of an area could be produced for fly-through or walk-through imaging using satellite pictures from different systems. The advantage that this technology could afford tactical and operational operators and planners is astonishing, especially

when considering its value in combination with other intelligence data.[49]

The key satellite systems used for geomatic support are:

a. LANDSAT. The US LANDSAT systems were designed for mapping applications. Orbiting the Earth in near-polar orbits at elevations of approximately 680 km, the six satellites in the system use a combination of multi-spectral scanning and thematic mapping sensors to provide resolutions in the order of 30 metres. However, with only six satellites in orbit, coverage of an area can occurs only every 16 days, limiting the capability to fewer than six useful images of a particular region per year. For support to short notice military or emergency operations, 16 days may be too long to wait to obtain needed mapping information.[50]

g. SPOT. France's Satellite Pour l'Observation de la Terre (SPOT) uses two High-Resolution Visible sensors (HRVs) on three operational satellites to produce images with 10 x 10 metre resolutions over a 117 km wide area. The advantage of this system is the provision of images in stereographic format for three-dimensional topographical analysis. As with the LANDSAT system, the SPOT satellites are in near-polar orbits that permit second passes over a particular region on a 26 day cycle.[51]

h. RADARSAT. RADARSAT is a Canadian-lead, joint US and private sector satellite system that provides "global information on ice conditions, crops, forests, oceans, and geological formations."[52] Using Synthetic Aperture Radar, the system offers a variety of viewing angles, areas of coverage and resolutions. On wide area coverage, the satellite provides routine surveillance of the Arctic region on a daily basis and scanning of Canada over a 72-hour period. Using this system, processed information on items such as ice in shipping lanes can be provided on demand within four hours of the satellite pass. For the CF, this system provides important information on Canada's northern regions, forestry, geological resources, oceans and floating ice, coastal zones, and Arctic sovereignty. In addition, it enables improved marine weather and sea state forecasts.[53]

While the RADARSAT system may meet many of the CF's requirements in supporting Canadian sovereignty protection, access to systems using different sensor types and varied areas of coverage are essential to give the CF a global mapping capability. The number of commercially available systems is expected to increase rapidly over the next 10 years. Canada, with its RADARSAT experience, is well positioned to become more involved in the commercial applications of this technology, particularly in the overlay and processing technologies. Canadian space contributions in this area could be a key to future access to other allied and US systems.

Weather Monitoring

Timely and accurate weather information is crucial in planning military operations. The US Military Defense

Meteorological Satellite Program (DMSP) uses two satellites in polar orbit to provide high-resolution weather data, in the form of cloud cover, cloud moisture, wind vectors, soil moisture, ocean current, and sea state data, to military operations. Data is transmitted directly to in-theatre ground terminals to support current military operations and to air force tracking stations for onward transmission and processing. To achieve cost savings, convergence of the DMSP with the US National Oceanic and Atmospheric Administration (NOAA) weather satellite system is in progress. Once completed, the combined system will provide weather information to both military and civilian users. Incorporation of the European meteorological systems to complete a single world-wide network is currently being negotiated.[54]

For the CF, access to this weather information is essential for accurate operational planning and weapons targeting. Investment in space-based weather systems is not in Canada's immediate interest owing to the high costs involved; however, acquisition of transportable ground terminals for in-theatre support and dedicated processing stations in Canada is required.

Data Acquisition and Exploitation Priorities

The CF needs to acquire space capabilities in the areas of surveillance from space, intelligence support, geomatics support and weather monitoring. While not entirely a military requirement, the CF is committed to participate in the SARSAT upgrade project. Development of more sensitive transponders will facilitate SAR activities in Canada, enabling more efficient use of CF SAR assets. Therefore, the SARSAT upgrade project is a top priority within the data acquisition and exploitation area. The Directorate of Space Development (D Space D) lists surveillance of space and surveillance from space as the key pillars of the Joint Space project. Within the surveillance from space capability, initial priority should be given to developing the capability quickly to acquire, process, manipulate and disseminate imagery information. By offering the capability to disseminate processed intelligence and geomatic imagery to allies over secure military satellite links, the CF would provide a valuable service that could facilitate access to other space systems. Next, the CF should pursue access to US and European weather satellite systems and processing terminals for rapid access to weather information. Participation in the US space-based radar programme through NORAD and continued research and development on the Canadian RADARSAT programme should be the next in line, followed by access to additional commercial imaging systems.

Surveillance of Space and Defence

This area of space capabilities includes the "surveillance of space and the establishment of defensive systems to safeguard against threats to national interests in, from or through space."[55] While Canada has actively participated in the surveillance of space through the NORAD arrangement, the Government has thus far opposed Canadian participation in Ballistic Missile Defence (BMD) in forms other than missile warning, research and consultation roles. As space capabilities continue to expand, control of space over Canadian territory is

becoming more important to Canadian sovereignty. Outside the BMD arena, the keys to space surveillance and defence are:

a. protection of Canadian access to space-based systems;

b. knowledge of the use of space assets over Canadian territory by potential adversaries; and

c. research into passive denial of space system usage by adversaries against Canada and its allies.

As the importance of space and space-based assets increases, the requirement to attain and maintain dominance in space becomes more pressing. Surveillance of space and defence are the two capabilities that combine to assure space superiority. These capabilities and the equipment necessary to acquire them are discussed below.

Surveillance of Space

Surveillance of space, a key element in space control, provides Canada with an awareness of foreign satellite activity over Canadian territory. In partnership with the US under the NORAD agreement, Canada is determined to take an active part in the development of a Space Surveillance Network in order to guarantee continued access to aerospace warning information. As part of its NORAD burden sharing, Canada plans to contribute to space surveillance through research support in the US Lincoln Lab and through the delivery of a space-based sensor system designed to survey space from space by the year 2004. Preliminary Departmental approval to commit up to $80 million to this endeavour was obtained in June 1999.[56]

The situational awareness that a space surveillance network will afford could, in combination with other systems, aid Canada in protecting its own and allied space systems while monitoring the capabilities of other nations. In addition, Canada is well placed geographically to detect future air and sea-launched space systems launched from the Arctic region, which might otherwise reach orbit undetected.[57] This is of great value in establishing an effective ballistic missile warning capability. To take advantage of our geography and make a valuable yet passive contribution to BMD, Canada could install ground based radar systems, in conjunction with the US, capable of monitoring space activity over Canada and the Arctic. This would complement the North Warning System, providing a total aerospace picture over Canada and the northern approaches to North America.

Space Defences

Defence against ballistic missiles that use the space medium is an area of special concern to Canada and her allies. Canada's involvement in this arena is currently limited to research and consultation.[58] Once the Canadian Government reaches a decision on the level of Canadian participation in space defence, Canada could expand its involvement to include research and development into technologies for passive space denial mechanisms such as signal interception, disruption or deception. Canada has not yet demonstrated the political will to engage in the physical attack of space systems or by space systems. However, the continued expediency of the NORAD arrange-

ment, and Canada's access to space-afforded information, may depend on Canada's support to the US National Missile Defence (NMD) programme.

The importance of the NORAD agreement to Canada cannot be understated. The surveillance of space and missile warning are both important aspects of DND's space requirements that are provided to Canada through NORAD. With the agreement almost due for renegotiation, Canada must be prepared to make an effective contribution towards the continued success of NORAD. This may require a shift in political intent toward support of the US NMD program. Alternatively, Canada could aid in renegotiating the Anti-Ballistic Missile Treaty between Russia and the US to permit ballistic missile defense without reinitiating the nuclear proliferation that the non-proliferation treaty, which currently

upgrade to the SARSAT system (SARSAT Upgrade Project), the acquisition of GPS Receivers (PDALF Project), and a project to secure guaranteed communications bandwidth on US military communication satellites (CANMILSATCOM) have already been discussed in this paper. All other space capability shortfalls have been incorporated into an umbrella project called the Joint Space Project, which is aimed at developing a comprehensive space capability in support of CF operations. Its main objectives are to satisfy the CF's space requirements in the following areas:

a. intelligence collection;

b. environmental observation, including weather and geomatics;

c. surveillance of space;

d. surveillance from space;

e. warning; and

f. defence.[59]

By funding specific developments and partnerships within each of the identified capability categories, the CF is making a valuable and determined contribution to space. These efforts are expected to secure access to systems that cannot be developed nationally while at the same time opening technology avenues for the Canadian space industry. The Joint Space Project, in combination with the other three capital space projects, should pave the way for meeting Canada's initial space capability requirements. However, it must be remembered that CF expenditures on space through these projects comprises only two percent of the defence budget over their 15-year implementation.

Equipping Canada for Space - Summary

From the discussion above, it is clear that an extensive amount of space-based, ground station and user terminal equipment is required to meet the 10 space capabilities that the CF requires. The CF has attempted to address a few of these requirements through capital space projects; however, these efforts merely scratch the surface of long-term space capability acquisition. Much of the technology is in its infancy, requiring significant research and development activities. A few of the more robust technologies, such as communications and remote sensing, have seen rapid commercial involvement and availability. Due to the fiscal realities of the current defence budget, Canada is not in a position to be able to develop and acquire national systems across the range of capabilities. Space capability must therefore be acquired through a combination of Canadian development, commercial leasing, industrial partnerships and secured access to systems owned and operated by our allies.

Recognizing fiscal constraints, this review of the CF's space equipment requirements highlights priorities for future space efforts. Effective participation in coalition operations and joint allied exercises demands that the CF address space-based command, control and communications requirements as the first space priority. The CANMILSATCOM and PDALF projects will provide the immediate navigation and strategic and tactical communication needs. However, priority should also be given to meeting the CF's additional satellite communications terminal and navigation warfare protection requirements. Because of the high level of

public support and visibility of the CF's search and rescue role, upgrading the existing SARSAT network is high on the space prioritization list, and this is being met through the SARSAT Upgrade project. To gain capability in the data acquisition and exploitation arena, the CF should concentrate on developing a robust capability to receive, process, manipulate and disseminate imagery information. In addition to the Joint Space Project, the CF should participate in the US space-based radar programme under the NORAD arrangement to acquire a continuous surveillance capability from space. Continued NORAD participation is the key to maintaining a space surveillance capability. From a defence perspective, protection of forces in theatre from short-range missile attacks is important. Therefore, prioritization should be given to participation in the US theatre ALERT system. A government decision on the extent of Canada's participation in space-based missile defence must be taken prior to expansion of the CF's efforts beyond the present levels of research and consultation.

Having looked at the space equipment requirements and priorities, and having identified key areas where Canada can make a valuable contribution to space development, the following section will address the feasibility, affordability and applicability of space capabilities and equipment to the overall CF mission.

Addressing the CF's Space Requirements

D Space D initiated space projects will give the CF a basic proficiency across the spectrum of space capabilities. They should also position Canada well in terms of gaining access to additional allied systems. At a price tag of approximately $1.8 billion over 15 years, this capability does not come cheaply. While representing only two percent[60] of the Defence budget over this period, it still represents a significant investment at a time when major investments are required to replace most of the CF's aging conventional aircraft fleets and to acquire equipment essential to sustaining Canada's combat capability across the three environments. Therefore, without an increase in defence spending, any increased space capability acquisition would have to come at the expense of conventional equipment requirements – a situation which would probably be untenable given the CF's current missions and operational tempo. Therefore, unless space-capabilities are included as integral components of conventional weapons platforms and support elements, the CF must carefully weigh the decision to acquire stand-alone space capability against the potential funding loss for more traditional requirements.

Space Equipment - Feasibility and Affordability

To ensure the best use of limited defence dollars, the first step in making an acquisition decision is to address the question of how a capability can best be delivered. Prior to making any decision to acquire space-based assets, each equipment proposal must be reviewed against effectiveness and affordability criteria, keeping in mind that space-based capabilities are not an end unto themselves. Where the purchase of user equipment and access to existing systems can meet the CF requirement, the project is more feasible and affordable, and, therefore, more likely to be funded.

Satellites are expensive. Because of weight restrictions, the hostile operating environment and reliability requirements, satellites tend to be technology intensive. Their high cost[61] makes it necessary to place as much capability and redundancy on the payload as possible to maximize cost effectiveness. "Piggy-backing" sensors and transponders on commercial or government-owned satellites is a practice that is often used to reduce costs. Launch facilities are limited and availability is at a premium. Orbital positioning is the key to ensuring a usable satellite footprint, but room to accommodate satellites in geostationary orbit is limited. Where satellites are placed in non-geostationary orbits, multiple satellites or multiple satellite passes may be required to gain full benefit from the space capability. Therefore, when considering the development and launch of space segment equipment, the CF must take these factors into account. In addition, the control station and assured access requirements must be considered.

With the exception of Canadian niche contributions to allied space efforts, such as RADARSAT, and capabilities requiring unique Canadian-owned space assets, the CF should avoid entering into high cost projects for satellite development. Where Canada requires specific capabilities that are not otherwise available, "piggy-backing" of space-born components on commercial or other satellites represents a more cost effective alternative. However, CF capability requirements are best served where access to existing commercial and allied systems can be assured.

Satellite information processing facilities are also an important consideration. Imagery, intelligence and command and control information are usually time sensitive, requiring rapid receipt, processing, manipulation and dissemination. The already high volume of data available from satellites is growing at an alarming rate, requiring the installation of ever more capable onboard processing power. This in turn enables direct transmission to locations where the information is required. Alternatively, transmission to select ground stations would permit additional processing and fusion with other militarily significant information prior to dissemination.

Raw data and imagery, despite onboard processing, may not provide all of the information required by commanders at the tactical and operational levels. Once robust military satellite communications are available and the appropriate user terminals are acquired, centralized processing and dissemination facilities would be of greater benefit to the CF. Centralized processing would enable selected views, superimposed information from multiple sensors, and intelligence assessments to be added to imagery prior to transmission to operational units, thereby better meeting the commander's requirements and permitting broader distribution. In addition, centralized processing would reduce the amount of user equipment required, making the overall space solution more affordable. However, it must be noted that while centralized processing offers information benefits, these come at the expense of timeliness.

The feasibility and affordability of user equipment depends on the capability provided and on the operational environment. For example, a full suite of satellite communications user equipment, from man-portable terminals to

satellite ground terminal installations, is commercially available to meet a myriad of operational requirements. In many cases, space user equipment, such as GPS receivers, is an integral component of existing weapons and support platforms. Where this is not the case, dedicated, sole-purpose space equipment may be required. The user equipment configuration and the level of integration with conventional equipment also impact on the equipment feasibility and affordability.

From this discussion it is evident that feasibility, effectiveness and affordability are important criterion in the acquisition decision process. Once the proposed space equipment passes this criterion, the next consideration is whether space, conventional or a combination of the two equipment types can best provide the required capability. This question will now be considered.

Space Capability – Applicability to CF Missions

Space capability is a major force enhancer in fulfilling the CF missions of sovereignty protection, North American defence, alliance participation and support to CF missions abroad. As discussed previously, space assets facilitate global communications, surveillance, navigation, weather monitoring, mapping, intelligence and reconnaissance. However, once a threat is identified, present space assets are unable to prosecute that threat. Existing laws and international agreements prohibit the deployment of weapons in space. As conventional weapons platforms are required to act upon the information that satellites provide, space capability should be seen as an augmentation to existing capabilities, not a replacement. Below, the applicability of space assets and conventional equipment to CF missions is reviewed by looking at three capability requirements.

A major task in sovereignty protection and the defence of North America is surveillance. Traditionally, surveillance has been accomplished through a combination of ground-based radar systems and air and sea patrols. Space-based resources, while not capable of totally replacing the existing surveillance assets, are highly effective in a surveying role, particularly in the detection of missile launches and unauthorized air and sea entry into Canadian territory. However, Canadian geography does not permit full territorial coverage by satellites in geostationary orbit. Therefore, for satellite surveillance to be effective, sufficient satellites must be placed in orbit to provide continuous or near-continuous coverage. Use of satellites in this manner should permit some Operation and Maintenance (O&M) savings by curtailing the number of air and sea patrols, enabling efficiencies to be applied to other tasks. Air and sea assets would still be required to react to threats or emergency (i.e., SAR) situations that were identified by overhead satellites.

Battlefield awareness, a major task in supporting CF missions abroad. Satellites offer a level of flexibility, responsiveness, timeliness, reliability and survivability that conventional assets cannot provide. Satellites have the advantage of being able to pass quickly over a designated area utilizing a mix of sensors and resolutions to compile a complete picture of the ground situation. Multiple flights by reconnaissance aircraft or unmanned vehicles may be able to provide the same level of

information; however, the timelines would be much longer and the lives of the aircrew would have to be put at risk. For some mission types, satellites have look-angle, weather, light sensitivity and resolution limitations that prevent them from being entirely effective. While superimposing images from multiple satellites and varied sensors can improve the quality of images in most cases, there is no replacement for the visual acuity of the human eye. Therefore, conventional assets capable of providing a battlespace awareness capability cannot be replaced entirely by satellite assets; however, the tasking levels of conventional forces in these roles will be greatly curtailed.

Satellites are highly effective at some forms of intelligence gathering. The range of sensors available and the level of continuous coverage over a specific area impact on the effectiveness of satellites in this role; however, satellites do not require permission to cross an adversaries border prior to making an active pass over a region. Little can be done to prevent satellites from obtaining radar and imagery information on almost every aspect of geography, population distributions, industries and military installations. While other forms of intelligence gathering will not disappear, satellites greatly facilitate many facets of intelligence collection.

This brief examination has shown that space assets, either alone or in combination with conventional equipment, provide a capability that enhances the ability of the CF to perform its assigned missions. Acquiring a space capability will not remove the requirement for conventional forces; however, space asset usage will enable efficiencies in conventional equipment employment to be realized, thus reducing taskings on overburdened resources or facilitating reassignment of resources to other CF roles.

Summary

Since the Gulf War, space has been recognized as a fundamental element in support of military operations. The capability of space-based assets to deliver integrated terrain, weather, intelligence and navigation information over high speed satellite links to deployed forces is providing a level of battlespace awareness that is changing the face of conflict. Command and control and interoperability requirements in future coalition or US-led operations mandates the capability to access, receive, manipulate, process and disseminate space-acquired information. Therefore, for the CF to remain an active player in military operations and alliances in the future, it is essential that the CF acquire key space technologies.

Through an examination of the key space capabilities, this essay has identified the equipment that the CF needs to acquire to remain an effective combat capable force in the future. While the CF intends to acquire capabilities across the spectrum of space technology, limited defence spending and the high cost of space programmes make it clear that these capabilities can only be acquired through alliances and industry partnerships. Canada possesses the intellectual and industrial capacity to play an active role in space, and these attributes lend themselves well to Canada providing "niche" space capabilities to allies in return for guaranteed access to space systems and information.

Prioritization of CF space requirements puts command, control, commu-

nications and precision navigation at the forefront. Canada's present international commitments combined with high levels of public support for search and rescue make the SARSAT upgrade project a CF space priority. Identified capital projects will go a long way towards meeting these requirements. The remaining space capabilities requirements are encompassed in the Joint Space Project, an umbrella project which initiates activities designed to address the CF's surveillance from space and space surveillance and defence requirements. Key amongst these requirements is the capability to quickly acquire, process, manipulate and disseminate imagery information, both from the standpoint of using the information internally and of providing a processing and dissemination service to our allies. Access to weather satellite systems, and participation with the US space-based radar programme through NORAD is another important surveillance requirements. Continued participation in NORAD is the key to a space surveillance and defence capability; however, a Government decision on Canada's participation with BMD is required before CF involvement extends beyond present research, consultation and sensor development activities.

A crucial caveat to the acquisition of space equipment is that these capabilities should not be acquired at the expense of convention equipment replacement programmes. While space-borne and space supported equipment can improve the efficiencies of conventional weapons and support platforms, they cannot entirely replace them. Space capabilities are force multipliers that enable efficiencies to be realized in conventional force employment - savings that are crucial in an era of limited defence spending.

Canada has been privileged, thus far, with easy access to the benefits of space provided because of her strong alliance with the US and NATO. The importance of these alliances, especially the NORAD agreement, will remain crucial to ensuring Canada's future space capabilities. Given the limited defence dollars allocated to space, the CF should continue to concentrate on communications and interoperability equipment acquisitions while pursuing surveillance capabilities through joint allied and commercial ventures.

Endnotes

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12. U.S. Space Command defines control of space as ensuring that the US and her allies will be able to operate freely in space while denying that capability to adversaries. Global engagement is defined as the combination of real time global surveillance and ballistic and cruise missile defensive systems. Full force integration is the critical role of ensuring all forces have access to, and can make use of, all available information. Global partnerships are the way ahead as opportunities, costs and risks are shared between business, industry, governments and the military. US Space Command, *Long Range Plan* pp. 7-10.

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16. *Ibid*, p. 202.

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18. Donovan, "Space Support to Military Operations, Seizing the High Ground" – A Briefing to the Joint Warfare Course by the Directorate of Space Development, slide 10.

19. "Remote sensing from space is the exploitation of the electromagnetic spectrum to reflect, radiate, refract or scatter to determine the state of the terrestrial domain. Basically it is a means to sense the earth's surface and air below without regard to boundary, sunlight, weather and, in some cases, foliage or soil characterises this portion of space operations. National security, science, agriculture, forestry, real estate, geology, environmental, and law enforcement are among the interests involved. A broader view of this area embodies the ability to survey and determine the status and operational profile of satellites or other objects in or transiting space." Jones, "Air Power in the Space Age", *Perspectives on Air Power*, p. 202.

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44. Navigation warfare involves the denial of access or tampering with a hostile nation's ability to use GPS while, at the same time, protecting allied access and use of these systems.

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Space, the RMA and Equipment Force Structure Issues for the Canadian Forces in the Twenty-First Century

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The issue of space as it pertains to future force structure issues for the Canadian Forces (CF) is one that relates very closely to that of the so-called revolution in military affairs (RMA). This derives from the fact that the driving force behind what has come to be known as the RMA is the rapid development and deployment of satellite technology in the areas of communications, navigation and surveillance. In considering this relationship four questions emerge. The first question is, "What will be the role of Canada and the CF in managing armed conflict in the twenty-first century?" The second question is, "What will armed conflict in the twenty-first century come to look like?" The third question is, "What role will space and space-based systems play in the resolution of conflict issues?" Finally, the fourth question is, "How ought space systems be integrated into the existing force structure of the CF?"

With respect to the question of Canada's involvement in future conflict situations, it seems clear that Canada and Canadians are intent on maintaining an active role within the international system. Canada's continued commitment to various NATO and UN operations is based not just on national pride and altruistic tendencies, but on the need to be assertive in claiming a seat at the table within the international system. Canada's active participation in these operations is an important outlet for Canadian efforts to influence the international agenda and to secure our national interests abroad. Given the extent to which Canadian economic interests have been absorbed by the process of globalization, it is imperative that we continue to demand a voice within the international community by projecting our influence to as great an extent as is possible.

The question of what twenty-first century armed conflict will look like rests squarely on our understanding of the RMA. General Maurice Baril, Chief of Defence Staff, has defined the RMA as "a combination of technological, organizational and doctrinal changes (that have the effect of) reshaping military operations."[1] This represents a fairly standard institutional explanation of what the RMA is. It is, however, inadequate. The weakness of the definition offered by General Baril and others derives from the fact that it only accounts for those factors which occur within the context of war, or in more general terms, within the context of armed conflict. In order to understand fully what an RMA is, one must go beyond the purely operational considerations of technology, doctrine, organization and tactics. One must also consider the broader international political context in which conflicts occur.

Much of the incentive for trying to identify a new RMA stems from the need to account for the changes that occurred within the international sys-

tem as a result of the end of the Cold War. The notion of the decline of the role of the state within the international system has become very popular as a result of the intensification of the process of economic globalization that accompanied the end of the Cold War and the collapse of Soviet and American "spheres of influence".

Changes have also occurred in the areas of armed force and international security. Indeed, the 1991 Gulf War was often sited as a signal of the changes to come in the area of conflict management in the post-Cold War era. Since then, however, the Gulf War has generally come to be acknowledged as something of an anomaly in terms of how it may be seen to characterize armed conflict.

Perhaps, it would be most instructive to begin by acknowledging that the changes associated with the end of the Cold War may have altered the character of war, or at least our perception of what it should be, but have had no affect on its fundamental nature as a political instrument. This fact underlines the point that the question of whether or not the RMA should be associated with the decline of the state in the international system is based entirely on the dual failure to understand the nature of those changes as well as the nature of the RMA itself. The RMA does not compromise the Clausewitzian definition of war as the pursuit of policy by other means. Clausewitz himself acknowledges that the character of war may change from one historical period to the next, but that the nature of war as a political instrument of the state remains constant.[2]

One of the most significant questions that seems to emerge consistently in the consideration of the RMA is that of the decline of the importance of the nation-state in the international political system. The question derives in large part from the misconception that the RMA somehow restricts the ability of states to employ force in pursuit of their national interests. This misconception is itself based on two intellectual failings. The first is a failure to understand that the process of globalization does not limit the utility of force in the international system. In fact, one could argue that the repetitive occurrence of conflict in areas such as central and western Africa, Algeria, Sudan, parts of the Middle East, the Balkans, the Caucasus, Indonesia, and India-Pakistan, to name only the most prominent hot-spots, suggests that some states have found that the utility of force has actually increased in the post-Cold War era. The persistence of Iraq in flouting established norms of international behaviour and the rather confrontational positions occasionally adopted by states such as Russia, China and North Korea also support the thesis that not all states perceive a decline in the utility of force.

The reality of the situation is that globalization has not limited the value of force. However, it has forced developed states sharing a multitude of mutual interests, including access to natural resources and shared markets, to work in concert with each other in order to achieve their political objectives. This, of course, implies the building of consensus, which can be extremely difficult even under the best of circumstances. The difficulty is only compounded by the fact that matters of military engagement are among the most politically sensitive of government policy issues. Furthermore, it is also

important to consider the fact that the need for developed states to deploy military forces tends to be in response to a threat posed by so-called rogue states. These states often have less invested in the stability of the international system than other, more developed, states and so can afford to commit to a course of action that might disrupt that stability. Consequently, the aggressor has the opportunity to seize the initiative and influence the political, economic, social, and strategic context of the confrontation. The end result of this phenomenon has been that developed states frequently find themselves drawn into conflicts not entirely of their choosing.

The second failure contributing to the misconception that the RMA acts to restrict the utility of force relates to a fundamental misunderstanding of what the RMA is. The origins of the RMA are typically traced to the writings of the Soviet strategist Marshal Ogarkov in the 1970s and 1980s.[3] Ogarkov noticed at that time that a growing technological disparity was emerging between American and Soviet military forces. He coined the term Military Technical Revolution (MTR) to describe this emerging disparity. The more recent concept of the RMA is popularly understood as a broadening of the scope of the MTR. Rather than simply accounting for the effects of technological developments, which by themselves tend to be evolutionary in nature rather than revolutionary, the RMA is seen to integrate these effects with doctrinal and organizational changes, which have a significant impact on the character of warfare.[4]

One aspect of the popular understanding of the RMA relates to a growing capability in the area of Dominant Battlespace Awareness (DBA), and the way in which this capability is affecting how militaries prepare for war by influencing organizational and doctrinal decisions. This capability speaks directly to the question of the role of space and space-based systems in the management of future conflict. It is generally accepted that the growing prevalence of space-based earth observation technology, as well as satellite communications and navigation technology is enhancing the capacity of the military commander to form a clearer, more concise picture of the battlespace. According to this understanding of the RMA, by slicing through the fog of war the same technology also enables the commander both to apply force with greater efficiency and to maximize the defendability of his or her own forces. However, upon closer scrutiny these technological advancements continue to be more evolutionary than revolutionary. While they do have an effect on the way wars may be fought, technologies that facilitate DBA are simply the next step in a logical progression of the integration of military intelligence and communications capabilities that have always been a part of organized militaries in one form or another.

It is necessary for the CF and other military institutions to acknowledge that this is, in fact, an evolutionary process, which has its roots in the Cold War security context. By continuing to develop and deploy successive generations of high tech kit and to alter force structures to accommodate these emerging technologies the CF and its allies run the risk of preparing for a type of warfare that may no longer exist in the international system. The implications of the continuation of such a trend are that the CF and its allies will be

equipped and trained to fight digital wars in a virtual world, but not able to meet the challenges they will face in the real world of the post-Cold War world. The high probability of prolonging conflict situations unnecessarily and the increased risk involved for our men and women in the field are unacceptable consequences of such folly.

This is to say nothing of the astronomical development and procurement costs associated with digital technologies. To inflict such an expense on shrunken defence budgets is one thing if the expense is justified. However, to incur great expenses in pursuit of a force structure geared towards an outmoded form of warfare is not justifiable.

It is not the intention of this paper to argue or suggest that there is no role for digital technology in modern force structures. To be certain, satellite communications, navigation and surveillance applications do bestow a valuable force multiplication attribute to modern militaries. There exists a need however, to strike a balance between developing a force structure that is top heavy on stand-off technology and digital weaponry, and one that does not take advantage of the potential benefits that digital technology has to offer.

It is necessary to constantly bear in mind that the doctrinal and organizational changes currently faced by all modern militaries are largely a function of the political changes that occurred in the international system between 1989 and 1991. The collapse of Soviet Communism, the re-drawing of borders throughout eastern Europe and parts of central Asia, and the spread of the process of democratization made it necessary to re-evaluate the role of strategic concepts such as nuclear deterrence, strategic balance, and arms control. It also meant that the operational requirements and deployment levels of military forces needed to be re-evaluated.

Both the rapidity and magnitude of the changes, along with the overall sense of relief at the "end of the Cold War", made an objective analysis of these requirements extremely difficult to achieve. As a result, some of the decisions made regarding the disposition of forces were not reflective of the new international security context as it began to emerge. The net effect is that over the last decade or so, the militaries of most developed states, including Canada, have been preparing to fight the war they want to more than the war that they may need to.

The recent trend has been towards developing and deploying more complex weapon systems, but in fewer numbers. The aim of this approach is to get the most out of a declining defence dollar by reducing the density of the twenty-first century battlefield. From the infantry soldier to stealth bombers and battle ships, the technological emphasis of defence institutions and the defence industry has been on developing more sophisticated technology to enhance passive defences such as speed, stealth, and stand-off capability, and to maximize the combat lethality of offensive weapon systems, primarily through the development of Precision Guided Munitions (PGMs) and other so-called "smart weapon" technology. Another perceived benefit of this trend is the facilitation of interoperability among nations through advances in communications technology, ostensibly leading to a more even contribution of forces among coalition members.

The theory behind this trend is that by simultaneously enhancing the defendability and lethality of weapon systems, states will be able to reduce the number of combatants that they must deploy to a theatre of combat, thereby lowering casualty rates. This, of course, is intended to generate net-savings in both political and economic capitol. The reality is that developed states have repeatedly found themselves confronted by potential conflict situations where, due to the inherently complicated nature of the globalized international system, a clear national interest exists but is sufficiently opaque as to make it difficult to rationalize the declaration of a precise military objective, and even more difficult to commit adequate military resources for the attainment of that objective.

Indeed, it is quite ironic that while, in principle, advanced military technology is intended to save both lives and money, the thought of risking multi-million and billion dollar weapon systems, in a conflict where national interests exist but seem diluted by the complexity of the relationships created by global interdependence, acts as a limiting factor in the willingness of governments to commit those forces. The irony is punctuated by the fact that, quite often, there is a significant humanitarian element to these conflict situations, in which the lives or general well being of large numbers of non-combatants may be at stake.

Upon considering these facts it is increasingly clear that one could conclude that the real RMA, such as it may be, has not yet occurred. In fact, the RMA is not a product of the integration of technological advancements with the doctrinal and organizational changes that occurred in response to a shift in the structure of the international system at the end of the Cold War. Instead, the actual RMA will manifest itself in the realization that those organizational and doctrinal changes did not reflect a complete understanding of the implications of the shift in the international system that occurred in the early 1990s. One could further conclude that until a more complete understanding of the character of conflict and the role of armed force in the post-Cold Ware era are achieved, it is futile at best and dangerous at worst to speculate on future procurement strategies for military space systems. A better approach, as part of the broader effort to understand the current and near future international security environment, is to examine the way in which space and space-based systems can be integrated into existing force structures and organizational schemes.

As Ogarkov began to notice in the 1970s, many western militaries had set out on a path towards developing high-tech weapons systems in preparation for a potential war with the Soviet Union. The current trend in developing and deploying high-tech military systems is merely a continuation of the earlier one identified by Ogarkov. What is significant is that the trend continued in spite of the fact that the Cold War ended in 1991. After the collapse of the Soviet Union the West continued to prepare for conflict against a single, identifiable, and somewhat predictable monolithic adversary. Moreover, the objective of military and strategic readiness during the Cold War was in contributing to the condition of strategic stability between the superpowers. In the newly emerging international security context of the immediate post-Cold War era the “enemy” became an obscure set

of poorly defined "enemies", whose actions could upset the stability of the international system. Consequently, the issue of strategic stability is no longer as prominent as it once was.

The prevalence of global interdependence has created an environment in which members of the international community with like interests now have to coordinate their policies for dealing with such threats. Thus it may be instructive to reflect on the concept of the "Anarchical Society", postulated by the international relations theorist, Hedley Bull.[5] Indeed, there can be little doubt that the need for states with common, yet sometimes conflicting, interests to interact with each other in a highly interdependent international system necessitates that certain societal characteristics must be introduced to international relations.

The Napoleonic Revolution ushered in a new era in military affairs by integrating technological, social, and political changes that together influenced a newly emerging international system. Perhaps we still remain too close to the heart of the changes brought about by the end of the Cold War in order to allow us to achieve an objective understanding of how they have influenced the character of military affairs in the post-Cold War era. It may be that a few more years time will be required before it will be possible to determine conclusively whether or not an RMA has occurred, or whether we currently find ourselves at the beginning of an RMA of a different character than the one that has recently become the focus of attention.

Clearly, the problem of identifying and adapting to the RMA is not unique to Canada or the CF, but is one that is faced by all modern states. It is a systemic problem that stems from a failure to clearly understand the nature and effect of the social, political, and economic changes brought about by the end of the Cold War. Having noted that there is no certainty in anticipating the long term effects of systemic change, the thesis of this paper remains firmly rooted in the statement that the real RMA will be realized when not one, but many, states begin to acknowledge that the strategic concepts, organizational structures, doctrinal positions, and force structuring practices of the post-Cold War have been little more than warmed over variants of those employed during the Cold War. The RMA can only be realized when states gain an appreciation for the fundamental differences between the current international system and that of the Cold War, and then respond by employing new strategic concepts, organizational structures, doctrinal positions, and force structuring practices.

With respect to what the RMA portends for Canada and the CF, there seems to be no easy answer that might lead to a short term solution to the current and future challenges posed by questions of procurement and force structuring. One thing is clear however, that is the fact that Canada's status in the international system is largely a function of the common perception of its close relationship with the United States. The greater the extent to which Canadian economic and strategic interests and values are seen to be inextricably linked to those of the United States, the greater will be Canada's influence in the international system. Unfortunately, this places Canadian strategists and policy makers in an extremely difficult position.

On the one hand is the need to acquire an objective understanding of the changes that have reshaped the post-Cold War international system and respond positively to them. The logical extension of this activity could very well be something as significant as a switch away from the emphasis on the development of increasingly sophisticated weapon systems that began during the Cold War. On the other hand is the need to retain a very close working relationship with the United States, which happens to possess the largest and most technologically advanced military force in the world. Clearly, as the world's foremost leader in what has come to be referred to as the RMA, the United States poses a particularly acute challenge to the need for Canada, and the rest of the world, to respond positively to an accurate understanding of the current international security context.

The only acceptable course of action open to Canada at this time is to attempt to pursue both sets of interests concurrently. Canada and the CF ought to play a lead role in promoting discussion among its allies about the current characteristics of the international security environment. Canada should also assume responsibility for generating an awareness of the fact that new methods of engaging the issues presented within that environment are required. At the same time the interoperability of the CF with its most likely coalition allies needs to be ensured. Any failure to ensure a high level of joint operations capability would certainly result in the marginalization of the Canadian contribution to an international effort, and the concomitant degradation of Canada's ability to wield influence in the international system. Such an unfortunate state of affairs would certainly compromise Canada's ability to fully pursue its own interests within the international system.

This two-sided approach to coping with the problem of the so-called RMA is not offered as an easy out to a difficult question, but as a means of providing a balanced solution to a challenging problem for Canadian defence and security policy. As was mentioned above, by alienating the United States and presenting Canadian interests as being distinct or even contrary to those of the US Canada would be undermining its own ability to exert its influence in the international system. However, by simply continuing along the current path of what is erroneously referred to as the RMA, Canada would be undermining its longer term ability to protect and pursue its interests by preparing for an enemy it would like to fight rather than for one it may need to fight.

By pursuing both avenues at the same time it is likely that Canada will eventually be able to field a multi-purpose combat-capable force of the sort described in the 1994 Defence White Paper. Indeed, such a force will be required to address the broad range of threats to the interests of Canada and its allies that will continue to emerge in the twenty-first century. This force will need to be able to demonstrate a high degree of adaptability to meet a broad range of threats and mission profiles, and will certainly have to take advantage of the benefits provided by modern military technology. However, some balance must be introduced into the equation. It must be understood that modern military technology may not always mean the most expensive or sophisticated technology, for it would be folly for Canada, or any other state,

to price itself out of the ability to deploy a force into the field with sufficient resources to achieve its objective.

The goal then, is to coordinate more concerted efforts to conceptualize the post-Cold War security environment with an analysis of how space and space-based systems can be used to manage conflict issues within the context of the post-Cold War, rather than the Cold War, international security environment. By conducting this parallel analysis the CF will better position itself to meet the challenges of future force structure issues as they pertain to space and space-based systems.

Endnotes

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3. In fact, the Soviets identified the concept of a nuclear RMA as early as the late 1950s to early 1960s, see William Kintner and Harriet Fast Scott (eds.), *The Nuclear Revolution in Soviet Military Affairs*, (Norman, OK: University of Oklahoma Press, 1968).

4. General Maurice Baril, CDS, excerpt from *1998-99 CDS Report* found at web site www.dnd.ca/eng/archive/may99/27cdsreport_b_e.htm.

5. Hedley Bull, *The Anarchical Society: A Study of Order in World Politics*, (New York: Columbia University Press, 1977). While Bull's theoretical concept of the Anarchical Society is based on a rather traditional realist interpretation of international relations and reflects many of the assumptions associated with the bipolar international security context of the Cold War, it may yet serve as a useful point of departure for a more detailed study of the societal qualities of international relations in the post-Cold War era.

A Canadian Forces Personnel Structure for Space

Syndicate 7: Lieutenant-Colonel Claude Rochette (Chair), Lieutenant-Colonel Benoit Carrier, Lieutenant-Colonel John Graham, Major André Dupuis, Major Doug Grimshaw, Major Antoine Hauteclocque, Major Dave Mulcair, Major Chione Robinson and Major Simon Sukstorf

Introduction

Space-based services pervade everyday life in Western society. The general population, however, is mostly unaware of the extent of these. When gas pump access cards were disabled for 24 hours a couple of years ago, most of the population was probably never aware that a meteor shower had disabled space communications links.[1] Equally, there is little awareness within the Canadian Forces of space capabilities as they relate to operational effectiveness because little space training and direct work experience is available within its personnel pool. In particular, force structure considerations for space operations both today and in the future have hardly been considered. This paper will address the question of what personnel force structure the CF should create for future exploitation of space capabilities.

Facts and Assumptions

The modern warfare environment extends beyond the conventional limits of sea, land, and air. The importance of assured access to space capabilities to support the strategic, operational and tactical levels cannot be overstated. As a preliminary step to examining personnel issues for space utilization, it is therefore helpful to highlight the following general points with respect to space limitations and advantages:

a. space-based platforms provide the ultimate high ground, offering an unrestricted global field of view and greatly increased line of sight;

b. due to its influence through information dominance in military operations, space is maturing as a warfare environment;

c. heavy military and civilian reliance on space-based systems, combined with their high cost, make them a centre of gravity and, therefore, a security concern;

d. due to the critical importance of access to space capabilities, international space partnerships will heavily influence strategic relationships;

e. legal aspects of space are becoming increasingly formal and codified through treaties and international space law detailing rights, obligations, and contractual remedies for space related activities and assets;

f. the rate of change in space technologies and capabilities is

rapidly accelerating. We have moved through the First Age of Space, a 30-year period during which space assets were nationally owned and used for strategic purposes, to the Second Age encompassing the past ten years, space assets have become commercialised and theatre level assets are used for routine operations. We are currently on the threshold of the Third Age, during which space capabilities will be fully integrated into warfighting at the tactical level; and

g. the Canadian Forces leadership acknowledges and fully understands the critical importance of space-based capabilities as a force enhancer and is actively pursuing exploitation of space capabilities consistent with national policy.[2]

In addition to these general statements, this paper is based on a number of assumptions with respect to the intentions of the Government of Canada and the Canadian Forces, which are as follows:

a. the Canadian Forces are committed to the integration and utilisation of evolving space capabilities and technical enablers as force enhancers;

b. the Canadian Forces will not pursue an independent space program but will adopt a space strategy dependent upon strategic partnerships primarily with the US, as well as with European nations and possibly other nations or agencies;[3]

c. the Canadian Forces will not have sufficient funding to invest heavily in system hardware for dedicated military service;[4]

d. the majority of the Canadian Forces contribution to international space partnerships will be in the areas of personnel and knowledge (software development);

e. interoperability for communications, surveillance, reconnaissance and targeting data will be heavily dependent upon the ability to use space capabilities; and

f. the Canadian Forces will continue to rely heavily on collective defence and interoperability with allies to meet defence commitments.

This paper has been formulated in the context of the above general points and assumptions. Clearly, appropriate management of Canadian Forces personnel possessing expertise in space-based technologies and systems is critical to maximize the military utility of space. Therefore, the Canadian Forces must put in place an adaptable system to recruit, develop and retain a cadre of select individuals capable of exploiting the military potential of space.

Aim

The aim of this paper is to show that the framework within which the CF can best manage its human resources in the area of space operations is the Occupation Specialty Specification (OSS) and Occupation Specialty Qualification (OSQ) structure. The paper intends to illustrate that this structure offers that best chance for joint focus in space operations, flexibility of personnel employ-

ment and dissemination of space knowledge throughout the CF. The scope will be limited to the examination of potential force structures for the Canadian Forces and not the Department of National Defence. As such, it will not include DND civilian options nor will it be concerned with the Canadian astronaut program, which is run by the Canadian Space Agency.

Background

Any discussion on the personnel requirements in the area of space must begin with the various roles and missions in which the CF may become engaged. This section outlines those roles and missions, moving from the general to the specific and beginning with a brief review of basic space doctrine, followed by an examination of DND space policy.

Space Doctrine

Basic space doctrine for the CF is contained in Chapter 26 of the *Canadian Forces Operations Manual*. Being general in nature, this doctrine outlines the full range of military roles and missions in space. Realistically, this complete list can not and should not be taken as a guide to actual requirements for personnel or resources because Canada neither owns nor operates the range of space-based assets needed to carry out the full spectrum of space missions. Nevertheless, given that space assets provide the new "high ground", CF members should strive to gain a comprehensive knowledge and understanding of space doctrine. The basic doctrine provides the four operational space roles depicted in Figure 1: enhancing operations for terrestrial forces, space forces support, space control, and force application. The following paragraphs will explain these roles and their component missions.

Enhancing operations. In this role, space-based assets are used as a force multiplier for sea, land, and air force operations. Missions are global in nature and include: surveillance and reconnaissance, secure and non-secure communications, environmental observation, precision navigation, and mis-

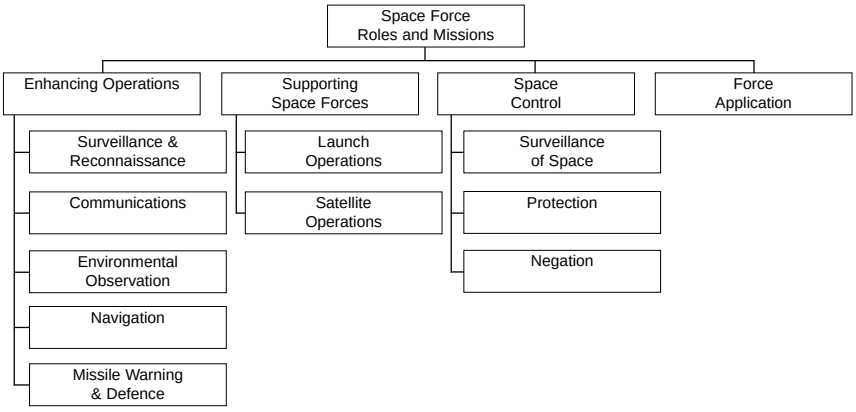

Figure 1. Basic Space Doctrine: Roles and Missions[5]

sile warning and defence. Of note is the fact that Canada has not yet made any decision regarding its participation in Ballistic Missile Defence (BMD). "To date, Canada has limited its activities concerning BMD to research and consultation with the United States and other like-minded states."[6] A negative outcome to this issue could have a proportionally negative impact on Canadian participation in space through NORAD and USSPACECOM space-based assets.

Supporting space forces. This role involves any activity that results in the deployment and/or maintenance of space-based hardware. It calls for a launch capability as well as a command and control capability. Performing this space role is highly infrastructure intensive. The requirement for ground stations, telemetry capabilities and a variety of other types of facilities can be considerable, depending upon the degree of support required.[7] In cooperation with the US armed forces, Canada plans to obtain "a Canadian Military Satellite Communication (CANMILSATCOM) capability to acquire reliable, secure, flexible and survivable data and voice communications in support of military operations" through the CF CANMILSATCOM project.[8]

Space control. This role is roughly equivalent to the air superiority role for air forces or sea control for naval forces. Surveillance of space is usually a nation's first entry into the space control role. To be effective, such surveillance must give the ability to construct a highly accurate catalogue to predict the location of any object in space at any time. The protection mission is a significant step in a nation's space posture and is oriented towards guaranteeing the use of friendly space-based systems. The negation mission goes one step further and aims to deny the enemy the use of his own systems.[9]

Force application. The foundation of the force application mission rests on space-based systems or platforms that are capable of applying force to ground, sea, and air targets in support of terrestrial military operations. At this time, no military possesses this capability, but Lockheed-Martin is developing a reusable vehicle to carry out such missions, and other such projects may be underway.[10] Although US national policy does not presently support the concept, the US Space Command Long-Range Plan includes this mission as a possible area of expansion if directed by the US government. Any system that could deliver a weapon, whether kinetic or some other type, such as a laser, would be included under this role.[11]

For a number of reasons, Canadian Forces participation in the above basic doctrine hierarchy is limited. National policy restrictions, cost constraints or both prevent participation across the full set of doctrinal roles depicted in Figure 1. Such restrictions and constraints are accounted for in DND's space policy, the capstone document for CF involvement in space.

DND Policy and CF Strategy

DND's space policy is intended to ensure that Canadian government direction is accurately reflected in space programs and activities. First articulated in July 1987 and based on the 1987 Defence White Paper, the policy was updated in September 1992 following the publication of the Departmental Space Appreciation document that year.

This Space Appreciation concluded that DND, as the primary guarantor of national security, ought to develop the requisite capabilities to safeguard any Canadian interests that could be threatened in, from, or through space.[12] Two years later, the 1994 Defense White Paper noted the increasing importance of space within the global security environment. The 1990 Gulf War provided compelling evidence of the importance of space surveillance, reconnaissance, and missile warning. DND's most recent space policy, published in September 1998, still draws heavily upon the 1992 Space Appreciation document, but reflects the increased space emphasis from the 1994 White Paper. According to this policy, DND and CF space goals are:

> a. to protect national security and sovereignty interests;
>
> b. to protect national interests from threats located in or passing through space; and,
>
> c. to fulfill Canada's defence commitments by supporting missions and tasks using space technology wherever appropriate".[13]

According to the policy, the following four space capability areas will be "*considered*" [authors' italics] for development by the CF in pursuit of the above goals:

> a. "the capability to acquire and assess space data of interest;
>
> b. the capability to support combat-capable forces deployed world-wide with command, control, communications and navigation tools;
>
> c. the surveillance of land, sea, air and space; and
>
> d. the development of warning systems."[14]

In doctrinal terms, then, DND seeks to develop capabilities in two of the four roles depicted in Figure 1: enhancing operations and space control. For the foreseeable future, the CF has no intention of developing capabilities in either the supporting space forces or the force application doctrinal roles.[15]

The policy acknowledges that the CF cannot develop the above capabilities on its own. Effective cooperation with other government departments, industry, and allies is essential.[16] The policy highlights the importance of Canadian-US space partnership within NORAD and calls for an "operationally oriented space research and development program" as well as an "adequately trained cadre of civilian and military personnel at all rank levels"[17] to bring the CF space effort to life.[18] In short, the CF aims to develop its space capability by three principal means: in coalition with other nations, particularly the US; through Canadian research and development; and by developing tailored expertise among CF personnel.

The details linking DND space policy with specific space-related projects are contained in the Canadian Military Space Strategy published in April 1998. This document details the capital equipment projects that will be pursued through the Department's Long Term Capital Plan. Two of the major projects are CANMILSATCOM and the Joint Space Project (JSP), a multi-faceted conglomerate of six smaller projects. The

strategy also cites a number of enabling activities in support of the overall space effort.[19] One of the main enablers is the Space Human Resources Working Group (Space HR WG). This group is mandated to develop a plan for the identification/tracking, training/education, employment and retention of CF space-qualified personnel.[20] This subject will be further discussed below, under the heading of Employment in DND.

CF Space Personnel Force Structure

Personnel Requirements

From the HR perspective, given that Canada will clearly not invest heavily in an independent space program, the CF will need to nurture a strong liaison capability to operate within alliances to meet its space policy goals. The knowledge and expertise requirement could take different forms; however, based on United States Air Force (USAF) space operations experience, the following HR requirements are likely for the CF:[21]

a. space operations staff personnel to command, manage and operate space and ballistic missile and warning systems, space control activities and associated analytical activities;

b. space operations analysts to manage space system analytical activities using computer systems, mathematical tools, and celestial mechanics to generate high accuracy satellite position predictions for space surveillance, tracking and space control;

c. space operations personnel to command, manage and operate electronic and optical space sensors, missile warning sensors and operations centre activities;

d. personnel to fill staff positions in relevant organizations to develop operational space doctrine to pursue the optimal use of space-based capabilities; and

e. subject matter experts able to identify potential areas of exploitation of space assets to enhance operational capabilities.

Despite these implied space tasks, there is currently no formal force structure for CF personnel involved in space activities. There is, however, an informal structure. About two dozen personnel are employed in full-time space-related activity, within the Directorate of Space Development (D Space D) and elsewhere. Additional personnel are employed with NORAD and receive space training before being employed. Unfortunately, CF qualification annotations reflect only courses completed not experience. Thus, career managers find it difficult or impossible to track space expertise other than via informal means. The Space Human Resources Working Group (Space HR WG) has tried to address this issue since 1998, but the problem remains unresolved. According to the 1998 space strategy, the working group undertook an initiative to develop a common Officer Specialty Specification based on a "Joint Space Operations Support course," but no means of tracking experience was examined. In this context, the solutions proposed in this paper are aimed at revisiting the entire problem.

Review of Other Solutions

One possibility for obtaining comparative information on this issue is to examine the situation in other countries. Over 50 countries are involved in space to varying degrees. In the top tier are Russia, the US, France, Japan, China, the UK, India, Israel and Ukraine.[22] All of these countries have launched indigenous satellites and most of them maintain comprehensive space programs, as well as providing commercial space services. At the other end of the spectrum of these fifty-some countries are those nations that have a demonstrated interest in space, whether for commercial or military applications, but have no significant indigenous programs. Canada is positioned around the midpoint of this spectrum, with countries such as Finland, Portugal, The Netherlands, and Norway. These countries might offer a basis for future comparisons of space personnel force structures, but little information was available at the time of this study.

A most useful basis for comparison lies in the US Navy's (USN) situation. Like the CF, the USN has an interest in space applications but does not own space assets. It relies on the USAF and other strategic organizations to provide it with space-related products. The USN personnel base is larger than Canada's, with approximately 340 personnel directly involved in space operations, but it operates along similar lines with respect to space. Navy personnel rotate in and out of space billets and their files are annotated with space qualifications. These billets, however, are seldom perceived as career enhancing. Thus, interest in them is generally poor, and turnover rates are high.[23] Nevertheless, the US Navy approach, even with a larger complement than that envisioned for the CF, is certainly a viable option.

Solutions for the CF

Before launching into the review of options, a few principles need to be considered. First, given our ambitious space objectives and very limited means, a CF space personnel force structure should provide for the needs of all three environments. As an added benefit, space resources could serve to further this integration of the environments into a more effective joint CF. Therefore, a joint approach to personnel force structure is not only necessary but also essential. Secondly, as the role of space evolves and expands, CF involvement could increase or change in scope, thus requiring adjustments to its space personnel force structure. Therefore, it should be flexible enough to accommodate such variations easily.

Finally, knowledge of space capabilities is at present, confined to a limited body of CF personnel, leaving large segments of the operational communities ill-suited to exploit space resources. At present, space has not been integrated into the operational structure of the CF, although it is clearly the significant field of the future.[24] A space personnel force structure that contributes to the dissemination of space knowledge would indeed enhance CF capabilities and effectiveness across the spectrum of operations.

Space Personnel Structure Options

In considering how the CF could meet its space operations needs as developed above, the following three options emerge: a separate Military

Occupation (MOC), a Sub-Military Occupation (sub-MOC), and the use of Occupational Specialty Specifications to track CF personnel with space-related qualifications. This section will examine each of these options. One option not considered is the use of DND civilians and contractors in manning space-related positions. This is not to suggest that there is no requirement for civilian participation in CF space issues. Civilians could be effectively employed in the scientific and managerial domains. Space operations, like all other operations within the military, require an innate understanding of the military requirement and therefore the nature of the task demands a military professional. Ergo, the options considered herein involve military personnel only. In the following paragraphs, a brief description of each option will be presented, and advantages and disadvantages will be discussed. Finally, a recommendation will be proposed and developed in the next section.

MOC. This option is the most complex. Good parallels for comparison can be found in the USAF, the United States Army, and the USN. Until very recently, only the USAF possessed the equivalent of a space operations occupation. The United States Army was the next to adopt this approach when it formed a Space Operations career field in 1999, using officers from other career fields.[25] The USN does not have a space career field at this time. Instead, it attempts to fill space-related billets with officers who have specialty training in a space-related area.[26]

Figure 2 is a comparison between the USAF, US Army, and the USN officer strength in space-related billets. From these numbers it is obvious that the USAF has by far the largest space operations organization. These figures reflect the various services' attitudes towards space operations. The Army and the Navy view space operations as a force enhancer, used to support the fleet at sea, or the soldier in the field. Although the USAF recognizes this force enhancement aspect, it goes a step further and views space as an independent combat element in its own right.[27]

Armed Service	Officers in Space Operations
USAF	3,600
Army	60
Navy	340

Figure 2

According to space policy, the CF views space operations as a force enhancer. This emphasis parallels the USN system. The US Army, on the other hand, developed a space operations career field essentially to support corps level activities. Given the Canadian Forces' limited size, it would be difficult to justify a separate MOC based on the need to support any formation. It would also be unwise to build an MOC in which most, if not all, of the operational employment is based on access to a foreign nation's capabilities.[28]

In addition, there is a very good organizational reason that the CF should have officers from various career fields cycle through space operations employment. Space operations are relatively new within the CF. A broad base of understanding of how space operations can affect the modern battlespace will become increasing important across all CF MOCs. Lieutenant-Colonel Jones, a student at National Defence University, specifically addressed this military internal cross-training aspect when discussing the pros and cons of the US Army (prior to the establishment of a career field) and USN approaches regarding space personnel:

> *The biggest pro is the constant cycling of warfighters through the space operations arena. This aids the mission of force enhancement in two ways. First, it ensures warfighter influence into the space operations arena, and secondly, when these officers return to their career fields, it ensures some space operations influence into the warfighting arena.*[29]

Given the small numbers of personnel involved in space, the limited CF operational space capabilities, and this preference for the broadest possible exposure of Canadian Forces personnel to space operations, it is neither feasible nor recommended that a separate Space Operations MOC be created for the foreseeable future.

Sub-MOC. A sub-MOC could be a viable option for space operations within the CF. Under this option, an existing MOC would be chosen from which personnel would be drawn to staff the sub-MOC.[30] Once an individual was trained in the space operations sub-MOC, the person's career, especially at the junior officer level, would be almost exclusively within space operations.

As with the previous option, a sub-MOC would provide for continuity and the building of a core of space experts with the CF. Management of space operations personnel would be very simple because all expertise would reside in one sub-MOC. The career opportunities available to members of a sub-MOC, although limited in the broader military context, might make recruiting of specialists much simpler for the CF. In addition, this option would allow the CF to develop highly specialized military personnel. Lastly, this option would also limit the training costs associated with space operations.

On the negative side, as with the first option, exposure to space operations would be limited to a select group. The vast majority of the CF would not have the opportunity to learn about and work in space operations. This would probably limit the integration of space knowledge across the CF and, in particular, across the warfighting communities. Conversely, a dedicated space operations sub-MOC would have a very limited knowledge base of broader CF operations. Finally, this option implies that a parent or feeder MOC[31] would have to be chosen. The question then becomes - which MOC? If the sub-MOC were drawn from an operational MOC, space knowledge would tend to remain concentrated within a specific environment. Choosing an air MOC, for example, would limit knowledge expansion within the army and navy.

This option is not very different from the MOC option. A sub-MOC would provide a vehicle for career management but would tend to compart-

mentalize the space knowledge within the CF. It carries many of the disadvantages of the first option with only marginal additional advantages. It is therefore not recommended.

Occupation Specialty Specification and Qualification. OSS refers to a CF specialty that can be easily documented and tracked using personnel management technologies currently used by the CF. OSQ refers to the database tag given to personnel in any MOC that is awarded after the completion of a formal course recognized by the CF.

The OSQ-granting course would not necessarily have to be one given by the CF. Personnel posted to space billets in the US, for instance, must attend formal training at a US training facility. In most cases this training is sufficient to satisfy an OSQ. For the few positions that do not require a formal course, members could attend, as a minimum, the Basic Space Operations Course given at the CF School of Aerospace Studies (CFSAS), Winnipeg. This course, coupled with on-the-job training, would be sufficient to grant an OSS qualification. Given the very small yearly throughput of members going to space billets, a specialized training course would be neither practicable nor economically viable.

An OSQ for space would open up space employment to the broadest possible number of CF personnel. It would also eliminate any problems with career management because personnel could be managed within the existing staff structure. The OSS coding system would also let CF identify all personnel who have space experience, allowing it to build a core of expertise where appropriate. In short, it encompasses most of the advantages of the two previously discussed options.

This approach of providing space operations experience to the broadest possible number of MOCs does have some disadvantages. Firstly, it does not result in a centrally managed body of expertise. Most officers would spend one, or perhaps two, tours in a space position, then cycle back to their respective MOCs to be managed by any one of the career managers. Only a very few selected officers could be groomed to become experts in space operations. The OSS system does provide a mechanism to track individuals with space expertise (whether this is a single basic course or varied experience and knowledge), but careful attention would need to be paid to actually tracking these personnel. Because the OSS methodology is only designed to track formal courses, a qualification that is awarded through on-the-job training or out-service academic training (such as an MSc in Space Operations) would not appear as an OSQ on a member's file. An OSQ also bears a training cost, however in this case that is mitigated by a broader personnel knowledge base. Furthermore, we would recommend that the CF use a single OSQ code as opposed to a variety of codes tailored to every different type of employment. The goal of a space OSS would be to identify a small number of specific personnel within the CF who have some type of space experience for employment some time later in their career. What is important is general space knowledge as opposed to specific technical skills.

The use of the OSS system to manage personnel involved in space operations encompasses most of the advan-

tages and few of the disadvantages of the previous options. It provides a mechanism to track personnel with a space operations background and allows the maximum exposure of a cross-section of CF personnel to space operations. Therefore, selection of this option would provide the most benefit in enhancing the combat capability of the CF and in determining appropriate requirements to manage CF personnel resources.

Human Resource Management

Having recommended the OSS/OSQ methodology as the best means of developing CF space expertise, this paper will now examine this approach in terms of the various human resource management processes. The following sections discuss resource management issues, including recruiting, training and education, employment, and retention issues.

Recruiting

Recruiting aims to locate and enrol candidates suitable for employment in military occupations. The recruiting effort can either focus on people possessing specific skills or search for suitable individuals capable of receiving education and training to the right level in such skills. While the former prevails in the civilian sector, military recruiting has traditionally focused on the latter out of institutional necessity. The need to progress through a rank structure and the uniqueness of most military occupations make enlisting trained workers directly from society difficult or impossible.

Given the OSS recommendation above, personnel needed to man space-related positions would need to come from various MOCs and trades within the CF. Upon selection, each person would be temporarily assigned to a space-related position just as in any other staff, shore or ground assignment. Upon completion of a space assignment, the individual would normally return to serve their former MOC community. Recruiting in this sense would therefore be a voluntary activity conducted through the career management network. Indeed, individual could effectively pursue two parallel careers, one in their MOC and one in space-related positions.

In support of the career management effort, one of D Space D's functions should be in the mentoring/awareness-raising area. D Space D should provide a 'road show' to tour the country informing CF audiences about space initiatives and opportunities. Such a program should be aimed at middle and senior leadership because they are the most influential in pursuing space issues. The reason for this suggestion is that it is essential to secure "buy-in" from these groups if the CF space effort is to have any chance of growing from its current status. The program should aim to keep a broad-based level of awareness in space-related issues.[32] This would require personnel with space skills, but preferably also with recruiting or career management expertise.

Space Training and Education

As mentioned previously, there is a need for a system that can track space knowledge and/or space experience ranging from formal course qualifications to on-the-job training. The system should give career managers the

capability to 'see' who in the CF population has the requisite space experience. Experience would consist of having filled a space-related position or, in some instances, of having completed civilian training in the space field. Knowledge would consist of having completed a course of some kind, whether academically or practically oriented. The CF advisor for space training and education should be D Space D, as the departmental expert in the subject and an officer working in the DCDS joint environment. There should be a number of key space-related positions to which junior officers can aspire and for which a level of knowledge and experience are necessary or preferable prior to appointment. For some positions, specific qualifications should be a prerequisite. For other positions, this level of formality is not needed, but candidates should still be carefully selected. In any case, the number and nature of courses should be expanded to fulfil the new requirements.

At present, CFSAS Winnipeg conducts the only two space-related courses available in the CF. The Basic Space Indoctrination Course referred to above is intended to "provide air operations and direct support personnel with a basic knowledge of the concepts and terminology associated with space operations."[33] Every year, up to 200 CF members, from the Corporal to the Major rank level, complete this five-day course. The second course offered at CFSAS is the General and Senior Officers Space Indoctrination Course (GSIC). It aims "to familiarise Colonel and General officers with space operations."[34] Conducted once annually, this course only produces 15 graduates. Being introductory in nature, both the GSIC and the BSIC would not meet the training needs created by an expanded CF role in space. Should CFSAS inherit the mandate to meet all CF needs in this domain, these courses will have to be modified and expanded or new courses created. Alternatively, some or all of these could be contracted out or procured from the US.

Employment of Personnel

Employment within DND. As part of the space planning process, the Space Development Working Group (SDWG) identified a requirement to develop a strategy for the training and employment of military and civilian personnel to meet the space-related requirements of the Department. A second working group consisting of representatives from the Joint Space Project, the Directorate of Force Concepts, and the Directorate of Personnel Plans was formed in May 95.[35] The group developed a Space Human Resources Strategy. Under the auspices of the SDWG, a comprehensive survey was undertaken in August 1995 to identify all positions that currently call for or should call for specially qualified space personnel. At the same time a review of in-service and out-service training capabilities was also completed. Initial survey results showed that there are approximately 105 DND personnel employed in "hard" operational or staff space positions and approximately 120 DND personnel employed in "related" operational or staff space positions.[36]

At the May 96 SDWG meeting, the working group presented the results of the survey and recommended that D Space D develop a plan for space training and education. The SDWG endorsed the recommendation, and D Space D continued the progress of the

original working group by establishing a Space Human Resources Working Group (Space HR WG). The aim of the Space HR WG was to develop a comprehensive plan for the education, training, professional development, and employment of CF space personnel.[37] The Space HR WG recommended that three areas be pursued to satisfy the future needs of DND:

> a. develop a space Post Graduate (PG) program at RMC to provide personnel with space expertise;[38]
>
> b. establish joint manning of NORAD space positions to develop personnel in space-related employment; and
>
> c. establish an OSS called "Joint Space Support to Operations" to track personnel possessing space qualifications, for further employment.

Unfortunately, improvement is still required in all of these areas. First, the space PG program at RMC has stalled due to a lack of funding. Next, International Trade in Arms Regulations issues and the implications for access to classified information are adversely affecting the combined manning of NORAD space positions. Finally, the OSS methodology has been initiated, but difficulties were encountered with the CF's *Peoplesoft* manning database software.[39] About 50 positions within Canada have been identified by D Space D as requiring a space OSS, but until a tracking system is up and running, matching personnel to positions will remain an ad hoc career management activity. Although career managers do their best under this arrangement, the potential benefit to the CF that could be derived from foreign and exchange experience is lost when members return to Canada. Invariably such members are cycled back to normal MOC employment that precludes applying their newly acquired expertise.

Out-of-country employment. Currently DND appears to be able to meet its requirements; however, in order to ensure that personnel are employed in areas of strategic interest to Canada, D Space D is pursuing other opportunities within the US.[40] The 1999 version of the Defence Planning Guidance calls for addressing space capability deficiencies through full cooperation with other government departments and agencies and emphasizes the importance of cooperative participation in US programs.[41] Indeed, the key feature of CF strategy is access to US systems. Specifically, the strategy is aimed at such access for all of the missions in the "enhancing operations" role (Figure 1) except missile defence. The CF position in NORAD is regarded as a vital link through which expanding access can be pursued, and must be preserved.[42]

A review of the complete CF personnel inventory within NORAD is ongoing, under the direction of the Deputy Commander in Chief (DCINC). Placing personnel in positions south of the border has potential benefits for DND, but within the past year some incumbents have had security restrictions imposed. This issue has been raised through the Military Cooperation Committee (MCC) and is being discussed.

D Space D has initiated positive steps to address employment issues within DND. Providing the human resource management tools required for

effectively employing personnel through OSQ tracking is a very good initiative and should be pursued vigorously. Seeking opportunities for employment in space positions within the US should be evaluated against the potential risks in data access imposed by restrictive US policies. Reaching an acceptable agreement through the efforts of the MCC could mitigate this risk.

Retention

With the passage of time, it is probable that increased pull factors from civilian industry could draw our expertise away. The space exploitation industry is projected to grow into as yet unforecast areas and dimensions. Due to the lack of tracking methods, reliable retention data is difficult to obtain, but at present retention does not appear to be a concern.[43]

Conclusion

This review of CF space roles and missions demonstrates that there is a significant and growing need for personnel with space expertise. The CF could fulfil this requirement by creating either a support function subservient to the navy, army and air forces or, less feasibly, a new MOC contributing jointly to the accomplishment of military objectives. In the short term, the Canadian context favours the first alternative simply because of Canada's limited resources, activities, equipment and personnel involvement in space. Going one step further, these realities lead one to believe that the establishment of independent CF space occupational trades would likely not be viable in the CF. The alternative, therefore, would be to select personnel with relevant knowledge and expertise from all appropriate career streams for training and employment in CF space roles and missions. The CF's strategy should be two-pronged: expanding the flow of personnel through the space community, and expanding the flow of expertise throughout the CF.

Political and fiscal realities dictate that CF involvement in space is likely to always be either within the framework of an alliance or a coalition. Furthermore, these realities are likely to limit or prohibit CF personnel participation in some space roles and missions. Nevertheless, it remains essential for the CF to cultivate an organic minimum level of knowledge and expertise in each space role and mission to meet and validate its military objectives.

Given this need, there are three possible options that the CF can pursue: create an MOC, create a sub-MOC, or apply the Occupation Specialty Specification methodology currently in place. Despite strong parallels with the USN, the CF does not have sufficient personnel strength to create a separate MOC. Creating a sub-MOC would tend to concentrate space knowledge in one parent occupation. The recommended option is to use the OSS methodologies to assign skill set prerequisites to positions, track space-qualified personnel and provide career management within existing personnel policies and structures. The preferred concept would be to rotate selected CF personnel through both space and non-space positions, allowing them to develop in their occupations while providing the CF with the space expertise it needs. D Space D could support this approach by raising space awareness across the CF. All types of training and experience,

including civilian qualifications, would be tracked. As well, a comprehensive database on space employment would be developed, and expanded CF training in space would be initiated. The advisor for space would remain the Chief of the Air Staff and NORAD will continue to be an essential alliance for the CF in space matters. Retention of qualified personnel is not currently seen as a problem area.

Access to space capabilities is vital in the modern warfare environment. As Canada continues to pursue its personnel and software niche involvement in space, the CF must ensure that it can provide a suitably qualified personnel force for space operations activities.

Endnotes

1. From research and personal knowledge of Lieutenant Colonel John Graham, Canadian Forces College Command and Staff Course 26 students.

2. Implied by the formation of Directorate of Space Development within the DCDS organisation and the commissioning and content of the Space Appreciation 2000.

3. Space Appreciation 2000.

4. The absence of a mention in DPG 2000 points to this fact.

5. Department of National Defence, Canadian Forces Operations Manual, Chapter 26, pp. 5/17-11/17.

6. Department of National Defence, [http://www.dnd.ca/eng/archive/aug99/19BMD_b_e.htm], 19 August 1999.

7. *Ibid.*, Canadian Forces Operations Manual, Chapter 26, p. 6/17.

8. Department of National Defence, Report on Plans and Priorities, Section III – Plans, Priorities and Strategies [http://-www.cadets.dnd.ca/vcds/dgsp/rpp/rpp98/sec_e.asp], 25 March 1998.

9. *Ibid*, p. 8/17.

10. General Estes, CinC NORAD and USSPACECOM, speech to the Senate Armed Services Committee, March 11-12 1997 [www.spacecom.af.mil/usspacecom/speech2.htm]. See also [www.imco.com:80/michaud/products/vstar.htm].

11. Canadian Forces Operations Manual, Chapter 26, p. 10/17.

12. Department of National Defence, *A Canadian Military Space Strategy: The Way Ahead for DND and the Canadian Forces* (Ottawa, DND, April 1998) p. 1.

13. Department of National Defence, *Space Policy* (Ottawa, DND, 1998) p. 2.

14. *Ibid*, p. 3.

15. Department of National Defence, B-GG-005-004/AF-025 Space Operations Doctrine, (Ottawa, DND, 1998) p. 6.

16.*Ibid.*, *Space Policy,* p. 4.

17. *Ibid*, p. 5.

18. *Ibid*, p. 6.

19. *Ibid.*, *A Canadian Military Space Strategy: The Way Ahead for DND and the Canadian Forces*, p. 9.

20. *Ibid*, p 10.

21. Lieutenant Colonel Bruce M. Roang, Space Operations Force Management – Can We Meet the Challenge? (Air University: Maxwell AFB, Alabama, May 1990), pp. 4-8.

22. The European Space Agency (ESA) also has a significant presence in the space field but not in military applications.

23. Roang, Lieutenant Colonel Bruce M., Space Operations Force Management – Can We Meet the Challenge? Air University: Maxwell AFB, Alabama.

24. Dr Madsen, Canadian Forces College.

25. Telecom Lt Col Fallen, Chief, Space Operations Proponent Division, U.S. Space and Missile Command, 29 Feb 2000.

26. Telecom Lt Cdr Dave Julian, Officer Professional Development Section, Officer Plans & Policy Branch, Navy Personnel Command, 29 Feb 2000.

27. Jones, LtCol Richard, USAF. *A Comparative Assessment of the Services' Management of Their Space Operations Personnel*. The Industrial College of the Armed Forces, National Defence University, Washington, D.C., 1992.

28. In a briefing note on Space HR Issues, D Space D endorsed this position and indicated that a survey of the number of space related personnel showed that this number was too small to justify the creation of a separate MOC.

29. Jones, Lieutenant-Colonel Richard, USAF. *A Comparative Assessment of the Service's Management of their Space Operations Personnel*. The Industrial College of the Armed Forces, National Defence University, Washington, D.C., 1992, pp. 9-10.

30.The reason a specific MOC would have to be chosen is that, by definition a sub-MOC is part of a specific MOC. If the same specialised skill set applies to more than one MOC it becomes an Occupation Speciality Skill (OSS).

31. As a note of clarification, employment in space operations need not be devoted to any specific MOC or grouping of MOCs, operations for example. The impact of space operations is ubiquitous and any and all MOC could benefit. Also currently are no, or very few prerequisites to fill space operations billets.

32. Air and Space Power Mentoring Guide, Air University Press, Maxwell AFB, Alabama, 1997.

33. CFSAS, Space Indoctrination Handbook, p. iv.

34. *Ibid*, p. ii.

35. Telecom Maj Mckay, D Space D 3-5, 27 February 2000.

36. *Ibid.*

37. Department of National Defence, 5275-1 (D Space D 3-5) 18 Nov 96, "Terms of Reference for the DND Space Human Resources Working Group", p. 1/3).

38. However, the authors of this paper do not see this as the most effective method of providing advanced learning in space matters. A better alternative would be to capitalise on the space expertise at civilian universities and US military institutions.

39. Maj Mackay, D Space D 3-5, during a discussion on 28 February 2000, provided information regarding the Space Human Resource Working Committee recommendations and actions.

40. E-mail from Colonel Aruja, D Space D dated 1 March 2000.

41. Department of National Defence, *Defence Planning Guidance 1999*, (Ottawa, DND, June 1998), pp. 2-4.

42. Syndicate 7's opinion based on various discussion with D Space D personnel.

43. Telecon Maj Mckay, D Space D 3-5, 27 February 2000.

PERSONNEL FOR SPACE OPERATIONS

Dr. Allan English

The question of the effects of the increasing demands for personnel employed in space operations in the Canadian Forces (CF) is important because, as most of us have heard before, personnel costs are the largest chunk of the CF's budget, people require a long time and a heavy investment to prepare them for their duties, and people are the only asset that can actually appreciate over time. And anyone reading the papers lately about the case of Canadian space researcher Judith Lapierre's experiences with the experiment in Moscow to determine the effects of space travel on human behaviour will understand that people are every bit as important as technology in the exploitation of space.[1] The personnel dimension of space is particularly important at the beginning of the 21st century because the air force we in Canada have worked with most closely since the Second World War, the US Air Force (USAF), is evolving from what the USAF has termed an "air and space force" to a "space and air force." This transformation, as Syndicate 7 implied, could have far reaching consequences for the Canadian air force. Therefore, it is prudent for us to consider the personnel aspects of this metamorphosis now because the young people who are joining the air force today will be its leaders in the year 2030 and after, well beyond even the vision statements of today

I would like to consider future personnel issues in terms of — what, who, how. Assessing what we think CF space operations personnel will be doing 10 to 30 years in future can give us some idea of who in the Canadian population could best do these things. Once we understand who we are looking for, we can debate the how: the development of policies to recruit, select, train, employ, and retain these people

Most attempts in the past to define what people might be doing even 10, let alone 30, years in the future have more often than not met with failure. Analyses of the work of those who have attempted to predict the future of society, including the noted futurists Alvin and Heidi Toffler, have revealed that they are wrong much more often than they right.[2] With today's dramatic changes in military doctrine, and operational and organizational concepts that are fundamentally altering the character and conduct of military operations, it may be even more futile to hope to accurately predict the future of space operations. Consequently, rather than try to identify any particular skill set, as our present Military Occupation Structure does, we might be better off looking for people who, as the draft "Officer Professional Development 2020 Statement of Operational Requirement" puts it can "think creatively, reason critically, act decisively in face of ambiguity and uncertainty,...anticipate, welcome and utilize the wave of technical advances sweeping us forward."[3]

If one accepts this definition of "what" we are looking for in our space operations personnel in the future then the draft SOR gives us an idea of who we are looking for, namely "outstanding leaders who demonstrate superior intellectual capacity...[and] greater mental agility...[they are] dynamic and

flexible in thought and action...innovative and proactive...They will operate effortlessly in a technological and information rich environment and be committed to lifelong learning." In addition, they should manifest qualities and ideals inherent in the military ethos upon which military effectiveness depends.[4]

Before looking at the "how" of recruiting, selecting, training, employing, and retaining these people, I will take a brief look at some of the issues raised by the "what" and the "who" above. First of all, if we accept the draft SOR's appraisal of who we are looking for, and it is very similar to those enunciated by our allies, this means we are competing for human resources with virtually every other institution in Canada (and the world), including industry and the public service, not to mention the attraction for some to work independent of any formal organization. Compounding this challenge are demographic trends, according to a discussion paper for Defence Management Committee prepared by Capt (N) Al Okros, that point to an aging Canadian population with a smaller proportion of the workforce in the youth cohort that the CF has traditionally recruited from. Furthermore, in this youth cohort, those who we wish to recruit (high-demand knowledge workers and moderately skilled individuals seeking to develop high-demand competencies) will have different career expectations from those who have traditionally joined the military. This new generation of knowledge workers will be accustomed to moving rapidly from job to job or following two to four careers in a lifetime.[5] Large organizations like the CF, therefore, will have to provide relevant inducements to these prospective recruits if they hope to attract and hold them. A recent survey by a large Toronto-based management consulting firm found that one of the biggest obstacles for major Canadian corporations to recruiting and retaining people on the cutting edge of business these days, those in "e-commerce," is the bureaucratic structure of most large companies combined with an organizational culture that impedes innovation.[6] In a similar vein, according to Okros's study, the key inducements for high skill workers to join and to stay in the CF will increasingly be an attractive organizational culture, fair treatment, and developmental opportunities rather than on other factors, even high salaries. Organizations will also need to recognize that different individuals will be seeking different inducements - some will look for stability, others for challenge and change.[7]

The current CF personnel production cycle (job analyses-occupation structure revision-recruiting-training), where it takes eight or more years to go from an Occupational Analysis which identifies a new skill set that needs to be developed to actually producing the first qualified people with that skill set, is no longer viable in an environment where the required skills change before the first products of the system can be usefully employed.[8] Elliot Cohen has argued that today's armed forces still reflect the industrial age military "preoccupied by standardization, specialization, professionalization, synchronization...[and] centralization" rather than the flexibility required to nurture the new traits expected to be needed in the future.[9] Okros' report contends that the current hierarchical "stovepipe" CF human resource system based on an internal labour market and predicated on constraints and assumptions from 30 years ago is no longer viable, and the report suggests that a complete overhaul of existing rank and MOC structures is necessary.[10] What may

be needed is a flatter organization with fewer ranks (remember Nelson's navy, where the man o'war was the most complex weapons system of its time, really only had two commissioned officer ranks (non-flag)- lieutenant and captain). Would this be a better model for space operations in the future than the CF's current seven officer ranks (non-flag)? Christopher Bellamy, a British defence writer, has gone even further and suggested that, given the complexity of modern operations, we should consider an all officer force.[11] In any case, Okros suggests that the CF needs to closely manage critical skill sets and high potential personnel while reducing the investment in career management, training, and succession planning for less critical personnel and average performers. He suggests that the CF needs to have "an open and agile" human resource system working in partnership with other governments, industry, allied forces and one more concerned with how people move in and out of the organization than trying to manage an internal labour market.

This discussion of "who" now leads us to "how" we might develop policies to recruit, select, train, employ, and retain the people needed for space operations. There are no easy answers to this question. But shortfalls in recruiting in Western armed forces in recent years have led to a number of proposals from those studying the problem.[12] One extreme is to adopt an entirely occupational approach to human resources and pay a competitive wage plus benefits (e.g., pension plan) in an attempt to attract and retain those needed by the Armed Forces. The other extreme is to attempt to return to a vocational model of the military by attempting to recruit, mould and retain those who wish to make the armed services a lifelong career and calling. As you know, neither of these extremes is likely to succeed; therefore, some hybrid will likely be necessary. A couple of historical examples may help generate some ideas about what this hybrid might look like.

In the 17th and 18th centuries the Royal Navy (RN) was on the leading edge of the technology of its era and involved in exploration and scientific research, not unlike some aspects of the space program today. How did it cope with personnel problems, for example increasing in size from 16,000 in 1792 to 120,000 in 1797 (a 7.5 increase)? In peace, most of the Royal Navy's ships were "in ordinary"(long term storage) maintained by a cadre of warrant officers who, looking for a stable career, stayed with the ships at all times and supervised their reactivation for war when necessary. Most of the seaman were engaged in civilian commerce keeping their seafaring skills sharp aboard merchant vessels. When war was imminent, press gangs brought them back into the navy to serve aboard the newly reactivated fleet. Most of the officers were on "half pay" in peace and returned to the fleet when called by the Admiralty. This system worked reasonably well and enabled Britain to "rule the waves" for over 200 years.

A Canadian example of maintaining expertise in a high technology military area can be found in the Royal Canadian Air Force (RCAF) Auxiliary after the Second World War. The RCAF Auxiliary was composed of formed units of part-time aircrew, mechanics, intelligence analysts, air traffic controllers, meteorologists, administrators, medical personnel, etc who practised their wartime roles on weekends and in the evenings. Organized into 12 flying squadrons, and more than 35 other units (including four intelligence units),

they manned everything from seven fighter squadrons (some equipped with jets) to the ground radars that controlled the interceptors. Most Auxiliary units were located near towns or urban centres to ensure a suitable recruiting base. The Auxiliary's wartime role was to augment and where necessary replace regular RCAF units in Canada so that they could be deployed overseas. A modern version of the RCAF Auxiliary might be a reserve information technology (IT) squadron, along the lines of 5001 Intelligence Unit based in Toronto in the 1950s. It could be formed from some of the many IT specialists who live in the Metro Toronto area. The motivation for belonging to such a squadron would not be financial, but perhaps the chance to work in an area (like space) that these specialists cannot work in during their normal employment. Other motivators, like the ones that sustained the RCAF Auxiliary in the 1950s and early 1960s, might be the camaraderie provided by belonging to such a squadron, and the chance to be a member of a prestigious "club" with its own distinctive uniform and mess. This system would have the potential of getting highly prized technical expertise for the air force at a very low cost. Some questions might arise, such as what if some of these experts were in wheel chairs? Would this preclude their service in static positions near their homes?

The questions I have raised are only intended to start the debate over what are beginning to become increasingly crucial personnel questions for all Western armed forces. What I find disturbing is that the CF has invested very little money in researching these critical issues. A significant amount of resources remain committed to technical research and technically-oriented post-graduate programs for serving officers, but a relatively small amount has been invested in studying the equally, if not more, vital personnel issues that challenge the CF. I suggest that it is time to get down to some serious, evidence-based study on what the future might look like and do some rigorous analysis of the issues before making decisions that will have long term implications for the ability of the CF to fulfil its mandate in a world increasingly dominated by space.

Endnotes

1. "Canadian Decides to Stay in Russian Space Study Despite Harassment," 28 March 2000, http://www.canoe.com-/CNEWSSpace0003/28_lapierre.html.
2. See for example Lee Patterson, "Future Imperfect,"*Forbes* (Apr 1998), 20; William A. Sherden, *The Fortune Sellers: The Big Business of Buying and Selling Predictions* (New York: John Wiley, 1998); and Sidney C. Schaer, "Back to the Future . . . Predictions from the past that haven't come true . . . yet," *Newsday* (22 Jan 1999), http://www.elibrary.com/s/edumark/.
3. "Canadian Officership in the 21st Century – OPD 2020 Statement of Operational Requirement," dated Jan 2000 (draft), i, p. 49.
4. "Canadian Officership in the 21st Century," p. 1.
5. Cdr A. Okros, "Into the 21st Century: Strategic HR Issues," a Defence Management Committee Discussion Paper, <http://www.vcds.dnd.ca/vcds/dgsp/analysis/hr_e.asp>, p. 4.
6. "E-commerce workers in demand," *Kingston Whig Standard* (10 Mar 2000), p. 14.
7. Okros, p. 9.
8. Okros, p. 11.
9. Eliot A Cohen, "A Revolution in Warfare," *Foreign Affairs* 75, no. 2 (March/April 1996), p. 38.
10. Okros, pp. 8, 9, 11, 12, 14.
11. Patrick Mileham, "The Future of Military Leadership," in *Ethical Dilemmas of Military Interventions*, Patrick Mileham and Lee Willett, eds. (London: Royal Institute of International Affairs, 1999), p. 55.
12. See for example, Robert Suro, "Pay, Morale Problems Still Beset Military," *Washington Post* (10 Jan 2000), p. A1.

Space and the Canadian Air Force: An Attitudinal Challenge

Lieutenant-Colonel (ret'd) Richard J. Young

Introduction

The importance of space assets to the modern military professional, whether warrior, peace-keeper or peace-maker, should by now be obvious. The 1991 Gulf War has been credited as the first in which space assets played a pivotal role, to the extent that an unexpectedly lopsided result was achieved by the coalition. Credit for whatever military success one can ascribe to the NATO campaign in Kosovo, achieved solely through the use of airpower, without a single combat-related casualty, is widely attributed to the enhancing and enabling nature of space-derived support. While space assets, as yet, play no direct part in the actual delivery of ordnance, space support in terms of providing the precision navigation and guidance, weather, surveillance, timing, battle-damage assessment, and warning, makes the force with space superiority formidable out of proportion to the normal calculation of combat power. Canadian airmen benefited alongside their allies in those theatres and no Canadian field commander need go into any theatre, regardless of the mission, without the benefit of the battlefield preparation made possible by the view from the ultimate high-ground.

However, the integration of the space dimension into our thinking as warriors is still embryonic and we are not anywhere near to pulling our own weight as a nation toward the capabilities upon which we are coming to rely. More particularly, the air force has been slow to seize the opportunity to lead the CF into the space arena. This paper will propose a number of reasons why the air force should be seen as the logical lead service for Canadian space capabilities. Once this is accepted, the task of developing doctrine, defining operational capabilities, developing force structure, and organizing, training and equipping personnel will become much easier.

National Security Challenge

The difficulties encountered while trying to put some logical structure into the CF space-related force development activities in the mid-1990s, stemmed from a policy vacuum at the highest levels of government. The "waterfall" model used to describe the process of DND force development has national security/military strategy, traditionally described in government white papers, setting the parameters from which DND develops its doctrine, force development models, personnel structures and operational activities.

The 1987 *White Paper on Defence*, "Challenge and Commitment", contained a rather good discussion on the link between space and national security, but within months of its publication, the paper was thoroughly discredited and any statements it contained, regardless of merit, were rendered useless in support of any planned program activity. Since that time, government level policy statements on space have been far less detailed and contain mostly innocuous generalities. Internal to DND, a series of policy pronouncements going back almost 15 years attempted to define those activities

which were permitted (mainly force enhancement activities such as surveillance, navigation, communications and weather), and to identify some of the more obvious things which were either beyond the pale (weapons in space) or which required further government direction (defence against space threats).

In keeping with the recent history of the dynamics within government circles, the Minister of National Defence must be very circumspect in pushing for government policy at the cabinet level, particularly on some of the more sensitive issues with respect to space. In the absence of explicit direction, DND, perhaps more than other departments, is more apt to use the casting of bones, stirring of entrails and sniffing of the wind to determine how much rope it can afford to give itself. Long time inhabitants of NDHQ often refer to this as the art of mind-reading. In such a climate, more study and less action is seen as a good thing. Besides, the potential cost of some of the space capabilities being discussed caused considerable concern to the advocates of traditional terrestrial systems.

But, the growing cooperation between DND and the Canadian Space Agency (CSA) on such things as RADARSAT, and the potential fielding of a National Missile Defence (NMD) system by the US, will soon force the government to take a stand on the nature of Canada's security interests in space (witness the recent verbal sparring between the Minister of National Defence and the Foreign Affairs Minister on the topic of NMD). Perhaps until that landmark decision is made, it is understandable that DND and the Canadian Forces will not want to get too far out front of the headlights. But that mustn't stop the process of looking ahead and planning prudently.

Space as a Joint Arena

What policy direction there was in the early 1990s stressed the joint nature of space activities, by which it was meant that all environments were to be equal beneficiaries of space products and services. To those within each of the environments who keep count of the scarce beans doled out to DND, jointness also means that whatever is proposed will not come at a cost to the core capabilities of their respective environments and none of the services yet include space as a core capability. For example, the Director of Naval Requirements in the early 1990s opined to a meeting of the Space Development Working Group that the money to be notionally assigned to the task of the Surveillance of Space would be better spent on "swill barges." The army was also skeptical, allowing the air force to demure without having to take a stand. In the collegial, consensus-driven nature of NDHQ decision-making, one hold-out is all a joint project needs to bring it to its knees. The knowledge that staffing a joint requirements document is a formidable task can usually be relied upon to forestall plans to spend resources almost indefinitely. A further challenge, even presuming an agreed upon requirement, is to find a champion for the entry of the proposed project's cash flow forecast into the Long Term Capital Plan. Important projects, today more than ever, need a strong advocate at NDHQ in order to make any significant progress. Jointness in this context can be a recipe for inaction.

Space Advocacy of Lieutenant-General Al Dequettville

By insisting on jointness, and in the absence of a lead-service concept, space-related force development could have

suffered the same fate as other such orphans to jointness such as Electronic Warfare (EW) and Nuclear, Biological and Chemical Warfare (NBCW). What saved the situation in the early 1990s was the vision of Gen Al Dequettville who, while in the VCDS Force Development Division, caused the formation of the Joint Space Project, corralled a significant notional budget for it in the Long Term Capital Plan, and single-handedly defended it long enough to prevent the infant mortality that it may have otherwise suffered. Ironically, his overt commitment to space seemed to disappear when he moved from Ottawa to Winnipeg to assume command of Air Command in the mid-1990s.

While in the VCDS Branch, he knew space was important and defended it by force of his position and powers of persuasion. He did not have a strong policy or doctrinal position upon which to base his advocacy then anymore than we do today. We have the benefit of ten years of experience to see what was reasonably apparent to some back then as being obvious today, but we are not much further ahead in terms of the hard policy/doctrinal issues, among them being:

- What role should space play in the security of Canada?
- What role should DND/CF play in space activities?
- What activities/operational capabilities should we develop?
- What part does each of the services play in these?
- What personnel policies/activities do these require?

The Air Force as Space Advocate

It is my contention that significant progress will not be made in addressing these issues until one of the environments (services) steps up to the plate and becomes the DND space advocate. I further believe that a good case can be made that this ought to be the air force. At present, the DCDS has been given the mantle of DND space advocate, and it is in his branch that the Directorate of Space Development (which manages the Joint Space Project) now finds its home.

While this may seem logical given the joint emphasis space has been given and the fact that the DCDS is the chief CF *operator* responsible for most joint support activities, the fact is that the DCDS is poorly positioned to be an agency for force development. Simply put, the DCDS is a force employer, not a force generator. His clear focus is the planning and management of the myriad operations the CF has been assigned. Issues of long-range policy/doctrine development and their relationship to capital planning and project management are not on the DCDS radarscope. What I am referring to here are the *organize, equip and train* issues, functions which the environments are uniquely accustomed to doing and are designed to address.

The review of headquarters structures done by the Management, Command and Control Review Team in the mid-1990s, briefly considered a central joint force generation agency operating in parallel with the environments, but ultimately decided against it. I should add that among the most consistent promoters of space activities within the department have been the staff of the Policy branch. Their support thus far has been key but they are even less suitable than the DCDS branch to carry on any of the needed doctrine and force development activities.

The CF does not have a capability to do joint force generation (a function

which includes joint force development), nor, in discussions I have had with many on this topic, does anyone seem to understand the implications of that fact. Despite the intentions of integration and unification, the CF still does all of its force generation activities as though there were still three separate services. All personnel are recruited and trained as a member of one of the three services and all equipment procurement (with only a few small projects excepted) is managed by one of the three services. Even though a legal fiction, the DND budget is essentially managed as though it was made up of the individual budgets of three separate services. That being the case, therefore, one of the services must take on this advocacy role if space capabilities are to be effectively integrated into the CF.

Why the Air Force?

Despite the air force insistence on the jointness of space (along with the other services), it is time to reconsider that attitude. The Canadian air force actually has a long history of being involved in aspects of space operations and continues to this day through membership in NORAD. Many air force personnel have worked in the United States Air Force Space (USAF) Command, and some now are employed in the United States Space Command. Until their decommissioning in the late 1980s and early 1990s, the air force operated space surveillance sensors on Canadian soil (Cold Lake, AB and St. Margaret's, NB) which fed directly into the US Space Surveillance Network. Until the early 1990s the air force carried on its list of capital programs, a project worth $1.5 billion to be used as Canada's contribution to the USAF project for a space-based wide area surveillance system. Only the demise of the project in the US caused the air force to abandon its plans for their contribution. The money was turned back (seen in large measure as the air force's contribution to belt-tightening), but the requirement was handed to the Joint Space Project Office then resident in the VCDS branch. With the money gone, the air force's interest in space seemed to suffer a similar evaporation.

Nevertheless, the nature of space operations arguably can be seen more as an extension of airpower than of any other military capability. The extension of airpower doctrine to aerospace power, ultimately to spacepower doctrine is a linear progression that makes sense. The USAF felt strongly enough about this that one of their recent Chiefs of the Air Staff stated that the USAF was an *air and space force on its way to becoming a space and air force*. Despite the joint nature of US Space Command, the USAF portion represents over 90 percent of its total personnel and capital activity. Only US domestic and inter-service politics prevents the USAF from being the sole space service. I refer to the American example simply to point out that the idea of the primacy of air forces in space activity is not an idea born in a vacuum.

I'm not suggesting that the Canadian air force try to establish itself as the sole proprietor of Canadian military space activity, but that it should consider itself the major stakeholder and, as such, should offer to be the principle coordinator of space doctrine and force development activity, as in fact it did (unsuccessfully) in the mid-1980s. The upside to this notion is logic; however, the potential downside is financial responsibility. This, in my opinion, is one of the prime reasons the air force has been hesitant to take a more proactive role in recent years. The other services would be happy to see the air force struggle with juggling space-related

force development priorities along with the other balls they already have in the air.

Why would I wittingly thrust the air force into what appears to be an untenable position in an already strained capital rationalization process? Because it is the right thing to do. It is to recognize that the current arrangements can only take things so far and it will not be far enough. This seizing of the ultimate high ground would require the Air Force to dispel the perception that it spends more time trying to rationalize and defend the status quo rather than looking to the inevitable future. Of course, lead service designation would have to come with assurances that the other services would contribute their fair share of resources.

Space Doctrine Development

Such responsibility would give the air force incentive to finish a process begun in the early 1990s to develop a space chapter to the growing volumes on Aerospace Doctrine. The project was assigned to the CF School of Aerospace Studies (CFSAS) in Winnipeg but was never completed for a variety of reasons, among them likely being the prevailing view that space was not the preserve of the air force. CFSAS is already seen as an important focal point for space-related expertise and training in the CF, and it already assists the other services by opening courses to their personnel on occasion. Officially designating the air force as the lead service for space would facilitate a broader mandate for CFSAS to expand their activities on behalf of the CF. A comprehensive doctrinal statement from the air force would also lead to a more detailed chapter in the Joint Doctrine Manual which would expand on what amounts now to a place-holder. Space doctrine needs a proper home.

Operational Focus – Surveillance of Space

If, as I have argued elsewhere, the Surveillance of Space was to become the niche CF operational contribution to collective security, through NORAD, it would be equally logical for the air force to resume this activity in Canada, thus increasing the personnel base involved in this activity. Many Air Weapons Controllers and Air Defence Technicians (or whatever they are calling each other these days), along with a smattering from other Military Operational Classifications (MOC), spend a good proportion of their careers engaged in this activity and it seems odd that this should be a career field that can only be pursued outside the country. Concentrating on Surveillance of Space would provide a focus for education and training for those to be involved, would give R&D focus to space-related activities and would narrow the focus of our force development activities. Not that I would advise abandoning the other elements of the Joint Space Project, but I would make it clear what the flagship of the project ought to be and who will be in the cockpit (notice I avoid the term *bridge*). Here again, none of this need exclude the opening of some positions in NORAD and elsewhere to personnel from the army or navy, a process that is already well established.

Supportive Personnel Related Activities – Education and Training

The focus of the air force should be on the organizing, equipping and training of those to be employed in the operational activity of the Surveillance of Space. There are many other space-related activities which require space-aware personnel from all the environments including terrestrial intelligence, surveil-

lance and reconnaissance activities, along with command, control and communications activities. These are not principally air force operations but one which should have strong air force input.

All services require a cadre of space-aware personnel and there are several vehicles available for this. The Space Science syllabus at RMC provides an excellent undergraduate program and graduates with Space Science degrees have already made important contributions in their short time as commissioned officers. However, RMC has had trouble in attracting cadets to take this otherwise popular field of study because many MOCs do not recognize it. That needs to change or RMC will not be able to continue without a critical mass of students enrolled in the program. The air force needs to lead the charge by insisting that light-blue MOCs review their assessment of the Space Science program. RMC has also offered to provide a post-graduate program but has not received much support for this proposal. This needs to be given serious consideration to facilitate the more technically demanding aspects of space operations and research activity. Presently, the only post-graduate opportunities for space-related programs are outside the country and are prohibitively expensive.

On the other side of the education and training coin, I have already mentioned the School of Aerospace Studies in Winnipeg. The Space Squadron at CFSAS has done yeoman work with a small staff to provide an impressive number of CF personnel, at all rank levels, with a basic awareness of space operations through their Basic Space Indoctrination Course, and General and Senior Officer Space Indoctrination Course. Recently, there was talk of developing a more advanced course, an initiative that I hope has been supported with the appropriate mandate and resources. An appropriate mandate in my opinion would be for CFSAS to be designated as the CF center of excellence in space-related training, to accompany and collaborate with RMC's designation as the center of excellence in space-related education.

A vehicle to force MOCs to be more cognizant of space-related credentials from either RMC or from CFSAS could be to formally adopt space operations as a sub-classification specialty. Activities requiring the specialty have already been catalogued by the Directorate of Space Development and the number of positions requiring either space-aware or space-qualified personnel is surprisingly high (in the hundreds). What still needs to be done is the designation of MOCs and the formalization of career paths.

Bottom Line

The purpose of the panel on Space Personnel Issues at this year's Air Symposium was to be more focussed on specifics than I have been in this paper. However, it was my intention to situate the discussion of personnel related questions as being at the end of an extensive process of determining national goals and objectives, defining required operational capabilities, and designating environmental roles and responsibilities, all finally leading to the determination of necessary personnel requirements. Many of the initiatives I have mentioned have been started, while others have only been discussed; in any event, there remains much to be done. Finishing the tasks begun, identifying what yet needs to be done, and providing the educated and trained personnel to do all this will be more effectively achieved if the air force were to take the lead role.

SPACE: A Future Centre of Gravity

Syndicate 8: Lieutenant Colonel Gilles W. Dufour, Wing Commander Edward J. Stringer, RAF, Major Stephen H.R. Bannister, Major Michael J. Conway, Major Jo-Anne E. MacDonald, Major Kirk J. Shaw, Major Timothy A. Slauenwhite, USAF, Major Alex M. Smith, and Major Pierre J.A.P. St-Cyr

Space, you're well aware, is increasingly at the center of our national and economic security. That fact isn't lost on the rest of the world, either. Allies and adversaries alike understand fully our dependence on space – it's their dependence too. And they understand that such dependency also creates substantial vulnerability, if not protected.[1]

General Richard B. Myers
Commander-in-Chief (CINC), US Space Command

Introduction

"What is it about space power that makes it so enigmatic?"[2] Despite the fact that modern societies count on space systems for everyday tasks - including weather forecasts, bank transactions, inventory control records, medical prescriptions, and the ever-expanding use of cellular phones - they are not space smart. The same could be said about modern defence forces that may have previously failed to understand or appreciate the opportunities that space provides in the conduct of war. Other equally important changes in the world, such as the Revolution in Military Affairs (RMA) and the coming of the Information Age seem to have dominated the military discourse of late, while space, as a future frontier, has been slower to be noticed and even slower to be exploited.

"Today, the United States (US) is the world's space superpower," and acknowledged leader in both space investment and capabilities.[3] In exploring space, therefore, it is impossible to ignore American efforts in this regard. This paper is not intended to extol the virtues of American dominance, simply because their space-based capabilities currently exceed those of all other nations. Instead, this paper explores space in terms of its potential impact on military operations. It provides an assessment of current environmental factors that will likely shape the future battlespace, reviews how space has been used in recent conflicts, describes current technological capabilities which space enables, identifies vulnerabilities of space, and recommends measures that must be adopted to protect space-based capabilities. This paper concludes that space is a future centre of gravity for military operations, based on its potential impacts on critical aspects of war, by reducing collateral damage through improved targeting, enhanced information dominance, and increased air superiority.

Aim

This paper suggests that military forces will become increasingly dependent on space-based systems, making these systems the centre of gravity for military forces and creating the necessity for their exploitation and protection.

Environmental Analysis

Prior to considering space-based technologies specifically, it is necessary to understand how several environmental factors are expected to impact space operations, and thereby affect future military operations. These environmental factors include political, military, economic, and informational, which will be discussed independently.

Political

Access to space for the conduct of military operations has created significant legal challenges and considerable debate; the same could also be said of space used for civil and commercial purposes. Because there is little in the way of international law which pertains to the control of a nation's use of space, reference must be made to a few international treaties which detail specific restrictions. The most significant of these legal documents is the 1967 *Outer Space Treaty* which prohibits the placement of Weapons of Mass Destruction (WMD) in space. A second treaty, the 1979 *INMARSAT Treaty*, allows their satellites to be used only for "peaceful purposes"; however, it acknowledges that "military uses" per se are not incompatible with peaceful purposes.[4]

International restrictions on the use of space may not be as important as statements that detail what is actually permitted. At the height of the Cold War, the Union of Soviet Socialist Republics (USSR) objected to US attempts to take imagery over their nation. The result of this issue was international law which stated that "countries have no grounds for objection to being imaged from space."[5]

Domestically, many countries see the proliferation of commercial satellites and the provision of high-resolution imagery as a potential sovereignty issue. As a result, several countries have taken steps to minimize the risks to their sovereignty by imposing laws, known as "shutter control". For instance, Canada has "reserved the government's right to review and approve all commercial remote sensing systems owned, operated, or registered in Canada."[6] The US issued a similar law in 1994 with Presidential Directive 23; however, this law is currently under considerable scrutiny for its potential unconstitutional nature. Conversely, Israel is considering launching additional imaging satellites and providing geographic control to commercial customers.[7] While countries strive to respect sovereignty concerns, there is a fear that these "shutter control" laws will have an economic impact on commercial satellite companies by driving potential customers away.

Another example of domestic control is "selected availability" on the US Global Positioning System (GPS) satellites. The US government is "committed to the non-military use of GPS on a continuous, world-wide basis, free of direct-user fees."[8] Nevertheless, it retains the ability to degrade the accuracy of the GPS signal to ensure that the US military and its Allies maintain an advantage.

Recently, the United Nations (UN) Secretary-General Kofi Annan accurately captured the essence of the debate in stating that "[w]e cannot view the expanse of space as another battleground for our earthly conflicts."[9] While several nations share this view, many others have already begun to exploit space for military purposes. The legal issue becomes even more complicated when consideration is given to

the growing number of commercial ventures and international partnerships. As the only international medium that borders every nation in the world, it is anticipated that the interest in this issue will be far-reaching and that a worldwide resolution will not be forthcoming very quickly.

In response to the demand for timely and accurate information, the media, through their enhanced space-based communication systems, plays an increasing role in shaping public opinion. As a result, democratic governments now take greater heed to messages, either implicit or explicit, being disseminated by various news mediums.

Military

The importance of the "high ground" has dominated military doctrine for centuries as commanders continually seek a higher vantage point. Throughout history, the high ground has offered defensive and informational advantages over the enemy. In 500 BC, Sun Tzu highlighted the defensive and observational advantages of mountainous terrain,[10] while more recently, Carl Von Clausewitz claimed that the "high ground offers three strategic assets: greater tactical strength, protection from access, and a wider view."[11] He added that, "occupation of high ground can mean genuine domination."[12] Today, space is the medium that offers the highest vantage over the enemy, and thus is considered the ultimate high ground.

Many countries advocate the military use of space, with the US being the primary example. Current US Air Force doctrine identifies the following space force missions: space control, force application, force enhancement (for terrestrial-based forces), and space support. Simply stated, space control means ensuring friendly access to space, while denying the same of the enemy. Examples of space control include the destruction of ground-based antenna systems, the jamming of satellite links, and the surveillance of space objects. Force application consists of space-based attacks against military targets. The US Government considers the use of Inter-Continental Ballistic Missiles (ICBM) as an example of space-based force application since ICBMs travel through space to reach their targets. Force enhancement operations are the principal focus of the American military space capabilities and consist of those space operations conducted with the objective of enabling or supporting land, sea or air forces. Navigation, communications and remote sensing (including reconnaissance, surveillance, early warning and weather) are examples of force enhancement operations. Space support is considered in terms of its ability to sustain, surge, and reconstitute elements of a military space system as needed. Examples include space launch and ground-based Command and Control (C^2) of satellites. The US doctrine recognizes that space provides global coverage, flexibility, economy of effort, and proven effectiveness for military forces.[13] In light of these space capabilities, it is expected that an increasing number of nations will be paying more interest in creating their own space systems.

Recent trends indicate that militaries can no longer afford to develop their own technologies, and thus will rely more on partnerships with industry, allies, and other services, in order

to meet their demands in a fiscally responsible manner. In fact, the US Department of Defense has directed that civil and commercial capabilities will be used to the maximum extent possible, including the use of allied and friendly capabilities, ensuring adherence to national security regulations.

From a military defence perspective, the challenge will be to find the right balance, or trade-off, in investment and capability, to create innovative partnerships between military, commercial and civil sectors, and to meet military requirements in the most cost-effective manner. One option in reducing costs may be the leveraging of commercial systems.

Economic

In keeping with a global economy that is transcending borders, commercial use of space is expanding quickly on a world-wide scale. Over the last decade, commercial space has experienced a 20 percent annual growth rate,[14] and in 1996 commercial space revenues, at $77 billion (US), outranked governmental space expenditures.[15] An estimated $500 billion (US) has been invested in commercial space systems over the last four years,[16] and this level of investment shows no signs of decline. In fact, various estimates indicate 1700 to 2100 satellites will be launched in the next decade and the expected market for high-resolution imagery is expected to top $3.5 billion (US) by 2004-2005.[17]

General Myers, CINC US Space Command, reported that, during the Kosovo crisis, commercial carriers satisfied the majority of the Allies' satellite communication (SATCOM) requirements. He expects that commercial imagery providers will continue to satisfy a large percentage of military requirements in the future, while an evolving community of privately owned space operators will dominate in providing remote sensing and launch services, to a steadily growing spectrum of global customers.[18] During the next decade, rapid growth in commercial space is expected in the areas of communications, launch services, and remote sensing.

Significant private ownership is expected to dominate the next stage of development, with investment originating from all over the world. Increased accessibility and affordability are expected to mark this era. Where practical and feasible, this commercialization activity will become even more attractive as militaries opt to access a needed capability with minimal capital investment. As a result, commercialization will allow militaries to either reduce costs or procure capabilities that they otherwise would be unable to access.

Informational

Sun Tzu stated that "by perceiving the enemy and perceiving ourselves, there will be no unforeseen risk in any battle."[19] The same belief rings true today. Whether the pace and extent of technological developments are considered revolutionary or evolutionary in nature, there is consensus that technology is transforming the conduct of warfare, just as the introduction of mechanization during the industrial age had previously changed warfare. The impetus for the RMA focuses on the application of information technology to conventional manoeuvre warfare; the enemy's sophisticated arena of command, control, communications, and

intelligence (C^3I) will be targeted in order to deny communications, interfere with data management, and destroy information networks. Besides giving commanders a dominant situational awareness of the battlespace, information operations have the potential of "putting an enemy at the mercy of both conventional attack on the battlefield and psychological operations aimed at controlling his perceptions and decision-making abilities."[20]

According to the US Air Force Historian, Dr. Richard P. Hallion, one of the qualities of aerospace power is its "view" which can lead to "awareness and the opportunity for informed decision-making leading to decisive action." He adds that, "with the spaceflight revolution, view expanded in this century from battlefield to theatre and now to global dimensions. Space systems are now an integral part of how "national leaderships learn about global developments and formulate plans to deal with them."[21]

Successful warfare in the information age requires rapid dissemination of information to combatants. Combatants who receive, analyse, decide and act on this information, within the enemy's decision and execution cycle, will set an operational tempo that may lead to victory.

Space progress in the current century "is likely to be determined more by economic and political considerations than by the availability of technology."[22] Although there are still some technological hurdles to clear, the laws of government rather than the laws of gravity are expected to factor into advances made in space.[23]

Use of Space in Recent Conflicts

Since the Germans launched V2 rockets in 1944 and the Soviets launched Sputnik 1 in 1957, the use of space-based assets has grown considerably. The US military employed satellites in Operations URGENT FURY (Grenada), EL DORADO CANYON (Libya), and JUST CAUSE (Panama).[24] Although their use was often ad hoc and incomplete, satellites still provided valuable lessons for military space operations and led to further developments and innovations. This section explores several space-based capabilities that were developed or exploited in the Falklands War, the Gulf War, and the Kosovo conflict.

The Falklands War

Although much has been written on the discreet support provided by the US to the United Kingdom (UK) during this conflict, one of the most important but least heralded areas of assistance was the provision of satellite access. This access allowed commanders in London to maintain daily real-time communications with commanders in the field and on the ocean. More importantly, the ability to link political activity with military activity being conducted eight thousand miles away conferred a great degree of flexibility on the British forces in what was a very political battle. The post action report to the House of Commons stated that "the vital importance was shown of satellite communications in operations conducted at great distance."[25]

The Gulf War

Because the coalition formed to fight the Gulf War was led by the

Americans, it was supported by the full complement of US space-based systems. Space forces satisfied the following requirements during the Gulf War: meteorological information, navigation support, geomatic services, communications, sensing, and missile launch warning.

American Defence Meteorological satellites provided weather information in areas where no other sources were available. Weather information was used in strike package planning and redirection, air refuelling control and in planning the ground offensive.[26]

The Gulf War saw widespread and highly successful use of GPS for navigation through obstacles and minefields, siting of artillery in a featureless desert, and direction-finding accurately across long distances at night. Commercial GPS receivers were purchased by a large number of individual soldiers to augment limited government supplies, highlighting the importance placed on GPS navigation.[27]

During DESERT SHIELD, mapping satellites permitted terrain to be analysed to identify areas, such as swamps, that would otherwise be impassable to tanks. By the commencement of DESERT STORM, satellite mapping had produced accurate maps that also charted the position of Iraqi obstacles. In addition, these satellites provided terrain following guidance information for cruise missiles.[28]

The reliance of coalition forces on satellite communications was such that "…90% of communications into theatre were via satellites." In addition, satellites carried most of Central Command's (CENTCOM) intra-theatre communications, demonstrating the enhanced flexibility of manoeuvre that satellite-based communications offer over land-line or radio communications.[29]

Space-based sensing provided critical intelligence information on Iraqi forces, which formed the basis of the Coalition's strategy. The success of the Coalition's campaign against Iraq highlights the importance of space-based sensing to military operations.

Missile warning was also important in the Gulf War. Iraq used the SCUD missile threat as a political tool, attempting to draw Israel into the war and hopefully tear apart the coalition. Consequently, the SCUD became much more important politically than it was militarily, and hunting it down became such a priority that it altered the air campaign plan. US Space Command operators at Cheyenne Mountain, in Colorado, optimized their sensing and reporting of SCUD launches to CENTCOM PATRIOT missile defence crews, such that coalition personnel received sufficient warning to don protective clothing, as well as arm and point defence systems.[30]

Two significant challenges in the Gulf War pertaining to space-based technologies were bandwidth and ground station security. Communications, intelligence, weather reporting, and missile warning all suffered, not from the problem of a lack of information but of possessing and needing to distribute too much information. As a result, it was necessary to control bandwidth in order that satellite communications would not become an operational "choke-point". Because, space technology is useless if it cannot transmit back through its ground station, ground stations become a critical node, which required protection.[31]

The Kosovo Conflict

Since the Gulf War, additional space-based capabilities had been developed, with North Atlantic Treaty Organization (NATO) forces relying extensively on those new capabilities during the Kosovo Air Campaign.

GPS provided navigation to the platforms, as well as to the munitions carried by those platforms. The B2 bomber was heavily dependent on GPS support for its GPS Aided Targeting System and GPS Aided Munitions.

The Kosovo Liberation Army used satellite telephones to communicate with NATO forces to provide beneficial intelligence. Satellite communications were equally applicable at all levels of the conflict, from the strategic to the tactical level. For example, some aircraft in Kosovo had the capability to be redirected to new targets while flying missions using satellite communications.[32]

Synthetic Aperture Radar (SAR) provided all-weather imagery, and a new tactical intelligence management structure was put in place to improve the use of intelligence gleaned.[33] The objective of this management structure was to process imagery and return it quickly to the planners and aircrew in theatre. To do so required reliable satellite communications, which in Kosovo were provided by a wide variety of US, NATO, British, and French space-based platforms. Increased use of space communications allowed the US to leave large portions of its support infrastructure and personnel at home, reducing both costs and risks in theatre.[34] As a result, space-based communications became a critical link.

This brief history highlights the expanding roles and increasing reliance placed on space-based assets. Their use has evolved from an inter-theatre communication tool in the Falklands War, to the provision of more specific capabilities in the Gulf War, to a virtual reliance during the Kosovo Conflict. Enhanced utilization of space during these conflicts has proven that space is the new high ground for military operations. A closer look at current military space-based capabilities will further emphasize this fact.

Current Space Capabilities

Space has evolved from being a unique asset for national leadership to being an essential consideration for military commanders at all levels of war. In the past, militaries used space exclusively as a force multiplier. Today, space-based systems provide capabilities that cannot be satisfied by other means. With the end of the Cold War, military budgets have been significantly reduced with a parallel reduction in defence infrastructure, while military deployments have dramatically increased. In order to meet the challenges of reduced resources and increased global commitments, nations are attempting to exploit technology, especially space-based systems. Space provides critical capabilities for military operations, including communications, navigation, weather, national defence, remote sensing and surveillance, each of which will be examined more closely.

Communications

The employment of space-based devices is rapidly becoming the primary medium for modern military communication systems. Civilian and mili-

tary satellites already provide critical support to military operations, and more advanced satellite communication systems are being deployed each year. They provide global, voice and data communications for military activities that demand timely information to facilitate mission success.[35] Military systems can be specifically designed to provide secure, jam resistant, and interoperable world-wide communications. Since their operational genesis in the Gulf War, military space-based communications have proven their advantages over traditional land-based systems, such as VHF, UHF, HF radios, and landline dependent equipment.

The inherent limitations of radio systems include VHF and microwave line-of-sight transmission restrictions and degradation in transmission quality due to long distances, electromagnetic interference and atmospheric conditions. An example would include degradation of long distance communications during periods of high solar activity. Consequently, long distance radio transmissions need to be downlinked to the closest landline systems or are systematically passed to numerous ground stations, resulting in significant transmission delays. As a result, real-time communications from the battlefield to the CINC are difficult. The landline dependent systems are vulnerable to enemy targeting and are unavailable in many areas of conflict, particularly for operations other than war. Both radio and landline systems are highly susceptible to damage from an electromagnetic pulse (EMP); hence, they would be rendered unusable by a nuclear blast.

Military space-based communication systems, such as the US Defense Satellite Communication System and the UK SKYNET 4 constellation, which have both been orbiting since the late 1980s, provide significant advantages to modern battlefield operations. With global coverage, these systems provide a continuous world-wide communications capability that can rapidly respond to unanticipated military transmission requirements, anywhere in the world. However, they do remain susceptible to EMP and some forms of electronic warfare. In addition, they are bandwidth limited, as previously discussed.

Future US military satellite communication systems are being designed to overcome these weaknesses. The new US MILSTAR system is a highly secure, jam-proof, radiation-hardened, EMP resistant satellite that is capable of moving to avoid an enemy Anti-Satellite (ASAT) attack.[36] The Advanced Extremely High Frequency (EHF) communication system is expected to increase military communication transmission rates by more than a factor of ten.[37] Similarly, other countries are pursuing enhancements to military satellite communications. An example is the French-led European consortium's Syracuse III system, expected to be in-service by 2004, which will be purely for military operations and include both X-band and EHF-band communications.[38]

The employment of commercial systems, such as GLOBALSTAR and IRIDIUM, will transform the quality of communications for air power operations by providing real-time sensor to shooter communications.[39] This capability has been demonstrated in recent aircraft tests, joint exercises, and operations. It provides a capability for commanders to better track aircraft and communicate with forward-deployed

units. It also provides aircrews with the ability to plan missions en route to targets during long over-water deployments.[40] Capitalizing on this potential capability, the US Air Force (USAF) is developing an integrated, global C^2 network, which will eliminate stovepipe applications and utilize a distributed architecture.[41] Space-based communications are providing critical capabilities that are unavailable through other means.

Navigation

Space-based radio navigation systems such as the US GPS and the Russian Global Navigation Satellite System (GLONASS) have revolutionized global navigation, performing both navigation and weapons guidance functions. Both GPS and GLONASS provide precise position fixing, velocity, and timing information to an unlimited number of users (civilian and military) on a continuous, world-wide basis. In addition, both systems provide 24-hour all-weather coverage.

The new generation of Precision Guided Munitions (PGM) relies heavily on space-based navigation systems. These PGMs provide all-weather capability with significant cost-savings. Such weapons and space-based capabilities provide the foundation for the USAF core competency of "precision engagement". For example, during Operation ALLIED FORCE, the GPS-guided Joint Direct Attack Munitions achieved great success from altitudes above cloud cover, and six of the eleven weapons used throughout the Operation were guided by GPS.[43] Space-based navigation has become so successful that it is regarded by many as the "centre-piece of the expected revolution in military affairs … every military aircraft will navigate using GPS, and almost 100,000 GPS units will be in use with the US Army. Every major PGM will target through GPS."[44]

The military dependence on, and integration of, GPS is projected to grow immensely.[45] More than 7,000 platforms and 500,000 weapons, using GPS guidance, are planned to be in service by 2006.[46] By all accounts, space-based navigation provides essential capabilities for modern militaries.

Weather

Weather satellites have become integral for planning military operations and PGM targeting, as demonstrated during recent conflicts. Weather observation systems have been in existence since the 1960s and have since evolved through many generations. Current systems include finer-resolution cloud cover sensors, aurora detectors, as well as temperature, moisture, and infrared sounders.

In order to enhance the management of systems while reducing costs, there is a trend toward merging civil and military satellite weather programs. An example is the National Polar Orbiting Operational Environmental Satellite System which combines US military, American civil, and the European EUMETSAT systems. These will predict, track, and monitor world-wide meteorological events with extraordinary accuracy, at a much-reduced life-cycle cost.

Military operations are routinely conducted in less developed regions of the world that lack advanced meteorological sensors. Satellite-based weather

systems provide critical information to military operations, especially rapid deployment operations.

National Defence

In light of an increasing threat of ballistic missiles and weapons of mass destruction (WMD), especially from what has become known as rogue states in the Third World, missile defence is being seen as an essential strategic asset. The US is expected to dominate global Ballistic Missile Defense (BMD) development for the foreseeable future, while their principal allies are likely to remain interested, albeit on the sidelines. BMD has always been a task assigned to the North American Aerospace Defence Command (NORAD), which accomplishes its missions by monitoring and leveraging space systems.

NORAD monitors space through the US Space Command Space Surveillance Network (SSN), which detects, tracks, and identifies all objects in space. The information from this network is used to identify foreign threats to national systems. Canada has recently announced its intention to field a space-based tracking system to augment the SSN. NORAD currently uses

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These enhanced ISR capabilities increase the operational commander's chance of success through the provision of more timely and accurate information, thereby allowing improved decision-making and execution cycles.

Commercial sectors are providing an incremental ISR capability at a much-reduced cost, particularly attractive to those nations that could not otherwise afford it. In addition, this commercial ISR capability will supplement the existing capability for other countries. Potentially, upwards of one hundred commercial and civil imaging systems could be launched within the next several years to provide subscribers with electro-optical, radar, multi-colour, multi-spectral imagery, with one metre resolution or better.[49]

The future of ISR is the migration of airborne to space-based C^2 platforms. Space-based moving target indication (MTI) radar applications will eventually replace Airborne Warning and Control System (AWACS) and Joint Surveillance, Tracking, and Reconnaissance System (JSTARS) aircraft in tracking air, ground, and sea-based enemy assets.[50] The future RADARSAT 2 will provide a prototype of a high-resolution space-based MTI radar system, the benefits of which will be constant world-wide coverage.[51] Data management and distribution will, however, remain the critical issues.

To date, space remains the only operational environment where military commanders have the potential to maximize the use of ISR capabilities without legal restrictions. In periods other than conflict, space-based ISR provides the only means to legally monitor foreign activity, including treaty compliance. As a result, exploitation of these capabilities is expected to be vigorously pursued.

Space-based systems have evolved tremendously during the past decade, as militaries attempt to exploit the ultimate high ground of space, through increased exploitation on these critical capabilities. Space-based inter and intra-theatre communications are less vulnerable and easier to deploy than ground-based systems. Global navigation systems provide precision capabilities that contribute to reduced collateral damage. Accurate world-wide weather forecasting is available as a result of space-based observation systems. Improvements in detecting, tracking, and defending against missile attacks are attributable to enhanced space-based capabilities. Finally, enhanced situational awareness, as well as the potential migration of C^2 platforms, are derived from improvements to space-based ISR capabilities. It is important to recognize the vulnerabilities of these systems and the requirement to implement appropriate security measures.

Security Implications for Space

As militaries become increasingly dependent on space-based systems and the capabilities derived from them, these capabilities become inherently more vulnerable to threats. To that end, appropriate security measures must be instituted to ensure their protection. "As military operations become reliant on space systems, it will become necessary to monitor, detect and react to threats from or through the [space] medium. This leads to the requirement for capabilities in the space control

area."[52] Space control, similar to control of the air, must be maintained through military action aimed at exploiting and ensuring the effective use of the space medium while reducing, or preventing, its use by hostile forces. The vulnerability of any space-based system can be examined in terms of its confidentiality, integrity and availability.

The confidentiality of data transmitted through satellites is maintained through the use of cryptographic equipment to ensure that the "need-to-know" criterion is respected. The integrity of information must be protected against any unauthorized "hacking" and data manipulation. The availability of space-systems, particularly in times of crises, must be preserved. Ground, link, and space segments of space-based systems can be subjected to lethal and non-lethal attacks, which will have an impact on the availability of the space system.

The ground segment can be directly targeted through conventional means or indirectly attacked by being isolated from its support elements, including power and communication sources. A space-based system remains less vulnerable to threats when it has redundant ground control stations, mobile ground control stations or greater autonomy from its control station. Space-based systems requiring unique or extensive ground-based infrastructure are extremely vulnerable to this form of attack. For instance, any system that requires significant ground processing support will be highly susceptible to threats and requires an active defence of these stations, or built-in redundancy. Miniaturization of the ground segment will enhance their survivability by making them harder to target. Examples include MILSTAR suitcase-sized communication terminals and cellular phone links to commercial communication systems.

The link element of space-based systems is also susceptible to direct or indirect attacks. Direct attacks are targeted against the communication link of these systems. An example would be the elimination of a satellite communications antenna, which isolates the space-based system or prevents the receipt of data. Indirect attacks also isolate the system but through non-destructive means. These include jamming, which is the blocking of a transmitted signal by overpowering it with noise, and spoofing, which is the deliberate alteration or replacement of a signal with a false one.[53] For example, GPS navigation signals can be blocked with a jammer the size of a hockey puck.[54]

The space element of space-based systems (satellites) can be attacked by anti-satellite weapon systems, such as directed-or kinetic-energy weapons. The practicality of shooting a satellite with a kinetic-energy weapon is diminished by the threat of debris to friendly systems in orbit. In addition, the possibility of rendering large satellite constellations inoperable is relatively remote. Directed-energy weapons provide a more likely threat to spacecraft. Spacecraft operators and manufacturers should install special sensors to quickly detect and report an interference attempt.[55] "Without such sensors, it is difficult to rapidly determine whether an anomaly was caused by natural phenomena, such as radiation, an onboard failure or an intentional effort to damage the satellite or disrupt service."[56] Lightweight, efficient and inexpensive

micro-sensors are being developed to mitigate these shortcomings; however, commercial operators are unlikely to install them on their spacecraft because there is no business case to justify a sensor's added weight, space and power consumption for protection.[57] In the long run, the lack of satellite manoeuvrability will determine its survivability. Research into methods of efficiently and effectively manoeuvring needs to be pursued.

Passive countermeasures to prevent the effective use of satellites include deception to either hide forces or lead the enemy to false interpretation of the information, thereby achieving the element of surprise. "The operational commander can also synchronize terrestrial activity to avoid times when overhead satellites are in the area. Current satellite paths and times of observation are regular, predictable and publicly available, allowing operational synchronization to avoid detection."[58]

Space control is expected to become the central issue of the next decade as the US and others attempt to address the problems associated with the increasing reliance on space for terrestrial military activities and for the increasing role in modern information-based global economies.

The focus for protection activities include improved hardening of space systems both in orbit and those located on the ground. The majority of military satellite communications now travel over commercial systems; however, these service providers see no threat or business case for protection. Military officials are urging commercial companies to take protective measures such as "hardening" their satellites to radio-frequency and laser interference, carrying interference detectors, hardening payloads, adding manoeuvring capability or designing in system redundancy – anything that would tend to improve the reliability of services bought by military customers.

Conclusion

Without question, both modern societies and modern militaries have become dependant on space systems. In spite of this dependence, many militaries have been slow to recognize space's potential to influence the modern battlefield. Indeed, space is the ultimate high ground, and will become the new centre of gravity for operational forces. While the US, perhaps better than anyone else, recognizes this fact and are spending more now on military space systems than all other players combined, other nations are also beginning to recognize the importance of the high ground of space.

Nations and non-state actors with enough resources will gain access to new space systems and technologies. They will access integrated space and information technologies. The rapid assimilation of information, enabled by space-based capabilities, will be the key to successful operations. High-speed, high-volume telecommunications, coupled with advances in computers, will enable vast, interactive, information databases on globally networked computers. Not only will these space-connected systems drive and control modern nation states and the global economy, they will enable the effective command and control, and engagement of military forces. Notwithstanding these trends, the use of space for military operations must overcome significant legal and political considerations.

Perhaps the most provocative of these considerations is the area of space weapons, which would include space-based lasers to shoot down hostile ICBMs, space weapons to attack other satellites and space-released weapons to destroy terrestrial targets. Currently, these kinds of weapon systems clearly break the thresholds of acceptability. They contravene several current international treaties and cross contemporary social and political norms. But the 21st century could well see a change driven by the proliferation of greater and greater range ballistic missiles. If this threat materializes, space weapons will likely be fielded because of their cost effectiveness, accuracy, and relative invulnerability.

From the early use of German V2 rockets in the Second World War through to most recent use of GPS-guided munitions in Kosovo, the military uses of space-based assets has grown considerably; these uses included communications, navigation, weather, national defence, remote sensing and surveillance activities. Clearly, space-based inter- and intra-theatre communications are less vulnerable and easier to deploy than ground-based systems. Global navigation systems enable precision capabilities that contribute to reduced collateral damage and increase the effectivenss of smaller military forces. Space-based weather systems provide accurate worldwide forecasting. Improved space-based capabilities enhance the detection, tracking, and defence against ICBMs. Space-based ISR capabilities provide enhanced situational awareness. These diverse, demonstrated capabilities have created a reliance and dependence for modern militaries on space-based systems, and this ever-growing dependence will make space a future centre of gravity for military operations.

Although the high ground of space will become the new centre of gravity for modern militaries, there are numerous associated vulnerabilities which must be protected. Communications confidentiality, integrity and availability must be assured through encryption and hardening from various forms of attack. Additionally, GPS navigation signals are particularly vulnerable to various forms of spoofing and jamming and likewise, must be protected. Space control will, therefore, be crucial to ensuring successful military operations in the future. Protection of space-based assets must begin now to ensure these assets are available when needed. Space will be the "hub of all power and movement"[59] (not to be ignored.

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Some Lessons for Space from the History of Air Power

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While I am delighted to be here, I must admit that when I was invited to participate, I protested mildly: "I am a historian; I know nothing about 'space'." "That's OK," I was told, "there will be lots of people there who know a lot about space. We just want you to provide some context." So that is what I will try to do, by suggesting some ways in which we can put all of what we have been hearing into some kind of historical perspective.

There are many parallels from which we can draw — especially from early sea power, as we have heard from other symposium participants. I particularly liked Al English's words on this subject; members of the Air Force, and erstwhile members of a space force, can derive great benefit from the study of naval history. However, given the audience, I decided to restrict my comments to things we should remember about the beginnings of air power and the reactions to the first aircraft. And, hopefully, remind us that we might learn from the less than enthusiastic reception earlier technological developments received. In Canada, airmen — in fact all military personnel — have suffered from hesitant policymakers in the past. We do not want that to happen again with space issues.

I should note that I was fortunate enough to sit in on the "Space Applications" course at the Canadian Forces School of Aerospace Studies (CFSAS) the week before last. For this I would like to thank the CFSAS commandant, Lieutenant-Colonel Murray Haines, and the staff of his "Space Flight" - Major Kid Johnson, Captain Kevin Smith (USAF), Steve James, and their other presenters, including Josh Dore and Captain Joe Churman, who are both with us this week. (And please do not worry. The instructors protected national security by asking me to absent myself from the three classified hours of the course.) I found the experience fascinating - and commend it to you. Even so, by no stretch of the imagination can I claim any expertise on space issues. I do, however, at least now have a nodding acquaintance with the kind of things that are being done and may be done with and through space assets. It is positively mind-boggling.

As I looked at the numerous missteps and missed opportunities in the evolution of air power, I was tempted to title this little contribution, "Never underestimate the importance of stupidity as a causal factor in history." The fact is that we have not always done the right thing. Although it is, admittedly, usually easier to criticize decisions (or the lack of them) after the fact than to make them at the time.

Even today, notwithstanding all the impressive things we have been hearing yesterday and today, some people remain

skeptical about space and the impact it might have on military affairs. One of my students observed that a satellite is nothing more than a balloon on a long tether.[1] While this sounds a little facile, in some ways he may be right — at least for some of its roles. But this new observation balloon also has much keener eyesight than did the First World War observer looking down from his basket hanging beneath his balloon. And, at least to this point, no nation has yet deployed the equivalent of an earlier generation's Sopwith Camels to shoot the eyes out of the sky — as far as I know. Moreover, today's observation balloons not only do a much better job of observing, they do many other things as well — as we have seen and heard here.

If we had more time, we could look at earlier periods of history and consider the skepticism with which many military leaders greeted other inventions that later had profound influences on warfare. Simply recall the lack of enthusiasm some generals and admirals had for the tank, for the submarine, for the machine-gun during the First World War. I do not know if General Douglas Haig really said that the machine-gun had no stopping power when confronted by the horse.[2] Even if he did not, the sentiment reflects that of a generation of officers. Many of us are probably familiar with the fear of many cavalry officers before, during, and even after the First World War, that the cursed — and useless — new flying machines would scare the horses. It has often taken some time for the military mind — or anyone else for that matter — to come to grips with new opportunities offered by great new inventions.[3] Such as the aeroplane.

Canadian military leaders have not been immune to skepticism when it comes to advances in technology. The infamous Sam Hughes, then Minister of Militia and Defence, is reported to have cautioned our first pilot — indeed the first person in the British Empire to fly a powered machine — J.A.D. McCurdy, in August 1914:

> The aeroplane is an invention of the devil and will never play any part in such a serious business as the defence of a nation, my boy.[4]

Not surprisingly, given such a strong expression of opinion, Hughes had reportedly expressed similar views before. One of the key figures in the history of Canadian military aviation, Major G.S. Maunsell, Director of Engineering Services in Militia Headquarters in Ottawa, wrote in December 1912:

> The Minister does not wish Aviation taken up, at any rate, at present.[5]

Canadians who know our air force history know that Sam Hughes had a brief flirtation with aviation when he unilaterally — and somewhat mysteriously — authorized the creation of a Canadian Aviation Corps to accompany the first contingent of the Canadian Expeditionary Force when it sailed for England in the fall of 1914. However, this was only a brief straying from his anti-aviation stance; he soon lost all interest in the new toy.

The $5,000 secondhand Burgess-Dunne biplane that accompanied our militia to the Salisbury Plain never flew in support of the troops. Lieutenant W.F.N. Sharpe, one of the three members of the Canadian Aviation Corps, died while learning to fly with the Royal Flying Corps; his commander, Captain E.L. Janney, except for a brief reappearance as a recruiter with the

short-lived Royal Canadian Naval Air Service in 1918, faded from the pages of history. The most diligent researcher can find even less about the other member of the corps, Staff Sergeant Harry A. Farr, our first air force mechanic.[6]

The lack of vision in Militia Headquarters and in the Cabinet prevented Canada from having its own air force during the First World War. Following the Great War it gave us a miniscule force whose members performed various civil roles as "bush pilots in uniform."[7] Consequently, when war came again in 1939 Canada had only a tiny cadre on which to build what eventually became one of the great air forces of the world. Even then it was a bit of an illusion because most members of the Royal Canadian Air Force who served overseas during the Second World War scattered through a foreign service, the British Royal Air Force.[8]

As we come to a crucial point in the evolution of Canada's defence policy, let us hope that our leaders show more vision and inspiration. Whatever we call our air force — or indeed the Canadian Armed Forces — we hope Canadians can serve as more than just individual cogs in a foreign service. Indeed, though some commentators have decried our limited participation in the Persian Gulf War and in the air war over the former Yugoslavia, at least CF members served largely in Canadian units in both conflicts.[9] We trust this can continue.

If, as one suspects, the current incumbents of National Defence Headquarters, Parliament Hill, and even the Liberal caucus lack unanimity on space and other defence issues of today, we can take solace from history. If Sam Hughes, and many others in Ottawa, had no use for aviation, a few Canadians expressed more open views — an approach we should encourage.

In March 1912, Major-General G.J. Mackenzie, Chief of the General Staff (CGS), offered a caution that bears repeating today. Although we would probably take this as a truism, it could be chiseled in stone over the entrance to the "headshed" — or National Defence Headquarters — in Ottawa.

> A military organization which does not keep pace with the latest scientific developments must be hopelessly left behind by organizations which are alive to that necessity.[10]

The Canadian CGS may have been in the minority, but he was not alone. In 1907, in the preface to the first volume of his Aerial Flight, the British author F.W. Lanchester wrote about the new science of aeronautics in a way that might still be applicable today - simply by changing a few key words. Commenting on the provision for the scientific study of aerial flight, Lanchester urged:

> The importance of this matter entitles it to rank almost as a National obligation; for the country in which facilities are given for the proper theoretical and experimental study of flight will inevitably find itself in the best position to take the lead in its application and practical development. That this must be considered a vital question from a National point of view is beyond dispute; under the conditions of the near future the command of the air must become at least as essential to the safety of the Empire as will be our continued supremacy of the high seas.[11]

Lanchester and a few other visionaries continued to express such views before and during the Great War, influencing a small number of key people. One was Major-General Sir David Henderson, then Director General of Military Aeronautics at the War Office. In 1916, when aircraft were just starting to demonstrate their true potential, he wrote:

> The aeronautical arm is a new force in war, performing new functions, extending its activities every day and, at present, recognising but few limitations to its possible development.[12]

Incidentally, Henderson penned these words for Lanchester's book, *Aircraft in Warfare*: The Dawn of the Fourth Arm.

We may have to take care with how we tack numerical adjectives on to our nouns - "third dimension," "fourth arm." It gets confusing. We already have things like "fifth column" and "the fourth" - or is it "the fifth? - estate." Who came up with this "third dimension" as the tag for space anyway? What does it really mean?

I have been told that we should not consider space as simply an extension of the air only at a higher altitude. Funny things happen to the physics — and therefore what is possible — when we leave the atmosphere behind. More than a "third dimension," it becomes a completely new world, where many of the old rules no longer apply. Or, at least to the unscientific mind, they seem to have a different impact. (Or maybe our understanding has been too conditioned by popular culture — from Buck Rogers to Star Wars.)

Does this mean that utilization of space requires the creation of a new service, force, or corps? Surely not. In the United States, it appears that the United States Air Force (USAF) has tried to appropriate this role. Space is taken as simply an extension of the air. We see this reflected in title changes ranging from professional air force publications to commands. Even so, as we have seen, the other American services still have organizations to deal with space questions, and would find it increasingly difficult (if not impossible) to conduct their business without utilizing space assets.

It all makes me wonder if, no matter what one thought of unification of the Canadian armed forces back in February 1968, maybe we have stumbled towards the type of military organization required for the next generation of warfare. Back then, of course, there was little or no thought of space. I am sure it did not enter into the thinking of Paul Hellyer or any of his advisers when he said, or apparently thought, "*Damn the Torpedoes*"[13] and pushed through his Canadian Forces Reorganization Act. Perhaps we may yet take good advantage of this one-service approach to defence problems.

However our forces are organized, one can argue that, in many respects, nothing has changed in the formulation of Canadian defence policy. As many historians and other commentators have pointed out, we are essentially an unmilitary people who have risen to the challenge whenever called upon. This has caused us to do some amazing things. Our fathers and grandfathers and great-grandfathers have made remarkable contributions to Allied efforts in two world wars — both at home and abroad. The extent of the total mobilization of our national human and economic resources made

Canada a key part of the winning strategy in both world wars. We have also made not insignificant contributions to other coalition campaigns — as many in this room know far better than I.

If such efforts seem to require more of a stretch for the government in Ottawa and most of the people it represents, we should remind ourselves that it was ever thus. What, for the last post-Cold War decade, has been called a "peace dividend" bedeviled previous military leaders and their political masters following other wars of the twentieth century and following those of the eighteenth and nineteenth as well. It seems that this country always wants to defend itself on the cheap. Douglas Bland has commented on this proclivity:

> Canadians, whether they admit it or not, believe in the Monroe Doctrine and they intuitively understand that "free-riding" on American defence capabilities is a rational defence policy, although they worry also about Canada's ability to defend itself against US help.[14]

This poses a dilemma for those making and implementing policy: how to protect Canada without spending money and, at the same time, without jeopardizing our sovereignty. Previous generations have wrestled with the same problem. Now that we have questions of "space" and the related complication of ballistic missile defence (whether called BMD, NMD or some yet-to-be-revealed acronym), the latest incarnation of the dilemma is going to be a particularly nettlesome one to resolve.

Finally, whatever our government decides, let us hope that the words of an early Canadian air force officer are kept in mind. In 1922, after visiting Baffin, Ellesmere, Bylot, and North Devon Islands in the arctic archipelago, Squadron Leader R.A. Logan advised:

> Canada, if it considers itself worthy to be called a nation, should have enough pride and spirit to take at least ordinary precautions to defend itself in any emergency.[15]

More words to chisel in a prominent place in Ottawa. Heck, they should go on the Langevin Block and the Centre Block[16] of the Parliament Buildings as well as NDHQ.

Endnotes

1. I am indebted to Capt Steve Maude, CFANS, for this analogy, although he admits that he may have got the idea directly from someone else or indirectly from the reading he has done as a student of air power and a navigation instructor.

2. Haig did write in 1914 that "two machine guns per battalion were more than sufficient." Quoted in A.J.P Taylor, *English History, 1914-1945* (New York and Oxford: Oxford University Press, 1965), 35. Taylor continued: "[Secretary for War, Lord] Kitchener thought that four per battalion might be useful, and anything more a luxury. [Chancellor of the Exchequer, David] Lloyd George said: 'Take Kitchener's figure. Square it. Multiply by two. Then double again for good luck.' The army began the war with 1,330 machine guns. During the war 240,506 were manufactured - thanks to Lloyd George."

3. Beyond conventional military histories, one can often get this impression from reading works such as Bernard and Fawn Brodie, *From Crossbow to H-Bomb* (New York: Dell Publishing, 1962) and the more recent Martin Van Creveld, *Technology and War: From 2000 B.C. to the Present*(New York: The Free Press, 1991).

4. Attributed to Hughes and quoted in J.R.K. Main, *Voyageurs of the Air: A History*

of Civil Aviation in Canada, 1858-1967 (Ottawa: Queen's Printer, 1967), p. 11. Main provides no source for this statement and some historians doubt its authenticity. It is consistent, however, with the mercurial Hughes's known views on aviation before the war. In addition, Main's long career in aviation and interest in its historical development put him in a position to acquire inside information. See also S.F. Wise, *Canadian Airmen and the First World War*, The Official History of the Royal Canadian Air Force, vol. 1 (Ottawa and Toronto: University of Toronto Press in co-operation with the Canadian Government Publishing Centre, 1976), pp. 17-18.

5. Quoted in Wise, *Canadian Airmen*, p. 18.

6. For more on the Canadian Aviation Corps, see Wise, *Canadian Airmen*, p. 27-9.

7. Used as the title of chapter 3 in the second volume of the official history of the Royal Canadian Air Force by W.A.B. Douglas, *The Creation of a National Air Force* (Ottawa and Toronto: University of Toronto Press in co-operation with the Canadian Government Publishing Centre, 1986), 91. For more on this understudied era of Canadian air force history, see W/C F.H. Hitchins, *Air Board, Canadian Air Force, and Royal Canadian Air Force*, Mercury Series, Canadian War Museum Paper No. 2 (Ottawa: National Museums of Canada, 1972).

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9. For the Gulf, see Maj Jean H. Morin and LCdr Richard H. Gimblett, *Operation Friction: The Canadian Forces in the Persian Gulf, 1990-1991* (Toronto and Oxford: Dundurn Press, 1997) and, for Kosovo, a growing body of literature including LCol David L. Bashow, Dr. Steve Harris, and Capt James Pickett, *et al*, "Mission Ready: Canada's Role in the Kosovo Air Campaign," *Canadian Military Journal*, vol. 1 no. 1 (Spring 2000), 55-61 (also available on the Internet at www.journal.dnd.ca).

10. Quoted in Wise, *Canadian Airmen*, p. 17.

11. F.W. Lanchester, quoting himself, in the "Author's Note" to his new book, *Aircraft in Warfare: the Dawn of the Fourth Arm* (London: Constable, 1916), xii. I am indebted to LCol Mark Matheson for lending me his copy of this valuable work.

12. Ibid., "Introductory Preface," p. viii.

13. Note the title of Paul Hellyer's memoirs, *Damn the Torpedoes* (Toronto: McClelland and Stewart, 1990).

14. Douglas L. Bland, *Chiefs of Defence: Government and the Unified Command of the Canadian Armed Forces* (Toronto: [Canadian Institute of Strategic Studies], 1995), p. 21-2. The Monroe Doctrine is the name given to the declaration made by U.S. President James Monroe, during his State of the Union address to Congress on 2 December 1823, warning European powers to refrain from expanding further into the Americas. In an ironic twist for Canadians, who today depend on U.S. protection, the young republic was apparently relying on the assumption that the strength of Britain's Royal Navy would provide *de facto* enforcement of the new policy.

15. Quoted in Leslie Roberts, *There Shall Be Wings: A History of the Royal Canadian Air Force* (Toronto: Clarke Irwin, 1959), p. 66; and in F.H. Hitchins, *Air Board, Canadian Air Force, and Royal Canadian Air Force*, National Museum of Canada, Mercury Series, Canadian War Museum Paper No. 2 (Ottawa: National Museums of Canada, August 1972), 80. For the original, and fascinating document, see R.A. Logan, "Report of Investigations on Aviation in the Arctic Archipelago carried out during the Summer of 1922," Directorate of History and Heritage, Document Collection accession number 74/414. See also Douglas, *The Creation of a National Air Force*, p. 105.

16. Home of the PMO, or Prime Minister's Office.

Space and Battlespace

Lieutenant-Colonel Ron Blank

There is widespread agreement that the strategic environment today is full of constantly evolving risks, uncertainties and threats to our security. As we have witnessed the unprecedented changes in the past decade, few would disagree that future conflict is likely to be highly complex, with an increasing probability of asymmetric struggles between various state and non-state actors, each attempting to avoid the other's strength, while at the same time attempting to exploit the other's weakness. There is also a welcomed trend towards sensitivity to casualties and the desire for decisive results that take neither too much time or too much of the nation's precious resources.

As we know, the fields of communications, computers and information transfer are advancing very rapidly, driven by Commercial Off The Shelf Technology (COTS) and by the adoption of web technologies. Nevertheless, we must remember that rates of change everywhere are different, and that this challenge is leading to vastly different levels of technical and military capabilities among the key actors on the political and military stage. As a military officer assigned to SACEUR's Air Command & Control staff in NATO, I can assure you that we are grappling with this issue daily. We find that maintaining strict interoperability and software configuration controls are the key to ensuring the Joint Force Air Component Commander (JFACC) has the right tools and the right information in the right format to meet the time-sensitive demands of decision makers.

One of the most impressive, but equally disturbing facts about today's dynamic military environment, is the sheer volume of data available to the operator that can rapidly lead to information overload. The spectacular advances in information technology leading to the establishment of a global information dimension are based upon the ready availability of unambiguous real-time data compiled from numerous sources and sensors, such as intelligence, surface, maritime, air and space. In the NATO Air Command & Control System (ACCS) project, our aim is to create a single, fused information domain for the JFACC. A combined product would also be made available to the Combined Joint Task Force or Regional Air Commander's planning staff and could then be used to form a Joint Operating Picture (JOP). This component level view of the battlespace will hopefully enable JFACC's to effectively manage aerospace assets to achieve the long-term aim of connectivity from "sensor-to-shooter" through a highly intelligent command and control network. This could also support the long sought after transformation from the current sequential and linear planning of air operations, to simultaneous, interactive planning, thereby significantly improving the tempo of the operations cycle.

The principal factor for the timely acquisition of information and intelligence and the completeness of fused data is the need to compile a battlespace picture for our Commander more rapidly than the opposing Commander. This

is no different today than it was in the past, as operators have always needed to provide all relevant data to every level of command that requires it for Command and Control (C^2) purposes.

In the next decade, the requirement to effectively co-ordinate the delivery of multinational air, maritime, land-based, and possibly, space-based precision weapon systems, with ranges up to thousands of kilometres, will be a challenge of the highest order. The overall effect will be to enhance the concentration of force, to expand the continuum of the battlespace, and to blur the divisions between the strategic, operational and tactical levels of warfare.

One of the most important attributes of being a good JFACC is having full situational awareness or SA. We must enable him or her to detect and locate an adversary's forces, to continuously monitor their activities, and to provide targeting and cueing info and a clear overview of operations. Moreover, to be effective, our Intelligence, Surveillance and Reconnaissance (ISR) assets must be able to provide comprehensive, 24-hr coverage over any terrain, in any weather and in all electromagnetic environments throughout the battlespace. Technology now offers extremely high-definition imagery at approximately one metre resolution to anyone. The ability in joint operations to assimilate near real-time cueing of platform sensors by other ISR assets (including those in space) will be significantly enhanced in the next few years. In my view, Canada needs to pay special attention to this development.

NATO recognizes that the information management challenge of exploiting the operational and technical info in a timely, efficient manner within the battlespace and of ensuring that the most current sources are used for the JOP represents one of the most significant challenges facing operational planners today. It has been reported that in Operation Allied Force, US DSP satellites were providing near real-time cueing of large IR incidents, such as exploding bombs and large fires directly to the CAOC operators. Such capabilities were not in their original design specifications, but history shows that resourceful and intelligent operators can often push the technical envelope of their sensors and weapons beyond their designer's limits.

Let us turn now to the question of whether the Canadian Forces (CF) have adapted their doctrine on how we conduct operations to incorporate the use of space. In fact, the CF has used satellite technology since the 1960s. We rely on satellite communications, we helped to pioneer SARSAT for Search and Rescue, we are increasing our use of GPS for navigation, we continue to participate in RADARSAT for furthering technology development, and we are also members of NORAD and several other bodies involved in military operations and scientific work that include space-based, or surveillance by space sensors.

Unfortunately, the CF does not own surveillance satellites or ground-based space sensors. Nor do we have dedicated communication satellites that are EMP-hardened, or that offer instantaneous access to any point on the globe for high amounts of data. Some may ask: what's the impact? In my view, there are only a few, but I believe they are significant concerns. Without dedicated surveillance from space, we rely

on data provided by our allies or that which we may purchase from commercial entities such as www.spaceimaging.com. Our Commanders must rely on someone else's imagery for target identification, selection and mission planning, as well as bomb damage assessment. In a multinational coalition scenario, this is probably acceptable, provided that our Air Force agrees daily participation in the CAOC's Joint Targeting Board and using data produced by others is good enough. This does not, however, permit Canada to carry out independent aerospace operations.

> As the second half of the 20th century has matured the air realm the first half of the next century will mature the aerospace realm. For air force purposes, space and air are not separate domains. Instead they are two parts of the same whole, as closely related as oceans and seas. We should think of the aerospace domain as a seamless volume from which we provide military capabilities in support of national security. Space is a place, not a mission.
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> General Michael Ryan, 1999

As this quote indicates, there is a growing awareness that the air and space above us form one endless continuum. Our government has tasked the Department and the CF to survey Canada's air approaches and the airspace above it. Since the mid-1980s we have not had ground-based space sensors. I believe there are initiatives underway at NDHQ to address this deficiency, but until a replacement capability is acquired, Canadians have to appreciate that we have no independent knowledge of any objects orbiting above us, unless someone else is kind enough to provide us with hard copy imagery, or to share access to their own surveillance systems.

Given the limitations imposed by reliance on allied, NATO or commercial communication satellites, I would only draw your attention to recent statistics from Operation Allied Force which state that this air campaign used five times more bandwidth from satellite communications than was used in Operation Desert Storm. Without assured, survivable communications, how do we guarantee that the CF can pass time-sensitive data to our senior leadership without this vital process being impacted by other military or commercial usage? I do not have the answer to that question but I raise the issue, because I believe that it is fundamental to our defence policy goal of being prepared to commit expeditionary forces anywhere on the globe.

So far, I have just mentioned technical capabilities. However, what about the training, procedures and doctrine of our air force? Sadly, with few exceptions, most military organizations only write doctrine to describe capabilities that they possess, and we have already heard from other speakers and in other seminars about a lack of CF doctrine for the use of space capabilities. We should have a doctrine that addresses all aerospace capabilities in a fundamental way, whether the CF operates them today or ever plans on acquiring them. Absent a detailed appreciation of what aerospace power is capable of doing, we are in danger of limiting our capabilities and capacities in this domain, as well as the resourcefulness and initiative of our servicemen and women.

The NATO Panel on Air Defence Philosophy recently completed a study

called " A Vision for the C^2 of NATO Aerospace Forces in Joint Operations." The authors believe that SA needs to be improved through the amalgamation of maritime, land and air pictures, including ground surveillance and space. In order to improve the integrity of C^2 and the means of aerospace forces to maintain freedom of judgement on the basis of global SA, space-based assets deserve special and particular attention. The final point is that NATO needs to evaluate space assets in more detail as they are new and are expected to play ever increasing roles in the future. These conclusions have immediate transferability to any air force.

As the reliance on commercial satellite technology is increasing, the space dimension, the control of the information and the data exchange all require everyone's full attention to maintain a technological edge over potential adversaries. It will be crucial for the CF to provide our operators with the tools, doctrine and training they need to achieve these benefits with their equipment, if we are going to be able to keep pace with the tempo of future operations in all dimensions. As exhibited by past visionaries such as Bishop, Barker and Slemon, the air force has always met challenges head-on in the past. Let us not allow the opportunity to be active players in all of the aerospace domain pass us by.