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THE CASE FOR SEA AND AIR-LAUNCHED CRUISE MISSILES IN THE CANADIAN FORCES

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ABSTRACT

In the past two decades, the Canadian Forces has operated in several theatres where long-range precision cruise missiles have been used to great success by Allied forces. This paper argues, using operational examples from our Allies, that the Canadian Forces should give full consideration to the acquisition and use of such long-range standoff weapons. This investment will return air and naval relevance to support of the Joint land battle. Such consideration is timely, as Canada embarks on a significant recapitalization of its Navy and Air Force. If factored into the early stages of new acquisition programs, the capability could be had for a modest cost increment. Alternatively, the capability could be retrofit into the existing Iroquois Class Destroyers and Victoria Class Submarines, as they already have the basic launch mechanisms. In discussing the predominant air and sea-launched cruise missile technologies of the past two decades, it will be shown that they have become "weapons of choice" and core tactical capability by the forces that employ them. Given that the Canadian Army is currently achieving a modicum of long-range precision fire capability with the M777 gun and is considering even longer range rocket type artillery, this paper will focus solely on sea and air launched cruise missiles.

INTRODUCTION

> He who uses fire to aid the attack is powerful;
> He who uses water to aid the attack is forceful.[1] Sun Tzu

Although Sun Tzu could not have predicted that one day fire would come from the water in the form of ship and submarine launched Tomahawk cruise missiles, he certainly appreciated the importance of firepower to the land battle. Technology has advanced considerably over the intervening millennia and flaming arrows have evolved into potent long-range precision firepower. Arguably, the most significant example of this capability is the modern cruise missile, which can be launched from ships, submarines and aircraft. These systems have become a "weapon of choice" due to their military utility and power diplomacy attributes. This perspective has been substantiated by US and UK experience in recent conflicts ranging from the First Gulf War (Operation Desert Storm) to the current actions in Iraq and Afghanistan (Operation Enduring Freedom). Such objective evidence has fueled both interest and general reticence within the defence and political circles of Canada, as well as other middle powers such as Australia, Spain and The Netherlands. They ponder the strategic and operational requirements for such systems against their costs and possible impact on regional stability.

In considering the recent employment of cruise missiles, it is useful to have a general appreciation that the Canadian use of hard air and sea power in support of the land battle has generally faded or not been used since the Korean War. While a notable exception is the use of Canadian CF-18s in Kosovo during Operation Allied Force in

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[1] Sun-Tzu, *The Art of War*, trans. Roger T. Ames (London: Folio Society, 2007), 134.

1999, this was not in support of a land battle per se. This lack of utility speaks to the diminished relevance that the two services have for current and future land battles.

Until Afghanistan, the Army had a similar dearth of experience using long-range firepower, particularly of the precise variety. This has been overcome somewhat with the recently acquired M777 artillery.[2] The Army is also in the early stages of staffing a Guided Missile Launched Rocket System (GMLRS) program.[3] Clearly the Army considers both range and precision as necessities vice options in modern warfare. As armies are tending towards these technologies for long-range precise fires, this paper will only discuss air and sea-launched cruise missile systems.

While the Army has a modicum of capabilities and plans, neither the Air Force nor the Navy currently has the capacity for long-range precision strike in support of land operations. There is an opportunity to draw conclusions relevant to Canada based on Allied experience using sea and air-launched cruise missiles. This paper will argue that post Cold War conflict requires the Navy and Air Force to be capable of exerting long-range precise fires in the form of air and sea-launched cruise missiles. Such consideration is a step in returning the Navy and Air Force's relevance to the Joint land battle.

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[2] Note: A modern towed Howitzer, the M777 is capable of shooting 155mm rounds 40km to within 10m of the intended target, using the new Excalibur round. "Excalibur," Raytheon, http://www.raytheon.com/capabilities/products/stellent/groups/public/documents/content/cms01_054624.pdf (accessed 24 Apr 2008).

[3] Note: This system has a range of 70 km and is capable of being fit for the Army Tactical Missile System (ATACMS), which has a range of over 300km. Andreas Parsch, "Directory of US Military Rockets and Missiles: MGM-140," http://www.designation-systems.net/dusrm/m-140.html (accessed 24 Apr 2008).

BACKGROUND

The basic cruise missile is not a new invention. In fact, it had its genesis as the V-1 Flying bomb of World War II fame.[4] With the exception of its lack of precision, its attributes fall within the generally accepted current definition of a cruise missile. Jane's Intelligence Review defines a cruise missile as:

> a relatively small, unmanned, expendable, aerodynamic, self propelled, autonomous or semi-autonomous vehicle that can fly at low, radar-evading altitudes and is used as a comparatively precise means to deliver a warhead to a target area.[5]

Cruise missiles are a prolific weapon system, with over 75,000 in existence, spread over 75 countries.[6] They are not exclusive to Western countries and there has been indication that some cruise missile technology has been reverse-engineered from unexploded missiles by such countries as China and Pakistan.[7] As such, it is beyond the scope of this paper to discuss the entire world-wide cruise missile capacity. Instead, this study will primarily focus on the naval and air use of cruise missile technology in the form of Tactical Land Attack Missiles (TLAM) and Joint Air-to Surface Standoff Missile (JASSM) respectively. These systems are the most representative of the technology due

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[4] Note: The Feiseler Fi-103, also commonly known as the "Buzz Bomb", was used in 1944-45 by Germany for area bombing of London. "V-1 Missile," Encyclopaedia Britannica, http://www.search.eb.com/eb/article-9074598 (accessed 24 Apr, 2008).

[5] Amy Truesdell, "Cruise Missiles: The Discriminating Weapon of Choice," *Jane's Intelligence Review* 9, no. 2 (Feb 1997), 89.

[6] Note: While most cruise missiles are anti-ship variants, some can be converted to a land role with ranges of 300 miles. Meilinger, Col Phillip S., "Range and Persistence: The Keys to Global Strike," *Air and Space Power Journal* XII, no. 1 (Spring, 2008), 65, http://www.airpower.maxwell.af.mil/airchronicles/apj/apj08/spr08/spr08.pdf (accessed 1 Apr 2008).

[7] "Executive Overview: Strategic Weapons," *Jane's Strategic Weapons* (12 Nov 2007), (accessed 19 Feb 2008).

to their recent operational use and ongoing development over the last two decades. Sea-launched cruise missiles will be discussed first.

SEA-LAUNCHED CRUISE MISSILES

It is widely acknowledged that "around 75% of the world's population lives within 300nm of the sea, and around 80% of industry is within 100nm of the coast."[8] It is therefore no wonder that long-range cruise missiles, fired from naval platforms for deep strike and naval fire support in the littorals, can be considered core capability for both major and middle power navies[9]. It may be that in a contested littoral environment, such long-range precision munitions are the only method for navies to project power ashore.[10] For this reason, sea-launched cruise missiles have become a prolific technology that has been used extensively in the past two decades.

After its initial appearance in World War II, the US further developed the cruise missile as a nuclear standoff weapon until the Inter-Continental Ballistic Missile (ICBM) capability matured.[11] Once the more capable submarine launched Polaris missile was proven, the US moved away from further cruise missile development until the early

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[8] Hooton, ER and Scott, Richard, "Striking from the Sea," *Jane's Navy International* (01 Oct 2002, (accessed 19 Feb 2008).

[9] Leadmark defines Littoral as "the coastal areas and that portion of the land which is susceptible to influence or support from the sea, generally recognized as the region which horizontally encompasses the land-watermass interface from 100 km ashore to 200nm at sea . Canada, *Leadmark: The Navy's Strategy 2020* (Ottawa, ON, Canada: Director of Maritime Strategy, (2001), GL12.

[10] Cote, Owen R. Jr, "Precision Strike From the Sea: New Missions for a New Navy, A Report of the M.I.T. Security Studies Program's Second Annual Levering Smith Conference" 8-9 Dec 1997, http://web.mit.edu/ssp/Publications/confseries/strike/strike_report.html (accessed 25 Feb 2008).

[11] Note: These early cruise missiles included the Hound-Dog (4 MT, range 674 nm) Air-to-Surface missile launched from B-52s and the Navy's Regulus I (3.8MT, range 575 nm) Brigety, Rueben E. II. *Ethics, Technology and the American Way of War*. New York, NY: Routledge, 2007, 58.

1970's.[12] At this juncture, primarily as a result of SALT I deliberations, development of a long-range naval cruise missile was reinitiated. [13]

This nuclear weapon, once modified with a conventional warhead, would go on to great operational fame as Tomahawk or TLAM (Tactical Land Attack Missile). Its first conventional role was as an anti-ship missile, however the complexities of Over-the-Horizon (OTH) targeting detracted from its initial naval acceptance.[14] It would ultimately have both nuclear and conventional variants.[15] The missile's primary advantage was its superior stealth quality, mostly derived from its low flying characteristics. However, this stealth came at the cost of the technical complexity that enabled the missile to fly at very low altitudes. In order to achieve the necessary navigational accuracy in the days before GPS, the system relied on TERCOM (Terrain Comparison) which demanded very accurate digital mapping and Digital Scene-Matching Correlation (DSMAC).[16] These navigational requirements necessitated detailed targeting and complex mission profiling at Theatre Mission Planning Centres. This planning process often required several days, as the missiles had to over-fly areas that were mapped to the accuracy necessary for TERCOM.

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[12] Brigety, Rueben E. II, *Ethics, Technology and the American Way of War* (New York, NY: Routledge, 2007), 59.

[13] Note: SALT I or Strategic Arms Limitation Talks were bilateral talks between the US and USSR from 1969 -1972, which had the objective of freezing the number of ICBMs, but allowed cruise missile development.

[14] Thomas G. Mahnken, *The Cruise Missile Challenge* Center for Strategic and Budgetary Assessments,[2005], 15.

[15] Norman Friedman, *Seapower and Space - from the Dawn of the Missile Age to Net-Centric Warfare* (London, Great Britain: Chatham Publishing, 2000), 193.

[16] ibid., 269

TLAM has undergone evolutionary development since its inception. With the advent of GPS, the Block III variant was developed which reduced the requirement for TERCOM. The latest variant of TLAM, known alternatively as Block IV, TLAM-E or Tactical Tomahawk (TACTOM), has incorporated several performance enhancements and significant cost reduction measures. With an extended range of over 900nm**,** the most significant improvement includes two-way satellite communications which enables the missile to be re-tasked in-flight and to return a "Battle Damage Indication" image, or other area of interest, immediately prior to impact. This resolves a noted difficulty for long-range weapons in general. The weapon can also loiter in the target area, thereby providing better response against time-sensitive targets. The mission planning architecture has also been simplified to the extent that it can now be done on the launch platform.[17] Block IV is currently in service with the RN and USN and further bi-national development signals the weapon system's longevity.

Having provided the basic technical development background of TLAM, it is germane to now consider the operational use of the weapon. TLAM was first fired as a strike weapon during Operation Desert Storm (Feb 1991), when the submarines USS Louisville (SSN-724) and the USS Pittsburgh (SSN-720) fired 12 missiles. While successful, these first firings were encumbered by command and control difficulties

[17] US Government, "US Navy Fact Sheet: Tomahawk Cruise Missile," http://www.navy.mil/navydata/fact_print.asp?cid=2200&tid=1300&ct=2&page=1 (accessed 17 Apr, 2008).

which highlighted the labour intensive nature of planning and positioning the weapon system.[18]

Eight years later, the USS Miami (SSN-755) fired TLAMs in the opening salvo of Operation Desert Fox, (16-19 Dec 1998) and subsequently in the Adriatic, as part of Operation Allied Force (Mar 1999). The first operation comprised standard advanced planned strike scenarios, while the later involved fewer, more time-sensitive firings with the submarine staying at periscope depth for long periods of time awaiting orders.[19] As prolonged submarine operations at periscope depth were considered unorthodox at the time, this reflected the growing importance of this new role.

TLAM quickly became a "weapon of choice," and during 1998-99 over 600 were fired by USN ships and submarines, 219 in Kosovo alone. This utility rate was not fully predicted, as Vice Admiral James F. Amerault stated to Congress, the Kosovo operation:

> …required the use of highly precise weapons to limit collateral target damage and minimize losses to friendly personnel and aircraft,… these weapons were employed in Kosovo, above the levels permitted in the planning guidance.[20]

The Block III TLAMs were considered ideal for use during poor weather conditions against heavily defended targets when precise targeting procedures were required to

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[18] Dietrich CDR Kuhlmann, "Submarine Strike Comes of Age," *Undersea Warfare - the Official Magazine of the US Subarine Force,* Spring 2000, http://www.navy.mil/navydata/cno/n87/usw/issue_7/submarine_strike.htm.

[19] Alexander LTJG Barbara, "The "Big Guns" Two Theater TLAM Tally," *Undersea Warfare - the Official Magazine of the US Submarine Force,* Winter, 1999, http://www.navy.mil/navydata/cno/n87/usw/issue_6/bigguns.html (accessed Mar 2008).

[20] Amerault, VADM James F., "Statement of Vice Admiral James F. Amerault," fas.org, http://www.fas.org/man/congress/1999/99-10-26amerault.htm (accessed 19 Mar, 2008).

avoid civilian casualties, minimize unintended damage and reduce the number of missiles used.[21]

Subsequent to the Kosovo campaign, the US and UK continued to use TLAM successfully against targets in Afghanistan and Iraq (Operations Iraqi and Enduring Freedom), firing over 800 TLAMS from ships and submarines.[22]

Based on these strategic and tactical successes, the US has continued to invest in the system and has retrofit the capability into existing platforms. The most significant example of this is the USN's Giant Shadow program which is modifying 4 SSBNs to TLAM capable SSGNs.[23] With 22 of each submarine's 24 launch tubes configured for cruise missiles, the SSGNs are capable of firing 154 TLAMs in rapid succession (6 minutes). This firepower is similar to what is normally carried by an entire carrier battle group (CVBG).[24] This investment and operational usage is indicative of the importance that the US places in this tactical/ strategic capability. Perhaps nothing manifests this point more than the fact that USN submariners are now taught in their submarine training

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[21] Bryan Bender, "Tomahawk Achieves New Effects in Kosovo," *Jane's Naval Forces News* (18 July 2000, , http://janes.com/defence/naval_forces/news/jdw/jdw000718_1_n.shtml (accessed 24 March 2008).

[22] Bartlett Roscoe, *Statement of Chairman Roscoe Bartlett Senate Armed Services Committee: Subcommittee on Projection Forces Conventional Long-Range Strike Capabilities* US Government, (3 Mar 2004), http://www.globalsecurity.org/military/library/congress/2004_hr/040303-bartlett.htm (accessed 17 Apr 2008).

[23] Note: The Giant Shadow Programme was precipitated by the 1994 Nuclear Posture Review which recommended that the two-ocean strategic deterrent be reduced to 14 Trident SSBNs. SSBN is the designation for nuclear powered strategic missile submarine, SSGN is the designation for nuclear powered guided missile submarine and SSN is the designation for a nuclear powered submarine. Cdr Robert Aronson, "SSGN: A "Second Career" for the Boomer Force," *Undersea Warfare - the Official Magazine of the US Subarine Force,* Winter, 1999, , http://www.navy.mil/navydata/cno/n87/usw/issue_6/ssgn.html (accessed 2 Mar 2008).

[24] ibid.

that "…you are more likely to shoot a Tomahawk missile than any other weapon during your time in the military – even a handgun."[25]

In summary, we have seen the US evolve the cruise missile from a Cold War delivery system for strategic nuclear weapons, to a long range conventional weapon that is now considered to be their precise naval tactical "weapon of choice". The only other navy to have deployed TLAM is the Royal Navy (RN), which will now be discussed.

BRITISH TLAM EXPERIENCE

In the past decade, the UK has also experienced operational success with TLAM, albeit exclusively using submarines as the firing platform. In 1995 the UK entered into a Foreign Military Sales (FMS) agreement with the US government for the procurement of 65 Block III Tomahawks.[26] These would be retrofit in the Swiftsure and Trafalgar Class submarines and a mission planning system would be built at Northwood, the UK's joint headquarters. This investment quickly resulted in operational success when in March 1999, on her return voyage from first of class Tomahawk sea trials, HMS Splendid fired the UK's first TLAM as part of Operation Allied Force in Kosovo. These were notably the first NATO weapons used in the campaign.[27] Until Kosovo, the UK's view of TLAM was best stated in the 1998 Strategic Defence Review as "…extending our ability to

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[25] Barbara, *The "Big Guns" Two Theater TLAM Tally.*

[26] UK Ministry of Defence, "Defence Fact Sheet: Tomahawk Land Attack Missile (TLAM)," Ministry of Defence, http://www.mod.uk/DefenceInternet/FactSheets/EquipmentFactsheets/TomahawkLandAttackMissiletlam.htm (accessed 21 Apr 2008).

[27] Dr Lee Willett, "TLAM and British Strategic Thought," *Undersea Warfare - the Official Magazine of the US Subarine Force* 2, no. 3 (Spring 2000), http://www.navy.mil/navydata/cno/n87/usw/issue_7/tlam.html.

apply pressure, for example to coerce rogue regimes to comply with international and UN requirements."[28] The Kosovo success was followed by firings in October 2001 as part of Operation Enduring Freedom.[29] In all, over 100 TLAMs have been fired successfully in Iraq and Afghanistan.[30]

This operational success precipitated an evolution in the UK's strategic thinking. The UK moved from considering TLAM as a purely strategic weapon to viewing it as the tactical extension of long range naval gunfire. The original requirement for the RN to procure the Block III submarine launched variant of Tomahawk had changed from simply "…a long range precision strike capability by which to exercise high-level "coercive" diplomacy… to a weapon of genuine tactical utility."[31] The UK was very satisfied with the success of TLAM as a precision standoff weapon during the Kosovo campaign, as it reduced collateral damage and risk to UK forces."[32]

Notably, Dr Lee Willet, Head of the Maritime Studies Programme at the Royal United Services Institute, has posited that the use of TLAM in Kosovo has fundamentally impacted British strategic and tactical thought.[33] By necessity, the weapon was mostly

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[28] UK Ministry of Defence, *Strategic Defence Review - Presented to Parliament by the Secretary of State for Defence by Command of Her Majesty* MOD UK, (Jul 1988), 378, http://www.mod.uk/NR/rdonlyres/65F3D7AC-4340-4119-93A2-20825848E50E/0/sdr1998_complete.pdf.

[29] UK Ministry of Defence, "Defence Factsheet - Operations in Afghanistan: Background Briefing 1," UK MoD, (2008).

[30] "Cruise Control: Successful Launch Sees UK Ready for Tomahawk Block IV Missile," *Jane's* (09 Aug 2007), http://www.janes.com/news/defence/naval/idr/idr070809_1_n.shtml (accessed 19 Mar 2008).

[31] ibid.

[32] Willett, *TLAM and British Strategic Thought.*

[33] UK Ministry of Defence, *Defence Factsheet - Operations in Afghanistan: Background Briefing 1*, (accessed 15 Mar 08).

used at the tactical and operational level for SEAD.[34] In fact, due to weather, TLAM was often the only weapon system available. It is this demonstrated tactical utility that is relevant for Canada.

Although the tactical rationale is in ascendance, the utility for coercive diplomacy remains and it has been suggested that TLAM could be a more cost effective method for the UK to achieve its power projection goals than via new aircraft carriers.[35] With proven performance and an increasing requirement for precision, the UK is moving on to the Block IV TLAM, which is viewed as an even more flexible and cost effective variant of the missile. With the successful test launch of a Block IV, 3 July 2007, by HMS Trenchant, all UK submarines will be brought to this standard.[36] Lord Drayson, the UK Minister of State for Equipment and Support, stated:

> "this test is a very significant milestone which gives a tangible demonstration of our ability to deliver precision attack at long range against selected targets… they will give the Royal Navy a world class capability and the ability to pre-position the missile covertly in our attack submarines gives enormous flexibility to our forces."[37]

With TLAM capability in all RN submarines, there has been some consideration for enabling this capability in new ship construction, such as future versions of the Type

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[34] Note: SEAD – Suppression of Enemy Air Defences

[35] Lieutenant-Commander Cluett-Green, "TLAM - the Ideal Power Projection Tool for the United Kingdom" (CFC Paper, Canadian Forces College, 1999).

[36] *Cruise Control: Successful Launch Sees UK Ready for Tomahawk Block IV Missile.*

[37] UK Ministry of Defence, "Royal Navy Unveils New 'Smart' Long-Range Submarine Launched Missile," UK MoD, http://www.mod.uk/DefenceInternet/DefenceNews/EquipmentAndLogistics/RoyalNavyUnveilsNewsmartLongrangeSubmarineLaunchedMissilevideo.htm (accessed 24 Mar 2008).

45 Destroyer.[38] However, the UK continues to appreciate the unique strategic value of firing the missile from a covert submarine.[39] In a somewhat similar vision to the US, some in the UK are promoting the option of TLAM in a common hull for both future SSBN and SSGN roles.[40]

This US and UK naval experience during the past twenty years has shown TLAM to be both the most utilized offensive capability in their naval inventories, as well as their modern naval "weapon of choice". In essence, they are getting a good return on their investment by demonstrating relevance to the Joint land battle from existing ships and submarines. This is a valid observation for any navy.

The operational and strategic utility of TLAM is not only appreciated by Rank One and Two navies, such as the USN and RN, but also by a number of Rank Three navies.[41] Awareness of the activity in these countries is relevant to Canada as she charts a course on the matter. Australia continues to consider TLAM both for the Collins Class submarines, as well as for the future F-100 Air Warfare Destroyer.[42] Australia's Defence

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[38] "Mk 41 Vertical Launch Systems," Lockheed Martin Corporation, http://www.lockheedmartin.com/products/MK41VerticalLaunchingSystem/index.html (accessed 21 Apr 2008).

[39] Dr Lee Willett, "Tomahawk in Diplomacy and Combat," *RUSI Journal* 147, no. 5 (Oct 2002), 20-27.

[40] Dr Lee Willett, "Astute, Trident and SSGN: Land Attack for the Royal Navy Submarine Service," *RUSI Defence Systems* (Summer 2005), 107.

[41] Note: Leadmark defines a Rank 1 Navy as a Major Global Force Projection Navy (complete) of which only the USN belongs. A Rank 2 navy is similar to Rank 1 except possessing partial capabilities enabling one out of area operation, comprises navies such as the UK and France. A Rank 3 navy is a Medium Global Force Projection Navy such as Canada, The Netherlands and Australia. Canada, *Leadmark: The Navy's Strategy 2020*, 44.

[42] Seapower Centre Australia, "Seapower Australia," *Semaphore: Newsletter of the Sea Power Centre Australia,* Issue 11, 2007, http://www.navy.gov.au/spc/semaphore/issue11_2007.html (accessed 15 Apr 2008).

2000 Whitepaper indicated the utility of delivering strike capability in the future via ships, submarines or new aircraft. The defence policy expanded on the purely defensive rationale by indicating that "…strike forces can provide excellent support to Australian forces deployed abroad, and may also offer a valuable option for contributing to regional coalitions."[43] The document also stated the requirement for the ability to conduct sustained strike operations with sufficient precision to minimize collateral damage.[44] In contrast to this now dated policy however, the current Rudd government has paused to reflect on the longstanding concerns regarding the weapon's impact on Australia's challenge in balancing its "…strategic aims and commitments, resources and programmes."[45]

The Netherlands has also been interested in Block IV TLAM at various times for its De Zeven Provincien Class air-defence and command frigates. Defence Minister Henk Kamp acknowledged the Tomahawk's potential for "…controlled, limited but effective power projection with minimal collateral damage and minimal risk for friendly personnel… [and] excellent support for land operations."[46] The current government

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[43] Australia, *Defence 2000 - our Future Defence Force* (Canberra, Australia: Commonwealth of Australia, 2000), 91, http://www.defence.gov.au/whitepaper/docs/WPAPER.PDF.

[44] ibid., 92.

[45] Dr Lee Willett, "Tomahawk for Collins," *The Navy: Official Journal of Navy League of Australia*, http://navyleag.customer.netspace.net.au/fc_07th.htm.

[46] Joris Janssen, "Tomahawk Buy Cleared by Dutch Parliament," *Jane's Defence Weekly,* 7 Dec 2005.

however, has cancelled the program due to budgetary constraints, possibly associated with the Dutch commitment to ISAF, Afghanistan.[47]

Additionally, Spain has given serious consideration to the procurement of such long range precision weapon systems. The Spanish S-80 submarine, currently under construction, is being built "Tomahawk" ready and the US government has approved the sale to Spain.[48] The Spanish F-100 Class Air Warfare Destroyer, which has also been selected by the Royal Australian Navy, will be fit with 48 Mk 41 Vertical Launching System cells, capable of firing TLAM.[49]

Although cruise missile technology, such as TLAM has demonstrated strength, it is not without several weaknesses. Against certain targets, TLAM may not be as effective as ballistic missiles armed with conventional munitions, due to smaller warhead size and shallower impact trajectory. Additionally, some aircraft delivered precision weapons are more effective against moving or hardened targets.[50] Pound for pound of ordinance delivered, they are also more expensive than Joint Direct Attack Munitions (JDAMs) and most artillery rounds. As for any ordinance; costs, capabilities and desired effects are

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[47] Menno Steketee, "Netherlands Abandons Tomahawk Acquisition Plan," *Jane's Navy International* (01 Jun, 2007), http://www8.janes.com/Search/documentView.do?docId=/content1/janesdata/mags/jni/history/jni2007/jni71206.htm@current&pageSelected=allJanes&keyword=netherlands%20tomahawk%20abandon&backPath=http://search.janes.com/Search&Prod_Name=JNI&.

[48] Richard Scott, "Spain's S-80 A Submarine Comes to the Surface," *Jane's Navy International, (*Dec, 2007), 26-31, http://www.navantia.es/irj/go/km/docs/documents/Portal%20Navantia/Noticias/Navantia%20es%20noticia%20PDFs/026-031_JNI_DEC07.indd.pdf.

[49] Seapower Centre Australia, *Seapower Australia.*

[50] Mahnken, *The Cruise Missile Challenge*, 35.

balanced in the targeting process. There are of course situations where TLAM is the only effective system that may be available for use.

In considering TLAM versus air-launched weapons, it has been posited that TLAM "… do[es] not require training, ha[s] minimal servicing costs and do[es] not need to be flown regularly to retain effectiveness."[51] In a more conciliatory tone, Dr Willett has summarized the UK debate as "cruise missiles and aircraft operate in a joint, complimentary and synergistic relationship."[52] That is to say, no single system can do it all, and air-launched cruise missiles fill a unique role for air forces.

AIR-LAUNCHED CRUISE MISSILES

Having summarized the most utilized sea-launched cruise missile of the past two decades, the comparable weapon systems in use or under consideration by Allied air forces will now be discussed, using a similar approach. While there are more variants and a definitive technology has yet to emerge, the air-launched cruise missile does share a similar pedigree to its naval brethren, in that they both were derived from nuclear weapon delivery programs. There is some technical divergence however, due to the fact that aircraft can deliver the weapon closer to the target before launch. Obviously if the aircraft has the range and the environment is benign, there are less costly precision munitions such as JDAMs which could be used.[53]

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[51] Cluett-Green, *TLAM - the Ideal Power Projection Tool for the United Kingdom*, 15.

[52] Willett, *Tomahawk in Diplomacy and Combat*, 20-27.

[53] Note: JDAM or Joint Direct Attack Munitions, is in fact considered a near precision munition as its circular error of probability is 42.9 feet vice the 9.9 feet required to meet the technical standard of precision. John A. Tirpak, "Precision: The Next Generation," *Airforce: Journal of the Air Force Association,* 86, no. 11 (Nov 2003), http://www.afa.org/magazine/nov2003/1103precision.asp (accessed 24 Mar 2007).

In the final decade of the cold war the US Air Force deployed nuclear armed Ground Launched Cruise Missiles (GLCMs), that were a variant of Tomahawk. These were removed from service in 1991. In parallel to naval development of TLAM, Allied air forces developed a variety of precision munitions and long-range standoff weapons. During the First Gulf War the USAF used 35 GPS guided Conventional Air-Launched Cruise Missiles (CALCMs) or AGM-86Cs which had been converted from the nuclear "B" variant.[54] These weapons were launched from B-52Hs, complying with the US doctrine of using long-range stand-off weapons initially in a conflict in order to neutralize enemy air defences at minimal risk to own forces.[55] The missile has been used effectively in every offensive operation since, including Kosovo.

Renowned defence correspondent John Keegan, placed great importance on the Kosovo Campaign and stated "there is a new date to fix on the calendar; Jun 3, 1999, when the Capitulation of President Milosevic proved that a war can be won with air power alone."[56] This rather bold statement reflects more broadly on the effective use of precise long-range weapons, rather than on simply air-dropped bombs. The importance of air-launched standoff weapons is also well understood by US decision makers, as stated in a recent CRS report for Congress:

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[54] Note: The AGM 86 C program was designed to rerole the weapon from its nuclear variant. Its mission was to "dilute an enemy's forces and complicate defence of its territory". With 20 missiles per B-52 and each missile armed with up to a 3000lb warhead with a range of over 600 nm. It is a potent weapon system. "US Air Force Fact Sheet: AGM 84 B/C/D Missiles," US Air Force, http://www.af.mil/factsheets/factsheet.asp?fsID=74 (accessed 18 Apr 2008)

[55] John A. Tirpak, "The State of Precision Engagement," *Airforce: Journal of the Air Force Association* 83, no. 3 (Mar 2000), http://www.afa.org/magazine/march2000/0300precision_print.html (accessed 26 Mar 2008).

[56] R. Grant, "Air Power Made it Work," *Air Force Magazine, (*Nov, 1999), 37.

> … the use of standoff weapons (usually cruise missiles or air-to-surface guided weapons) against hostile military units, intelligence centers, terrorist camps, and WMD facilities has become a commonly-accepted U.S. military practice.[57]

The US Air Force has also acknowledged the contribution of precision weapons in Iraq and Afghanistan, and is moving towards "…stealthy, longer ranged weapons [which] will extend USAF reach through rings of heavy anti-aircraft defenses, making it possible to strike high-value targets without undue risk to aircraft."[58]

The most current air-launched cruise missile, after the CALCM, is the AGM-158A, Joint Air-to-Surface Standoff Missile (JASSM). The missile has been designed to be carried by a variety of current and future aircraft. While it has been plagued by developmental problems, recent test flights have proven to be successful in demonstrating the missile's capabilities. The stealthy, low-winged missile is fit with a 1000lb penetrating warhead and has a range of over 200 miles. An extended range version of the missile, JASSM-ER, will have a range of over 400 miles.[59] Australia has chosen the JASSM to meet its Follow-on Standoff Weapon (FOSOW) requirement for their F/A 18 Hornets, thereby allowing the retirement of the F-111 strike aircraft. It is also being proposed for Australia's Joint Strike Fighter (F-35) program, in which Canada is also an international partner.[60]

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[57] Andrew Feickert, *Missile Survey: Ballistic and Cruise Missiles of Foreign Countries* (Washington, DC: Congressional Research Service: Library of Congress,[2004]).

[58] Tirpak, *Precision: The Next Generation.*

[59] "AGM-158A JASSM (Joint Air-to-Surface Standoff Missile), AGM-158B JASSM-ER, *"Jane's Air-Launched Weapons"*, (23 Jan 2008), (accessed 19 Feb 2008).

[60] "Australia Selects JASSM for FOSOW Requirement," *Jane's Missiles and Rockets* (1 Apr 2006), (accessed 19 Feb 2008).

The UK appreciates the utility of air-launched standoff weapons, as acknowledged by Air Chief Marshal Sir John Day (former Commander-in Chief HQ Strike Command) in stating the importance of considering the "…widest range of possible scenarios for usage" and "maximum flexibility" when procuring new weapon systems.[61] Standoff weapons have several advantages for air forces beyond the obvious avoidance of flying through hostile airspace. Fundamentally, they increase the effective range of fighters by upwards of 600nm, since an hour of loitering and looking for a target costs a fighter approximately 250 miles in combat radius.[62]

Other standoff precision weapons being developed for the USAF include the Low Cost Autonomous Attack System (LOCAAS), and Small Diameter Bomb (SDB), as well as the Low Cost Mini Cruise Missile (LCMCM) and Precision Guided System (PGS). The latter systems are being developed for internal carriage on the F/A 22 Raptor and F-35 Joint Strike Fighter. The LCMCM could ultimately loiter for 24 hrs and carry 3 to 5 PGS payloads.[63]

Another development is the Joint Stand-Off Weapon (JSOW or AGM-154). While originally a precision glide bomb, an extended range variant (300nm) is under development. This powered version of the weapon, is strictly speaking not in the same

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[61] Day, Air Chief Marshal Sir John, "Joint Strike: Missiles and Aircraft in Long-Range Land Attack," *RUSI Journal* (Jun 2001), 49.

[62] Meilinger, Col Phillip S., *Range and Persistence: The Keys to Global Strike*, 67.

[63] "Low Cost Mini Cruise Missile (LCMCM) and Precision Guided System (PGS)," *Jane's Air-Launched Weapons* (26 Jun, 2006) (accessed 19 Mar 2008).

class as JASSM, as it is not terrain following.[64] As it can be fired from F-16s, air forces that such as The Netherlands, Turkey, Greece and Poland, have expressed interest in the affordable ER variant (est USD 350K).

As all major recent conflicts have used Allied airpower to support the land battle, aircraft replacement programs such as the CF-18 Fighter and CP-140 Maritime Patrol Aircraft should consider such precision standoff weapons as JSOW or JAASM. These technologies will have matured further by the time these programs need to be specified.

OTHER CONSIDERATIONS

TLAM, and any precise long-range cruise missile for that matter, has been considered revolutionary for "…its theoretical ability to destroy *exactly* what it was intended to hit and to do so at virtually no risk to the attacker and with a high degree of survivability for the weapon en route to its target."[65] This effect, delivered with proportionality and discrimination meets with the Just War principles of *jus in bello*. Such performance, and its potential for minimizing collateral damage and loss of life, may mitigate humanitarian concerns.[66] This utility has tended to decrease the political reluctance to use the weapon, thus increasing the probability that it will be used in the future. Recent examples would appear to substantiate this viewpoint.

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[64] "JSOW-ER Engine Passes Second Test Firing," United Press International, http://www.upi.com/International_Security/Industry/Briefing/2008/02/11/jsow-er_engine_passes_second_test_firing/5862/ (accessed 21 Apr 2008,

[65] Brigety, Rueben E. II, *Ethics, Technology and the American Way of War*, 66.

[66] ibid., 67.

CANADIAN PERSPECTIVE

The requirement for Canada's Navy and Air Force to be ready and capable to support the land battle is clear. It is the essence of Joint operations. Arguably this fact, in combination with the reality that the modern cruise missile is now a "weapon of choice", may be a force for changing the defense and political environment within which such a capability is considered. The most recent Canadian defence policy, as laid out in the Martin government's *A Role of Pride and Influence in the World – Defence,* highlights the utility and focused effects provided by precision weapons. It also notes that Maritime forces shall have the capacity for precision fire support for forces ashore.[67] While this policy is reflective of the previous government's position on the role of the Canadian Forces, the perspective on the necessity of precision in the execution of naval and air power is unlikely to change.

Leadmark, the Canadian Navy's strategy for 2020, also speaks somewhat to the need for Naval support to forces ashore. While the document acknowledges the strategic value of capable 'Naval Fire Support', it is somewhat timid in stating that Canada would only be concerned with the tactical utility of such systems.[68]

The Canadian Air Force's capstone doctrine "*Canadian Forces Aerospace Doctrine*" is clear in stating the strategic and tactical utility of air delivered munitions.

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[67] Canada, *Canada's International Policy Statement: A Role of Pride and Influence in the World Defence* Government of Canada, 2005), 30.

[68] Canada, *Leadmark: The Navy's Strategy 2020*, 160.

However, it is thin on the specifics of precision standoff weapons such as cruise missiles.[69]

Most recently, one of the "Manley Report's" recommendations included the necessity of making "forceful representations with Afghanistan's neighbours, in particular with Pakistan, to reduce the risks posed to regional stability and security by recent developments in that country."[70] While it would be presumptuous to draw the conclusion that this represents political support for long-range precision strike capability, it may indicate that the Canadian political environment is more understanding of the "power diplomacy" utility that precision strike capability would bring to the diplomatic tool bag.

While these high level policies are not intended to be prescriptive in which weapon systems are required for the CF, they do emphasize the government's position that the CF's use of force shall be judicious and precise. It is reasonable to assume that any future policy would at least be consistent in this tone. Sea and air-launched cruise missiles are a weapon system that complies with this vision.

In advance of future possibilities in the area, the CF is investing in what could be the genesis of the targeting and coordinating system for long-range precision cruise missiles. The Canadian Forces Experimentation Centre (CFEC) is managing a Joint Fires Support (JFS) Technology Demonstration Program (TDP), which has mandate "…to

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[69] Canada, *Canadian Forces Aerospace Doctrine: B-GA-400-000/FP-000* Director General Air Force Development, (2006), 40.

[70] Manley, The Honourable John, *Independant Panel on Canada's Future Role in Afghanistan*Government of Canada,[2008]), http://www.independent-panel-independant.ca/pdf/Afghan_Report_web_e.pdf (accessed 8 Apr 2008).

develop an effective and efficient Canadian Forces Joint fires model."[71] The program is focused on such things as co-ordination and battle space synchronization, sensors, decision aids and weapons, rather than on particular delivery systems such as cruise missiles. The JFS TDP implicitly considers the utility of air and sea-launched cruise missiles and that "…the nature of combat power is fundamentally shifting from mass to precision, becoming more responsive and networked as never before."[72] This effort will create the framework within which future long-range stand-off weapons would work.

SUMMARY AND CONCLUSION

The technical background, capabilities and recent use of air and sea-launched cruise missiles have been discussed. Their strategic and tactical utility in support of the modern land battle has been summarized, in the context of US and UK experience during the past two decades. This operational success has resulted in cruise missiles becoming a "weapon of choice" due to their increasingly tactical vice strategic effects. This perspective of tactical utility has resulted in several middle power countries considering cruise missiles for both their current and future naval and air platforms. The ability to deliver timely and precise effects at extended range is an attractive attribute from both a military and political viewpoint, primarily due to the reduction in both collateral damage and threat to own forces. This discriminating ability ultimately increases the probability of their being used instead of less precise weapons. Canada's strategic climate is

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[71] Cdr George Prudat, "Joint Fires Victoria Working Group Introduction Presentation 14 Feb 08" Canadian Forces Experimentation Centre, (2008).

[72] Cdr George Prudat, *Operating Concept for Joint Fires Support* Canadian Forces Experimentation Centre, (14 Feb 2008), 2.

maturing in this direction and current Canadian defence policy demands that if lethal force must be applied, it must be delivered precisely.

It has been shown that to date, cruise missile technology has been successfully deployed on both new as well as existing platforms. Significant Allied air and naval programs are being specified with cruise missile capabilities as a requirement. The success in retrofitting the capability is a pertinent observation for Canada that is relevant to the Victoria Class submarines and Iroquois Class destroyers.

As a minimum however, major procurements should be designed with a "fit for but not with" methodology, in order to protect the flexibility of future capability decisions. The replacement programs which could incorporate cruise missiles include; CP-140 Maritime Patrol Aircraft, CF-18 Fighters, and DDH-280 Destroyer Replacement. A multinational approach in appropriate areas, such as Theatre Mission Planning Centres, could make the program more cost effective for Canada. The major platform replacement programs will undoubtedly cost many billions of dollars. Serious consideration must be given to incorporating these modern "weapon of choice" capabilities into each platform's core requirements. Such capability will provide a "return on investment" by enabling these platforms to be relevant in the future Joint battlespace.

It is inconceivable that the requirement for precise long-range fires will diminish in the future. All future weapon systems must be precise and discriminating or they will never be used. Allied use of long-range standoff cruise missiles during the past 20 years indicates that these systems indeed have a higher probability of being used than many other systems, such as air to air missiles or even torpedoes. As was previously stated,

"…you are more likely to shoot a Tomahawk missile than any other weapon during your time in the military – even a handgun."[73] Canadian decision makers must consider this proven utility when deciding to include such capability in future programs.

While modern cruise missiles may be considered complimentary in effect to JDAMs or precision artillery, they are unique in their capacity for range, which provides necessary standoff in hostile environments, and their ability to loiter, which enables flexibility in engaging time sensitive targets. The newer capabilities for two-way communications provides for the significant advantages of re-tasking and Battle Damage Indication.

In conclusion, as Canada moves forward with new capabilities to confront the threats of the 21st century, it must give full consideration to enabling cruise missile technology in naval and air platforms. Such decisions would result in a "better return on investment," as these significant capital assets would then exhibit necessary relevance to the Joint land battle.

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[73] Barbara, *The "Big Guns" Two Theater TLAM Tally.*

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