Abstract

The HALIFAX Class ships were originally designed and built to meet the Cold War threat. At the turn of the century and throughout the first years of the new millennium, state-sponsored terrorism has increased the overall threat dramatically with a proliferation of missiles today with greater capabilities than those of the period when the ships were built. The HALIFAX class frigate needs to have its combat suite upgraded, there is no plan on the horizon to replace them soon, and upgrading their combat capabilities remains the only viable option. If Canada still wishes to maintain a front line navy, it will have to look at the modernization option. While this paper is not an extensive review of naval warfare technology, the most important naval issues for modernisation have been addressed, C4ISR and Self-Defence capabilities. When completed, the mid-life upgrade of the HALIFAX class will help maintain the force structure of our core combatant while delivering upgraded capabilities faster than any other alternative.

Events of the past decade demonstrated that naval forces must be prepared to confront a variety of threats while executing diverse missions, ranging from peacekeeping, maritime interdiction operations, leadership operations, disaster relief to combat operations. The absence of the superpower stability of the Cold War, has thrown several regions of the world into conflict and violence, underscoring the need for an highly effective, combat capable and credible forces to protect our sovereignty at home and interest abroad. This increase operational tempo and reorientation of theatre of operations has forced modern navies to review and publish new naval strategy in order to face this new world era.

In 1999, the Chief of the Defence Staff promulgated Strategy 2020[1], it is a keystone reference for the Canadian forces for all force development initiative in the department. For that, the Chief of the Maritime Staff promulgated Leadmark, which has articulated a new Canadian naval strategy for the 21st century[2], the Leadmark strategic planning process has identified the operational capabilities that will prove to be essential to the implementation of that strategy. The document established core elements that Canada's oceanic estate will demand, the navy expanded these elements into competency components that will be required to establish legitimacy as a "navy". As such, these basic competency components were promulgated and are categorised as follow[3]:

- Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR);
- Self-Defence (SD), Sensors and Weapons;

1 Shaping the Future of the Canadian Forces: Strategy for 2020, Baril, Général C.D.S., Ottawa, June 1999
2 Leadmark: The Navy's Strategy for 2020, Directorate of Maritime Strategy, NDHQ/ CMS, Ottawa, 2001, 176 p.

- Force Generation;
- Sustainement; and
- Organic Air.

These general components establish the core of naval capabilities, and for a navy to remain credible amongst other medium size naval forces, it must have all of these components, if it doesn't it would qualified only as a constabulary forces[4]. Amongst all critical challenges that Leadmark offers, the vital one is finding and allocating resource to modernize the HALIFAX class ships. We must replace Cold War-era systems with significantly more capable sensors, networks, and weapons. The Halifax class frigates which composed the core capability of the navy were design and built in the late 80's to face threat of the 90's, as there are no plan on the horizon to replace them soon, upgrading their combat capabilities remains the only viable option.

If Canada still wishes to maintain a front line navy, and meet the objective of Leadmark it will have to consider the technological evolution better known as Revolution in Military Affairs (RMA). RMA has dramatically improved military capabilities, primarily through achievement of information superiority. The Information Technology (IT) has benefited the most from RMA and through the miniaturisation of computer hardware components, the capability of radar and weapon systems has improved extensively.

This essay will determined how the navy is to address these above mentioned competency components, specifically; it will focus on the C4ISR and SD capabilities. It will look at the current state of today's navy, specifically it's deficiencies in these two capabilities components, what created these deficiencies, the influence of commercialisation of the

[3] Leadmark: The Navy's Strategy for 2020, Directorate of Maritime Strategy, NDHQ/ CMS, Ottawa, 2001, p.126
[4] Ibid, p.45

Information technology into military hardware, the upgrade that are required to maintain a relevant navy and prolong its capability to maximize the lifespan of the class. It will look at the strategy and objective of the United States Navy (USN), how they intent to address the same competency components and analyse their approach to ours. Finally, this essay will analyse the road map that the navy has chosen to address these deficiencies and meet the objective of Strategy 2020 and Leadmark.

The world of C4ISR

Changes are inevitable, but if the navy aspires to prepare itself for the next century and be ready to face the new world, it must lead change and in order to accomplish this in IT, it must be prepared to live it too[5]. When did IT really started? The origins of the Internet were distilled from the visions and work of computer visionaries of the 1960s far away from military planning table. Three computer gurus from MIT first proposed a global network of computers in 1962. Later that year, they were assigned the task of developing it. Three years latter, a computer from MIT was connected with a California computer over regular dial-up telephone lines. This clearly demonstrated the feasibility of wide-area networking.[6] The resulting effect of these three gurus project are part of our day-to-day life, our culture is part of a network society that is changing is way of conducting business almost regularly. At the end of 1998, according to one published account, 900 million voice messages were exchanged each day, 5 million e-mails were sent each minute, it is estimated that Internet traffic was doubling every 100 days, and there were 285 million new cellular phone subscribers, the same technology has found its way into military hardware through RMA.

[5] Embrassing Change: Continuing Transformation, D Porter, Chips magazine, Winter 2003 P.5
[6] Brief History of Personal Computing, Long D.J., Chips magazine, Space and Naval Warfare Command, Charleston, p.35

C4ISR Objectives

These technological advancements have reached the military, the synergy that is associated with networks; instantaneous information access and information fusion technology is currently found in most modern warships. In its Leadmark document, the Canadian navy state that one of its primary requirement is to address C4ISR, this capability is the single most important capability, it will allow our navy to provide support to national and multinational missions, which reflects well the objectives in Strategy 2000 for greater interoperability and modernization. Strategy 2020 states clearly that:

> *For future force development considerations, we ought to achieve seamless operational integration at short notice with our major allies (and the USN, in particular) in this area of warfare*[7].

This statement also reflects a similar US Navy statement, their new Strategy document Sea Power 21 provides a clear vision that the US intent to share high level technology with its coalition partners:

> *Sea Power 21 defines news ways of deterring conflict…leading to major increase in operational effectiveness. This transformation will be enabled by interoperable, netcentric operations between Joint Service, Allied and Coalition forces…*[8]

[7] Shaping the Future of the Canadian Forces: Strategy for 2020, Baril, Général C.D.S., Ottawa, June 1999, p.17.
[8] Sea Power 21, Clark V. Admiral US Navy, Naval Proceedings, Oct 2002, p. 8.

Leadmark and Sea Power 21 have similar objectives and addressed same groups of capabilities, before that we describe and understand some of these capabilities, lets recognize the deficiencies of our own C4ISR system.

C4ISR Current Deficiencies

The navy Command & Control System (CCS) was built between 1986-89, and has been improved every years since. The CCS integrates a Tactical Data Links (TADIL) widely use amongst NATO countries, it integrates all weapons systems so that the operators is provided with a variety of options to defend his ships and it also allows the commanding officer to rely on automatic reactions of some of its weapons systems. The network architecture used to assemble these systems into one single network was purely a military technology, and no one could have foresees the Internet evolution of the following decade. It was built as a close network architecture, which did not facilitate modernization of its sub-systems without affecting the overall infrastructure of the network. However, at the time of entry into service, when the system was commissioned, it offered state of the art military computer technology and was truly a technological achievement in naval systems. Like any computers hardware, technology has evolved, and the CCS needs to be replaced for two basic reasons, one is that it is becoming very difficult to maintain and support, since some of the spare parts aren't available anymore and secondly the navy is upgrading its C4ISR capabilities along with most of its weapons, TADIL and sensors systems[9]. The technologies of these new systems resemble commercial computer technology; they are based on an open architecture that allows rapid integration into a CCS. The Chief of the Command Information Office (CIO) of the USN states:

[9] HALIFAX Class Command & Control Update Project, Directorate of Maritime Policy and Plan Development, Synopsis Sheets Identification M 2793, Hull, Oct 2001, p. 4

By adapting existing Naval and other Service systems and commercial products in an innovative way, we have developed systems that will be essential elements of future Joint, Inter-government and coalition operations.[10]

D.M. Wennergrenn, CIO-USN

C4ISR Concepts

The advance of computer technology has had no greater impact that in the field of C4ISR. The capabilities provided by modern C4ISR systems dramatically changed the way conflicts will be resolved. An innovative, efficient, and well-coordinated approach to technology infusion is necessary to establish connectivity for joint and combined warfare scenario.

Lets look at some of the technologies that the USN wants to put to sea, as Leadmark stated clearly, where our navy wishes to be next, we will look at the USN net-centric technology. Better know as Network Centric Warfare (NCW), it will be a central aspect of all future naval operations, NCW derives its power/advantages from the reliable and ubiquitous networking of well-informed, geographically dispersed forces.

What is NCW; it is a joint concept where war fighters can instantly access any piece of information across a secure, worldwide network, anywhere and at anytime. This network represent the military application of highly successful principle of network operations developed to support commercial endeavours. Commercial networks are based on the application of IT and demonstrate tremendous competitive advantages for exploiting information superiority[11]. The

[10] Fiscal 2004 Defence Authorization: Information Technology Programs, *D.M. Wennergrenn, CIO-USN, p. 6…*
[11] Canadian Navy Command and Control Blueprint to 2010, Publish under Canadian Way Ahead Paper to 2010. January 2002, p.12.

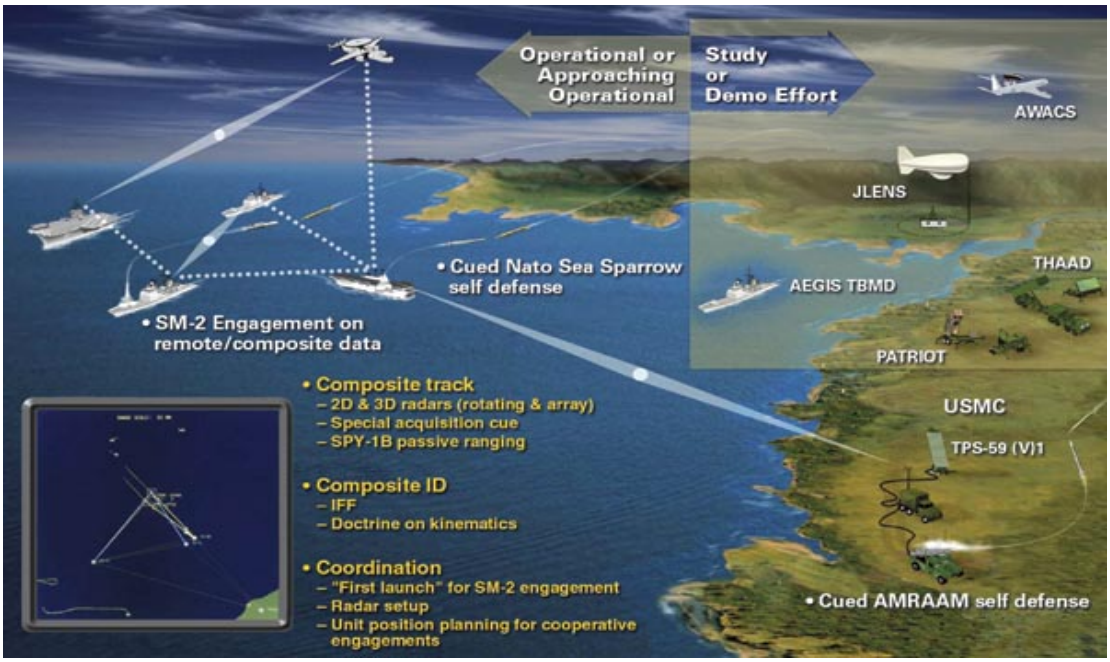
backbone of NCW is the ForceNet which comprise of two important components that are worth looking at: the first one being Global Command Control System - Maritime (GCCS-M) is the naval component of the Joint Command Control System used by Air Force, and the second one is the Cooperative Engagement Capability (CEC).

GCCS-M will enable our navy to have access to command and control (C2) and tactical intelligence source in real-time manners to the at sea war fighters. GCCS-M provides timely, accurate, and complete all-source C4ISR information management and develops a common operational picture for at sea day-to-day operations. This system has been introduced into service in mid 90s, and has become widely use within NATO and other friendly nations such as Australia. This system has an open-architecture concept and the protocols that it using enable the sharing and the merging of information with a coalition Task Force (TF). It will facilitate the integration of naval units when conducting operations as a whole or independently while sharing same information data.[12] The next system that this paper will look at is CEC.

CEC is a weapons-control network that uses revolutionary sensor netting technology to exchange raw sensors data between ships or aircrafts to develop composite air tracks. This capability will expands the battlespace and provides increased situational awareness to the operators. CEC is the foundation network for the development of a single integrated air picture, which is vital to air superiority. CEC also will allow operators to make maximum use of SAM systems. CEC will act as force multipliers in that, each firing platform benefits from a force-wide (larger area than own sensors) network of netted sensors that provides data to the fleet. In addition, the ability to build force-wide composite tracks means that every ships connected into

[12] C4ISR System 2001-2002, Jane's, Thirteenth edition, Edited by Clive Walker, Alexandria, p.462

the network has an identical, real-time tactical picture and as a result gain valuable battlespace time[13].



Cooperative Engagement Capability Diagram

(Source Jane's Navy International, Apr. 2002)

There are many other options that are being developed around the world and our navy could look at them however; it is logical to embrace the same technology that the USN intent to acquired. As we have already identified, Leadmark and Sea Power 21 both describe high level strategic vision that are very similar, and they both identify that C4ISR is a central element of naval activity. Leadmark states:

> *Effective C4ISR, is not a substitute for superior ships, people or systems. It is however, and will continue to be, the link between these three, and thus the key to exploiting these capabilities…*[14]

[13] C4ISR System 2001-2002, Jane's, Thirteenth edition, Edited by Clive Walker, Alexandria, p.367

C4ISR Summary

Modern C4ISR will help turn information into advantageous power, it was clear during Desert Storm and the Kosovo campaign that access to superior information brought a decisive advantage to the coalition[15]. The C4ISR systems will be the key to operational success in the future. The GCCS-M and CEC will be will be critical systems to the at sea commander and the navy shall continue his path toward fielding this technology. This approach will provide the navy with the instrument and capability to meet the objective sets in Leadmark. The following chapter will address the second part of this paper, that is Ship's SD.

Self-Defence Capability

In the early 1990's, the threat once again emerged. Various rogue states became aggressive. There was an arms build-up in some parts of the world; anti-ship missile (ASM) of which many will be sea skimmers that reduce reaction time to minimum and other worse associated technology is becoming more plentiful. At the turn of the century and throughout the first years of the new millennium, state-sponsored terrorism has increased the overall threat dramatically with a proliferation of missiles today with greater capabilities that those of the period when our ships were built. Just to mention the reality of the threat, the Falklands war, the attack on the USS STARK by two Air launched Exocet missiles, the attack on the USS COLE and events of 11 September 2001 tragically illustrated that promise of peace and security in the new century is fraught with profound danger.

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[14] Leadmark: The Navy's Strategy for 2020, Directorate of Maritime Strategy, NDHQ/ CMS, Ottawa, 2001, p.132
[15] Change in the Navy, Rear-Admiral KD Slaght, USN Commander SPAWAR, February 20, 2002 P. 2

Since the introduction of the HALIFAX class ships, technology has also advanced. Processing speed, new programming capabilities and technologies have created missiles that are stealthier, faster, and smarter… essentially more lethal. Therefore, the threat currently posed to ships versus their capabilities in handling that threat has widened significantly. This part of the essay will provide a high level analysis of th our self-defence capabilities to meet the new

Today' hip SD is still about tomorrow's threat and environm The problem is complex because many of the missi peacel being carried-out under highly restrictive rules of engage The an attacker, who can conceal himself in the indigenous air a o operates; September 11, 2001 is a clear evidence of this scenar e argument against the requirement for naval units to possess a s when operating in an environment in which and air threat is a real ely, the level of capability required is a function of a variety of fac the followings are to be considered:

f warfare in which a ship is design to fight;

doctrine and task assign to various type of ships in a given con e their requirement for self-defence capability; and

ceptable risk. No defensive mechanisms are perfect and a d

Leadmark state clearly that a ship's self-defence capability will need to be multi-dimensional in nature[18]. It may come in the form of attacks by traditional kinetic weapons such as bullets, bombs, missiles or mines, or even in the form of Nuclear, Biological or Chemical weapons. To counter these threats, modern and effective defensive measures will be required[19]. This strategic statement needs to be quantified in order to develop plausible requirements. The following paragraphs describe some of the process that our navy and largely most of the western world navies have adopted.

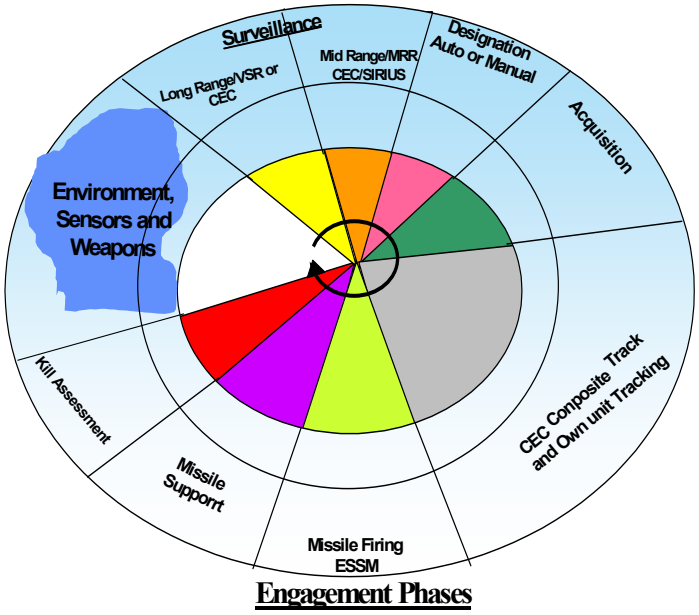
How to define Requirement

In defining ships capabilities requirements in a defensible manner, navies draw on a methodology that define realistic threat scenarios and outcomes, this methodology was adopted by many navies. The Canadian navy has been using this process to create a new threat reference document[20]. This methodology generates operational necessities when designing combat systems and creates the basis for future systems capabilities. This was the case for the following NATO study.

The development of an integrated ships self-defence concept goes back to the late 80s when multiple NATO nations including Canada formed a consortium to develop a ships self-defence capability. This work was conducted under a program called NATO Anti-Air Warfare Study. Their work was to develop of the Statement of Requirement (SOR) and to perform

[17] Self-Defence: Self-defence is understood for this essay to be the action of engaging only those targets which are deemed at one moment to threaten a defending ship.
[18] Leadmark: The Navy's Strategy for 2020, Directorate of Maritime Strategy, NDHQ/ CMS, Ottawa, 2001, p. 137
[19] Ibid, p.133..

engineering studies and critical experiments that would lead to a system concept and specification[21]. The requirements for today's SD are primarily driven by the operational necessities describe in the NAAWS study, figure 1 below illustrate the raid annihilation problem that SD systems need to solve.



The above diagram offers a brief description of an engagement phase conceptually: The ship's sensors search the volume or get cued by other sensors such as CEC, detect a supersonic, low-flying, manoeuvring ASM, a target track is establish and instantaneously distributed to all units participating into the CEC network. The composite track is computed by associated CCS and an analysis of the threat is conducted for threat evaluation ranking against define theatre threat criterion, than a weapon is assign and a fire control solution is develop. Operators monitor the sensor and weapon control doctrine and their dynamically changing status while the system continues to compute the best weapon laying and engagement solution. An engagement takes place either automatically or manually. The system continues to manage the engagement and

[20] Above Water Warfare Naval Threat document for establishing Naval Requirement, Directorate of Maritime Requirement Sea, July 2003, p. 22-35

support the missile in flight to maximize its trajectory for manoeuvring ASM and ensure weapons support through missile intercept, and finally the system measure the engagement for kill assessment. The concept has been proven through a successful at sea demonstration conducted on the Self-Defence Test Ship (SDTS) in 1993 and 1994[22].

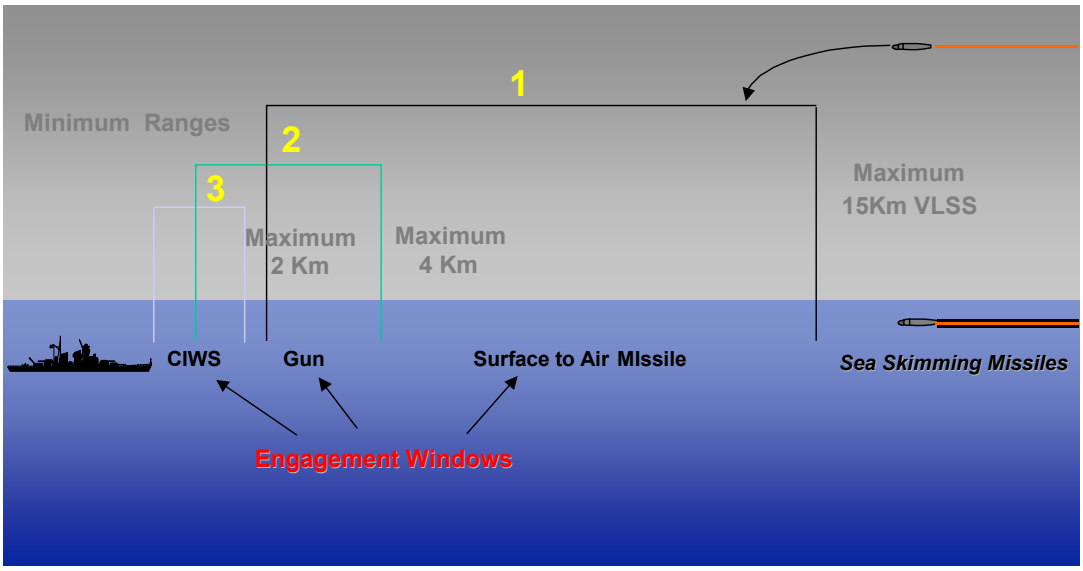
As we describe above, the participating nations to the NAAWS study used the result of the program to develop the combat systems and components to best matched their requirements. The study address three aspects of a combat systems and associated components, sensors, command and control system, and weapons elements. This portion of the essay will be looking first at the sensors elements than second at the weapons best suited for our navy to meet future scenario.

The Solution

The NAAWS study concluded to have an effective self-defence, it must comprise a layered structure of detections and weapons systems, which permits the continual engagement of an attacker several times from the moment of detection to the moment of impact and as such the HALIFAX class ships have a similar capability[23]. The fists layer on the frigates consist of sensors systems to alert operators either at long range which is accomplish by means of a Volume Search Radar (VSR), the SPS-49 or at medium or close range with a Medium Range Radars (MRR), Sea Giraffe. For weapons systems the ships were fitted with the Sea Sparrow Missile system, the Bofors 57mm Gun and the Close-In Weapons System (CIWS). As we have seen in the above paragraph on C4ISR, all of these sensors were first operational in the early 80s

[21] NATO Anti-Air Warfare Systems study, NATO Naval Group 1, Johns Hopkins APLaboratories, Washington D.C., 1994, 349 p.
[22] Integrated Ship Defense, RJ Pringaman, John Hopkins Technical Digest, October 2001, Volume 22, number 4 p. 518-535
[23] AWW Requirements, DMPPD, MS : 3293-41, Hull, Dec 99, p. 15.

an as such have not been upgraded to meet the new evolving threat. The diagram below provides a visual presentation of the current configuration of the HALIFAX class. The navy intent to conduct a Mid-life upgrade for this class of ships, at the same time it is considering upgrading these systems under new capital projects[24]. Before that we analyse our navy approach, lets look at the USN and their upgrade project.



HALIFAX Class Layered Defence System

(Source: DND SAWS Handbook)

USN Approach

To meet the new Strategy Sea Power 21 and the requirement of the NAAWS study, the USN has chosen to modernize all cruisers starting in 03 through a mid-life conversion plan[25]. Under the adjunct of Force Protection program, it intent to modernize all its radars, to develop an IRST system and upgrade all weapons systems to defend against new ASM. This essay will only look at the same systems that we have incorporated into our fleet. First, their existing radar SPS

[24] Infra-Red Search & Tracking SIRIUS, Directorate of Naval Requirements, Synopsis Sheets Preliminary Project Approval M 2664, Hull, July 97, p. 7.

49, it has received an upgrade which include key performance enhancement under the Medium Pulse Frequency Upgrade program that incorporates increase detection of small targets, increase reaction time through firm track criteria changes etc. The enhance capability of this new version has been published and proved to meet new threat criterion[26]. The USN has rapidly recognised the deficiency of radars in the littoral environment and has developed an IRST system to address this concern in addition to the identification issue mentioned before[27]. The IRST will provide a unique sensing capability required for detection, passive and lightweight and immune to jamming when compare to radars, it will be an outstanding complement to the detection systems[28]. Under the same Force Protection program, the USN intent to modernize weapon systems, such as the Sea Sparrow missile to the new Evolve Sea Sparrow Missile (ESSM) and their CIWS. The ESSM is an improved version of the Sea Sparrow; it is a faster missile with an improved warhead, increased range and designed to operate with current and future fire control systems. The ESSM has enhanced capability to destroy next generation ASM[29]. And finally, their CIWS improvement program is firmly in place with the introduction of the new CIWS Block 1B model that will bring a last but lethal defensive capability. Prior to commissioned new systems, the USN tested these new capabilities onboard the US Navy ship DECATUR the Self-Defence Test Ship, in order to prove their performance under operational condition. After this brief look at the USN program, lets now look at our approach sees if the planned improvement that are in place compare to the improvement that the USN is planning.

Canadian Navy Approach

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[25] AEGIS Cruiser Conversion, New Capability for the 21st Century. CNO - PEO AEGIS, Apr 2001, p. 11
[26] Records of the 45th Annual Tri-Service Radar Symposium, p 1-16, 1999
[27] Radar Technology Encyclopedia, Alternative to Radar. Chicago, 1992, p.128-154
[28] Radar and Electronic Warfare Systems1999-2000, Jane's, Eleventh Edition, San Diego, p. 345
[29] Radar and Electronic Warfare Systems1999-2000Jane's, Eleventh Edition, San Diego, p. 322.

In the latest Maritime Capital Plan, the navy has announced that his intention to conduct a mid-life refit upgrade to her fleet of frigates, this will be conducted under the Project FELEX[30], along with this project, the AWW warfare department of the navy has multiple projects undergo at different stages of approval to address new threat scenarios mentioned before. The navy is planning to make use of the mid-life refit to incorporate these new upgrade minimizing time that ships could out of service[31].

The current HALIFAX class anti-air warfare capabilities were well describe above and now that we have analysed the way ahead that the USN has taken, we will look at the systems improvement that the navy is planning to perform. In view of the fact that the basis for their improvement were the result of the NAAWS study lets consider its findings. The NAAWS sensors suiteects undergo

the MFR option offered in the NAAWS study is the best option however, in order to implement this capability into an existing platform the ship would require a major redesign and the cost associated with that level of works is substantial[32]. This option will not be considered. The current MRR is the Sea Giraffe, this radars is currently fielded in only medium size navies such as the Royal Australian Navy and the Swedish Navy but an upgraded 3D version has been developed and is currently at sea on Swedish naval ship[33]. Using the same rational that was used for the SPS-49, this option should be considered first if its capability meet the requirement. The next sensor that the NAAWS study is proposing is an Infra Red Search and Tracking system (IRST), such systems are not yet commissioned, however, the Dutch and the Canadian navy have formed an Bi-lateral partnerships to develop such a capability similar to what the USN is developing and the current name of the system is SIRIUS. As mentioned above an IRST provide a unique sensing capability required for detection, passive, lightweight and immune to jamming when compare to radars, it will be an outstanding complement to the detection systems, further the inclusion of an optical sensor such as SIRIUS is key to solve the identification quandary and disseminates friend from foe targets[34].

Hard Kill System

The portion of the essay will be looking at the Anti-Air (AA) hard kill systems (these comprise guns and missiles) that are currently in service in the Canadian navy, and compare the upgrade plan to the recommendation of the NAAWS study. The navy has standardized its entire missiles inventories on USN developed missiles, this is true for both, it's Surface to Air Missile

[31] FELEX Project Brief. This information was contain in the briefing given at CFC to CSC 29 by the Project Director during the Maritime element in March 2003.
[32] DGPMEPM conducted an high level study in1999, the findings were published as part of annual Engineer Periodical.
[33] Naval Electro-Optic System 2001-2002, Jane's, Seventh edition, Edited by Keith Atkin, Alexandria, p.450

(SAM) and Surface to Surface Missile (SSM). The SAM systems in service in our navy are semi-active systems employing illumination radar to guide itself towards the target whereas the SSM are autonomous fire and forget weapons, given the nature of this essay and the security classification required to elaborate on the SSM subject, this paper will not analyse SSM weapon system. The SAM system fitted onboard the HALIFAX class is the Vertical Launch Sea Sparrow (VLSS), the VLSS was originally developed by the US Air Force to counter the North-Vietnamese threat. Since, it has been adopted to shipboard environment and received multiple upgrades however, by the early 80s it was assessed that the system will be obsolete by the late 90s. As a result, the ESSM was developed, in 1999, the navy has decided to upgrade it's VLSS to ESSM and, Treasory Board approved the project for full replacement of the VLSS inventory[35]. This new capability will provide the HALIFAX class a major upgrade in self-defence hard kill capability and allow the navy to maintain its capability through the lifespan of the frigate. This upgrade also meet one of the recommendation of the NAAWS study. The main gun system is the 57 mm Bofors, Jane's Weapons Systems has qualified it as one of the best medium calibre gun in service worldwide[36]. The navy has currently no plan to replace it soon. The next and last hard kill system in the layered defence fitted onboard the frigate is the CIWS. Multiple versions of this system are in service worldwide, the navy possessed the CIWS Block 1A version, which has been in service for more than ten years. Being the last defence against ASM, this system needs the capability to take on the most lethal cruise missile and for that the USN has developed version 1B which provides enhanced capability in anti-air warfare and in surface warfare against fast manoeuvring patrol boats. Lately, the Canadian navy has announced its intention to upgrade

[34] Naval Electro-Optic System 2001-2002, Jane's, Seventh edition, Edited by Keith Atkin, Alexandria, p.450.
[35] ESSM Project Synopsis Sheet Effective Project Approval, October 1999. DND MS: 3293-40 (DMPPD 4-2)
[36] Radar and Electronic Warfare Systems 1999-2000, Jane's, Eleventh Edition, San Diego, p.311

its inventory to this new version in order to meet the evolving threat and the new asymmetric threat similar to the one that hit the USS COLE[37].

Self Defence Summary

The next ten years will sees the navy complete the transition to a new era, when completed, the proposed upgrades under the navy FELEX project will enable our HALIFAX Class frigate to defeat evolving threats. The navy will maintain its core AA capability for an extended period until 2020 period when a new ship replacement program is being proposed in the navy long-term capital plan. The fleet will be able to sail alongside other coalition ships and have the capability to defend itself without relying on others and fulfill the mandate of Strategy 2020 and achieved objectives set in Leadmark.

To conclude, if Canada is to remain a credible and effective defence partner with US and other coalition forces, the navy must commit to adapting advanced commercial information technology to its fleet. It must retain essential self-defence capability by preserving and maintaining its core defensive capability against an evolving threat. Under its current plan to upgrade its C4ISR capability with a GCCS-M and CEC, the navy will be able to integrate itself directly into coalition formed task group. By adopting some of the pre-developed systems that the USN intent to put to sea, Canada's navy will profit from their experience and testing. On the other hand, upgrade initiative in SD are already well underway, with the approval of the ESSM, CIWS upgrade and the SIRIUS projects the navy should be well place amongst the medium size

[37] The USS COLE , an Arleigh Burke class destroyer was hit by terrorist attack that move towards the ships using a small boat and exploded it beside the ship creating 12 deads and put the ship out of service for more than a year.

navy with capability that will allow the HALIFAX class to defend itself against the most lethal threat.

As we know the HALIFAX class frigates were built to face threats that have evolved, the navy can not plan replace their capability soon, and as we seen upgrading by adopting some of the pre-developed proven systems, their combat capabilities remains the only viable option. If Canada still wishes to maintain a front line navy, it will have to look at the modernization option. While this paper is not an extensive review of naval warfare technology, the most important naval issues have been addressed, C4ISR and Self-Defence capabilities, they are key drivers for planning future deployment. When completed, the mid-life upgrade of the HALIFAX class will help maintain the force structure of our core combatant while delivering upgraded capabilities faster than any other alternative such as new platform built. This will help capitalizing on the navy prior investments, it will extent the service life for twelve frigates and will maintain our status of a medium level capable navy.

The navy must be ready to face a new world, so far in the last five years the world has seen more conflicts than in the past 30 years, and new war bring new weapons systems, much faster than defensive systems can be developed. Can we be ready all the time, unlikely.

Bibliography

Clark V. Admiral US Navy, Sea Power 21, Naval Proceedings, Oct 2002, 11p.

Haydon Peter t., Sea Power And Maritime Strategy in the 21st century, Maritme Security Paper no. 10, Center for Foreign policy Studies, Dalhousie University, Halifax, Oct 2001, 139 p.

Hyer Scott A. et al.., Integration of the ESSM into Ships of the NATO Consortium, Johns Hopkins APL Tech Digest Vol 17, Laurel Maryland, Sept 1996, 324 p.

Jane's, Fighting Ships 2002-2003, 105th edition, Edited by Cmdre Suanders R.N., Alexandria, Va, 692 p.

Jane's, Radar and Electronic Warfare Systems1999-2000, Eleventh Edition, San Diego, 560 p.

Jane's, C4ISR System 2001-2002, Thirteenth edition, Edited by Clive Walker, Alexandria, Va., 508 p.

Jane's, Electro-Optic System 2001-2002, Seventh edition, Edited by Keith Atkin, Alexandria, Va, 672 p.

Johns Hopkins Applied Physic Laboratories Technical Digest, Air Defense Part 1, Laurel, Maryland, Sept. 2001, 412 p.

Johns Hopkins Applied Physic Laboratories Technical Digest, Air Defense Part 11, Laurel, Maryland, Dec 2001, 660 p.

NATO Naval Group 1, NATO Anti-Air Warfare Systems study, Johns Hopkins Applied Physic Laboratories, Washington D.C., 1994, 349 p.

USN Committee for Naval Forces, NATO Anti-Air Warfare Systems study, Records of the 45th Annual Tri-Service Radar Symposium, p 1-16, 1999

Long D.J., Brief History of Personal Computing, Chips magazine, Space and Naval Warfare Command, Charleston, N.C., 48 p.

Sea Power center, Australian Maritime Doctrine, Navy HQ, Chief of the Navy, First edition, Defence Publishing Service, DOD, Canberra, 2000, 174 p.

Slaght K.D. Rear-Admiral, Change in the Navy, USN Commander SPAWAR, San Diego, February 20, 2002 P. 2

US DOD-PEO TSC, Aegis Cruiser Conversion-New Capabilities for the 21stCentury , Washington D.C., 1999, 39 p.

Wallsh E.J., Navy Strategy Stresses Shipboard Networking and Connectivity, Office Naval reserach, Washington, 2002, 12 p.

Wennergrenn D.M., Information Technology Programs, House Armed Services, Military & Governemnt Collection, Washington D.C., March 2003, 7 p.

Reference documentation from the Department of National Defence

Baril, Général C.D.S., Shaping the Future of the Canadian Forces: Strategy for 2020, Ottawa, June 1999

Chief of Maritime Staff, The Canadian navy's Blueprint/Wayahead papers to 2010, Ottawa, 2002, 480 p.

Directorate of Maritime Strategy, Leadmark The Navy's Strategy fo 2020, NDHQ/ CMS, Ottawa, 2001, 176 p.

DGMEPM, Incorporating Theatre Ballistic Missile Defence in the Iroquois Class, Hull, Jun 1999, 14 p.

Directorate of Maritime Policy and Plan Development, HALIFAX Class Command & Control Update Project, Synopsis Sheets Identification M 2793, Hull, Oct 2001, 12 p.

Directorate of Maritime Policy and Plan Development, Frigate Life Extension Project, Synopsis Sheets Identification M 2894, Hull, Jun 2002, 14 p.

Directorate of Maritime Policy and Plan Development, HALIFAX class Radar Upgrade Project, Synopsis Sheets Identification M 2891, Hull, Jan 02, 14 p.

Directorate of Maritime Policy and Plan Development, AWW Requirements, MS : 3293-41, Hull, Dec 99, 20 p.

Directorate of Naval Requirement, Infra-Red Search & Tracking SIRIUS, Synopsis Sheets Preliminary Project Approval M 2664, Hull, July 97, 11 p.

Directorate of Maritime Requirement Sea, Evolving Sea Sparrow Missile Above Water Warfare Naval Threat document for establishing Naval Requirement. July 2003, 45 p.

Directorate of Maritime Requirement Sea, Above Water Warfare Naval Threat document for establishing Naval Requirement. July 2003, 45 p.