University of Tennessee, Knoxville
Trace: Tennessee Research and Creative Exchange

Masters Theses

Graduate School

5-2006

The Development of an Assault Directed Infrared Countermeasures (DIRCM) Program

Tracy Anne Barkhimer
The University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Tracy Anne Barkhimer entitled "The Development of an Assault Directed Infrared Countermeasures (DIRCM) Program." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Aviation Systems.

Robert B. Richards, Major Professor

We have read this thesis and recommend its acceptance:

George W. Masters, Rodney C. Allison

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

I am submitting herewith a thesis written by Tracy Anne Barkhimer entitled "The Development of an Assault Directed Infrared Countermeasures (DIRCM) Program". I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Aviation Systems.

Robert B. Richards
Major Professor

We have read this thesis and
recommend its acceptance:

George W. Masters

Rodney C. Allison

Acceptance for the Council:

Anne Mayhew
Vice Chancellor and Dean of
Graduate Studies

(Original signatures are on file with student records.)

THE DEVELOPMENT OF AN ASSAULT DIRECTED INFRARED COUNTERMEASURES (DIRCM) PROGRAM

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Tracy Anne Barkhimer
May 2006

DEDICATION

This thesis is dedicated to my husband and best friend, Erik Barkhimer for his untiring patience and support through my time spent at the United States Naval Test Pilot School and during the pursuit of my Masters' Degree from the University of Tennessee Space Institute. His encouragement and continual mentorship allowed me to reach ever higher in order to achieve my goals in spite of any obstacles encountered along the way.

ACKNOWLEDGEMENTS

I wish to thank all those who helped me complete my Master of Science Degree in Aviation Systems. First and foremost, I would like to thank Dr. Bob Richards for his guidance and support during my time spent at the United States Naval Test Pilot School as well as for the long distance support he provided while I was stationed out of the area working toward the completion of this degree. I would also like to thank Ms. Betsy Harbin for all her encouragement and patience over the past six years.

I would especially like to acknowledge the help of my Assault DIRCM Team members who follow my lead at work every day and who have supported me over the past year as Assault DIRCM attempts to get started. In particular, I'd like to acknowledge Mr. Charles Johnson who is a consummate program manager and the perfect co-lead for me. He never forgets that we are here to serve the Sailors and Marines who protect us on the war front. I'd also like to acknowledge Mr. Richard Lamarca, and Mr. Don Harwood, my lead and program engineers for the support they gave me as I formulated my opinions while preparing this thesis.

ABSTRACT

The purpose of this thesis is to document the history of the development of an Assault Directed Infrared Countermeasures (DIRCM) Program as well as Navy Program Office (PMA272) efforts to date, to initiate a new start ACAT II Program for Navy and Marine Corps helicopters starting in Fiscal Year (FY) 2006. It concentrates on the programmatic aspects of Assault DIRCM and does not go into detail on the design or technical aspects of the development of the system. This thesis will introduce emerging threats to helicopters operating in theater and describe the requirement for a DIRCM technology. It will also highlight program issues based on observations made over the past year as well as provide a recommended path forward for immediate program execution considering internal and external program and acquisition constraints both real and perceived.

PREFACE

The information and technical data contained in this thesis are broadly based on actual program information pertaining to the Assault DIRCM Program. Historical data are presented to the best of the author's knowledge. This thesis is UNCLASSIFIED and all data presented were accessed via public access in various publications, articles and on the world-wide-web. This thesis is not and should not be construed as an endorsement for any company or product. It merely studies current circumstances and provides one option of several as a means by which to move forward with an Assault DIRCM Program today. The findings, conclusions and recommendations expressed herein are the sole opinion of the author and may or may not represent the official position of PMA272, PEO(T), Naval Air Systems Command or the Department of the United States Navy.

CONTENTS

1.0 INTRODUCTION……………………………………………………………………..1

2.0 THE THREAT…………………………………………………………….……...5

3.0 EXISTING INFRARED COUNTERMEASURES PROGRAMS……..…..…….…..10

3.1 ARMY SUITE OF INTEGRATED INFRARED COUNTERMEASURES..…..10

3.2 LARGE AIRCRAFT DIRECTED INFRARED COUNTERMEASURES…..…14

3.3 DIRECTED INFRARED COUNTERMEASURES………………………...…..14

3.4 TACTICAL AIRCRAFT DIRECTED INFRARED COUNTERMEASURES…15

3.5 ASSAULT DIRECTED INFRARED COUNTERMEASURES……………..…16

3.6 CH-53E TECHNOLOGY ASSESSMENT PROJECT…………………….……20

4.0 ANALYSIS……………………………………………………………….…..…21

5.0 DISCUSSION………………………………………………………………….…..22

6.0 CONCLUSIONS……………………………………………………………..23

7.0 RECOMMENDATIONS………………………………………………………..…26

LIST OF REFERENCES…………………………………………………………….…30

SELECTED BIBLIOGRAPHY……………………………………………………...…32

APPENDIX A……………………………………………………………………..…34

VITA…………………………………………………………………………………....36

LIST OF FIGURES

Figure 1-1 Infrared (IR) Missile Generations……………………………………….2

Figure 2-1 Examples of MANPADS……………………………………………..6

Figure 2-2 Main Components of a typical MANPADS………………………….7

Figure 2-3 Simplified DIRCM Solution…………………………………….…9

Figure 3-1 Army ATIRCM/CMWS Components……………..………………..11

Figure 3-2 Army ATIRCM/CMWS Roadmap…………….….……………..…..13

Figure 3-3 NGC Family of DIRCMs……………………………………………15

Figure 3-4 ATIRCM/CMWS Increment 3………………………………………17

Figure 3-5 Notional Increment 3 Development NRE…………………………...19

Figure 6-1 NDI Option for Assault DIRCM…………………………………..…25

Figure 7-1 Assault DIRCM Functional Architecture……………………………28

LIST OF ACRONYMS AND ABBREVIATIONS

AAR-47	Navy Missile Warning Sensor Nomenclature
ACAT	Acquisition CATegory
AN/AAQ-24(V)	NGC DIRCM Nomenclature
AN/AAR-57	BAE CMWS Nomenclature
AN/ALQ-212	BAE ATIRCM Nomenclature
ASE	Aircraft Survivability Equipment
ATAPS	Advanced Tactical Aircraft Protection Systems
ATIRM	Advanced Threat Infrared Countermeasures
BAE	BAE Systems Inc.
CCA	Circuit Card Assembly
CCM	Counter Countermeasures
CDD	Capabilities Development Document
CECOM	Communications-Electronics Command (Army)
CMWS	Common Missile Warning System
COR	Contracting Officer Representative
CR2	CECOM Rapid Response Program
DCMA	Defense Contracting Management Agency
DIRCM	Directed Infrared Countermeasures
DoD	Department of Defense
DoN	Department of the Navy
EOA	Early Operational Assessment
FRPDR	Full Rate Production Decision Review
FY	Fiscal Year
GAO	Government Accounting Agency
GWOT	Global War on Terrorism
IOC	Initial Operational Capability
IPT	Integrated Product Team
IR	Infrared
IRCM	Infrared Countermeasures
JROC	Joint Requirements Oversight Committee
LAIRCM	Large Aircraft Infrared Countermeasures
MANPADS	Man Portable Air Defense System
MDA	Milestone Decision Authority
MOA	Memorandum of Agreement
MWS	Missile Warning System
NAVAIR	Naval Air Systems Command
NDI	Non-Developmental Item
NGC	Northrop Grumman Corporation
NRE	Non-Recurring Engineering
NRL	Naval Research Laboratory
O&S	Operation and Sustainment (Costs)
OAG	Operational Advisory Group
OEF	OPERATION ENDURING FREEDOM

LIST OF ACRONYMS AND ABBREVIATIONS CONTINUED

OER	Operational Emergency Requirement
OIF	OPERATION IRAQI FREEDOM
OTS	Off-The-Shelf
PBD	Program Budget Decision
PBM	Program Budget Memorandum
PCO	Procuring Contracting Officer
PEO(T)	Program Executive Office, Tactical Aircraft (Navy)
PM, AES	Program Manager, Aviation Electronic Systems (Army)
PMA261	Program Manager, Heavy Lift Helicopters (Navy)
PMA272	Program Manager, Advanced Tactical Aircraft Protection Systems (Navy)
RF	Radio Frequency
SAM	Surface-to-Air Missile
SIIRCM	Suite of Integrated Infrared Countermeasures
SOCOM	Special Operations Command
TADIRCM	Tactical Aircraft Directed Infrared Countermeasures
TAP	Technology Assessment Project
TAP	Technology Assessment Project
UK MoD	United Kingdom Ministry of Defense
UV	Ultra violet

1.0 INTRODUCTION

While addressing the Asia Pacific Economic Cooperation forum, Secretary of State Colin Powell warned that “no threat is more serious to aviation” than man-portable air defense systems (MANPADS).[1] Man portable shoulder-fired infrared (IR) guided surface-to-air missiles (SAMs) or MANPADS have been the primary cause of combat losses of helicopters and fixed wing aircraft since the first Gulf War. With the advancement of more sophisticated IR seekers, as depicted in Figure 1-1, comes the need for more advanced infrared countermeasures.

The recent urgency is highlighted by irrefutable evidence of the proliferation of these systems by terrorists and insurgents as they target helicopter operations in Iraq and Afghanistan. Low altitude helicopter tactics make these platforms particularly vulnerable to MANPADS as newer generations of IR SAMs are showing improved immunity to existing onboard flares. The requirement for a Directional Infrared Countermeasures (DIRCM) system is vital to the survivability of helicopters in today’s Global War on Terrorism (GWOT). The Department of the Navy (DoN) has recognized that helicopters currently have a greater need for this protection than tactical fixed wing jets and has directed funding, to start an Assault DIRCM Program for assault helicopters in Fiscal Year (FY) 06 with a Tactical DIRCM (TADIRCM), or commonly called, Strike DIRCM Program start in FY 08.

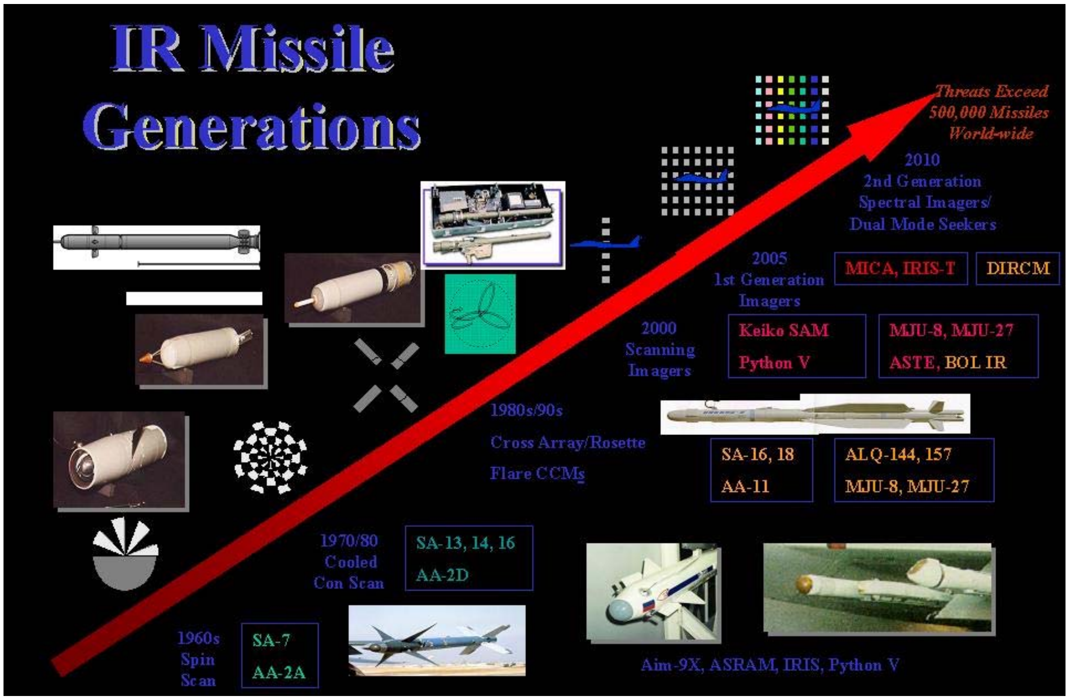

Figure 1-1. Infrared (IR) Missile Generations
Source: PMA272, Electronic Warfare Program Office Road Map Brief, June 2003

In today's acquisition environment it is imperative that joint requirements between the Services (Army, Navy, Air Force, and Marine Corps) be considered to the maximum extent possible for a variety of reasons, but primarily to ensure affordability and interoperability is considered. Based on the fact that there are a number of Department of Defense (DoD) programs already in development or production, in 2003, the Joint Requirements Oversight Committee (JROC), in an executive meeting, designated the Army as Lead Service for IRCM development for all DoD helicopter programs.[2] Similarly, the Air Force was designated Lead Service for IRCM development on all DoD large transport fixed wing aircraft and the Navy was designated Lead Service for Strike or fighter aircraft. It should be noted that this guidance directly affects any new start program(s) today.

The Program Manager for Advanced Tactical Aircraft Protection Systems (ATAPS), PMA272, at Naval Air Systems Command is required to execute the Navy's Assault DIRCM Program for Navy and Marine Corps helicopters under the Army's existing IRCM development effort for Army helicopters. Within the Department of the Army, the Project Manager Aviation Electronic Systems (PM, AES) manages a family of programs or a suite of electronic components namely the Suite of Integrated Infrared Countermeasures (SIIRCM), that address IR, radio frequency (RF), and laser-guided threats to protect helicopters and aircrew.

As part of SIIRCM, the Army is currently testing the AN/ALQ-212 Advanced Threat Infrared Countermeasures (ATIRCM)/Common Missile Warning System

(CMWS) which provides passive IR guided missile warning and laser countermeasures and cues flare dispenser countermeasures to defeat current and future missile threats. The ATIRCM/CMWS Program has experienced a number of technical and programmatic challenges that make joining the program in the near term difficult for the Navy and Marine Corps.

This thesis will provide background information on the MANPADS threat evolution, countermeasures required, and existing programs available today. It will also discuss program management challenges and constraints that have hindered program progress and provide several alternative options.

2.0 THE THREAT

Man Portable Air Defense Systems (MANPADS) are small, light-weight missile launching weapons designed to be fired from an operator on the ground at a target in the air. They are commonly described as shoulder-fired anti-aircraft missiles that are short range surface-to-air missiles (SAMs) that can be carried and fired by a single individual or carried by several individuals and fired by two people acting as a crew. Depending on which source is used, there are an estimated 500,000 to 700,000 missiles supporting over 100,000 complete MANPADS systems, many thousands of which are estimated to be available on the black market making them easily accessible to terrorists and other insurgent groups. MANPADS are particularly attractive to these groups because they are inexpensive, highly portable, easily concealable and extremely lethal particularly against helicopters and other low flying aircraft such as those operating in terminal areas. According to the Small Arms Survey 2004, *Big Issue, Big Problem?*, there are at least 13 non-state groups in possession of MANPADS, most of which are considered terrorist organizations.

MANPADS have been in existence for nearly 40 years but have recently been gaining attention in world news as terrorist groups are getting more proficient at using them and as more sophisticated systems are being developed. Most MANPADS weapon systems consist of a rocket propelled guided missile packaged in a tube, a launching mechanism and a battery. The tubes, which have an aiming device, protect the missile until it has been launched and are disposed. Figure 2-1 depicts several examples of MANPADS being used in the field.

Figure 2-1. Examples of MANPADS
Source: Various Sources

MANPADS missiles often use an on-board battery to power electronics of the weapon for guidance and often a cooling unit to cool the missile's sensors. Figure 2-2 details the typical components of a MANPADS.

MANPADS systems typically range from about 4 feet to 6 ½ feet in length and about 3 inches in diameter. They normally weigh between 25 and 56 pounds making them very easy to transport and conceal.

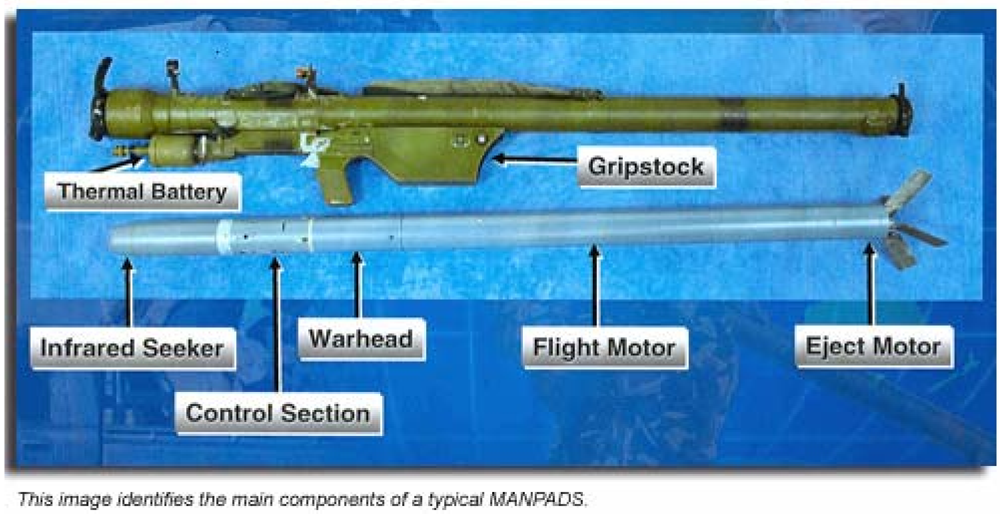

Figure 2-2. Main Components of a typical MANPADS
Source: US Dept of State Fact Sheet, The MANPADS Menace

There are three main types of MANPADS generally classified by their guidance systems or seekers. Most missiles use an infrared (IR) guidance system which seeks a target by contrasting the heat signature from an aircraft's engine or hot exhaust gases with the outside ambient temperature. The vast majority of MANPADS available use these passive infrared seekers. These missiles are sometimes called "fire and forget" missiles because the operator doesn't have to guide the missile to its target. It merely flies to the hottest source in its path. A second commonly employed method uses operator guidance commands relayed to the missile via radio signal, somewhat similar to radio controlled airplanes. This design requires the operator to visually aim at the target and manually guide the missile. The former method is more common and a since it doesn't emit energy from the launcher, is very difficult to detect and evade. As these operators become more proficient however, the latter method may become more detrimental because the missile can be guided to the target regardless of any countermeasures employed. The third type of MANPADS available today employs a laser beam that guides the missile along the laser beam to the precise point that the beam is aimed. This requires the operator to continuously track the target by keeping a laser beam pointed on it.

MANPADS are becoming increasingly sophisticated offering greater range, greater flexibility, more accuracy in hitting the target and inflict greater damage. Some of the newer generation MANPADS employ image seekers that lock on to UV or IR targets. Newer MANPADS can also engage targets at ranges of up to 6000 meters. (Small Arms Report) The combination of these improvements enables the operator to lock-on target at greater ranges from greater angles and have a greater chance of hitting aircraft.

The US Military has recognized the increasing threat to its tactical and assault aircraft particularly from infrared guided missiles. The lethality and proliferation of IR surface-to-air missiles was demonstrated during the Desert Storm conflict. Both IR SAMs and IR air-to-air missiles have seekers with improved counter countermeasures (CCM) capabilities that seriously degrade the effectiveness of current expendable decoys.

MANPADS are the most serious threat to our large, low maneuverable and slow flying aircraft. Notwithstanding small-arms-fire, MANPADS are also the greatest threat to US Military helicopters operating in theater.

In the past two decades, infrared guided missiles have caused half of the total aircraft losses in theater. The development and proliferation of advanced infrared-guided surface-to-air missiles, which have improved lethality and increasing immunity to flares are driving the requirement of infrared countermeasure systems.

Directional Infrared Countermeasures (DIRCM) are technologies used to protect aircraft from these advanced infrared-guided missiles. Simply depicted in Figure 2-3, a DIRCM system confuses the infrared seeker in the nose cone of the missile, forcing it off course and missing its intended target. An on-board DIRCM system first warns of an incoming IR missile and then hands off this information to a jammer. The jammer uses an infrared tracker that follows the incoming missile and guides a laser beam to the IR seeker in the missile's nose cone. The system then transmits the appropriate jamming signals that forces the missile off track.

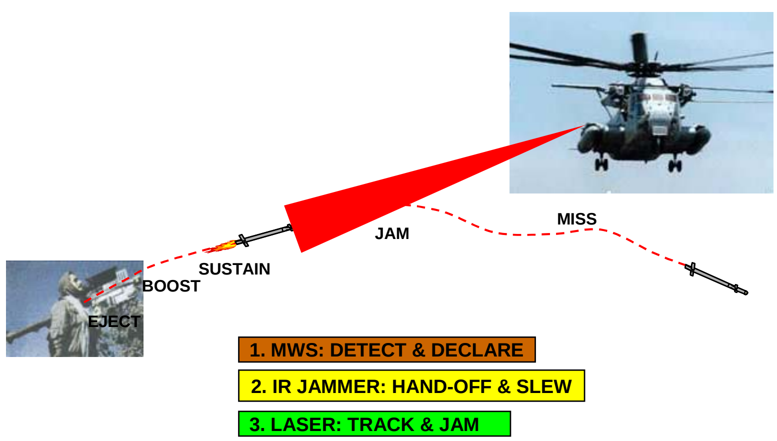

Figure 2-3. Simplified DIRCM Solution
Source: NGC CH-53E TAP Stakeholder's Brief, October 2005

3.0 EXISTING INFRARED COUNTERMEASURES PROGRAMS

There are a number of IR countermeasures systems that are currently in development or are already in production within the DoD that can potentially be leveraged from as a joint program for the Assault DIRCM Program.

3.1 ARMY SUITE OF INTEGRATED INFRARED COUNTERMEASURES

A Suite of Integrated Infrared Countermeasures (SIIRCM) includes the Army's next generation lamp/laser jammer, coupled with the new missile warning system (MWS), an advanced flare dispenser, and an advanced flare munition. The suite essentially consists of the AN/ALQ-212 Advanced Threat Infrared Countermeasures (ATIRCM) (Increment 2) and the AN/AAR-57 Common Missile Warning System (CMWS) (Increment 1) as depicted in Figure 3-1.

The ATIRCM/CMWS suite design is modular to allow multiple configurations on a wide range of aircraft and other vehicles. In January 1995, the Army ATIRCM/CMWS Program became a joint program as the Navy/Air Force Advanced Missile Warning System Program joined to leverage off of the CMWS part of the program. The lead platforms were to be the MH-60K helicopter for the Army, the AV-8B jet aircraft for the Navy and the F-16 jet aircraft for the Air Force. At its peak as a joint program in 1998, the total program cost was projected to be $3 billion. Delays and cost increases plagued the ATIRCM/CMWS program and in 1999, the Army restructured the program to provide more time and money for serious developmental problems uncovered during CMWS testing.

Figure 3-1. Army ATIRCM/CMWS Components
Source: PM, AES, ATIRCM/CMWS Brief, August 2004

At the time, DoD investigated alternatives but decided to stay with ATIRCM/CMWS for Army aircraft. However, the Air Force backed out of the program in 1999 shortly followed by the Navy. After restructuring the program, the Army delayed the low-rate initial production decision to 2002 and the full rate production decision to 2003. The system's overall developmental costs had increased from $54 million to a projected $127 million.[3]

In addition to reported software challenges, as of April 2001, the Defense Contract Management Agency (DCMA) was rating hardware issues and the system's readiness for production of moderate risk, likely to result in unacceptable or marginal performance.[4]

The ATIRCM/CMWS program has been at risk of total cancellation since 2001. In Program Budget Decision (PBD) 161, the DoD zeroed the AITRCM/CMWS line in the Fiscal Year 02 budget. Deputy Secretary of Defense Paul D. Wolfowitz, however, reinstated funding with Program Decision Memorandum (PDM) 2.[5] The Army still desperately needs improved IRCM protection for its helicopters as was painfully evident in the loss of aircraft during Operations Iraqi Freedom (OIF) and Enduring Freedom (OEF) in 2003 and 2004.

Following cancellation of the RAH-66 Comanche Helicopter Program in early 2004 the Army has increased funding for survivability improvements for its existing helicopter fleet.[6] In December 2004, as presented to PMA272, the ATIRCM/CMWS Roadmap showed an ATIRCM Full Rate Production Decision Review (FRPDR) in Fiscal Year 06 as depicted in Figure 3-2.

In March 2005, the Government Accounting Agency (GAO) released an assessment of selected major weapons programs in Defense Acquisitions.[7] In this report the GAO assessed 54 programs, which represent an investment of over $800 billion, most of which are costing more and taking longer to develop than planned. The report briefly discussed ATIRCM/CMWS Program technology maturity, design stability and production maturity. The GAO and the Army both confirmed in the report that initial operational tests and evaluation will be completed during Fiscal Year 05 for CMWS and in the Fiscal Year 06 for ATIRCM. The full-rate production decision review (FRPDR) for the complete system is officially scheduled for 2006 but it rumored to be slipping again.

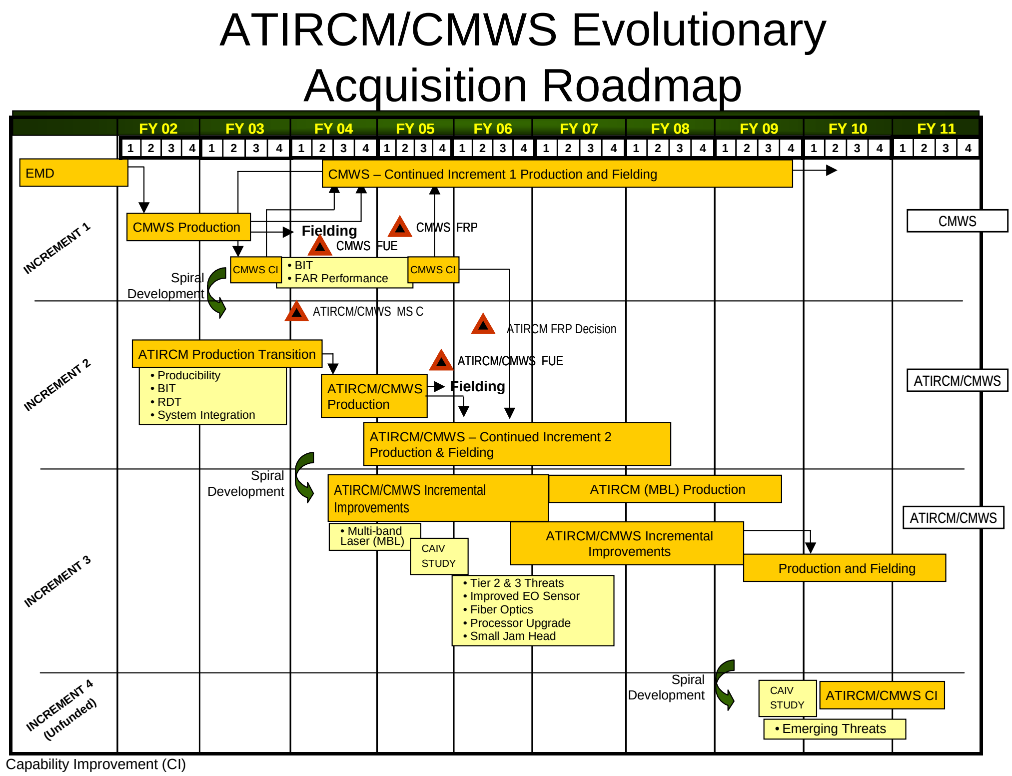

Figure 3-2. Army ATRICM/CMWS Roadmap
Source: PM, AES (PEO IEW&S)

3.2 LARGE AIRCRAFT DIRECTED INFRARED COUNTERMEASURES

Large Aircraft Directed IR Countermeasures (LAIRCM) is an Air Force managed program for large tanker and transport aircraft to improve the capability against MANPADS. LAIRCM is optimized for large aircraft, which present a large IR heat source (in both surface area and intensity) for incoming missiles. A higher powered laser and a greater range missile warner is required, which is not suitable for smaller fixed wing aircraft and helicopters. LAIRCM is currently in production and is planned for the Air Force C-17, C-130, KC-135, and KC-10 aircraft. LAIRCM is also one of three candidates being considered by the Department of Homeland Security (DHS) to protect airliners from terrorist missiles.

3.3 DIRECTED INFRARED COUNTERMEASURES

The Directed Infrared Countermeasures (DIRCM) system is a variant of the Northrop Grumman Corporation (NGC) LAIRCM system. ‘DIRCM’ is the term commonly used for the NGC *Nemesis* (UK name) variant. Figure 3-3 depicts the family of NGC infrared countermeasures. In 1989, under Operational Emergency Requirement (OER) 3/89, the UK Ministry of Defense (MoD) began funding infrared countermeasure research, with the US Special Operations Command (SOCOM) joining the project in 1993.[8] The Army’s ATIRCM/CMWS suite was far from production ready and in March 1999, the NGC DIRCM was selected by the UK MoD and SOCOM for their fixed wing and helicopter fleets. DIRCM testing began in October 1997 and was completed in January 2001. SOCOM has now picked DIRCM for the CV-22 aircraft and the MH-53 helicopters.

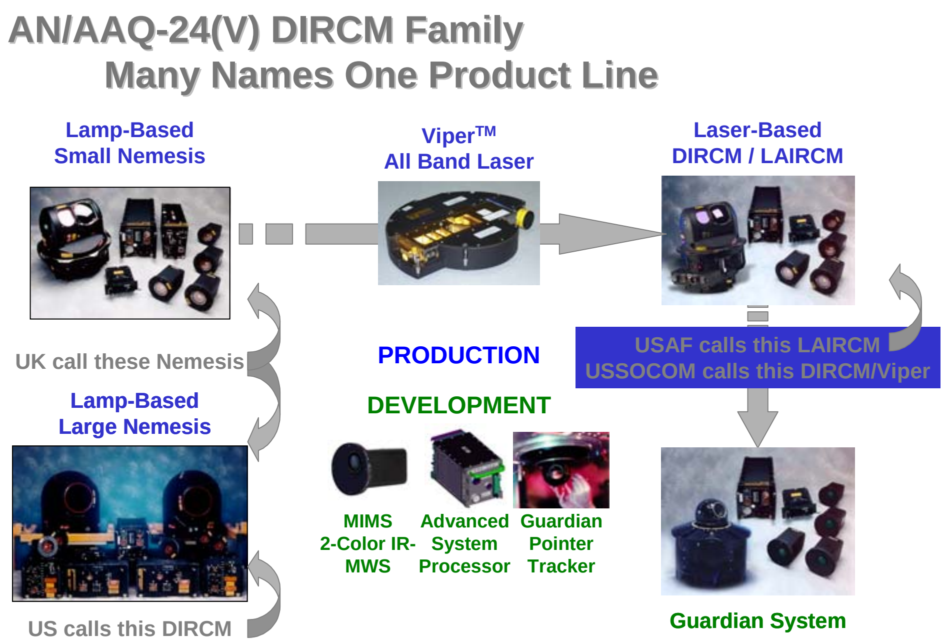

Figure 3-3. NGC Family of DIRCMs
Source: Northrop Grumman Corporation

3.4 TACTICAL AIRCRAFT DIRECTED INFRARED COUNTERMEASURES

The US Navy's Tactical Aircraft Directed Infrared Countermeasures (TADIRCM) program is researching the feasibility of a deployable IR laser countermeasures capability aboard tactical fixed wing aircraft. TADIRCM is an Advanced Technology (ATD) program directed by the Naval Research Laboratory (NRL). It is a low profile, laser-based infrared (IR) countermeasure system designed to protect fixed wing aircraft from both today's and tomorrow's surface to air and air-to-air IR guided missile threats. TADIRCM consists of an infrared missile warning system (MWS) and a directed countermeasure system (DIRCM) intended to be operationally deployed on tactical jet aircraft, specifically the Navy's F/A-18 E/F Super Hornet.

The TADIRCM program is currently a concept demonstration effort managed by PMA272 at Naval Air Systems Command. The goal of the program is to develop and demonstrate missile warning, pointing/tracking and directed IR jammer technologies that can meet the needs of tactical fixed wing aircraft. Requirements for tactical jet aircraft exceed the requirements for helicopters primarily because of the different operating environments to which they deploy. One such example is a considerably smaller, more aerodynamic jam head for the laser jammer needs to be utilized, much smaller than the ATIRCM or DIRCM jam heads intended for helicopters and large transports. Another example is TADIRCM requires an IR staring sensor that has a longer range and better clutter rejection and operates at different wavelengths to minimize false alarms. TADIRCM is being developed as a podded system.

An Early Operational Assessment (EOA) is currently underway to further advance the technology and act as a risk reduction effort. TADIRCM will result in a Strike DIRCM Program currently budgeted as a Fiscal Year 08 program start.

3.5 ASSAULT DIRECTED INFRARED COUNTERMEASURES

Following JROC guidance, the Navy submitted a budget proposal for Assault DIRCM based on joining the Army's ATIRCM Program. In 2004, the Navy received FY 06 funding for a new start ACAT II Program namely an ATIRCM Increment 3 based on the notional evolutionary acquisition roadmap depicted in Figure 3-4. It should be noted that this figure is identical to Figure 3-2 with Increment 3 highlighted as being a Navy-

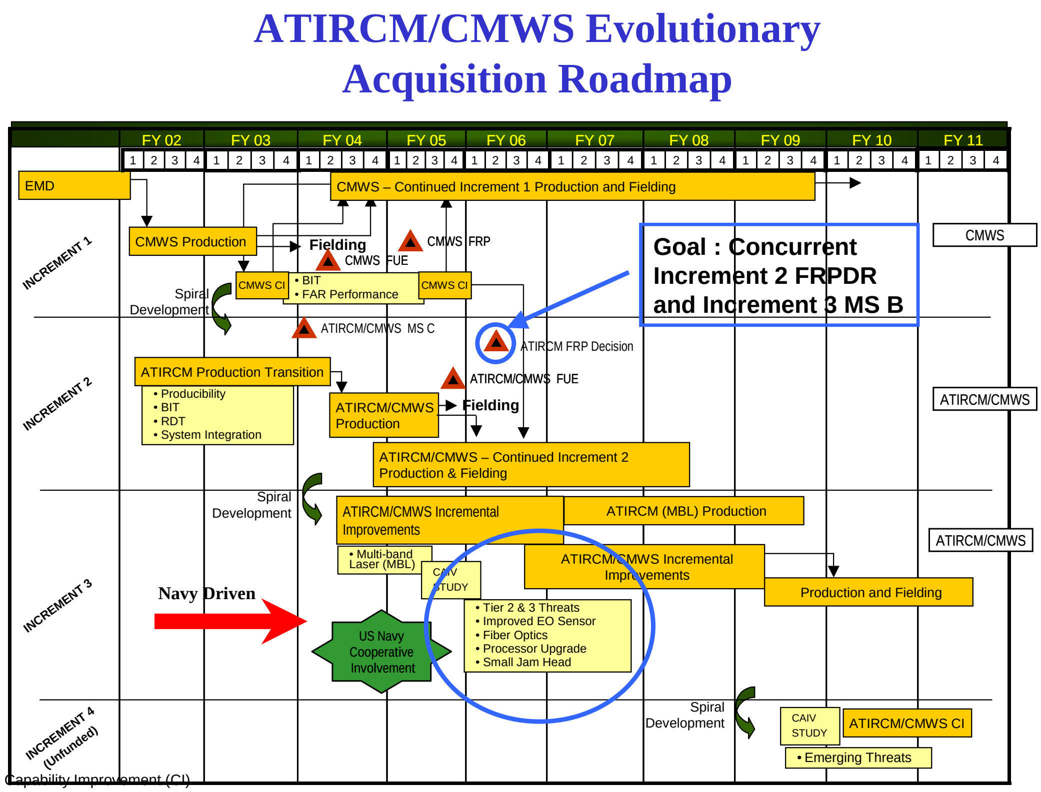

Figure 3-4. ATIRCM/CMWS Increment 3.
Source: PMA272 and PM, AES Joint Brief, October 2004

led increment. Navy would develop Increment 3 satisfying the Army requirements as well.

The program was to be cooperative with the Army leading the spiral development but the Navy would have the technical lead of Navy unique requirements. The Milestone Decision Authority would be the Army Acquisition Executive; Communications-Electronics Command (CECOM) would be the Procuring Contracting Officer (PCO) and the Navy would be the Contracting Officer Representative (COR) for Navy unique contract efforts. The contract would be Cost Plus Incentive Fee, sole source to BAE. Per the approved Army Acquisition Strategy already in place, BAE would compete component upgrades as directed.

Considering capability requirements (future threats) annotated in the draft Capabilities Definition Document (CDD) and with Navy legacy aircraft and different existing systems, there was only one common component available in Increment 2 that the Navy could feasibly leverage from. The Circuit Card Assembly (CCA) was the only common funding requirement that was to be developed. All other components would have to be developed to accommodate current Navy aircraft configurations and future capabilities requirements. A notional developmental Non-Recurring Engineering (NRE) component diagram is depicted in Figure 3-5.

The Navy worked with Army to comply with JROC guidance as a cooperative program for ATIRCM Increment 3. A concurrent Army Increment 2 Full Rate Production Decision Review (FRPDR) with a Navy led Increment 3 Milestone B was planned with the Army Acquisition Executive staff. A Memorandum of Agreement (MOA) and a Charter between PMA272 and PM, AES was drafted and the Navy Requirements Officer, N-78, drafted a CDD with the Army in 2004.

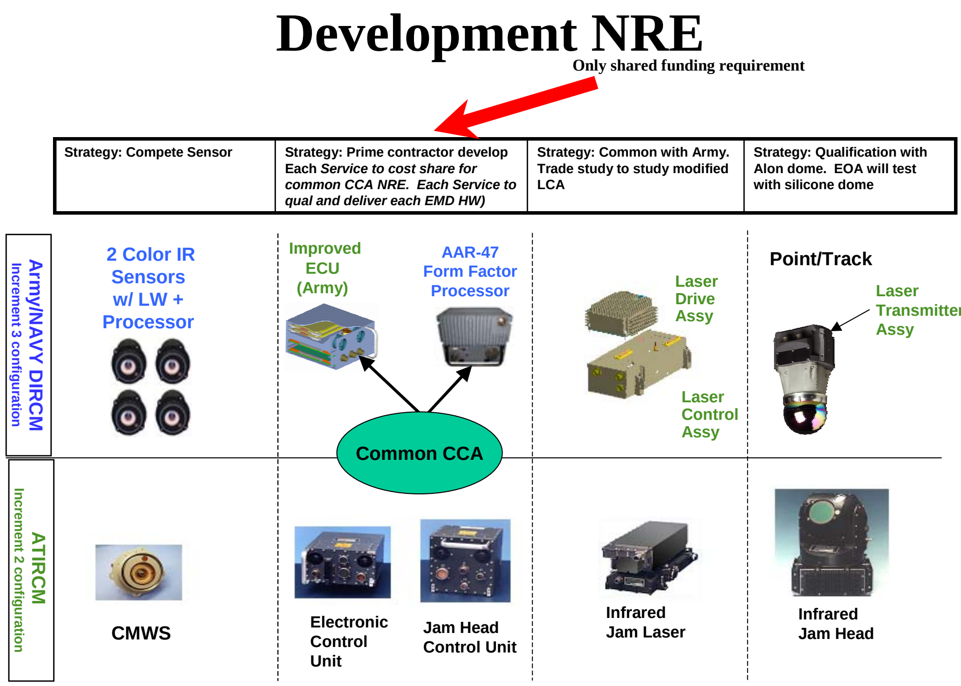

Figure 3-5. Notional Increment 3 Development NRE
Source: PMA272

In August 2004, progress between PM, AES (the Army ATIRCM PM) and PMA272 slowed. The CDD, MOA and Charter remained in a draft status and a Joint Acquisition Strategy had yet to be worked. The PM, AES cited technical problems with ATIRCM/CMWS testing as well as a lack of resources as the cause for the inability to work Increment 3 with the Navy. Rightfully so, the Army had current problems that needed immediate attention and focus. Army said a delay of at least until June 05 was inevitable. This meant at least a six-month delay for the Navy effort. As of November 1, 2005, no progress has been made to propel a joint ATIRCM/CMWS Increment 3.

3.6 CH-53E TECHNOLOGY ASSESSMENT PROJECT

FY 05 Supplemental funding was received in July 2005 to provide for the procurement and testing of a Directed Infrared Countermeasures (DIRCM) for the CH-53E Helicopter, proven capability currently employed on SOCOM's MH-53J. PMA261, the H-53 Heavy Lift Helicopter Program Office, requested assistance from PMA272 in the execution of this effort. PMA272 agreed to execute the effort as a Technology Assessment Project (TAP) to assess the improved survivability of a DIRCM system as compared with currently installed aircraft survivability equipment (ASE).

A competitive award was given via CECOM's Rapid Response (R2) Program Office to Northrop Grumman Corporation (NGC) on September 29, 2005. It is a one-year effort where the NGC will temporarily install a DIRCM system for evaluation of improved survivability over the currently installed ASE equipment. This project currently does not have funding for fleet introduction.

4.0 ANALYSIS

Limiting the scope of the thesis, keeping it unclassified, protecting DoD information and protecting contractor proprietary information made it difficult to adequately define all the issues in this thesis. Program Office resources were used which included the author's program briefs, DoD program information, as well as data from four prime contractor data packages. To ensure information was protected, all information included herein, was verified via public access venues. Additionally, a literature review was conducted by both the author and the Patuxent River Technical Library. Selected results of the literature review are included in the bibliography.

5.0 DISCUSSION

For a variety of technical reasons, the Navy's effort at joining the Army's ATIRCM/CMWS program has virtually come to a stall. Problems with ATIRCM/CMWS are well known but how the Army PM will ultimately mitigate these problems has not been publicized to date. One potential solution prevents the Navy from spiraling in with the Army development until FY 09, which is unacceptable to the Navy. It is clearly evident that Navy cannot execute a program in FY 06 with the Army, therefore other program options have been looked at and a final recommendation is presented here. Program cost estimates were completed and used to support the final program recommendation. Due to the proprietary nature of the data, the cost estimates are not included in this thesis. Estimates were derived based on program office experience and actual costs from the LAIRCM, ATIRCM/CMWS and TADIRCM programs were used as well as contractor estimates based on projected sales. Estimates were based on FY06 dollars and there were no adjustments made for inflation. Team estimates, engineering and logistics, and test and evaluation costs were rolled up into one sheet. Representative results of the rolled up estimate for the recommended strategy are included in Appendix A.

Affordability and total life cycle costs for each option were also developed and used as a tool to validate the final recommendation. Estimates derived and presented here have not been validated and a complete cost analysis by cost estimators has not been done. The results have not been approved by PMA272.

6.0 CONCLUSIONS

The Department of the Navy 2005 Electronic Warfare Operational Advisory Group (OAG) listed Assault DIRCM Initial Operational Capability (IOC) as a top priority for FY08. The Navy has funding and a budget starting in FY06 for an Assault DIRCM Program. Based on Joint Requirement Oversight Committee (JROC) guidance, the Army is the designated lead for all DoD helicopter IRCM programs. The Army is experiencing continual technical and programmatic difficulties on the ATIRCM/CMWS program and there is a potential for the Full Rate Production Decision Review (FRPDR) to slip to the right as far as Fiscal Year 09. Bottom line; ATIRCM/CMWS is not production ready and does not meet the urgent needs of the Navy.

Team estimates have indicated that staying the course with ATIRCM/CMWS will not only put Navy's FY 06 and FY 07 funding in jeopardy but will incur excessive developmental as well as O&S costs and, more significantly, will push the IOC for the 'lead the fleet' aircraft out as far as 2015. Additionally, if the Army does not outfit their entire helicopter fleet with complete ATIRCM systems, procuring 'big lots' with the Army may not present a great savings as once anticipated.

If the DoN wants DIRCM capability on Navy and Marine Corps helicopters in the near future, ATIRCM/CMWS is not a viable option.

There is only one currently available DIRCM system on the market today that has the ability to meet the immediate needs of the Navy and the ability to meet future requirements such as future IR threats expected to be proliferated beyond 2015. The NGC DIRCM does not meet all the draft Capabilities Definition Document (CDD) requirements today but provides the opportunity to incrementally meet those capabilities. LAIRCM, a direct relative of DIRCM, is planning incremental developments that will directly benefit DIRCM improvements. Additionally, a number of Navy helicopter program offices do not support waiting until 2015 for a DIRCM capability and will likely procure systems on their own if PMA272 doesn't develop a common system for all DoN helicopters in the near term. Procuring DIRCM initially as an Off-The-Shelf (OTS) system and incrementally developing capabilities not only meets the intent of a joint program (with the Air Force), it increases commonality and thereby reduces overall life cycle costs to the Navy and Marine Corps platforms.

SOCOM is planning to procure and maintain their DIRCM systems on their fixed wing and helicopters via the Air Force LAIRCM Program starting in 2007. LAIRCM is investing millions of dollars to advance DIRCM capabilities that will also be available to SOCOM aircraft. The Air Force and SOCOM are planning to outfit over 1000 aircraft with a complete NGC DIRCM system. If Navy joins the Air Force and procures the DIRCM system, it will benefit from LAIRCM's technological investments. Additionally, economy of scale is expected to reduce the costs of a complete system by 40% within the next 10 years.

In conclusion, considering the current needs of the Navy and Marine Corps Fleet as well as current technology and life cycle costs, the Navy should consider breaking away from the Army and join the Air Force under the LAIRCM program to install NRE DIRCM systems on our helicopters as depicted in Figure 6-1. This option would allow Navy to procure and deliver much needed DIRCM technology to assault helicopters now and it would also provide for future upgrade capability as future threats emerge.

TADIRCM Acq Strategy
NDI upgrade for Assault DIRCM

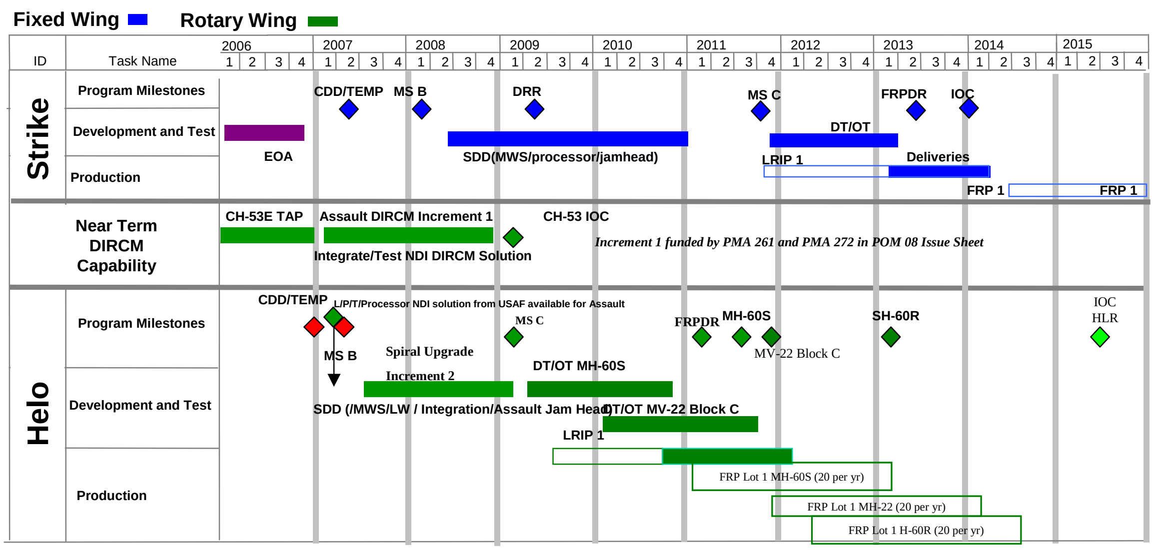

Figure 6-1. NDI Option for Assault DIRCM
Source: Author

7.0 RECOMMENDATIONS

The following recommendations are provided based on the author's observations and lessons learned while assigned as the Assault DIRCM IPT Lead.

a) First and foremost, it is imperative that program requirements be defined. It is impossible to formulate a strategy for a system development acquisition program with moving requirements. Once capability requirements are defined and approved (CDD approved), then a program manager can expect to develop a program to meet those requirements.

b) If JROC or DoD direction requires joint participation on a program or assigns a lead service for a developmental effort, responsibility for that effort needs to be placed on the lead service. An example of holding the lead service accountable might be to make joint participation an entrance criteria for a milestone decision. In other words, as an example, since Navy is designate the lead service for tactical jet aircraft IRCM development, then the Milestone Decision Authority (MDA) should ask the question "What have you done to incorporate the other service's requirements into the program? Where is the join application on the program?" If the answer is not adequate, and verifiable, then the MDA should not approve the Milestone Decision. This would put the onus on the lead service to take the lead.

c) A total systems engineering approach must be applied to the development of an Assault DIRCM Program. Currently, there is no design philosophy for common self-protection systems. Instead of 'buying boxes' and acting as an integrator, we need to apply sound systems engineering processes to include open architecture and a total design philosophy so that our systems are compatible on all of our aircraft as well as compatible with each other.

d) Initially, when efforts were underway to work on a spiral upgrade to the ATIRCM/CMWS Program, a developmental Non-Recurring Engineering (NRE) slide was used for all briefings that drove the solution to the problem (Figure 3-5). By using this slide and this fundamental way of thinking, we were defining the requirements with existing hardware and driving the solution to undefined requirements and therefore a particular contractor. A key example is the assumption on the part of many that 2-color IR sensors are the only answer for a MWS to counter future threats. If we present functional requirements, we might very well find that 2-color technology is not the only solution. It is recommended that a functional design, as depicted in Figure 7-1 be used so as not to drive the solution to components.

e) DIRCM system sensors for Navy and Marine Corps helicopters should be designed with an AAR-47 sensor form-fit-factor to the maximum extent possible. This will enable easy airframe integration and prevent major structural modification for a new sensor. It will significantly reduce overall cost to the helicopter platforms.

f) A DIRCM system design should incorporate robust integration with the ALE-47 flare dispensing system. It should not be assumed that DIRCM will be the only countermeasure installed on the aircraft.

g) And finally, an important consideration when developing a DIRCM system for Navy Assault Helicopters is Open Architecture. An open architecture is an

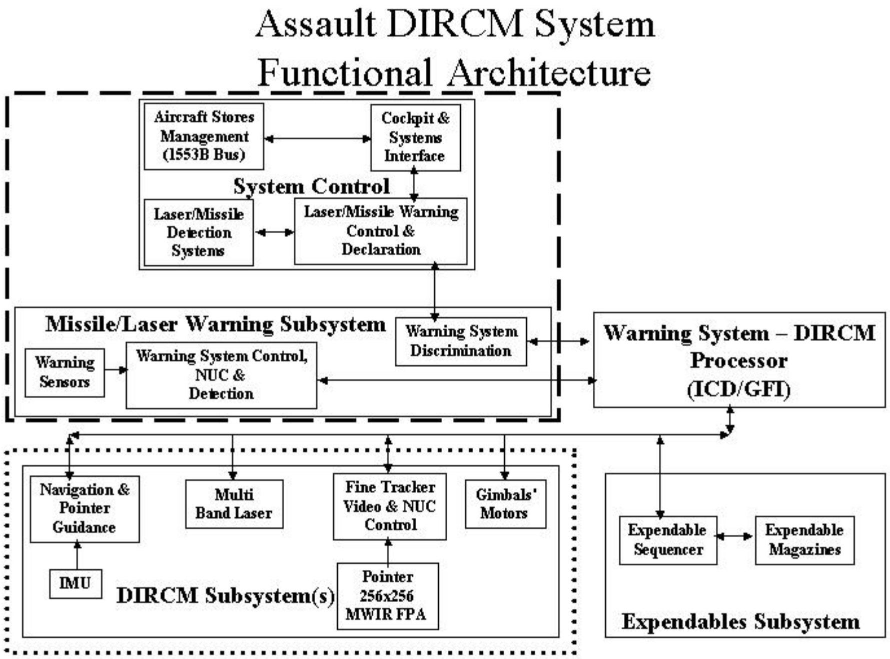

Figure 7-1. Assault DIRCM Functional Architecture
Source: PMA272 Assault DIRCM IPT

h) architecture wherein specifications are public. This allows for the sharing of functionality to integrate hardware, software and/or operating environments. The great advantage of open architectures is that anyone can design add-on products for it. An open standards operating system must be used in all new Navy systems to ensure future system interoperability and to support software reuse.

Open architecture:

- accommodates evolving requirements and technology
- realizes efficiencies as a common operating system
- reduces and consolidates independent functions of legacy and future applications

- allows for the control of the migration of as-is architecture transitioning to to-be architecture
- permits interoperability and net centric warfare and
- reduces overall cost of developing new operating systems.

There are some factors that need to be considered when applying open architecture to the development of DIRCM. Commonality, interoperability, security (anti-tamper requirements), migration of legacy platforms, etc., all must be considered during the design process.

In order for us to design to open architecture philosophy, we must make several assumptions. First and foremost, capability definition must be defined and not changed during the design and implementation phase. It must be assumed that open architecture design of a DIRCM system will not impact individual aircraft software. It cannot be proprietary. Existing software is not conducive to open architecture. And system documentation needs to be thorough and complete and allow for anyone to use it.

LIST OF REFERENCES

LIST OF REFERENCES

1. Beveridge, Dirk, “APECD Nations Agree to Limit Missile Sales”, Associated Press, 18 October 2003.

2. JROCM 234-03, Minutes of the 17 November 2003 JROC Meeting, 19 December 2003

3. GAO-01-1448, Electronic Warfare: The Army Can Reduce it’s Risks in Developing New Radar Countermeasures System, April 2001.

4. GAO-01-1448, Electronic Warfare: The Army Can Reduce it’s Risks in Developing New Radar Countermeasures System, April 2001.

5. Journal of Electronic Defense: Tug-of-War over ATIRCM/CMWS Funding, January 2002.

6. Frank Colucci, Finding Ways to Stay in the Fight, Defense Daily Network, May 1, 2005

7. Defense Acquisitions: Assessments of Selected Major Weapons Programs GAO-05-301, March 31, 2005

8. A Case for International Cooperative Acquisitions: Lessons from Developing and Executing a Section 27 “Quayle” Authority Program. Dr. Alan Childress and LtCol James Larson, USAF, Acquisition Review Quarterly, Fall 1998

SELECTED BIBLIOGRAPHY

SELECTED BIBLIOGRAPHY

1. Adamy, David, *EW 101, A First Course in Electronic Warfare*, Artech House, Inc., 2001

2. Adamy, David, *EW 102, A Second Course in Electronic Warfare*, Artech House, Inc., 2004

3. Small Arms Survey, "Big Issue, Big Problem?", *Small Arms Survey 2004*, July 2004

4. Rockwell, David L., Teal Group, AIAA – Aerospace America Online – *Eye on Electronics, IRCM: The Place to be in EW*, Aerospace America, May 2002

5. US Department of State Fact Sheet, *The MANPADS Menace: Combating the Threat to Global Aviation from Man-Portable Air Defense Systems*, 20 September 2005

6. Pais, Salvatore Cezar, *Directed Infrared Countermeasures – The Total Solution?*, Homeland Defense Journal Online, http://www.homelanddefensejournal.com/scoop_dircm.thm , 28 September 2005

7. Aviation Week and Space Technology, *Outlook/Specifications on Electronic Warfare Systems*, 17 January 2005, www.aviationnow.com/awst

8. Journal of Electronic Defense, *LAIRCM Proposals Submitted*, February 2001

9. Pena, Charles V., CATO Institute, Policy Analysis, No. 541, *Flying the Unfriendly Skies, Defending against the Threat of Shoulder-Fired Missiles*, 19 April 2005

10. Sarkady, K. A., *Tactical Aircraft Directed Infrared Countermeasures System Overview*, Naval Research Laboratory, 2001

APPENDIX A

APPENDIX A

Representative IPT Lead Roll-up Estimate for NDI Option for Assault DIRCM Program

Task	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	Total
Team Estimate	1,837.25	2,074.00	3,113.50	3,756.50	3,761.50	3,444.50	2,796.00	2,017.25	1,982.25	24,782.75
Engineering & Logistics	3,700.00	25,500.00	56,500.00	22,900.00	5,050.00	3,050.00	1,150.00	100.00	100.00	117,150.00
T&E			4,220.00	1,780.00	3,420.00	380.00	800.00			10,570.00
TOTAL	5,537.25	27,574.00	63,833.50	28,436.50	12,231.50	6,874.50	4,746.00	2,117.25	2,082.25	152,502.75

Assumptions:

1. All estimates are using a FY06 dollar basis (no adjustments for inflation).
2. Lead platform is an MH-60 Multi-Mission Helicopter.
3. This option assumes a Navy led program and modification of an existing system.
4. Includes LW integration w/MW sensor.
5. Some repackaging of the Jammer is required.
6. Will use house-keeping software (BIT, Interface control, etc.) with little to no change.
7. SDD contract award in FY07.
8. Fabrication and GFE costs include spares quantities for test program.

VITA

Tracy Anne Barkhimer was born in Staten Island, New York in May 1964. She attended The State University of New York (SUNY), Maritime College at Fort Schuyler in the Bronx, New York where she received a Bachelor of Engineering in Electrical Engineering and a United States Coast Guard (USCG) Third Mate's License in the United States Merchant Marine in 1988. Upon graduation she received a commission as an Ensign in the United States Navy and received her wings of gold in June 1990. Tracy served her first tour in the Navy as a Helicopter Combat Support Pilot at HC-11 flying the CH-46 on two deployments in the Western Pacific before serving on Capitol Hill as a Liaison Officer in the House of Representatives. In 1996, Tracy was selected to the Aerospace Engineering Duty Officer (AEDO) community and reported to Patuxent River to serve as the V-22 ASPO. She also attended the United States Naval Test Pilot School (USNTPS); served as the Navy H-3 Assistant Program Manager for Systems Engineering (APMSE) and served at DCMA Sikorsky Aircraft in Stratford, Connecticut as the MH-60S Program Integrator and the Government Flight Representative (GFR). She is currently assigned as the Assault DIRCM IPT Lead for PMA 272 at Naval Air Systems Command in Patuxent River, MD. She is married to Erik R. Barkhimer of White Salmon, WA.