

Transforming Maritime Patrol Aviation

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Subject Area Aviation

# **TRANSFORMING MARITIME PATROL AVIATION**

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## EXECUTIVE SUMMARY

- Title:** Transforming Maritime Patrol Aviation
- Author:** LCDR Gary T. Ambrose USN
- Thesis:** The transformation of Maritime Patrol Aviation will entail the acquisition of a new aircraft and possibly the addition of an unmanned aerial vehicle. The U.S. Navy faces a crucial decision regarding aircraft type and future employment roles. The Navy must also refocus on its core competency of Anti-Submarine Warfare and may have to adopt new tactics in support of Sea Power 21 concepts.
- Discussion:** The Navy's P-3 Orion is rapidly approaching its service life and is need of immediate replacement. The Navy will choose either the Boeing 737-700 variant or the Lockheed Orion-21 aircraft as it future Anti-Submarine Warfare (ASW) and Intelligence, Surveillance, and Reconnaissance (ISR) aircraft. The propeller driven Lockheed aircraft will certainly make a suitable platform for conducting ASW and ISR missions, however, Lockheed does not currently have an open production line for such aircraft. Boeing is offering a militarized 737 commercial variant aircraft, which is currently in production and offers potential savings to the Navy. Boeing also is marketing a maintenance and supply infrastructure that will notionally save the Navy large amounts of money in comparison to a non-commercial source.
- Boeing is the clear winner when viewed in a purely fiscal environment. Lockheed may offer a more suitable product but the price may exceed the Navy's budget, especially in time of "transformation".
- The Navy needs to see a reemergence in excellence in regards to ASW. The last decade has brought a considerable shift away from ASW and redirected the focus towards ISR. MMA will have capabilities to meet Navy requirements in both areas of war fighting, however, ASW is a perishable skill and needs to be practiced more than the Navy is currently funding.
- Recommendation:** The Navy should purchase the Boeing 737 variant as the future MMA, provided they can meet all of the Navy's operational requirements. The Navy will enjoy ownership costs by utilizing the commercial support network, UAV technology, and reduced maintenance costs. The Navy also needs to focus on ASW as a primary mission while maintaining their fall out capabilities such as ISR and interdiction type missions.

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## LIST OF ABBREVIATIONS

AIMD	Aircraft Intermediate Maintenance Department
AIMS	Advanced Imaging Multi-Spectral Sensor
AIP	Anti-Surface Warfare Improvement Program
ASU	Anti-Surface Warfare
ASW	Anti-Submarine Warfare
BMUP	Block Mod Update Program
CAD	Component Advanced Development
C4	Command, Control, Communications, and Computers
COTS	Commercial Off The Shelf
DOD	Department Of Defense
EER	Extended Echo Ranging
EO	Electro-Optical
ESM	Electronic Support Measures
FMC	Full Mission Capable
GHMD	Global Hawk Maritime Demonstration
IFR	In-Flight Refueling
IOC	Initial Operating Capability
IR	Infra-Red
IRDS	Infra-Red Detection System
ISAR	Inverse Synthetic Aperture Radar
ISR	Intelligence, Surveillance, and Reconnaissance

JTF	Joint Task Force
JTRS	Joint Tactical Radio System
LRAACA	Long Range Air ASW Capable Aircraft
LRIP	Low Rate Initial Production
MAD	Magnetic Anomaly Detector
MDAP	Major Defense Acquisition Program
MIO	Maritime Interdiction Operations
MMA	Multi - Mission Maritime Aircraft
MPA	Maritime Patrol Aircraft
MPRF	Maritime Patrol and Reconnaissance Force
OEF	Operation Enduring Freedom
P&D	Production and Deployment
PMC	Partial Mission Capable
SAR	Search And Rescue
SAR	Synthetic Aperture Radar
SDD	System Development and Demonstration
SEI	Specific Emitter Identification
SIGINT	Signals Intelligence
SLAM	Stand-off Land-Attack Missile
SLAP	Service Life Assessment Program
SLEP	Service Life Extension Program
SRP	Sustained Readiness Program
SRS	Sonobuoy Reference System

SSI	Structurally Significant Inspections
TCDL	Tactical Common Data Link
TTP	Training, Tactics, and Procedures
TV	Television
UAV	Unmanned Aerial Vehicle

## I. INTRODUCTION

The U.S. Navy is currently searching for an aircraft to replace the aging P-3 Orion.<sup>1</sup> With no foreseeable end on the War on Terrorism and the ever-present expectation of transformation, the U.S. Navy is attempting to leap ahead two generations of warfighting capabilities while maintaining its current state of readiness. Naval aircraft procurement is nearing record lows while the demand for persistent Intelligence, Surveillance, and Reconnaissance (ISR) is at an all time high.<sup>2</sup> The Navy will soon make a crucial decision regarding which platforms will carry out the brunt of its Anti-Submarine Warfare (ASW) and (ISR) missions for the next two decades. The future platform, named Multi-mission Maritime Aircraft (MMA), will leverage technologies to provide a broad spectrum of warfighting capabilities. Sea Power 21's triad of Sea Basing, Sea Shield, and Sea Strike will be fully supported and enabled by MMA. Achieving battle space dominance within the constraints of a finite budget will be a difficult task, thus the decision on which platform the Navy will fund has incredible long lasting effects.

With the former Soviet threat of submarine warfare significantly diminished, the P-3 community was forced to restructure itself. Relying on fallout capabilities, the P-3 was able to adapt to new threats and excel in areas of warfighting that were once considered secondary in nature. For the P-3, the ASW and Anti-Surface Warfare (ASU) missions held the lead role for decades. It was not uncommon for a P-3's operating in the early 1980's to hold contact on numerous Soviet submarines for extended periods. Following the collapse of the Soviet Union however, budget cuts reduced the P-3 fleet by

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<sup>1</sup> For continuity the author will refer to the P-3 Orion as simply the P-3 throughout the remainder of this paper.

<sup>2</sup> Mike Spence, Captain U.S. Navy, "Naval Aviation Is Behind the Power Curve," Proceedings Feb. 2003.

half and forced the remainder to adapt to the next highest priority of missions. The P-3 has always been an inherently superb ISR platform. Missions such as armed reconnaissance, interdiction, and ISR, which at one time were secondary or non-existent, are now the mainstay for the P-3.<sup>3</sup> The P-3's great endurance and array of optical and electrical sensors enabled the Maritime Patrol community to extend its warfighting reach from the open ocean and littorals to overland areas, provided that the threat was relatively benign. It was only natural to shape and redirect the P-3 from hunting submerged and surface targets to hunting and potentially killing targets inland. Sensors originally designed for maritime scenarios enable the P-3 to fill an existing ISR gap and give the P-3 the capability to conduct strike support, armed reconnaissance, and leadership interdiction. This new focus was a relatively easy transformation for the P-3 since it already possessed the sensors, weapons, and endurance required to hunt targets, regardless of the medium within which they were hiding. Within the last decade these missions have taken on a greater importance and have become more apparent throughout Operation Enduring Freedom (OEF). The perishable skills and experience base required to conduct ASW are no longer as robust as they once were, since the majority of the P-3 missions are now ISR or some form of interdiction.

MMA must be capable of performing all of the current P-3 war fighting missions, and it must do so in a more reliable and cost efficient manner. Battle space dominance within the construct of Sea-Power 21 requires persistence in every mission type, ranging from ASW to ISR, and the current aging P-3 does not support persistence throughout the next decade.

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<sup>3</sup> A snapshot of an East Coast P-3 Squadron showed that 71% of its missions were ISR during a 2002 deployment.

The competition regarding which aircraft the Navy will choose to replace the P-3 is currently in the Component Advanced Design (CAD) phase. Two remaining companies (Boeing and Lockheed Martin) were awarded contracts to design their respective replacement aircraft. Boeing plans to offer its version of MMA as a militarized Boeing 737-700 aircraft, modified to carry ordnance, deploy sensors, and containing additional fuel storage which enables increased endurance and range. Boeing also plans to market their established support infrastructure, an enhanced capability supporting commercial aircraft throughout the world.

Lockheed Martin's version of MMA is a new production Orion, however, a remanufactured type offer remains a possibility. The new Orion, named "Orion -21" offers new engines, new propellers, and a digital flight station. Both companies intend on incorporating an improved avionics system that will be capable of supporting system growth and integration as advances in technology develop. System Development and Demonstration (SDD) phase of the acquisition process is planned for 2004, when one final competitor will be selected to begin construction. The Navy desires the Initial Operational Capability (IOC) of one Patrol Squadron ready to deploy in 2012, with as many as 150-180 aircraft being built throughout the life of the program.<sup>4</sup> Speculation has arisen that the IOC may be accelerated to accommodate the demand for increased numbers of persistent ISR aircraft, due to unprecedented flying rates generated from the War on Terrorism.

It is quite probable that coalition and allied countries will purchase the new platform, since most of their ASW and Maritime Patrol Aircraft (MPA) platforms are also becoming antiquated. The Navy is actively marketing MMA to potential partners for

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<sup>4</sup> The Navy has not yet determined how many aircraft will be assigned to a Squadron as of April 2003.

cooperative development or partnership through foreign military sales rules. In all likelihood however, foreign Navies and Air Forces will wait for the U.S Navy to absorb the brunt of initial start up costs before committing their own funds. Regardless of the platform the Navy decides upon, it is certain that the U.S. needs a new manned aircraft to perform persistent ASW and ISR missions. These missions are critical to winning the War on Terrorism and supporting Sea Power 21 concepts.

## II. BACKGROUND / UPGRADES

The Maritime Patrol Reconnaissance Force (MPRF) has done an exceptional job at keeping up with technological developments throughout its history. However, after nearly 40 years of change, the majority of the P-3 fleet has been through so many modifications, that numerous configurations present expensive supportability issues. Training, maintenance, and reserve force relevance continue to challenge Navy leadership.

In 1958 the U.S. Navy began production of the P-3 Orion, a replacement aircraft for the P-2 Neptune and P-5 Marlin. The P-3 was a factory derivative of the Lockheed Electra L-188 propeller driven commercial airliner. The early P-3A aircraft incorporated a handful of ASW systems that gave the Navy a persistent long-range airborne ASW and maritime patrol platform. A follow on model, named the P-3B, included avionic and airframe modifications as well as the improved Allison T-56-14 motor. In 1968 the Navy began flight-testing on the P-3C, which brought a central computer, upgraded sensors, and a revised arrangement of crew stations. Following the initial production of 118 P-3C aircraft, the Navy developed the Update I program, which incorporated further technological improvements: the addition of new navigational systems, enhanced acoustic processors, and increased central computer memory. Rapid weapon system improvements such as the Infra-Red Detection System (IRDS), an upgraded Electronic Support Measures (ESM), and the AGM-84 Harpoon missile system were incorporated into the Update II aircraft. The P-3C Update II program capitalized on technology with the addition of Omega navigation, Sonobuoy Reference System (SRS), and improved acoustics processing. In 1981, 36 additional aircraft were designated P-3C Update II.5

which incorporated minor avionic improvements. In 1983 the Navy purchased the final 36 production P-3C aircraft, which carried the designation Update III. The Update III version had included a new ESM system, sensor improvements, and a new acoustic processor. The Navy also purchased additional Update III kits to be retrofitted into older “baseline” P-3C’s.

In 1987 the Navy was concurrently researching an avionics upgrade program known as the Update IV program, and a concept to redesign the entire airframe, which was known as the Long Range Air ASW Capable Aircraft (LRAACA) program. A contract was awarded to Boeing for the Update IV program, which consisted of numerous avionics improvements. Lockheed won the LRAACA competition and designated the platform as P-7, which was intended to be a replacement airframe for the P-3. A decision was made to use the Update IV avionics package in the new LRAACA concept. However fiscal constraints, schedule delays, and cost overruns forced the Navy to abandon LRAACA in 1990 and two years later the Update IV program fell by the wayside as well. With the cancellation of the P-7A LRAACA and the Update IV programs, the Navy re-evaluated the need to modernize the existing P-3 fleet, which was by now growing older by the year.

Using money originally set aside for the LRAACA program, the Navy once again made attempts to obtain a replacement P-3 with the remanufactured P-3H proposal in 1990. The Navy requested to retain \$98 Million of FY-91 P-7 money and realign those funds as development money for the P-3H, however Congress denied the request. The Navy made another attempt in 1991 with the P-3G proposal, which leveraged Korean P-3C procurement, however this program also failed to obtain approval. The Navy was

finding it especially difficult to attain funding for ASW due the collapse of the Soviet Union in 1989 and the perception that the world's submarine threat had diminished.

Lockheed Martin was awarded the contract know as Block Modification Upgrade Program (BMUP) in 1997. Having closed the P-3C Update III retrofit line, the concept reintroduced Update III capabilities into 25 existing P-3C Update II aircraft. BMUP upgrades took advantage of Commercial Off The Shelf (COTS) technologies to improve the reliability of the P-3 while reducing the overall weight of the aircraft. The BMUP incorporated a new central computer as well as new tactical displays at each operator crew station. BMUP also provided an improved acoustic processor and recorder; however, exact commonality with production Update III aircraft was not achieved.

Many new weapon and avionic systems upgrades were concurrently becoming available during the BMUP program and the Navy desired to maintain pace with technology. Due to funding constraints, the complicated acquisitions process, and the rapid growth in technology, yet another upgrade program was born. The Anti-Surface Warfare Improvement Program (AIP) contract was awarded to Lockheed Martin in 1994, with the first delivery in 1998. AIP operated concurrently with BMUP, however, the AIP was able to organize and employ technologies that outpaced BMUP. The AIP began deliveries to the Fleet in 1998 and has funded 68 P-3C aircraft in the FY-03 budget. The Navy currently maintains an operational requirement of 146 AIP modified aircraft, however, only 57 aircraft have been delivered as of April 2003. The AIP program has thus far been the best improvement to the P-3 in terms of technology and ISR capability. The upgrade consists of a modernization and common installation of the APS-137C (V) 5 Early Limited Combat ID (EL CID) Inverse Synthetic Aperture Radar (ISAR). The

improved version of the APS-137 radar provides clear target resolution that permits standoff target identification with near photo quality images. Specific Emitter Identification (SEI) capability and a new display and control processor system were also inclusive within the AIP upgrade. Major improvements were also incorporated into the electro-optical sensors systems as well as a satellite communications suite, which provides connectivity for near real time data to battle commanders. The Advanced Imaging Multi-Spectral Sensor (AIMS) system combines Electro Optical / Infra-Red (EO/IR) capabilities while reducing aircraft weight by 700 pounds. Survivability enhancements and strike weapons such as the AGM-84E Stand-off Land Attack Missile (SLAM) and the TV or IR controlled AGM-65D/F Maverick missile were also included.<sup>5</sup> The Pioneer and Tactical Common Data Link Systems were procured in very limited numbers so a select few AIP assets would have the capability to provide real time streaming video to operational commanders. The limited numbers of these systems complicates the existing configuration challenges the P-3 fleet faces.

Together, all of these weapon and system upgrades have enabled the P-3 to claim a lead role in Maritime Interdiction Operations (MIO), armed reconnaissance, and leadership interdiction operations. Ground forces would utilize AIP assets as a deep reconnaissance for their own patrols. The AIP modified aircraft would provide force protection to advancing ground forces and let them know what to expect over the horizon. Several times the P-3 would serve as a relay / fire control platform coordinating fires to protect advancing ground units. Ground forces would routinely place liaisons

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<sup>5</sup> These weapon systems were also incorporated into some Update III aircraft.

aboard aircraft to aid in communications and assist in coordinating the fire support locations.<sup>6</sup>

Joint Task Force (JTF) and Combatant Commanders have placed the AIP P-3's operational value at a premium during their quest for battle space dominance. The high demand and limited number of AIP assets requires operational commanders to leave the airframes in theater for extended periods of time. It is common practice for P-3 squadrons to leave AIP assets in theater for extended periods, thus forcing squadrons to "swap" aircraft as they enter and depart theater. The constant employment of AIP aircraft has forced Navy leadership to recalculate the Fatigue Life Expended (FLE) of airframes and develop realistic retirement dates. Exposure to extended periods of combat operations may necessitate the early retirement for some airframes. The Navy is facing a greater shortage than previously expected and may have to expedite MMA and AIP procurement.

Throughout the last 3 decades, the Navy has incorporated many airframe and avionic upgrades to the P-3 fleet. Due to finite resources and the heightened requirement for ISR assets, the Navy is faced with a situation of diminishing returns. AIP modified aircraft are being flown at greater rates than previously expected and will reach the end of their service life much earlier than originally anticipated. The Navy is considering imposing flight restrictions upon portions of the P-3 fleet, since many corrosion and fatigue life issues remained unresolved.

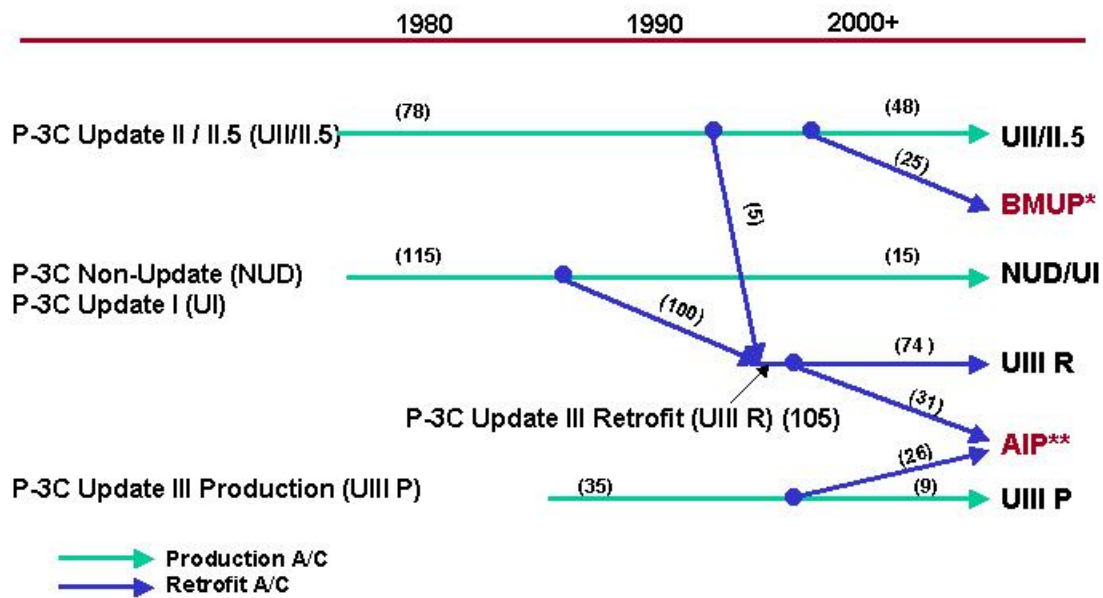
As MMA becomes a reality, generating budget dollars to revamp existing P-3's becomes more difficult. The Navy is facing budgeters who believe in the adage of why should they put money into their old car when they plan on getting a new one in a few

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<sup>6</sup> Conversation with Major Thomas Ditomasso U.S. Army on 16 April 2003.

years? The question has been raised as to what are we using our “cars” for? The current and foreseeable missions that the P-3’s are tasked with, such as ASW and ISR, are essential to Sea Basing and the War on Terror. These missions require state of the art technologies and a Mission Capable (MC) rate that the majority of the P-3 fleet cannot attain. The Navy is forced to fly and maintain the workhorse AIP aircraft while neglecting to upgrade technologically inferior platforms. Without funding more AIP airframe upgrades and expediting MMA to the fleet, a culminating point will be reached in which there simply won’t be enough ASW and ISR assets in theater.

## P-3C Genealogy (Active Aircraft)



\* 25 Block Mod Upgrade Program (BMUP) a/c funded  
 \*\* 84 Anti Surface Warfare (ASuW) Improvement Program (AIP) a/c funded in TPOM-04

The lack of commonality in airframes has put very real and identifiable constraints on commanders in regards to training, maintenance, and logistics. Reserve

force integration and training has now become even a greater problem since the reserve fleet is composed of older and less capable airframes. This places the P-3 reserve community operationally out of touch with the front line AIP assets. Reserve assets can adequately perform ASW but lack upgrades (AIP) to perform ISR on the same level as their active counterparts. The art of ASW is a perishable skill and is not practiced enough within the active fleet. Quite arguably, the reserve force has difficulties competing with active units due to their reserve rotation. The reserve force does possess many experienced operators but regrettably they do not practice ASW as much as needed.

The U.S. Navy and Congress must continue to invest in a long-term acquisition plan to replace the aging P-3 fleet. The Navy and Office of the Secretary of Defense (OSD) have exhaustively examined alternatives to fulfill its operational requirements and have decided that a hybrid force of MMA and Unmanned Aerial Vehicles (UAV's) most effectively provide the required capabilities.

The MMA must incorporate existing technologies and have the capability to absorb new technologies as they emerge. By using hardware that openly accepts growth, additional modifications can be fully incorporated with software changes and only minor airframe changes. MMA will be designed with an open architecture in order to capitalize new technological advances that will surely take place.

### III. AGING AIRFRAMES

The P-3 has served the Navy extremely well over the last 40 years, but is now simply too old and has reached the end of its service life. A typical P-3 squadron returning from a 6-month deployment to the Persian Gulf region averaged greater than 17 maintenance hours per flight hour.<sup>7</sup> The same squadron had only 12% FMC rates and 62% Partial Mission Capable (PMC) rates. The aging airframes require operational Commanding Officers to push their maintenance crews to the limit in order to meet all of the required tasking. Another maintenance challenge is the technologically inferior T-56 engine, which drives a propeller through a reduction gearbox. This configuration requires an incredible amount of maintenance hours when compared to a more recently designed engine. Squadrons are forced to change well over a dozen engine and propeller systems during a typical 6-month deployment and in many cases are operating in forward areas such as Bahrain or Kuwait, which have no Aircraft Intermediate Maintenance Department (AIMD). This requires the squadron to have replacement parts held on station or flown into theater after an aircraft breaks. Aircraft On Ground (AOG) time is increased and FMC/PMC rates plummet due to the increased logistical support required in keeping older aircraft in the air.

Extensive corrosion and fatigue problems that are common to the P-3 fleet were to be addressed by the Navy's Sustained Readiness Program (SRP), however it was cancelled due to a lack of funding and the severity of corrosion discovered during repairs. The Navy chose to induct their most severely corroded airframes into SRP, which overwhelmed the program. SRP was initially funded in 1994 and awarded to Raytheon

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<sup>7</sup> The author took a snapshot look at a P-3 Squadron that has returned from a typical deployment. The author elected not to name the squadron however the numbers are accurate.

located in Greenville, Texas. But in 2000 the contract was modified due to problems with schedule slippage and cost overruns. A stop work order was issued in 2000 after the completion of only 13 aircraft. 18 of the remaining 19 aircraft that were inducted into SRP were ferried to Lockheed-Martin's Greenville, South Carolina facility to receive a modified version of SRP, while the last one completed repairs in Texas. Corrosion problems scheduled for repair during SRP such as wing spars, fuselage-attach fittings, and aircraft skin are common throughout the P-3 fleet.

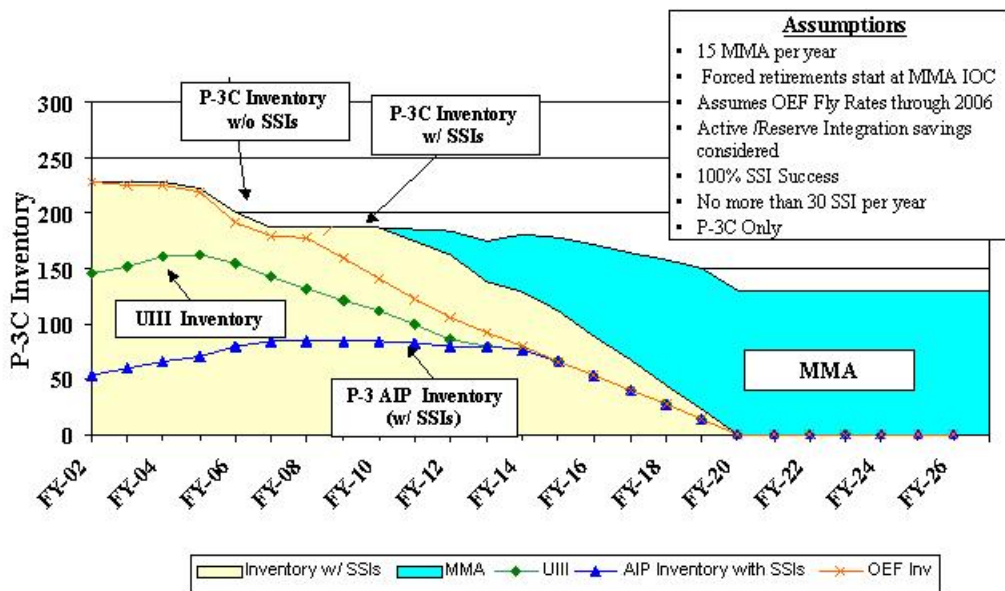
The failure of SRP forced the Navy to take on other measures that sustained P-3 operations and make further attempts to mitigate corrosion issues. Lockheed Martin was chosen to perform a Service Life Assessment Program (SLAP), which is a fatigue life assessment and inspection process. This program provides the Navy with more exacting data so leadership can make accurate determinations regarding service life.

The fleet of P-3 aircraft was built in the early 1970's and is rapidly approaching the end of their service life, and in some cases exceeding it. Due to a lack of direction and commitment regarding funding for the P-3, and the frustrating Department of Defense (DOD) budget process, the Navy was forced to piecemeal P-3 modernization and readiness efforts. The lack of long-term vision and fiscal commitment within the DOD during the 1980's had left the Navy with several programs attempting to rectify P-3 corrosion problems. Operational commanders and maintainers have done a remarkable job in managing readiness thus far, despite the constraining budget allocations. However, the problems identified above will soon reach a culminating point without either additional funding for SLEP and AIP or preferably speeding up the MMA acquisition program. Optimally, the MMA program will come to fruition sooner than expected and

AIP funding will be sustained. Community leaders diligently track FLE in order to determine which airframes would benefit the most from an AIP upgrade and which are in need of retirement.



## P-3C Force Inventory (POM-04)



12/16/2002

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#### IV. TRANSFORMATION

That great struggle is over. The militant visions of class, nation, and race, which promised utopia and delivered misery have been defeated and discredited. America is now threatened less by conquering states than we are by failing ones. We are menaced less by fleets and armies than by catastrophic technologies in the hands of the embittered few. We must defeat these threats to our Nation, allies, and friends.

The President of the United States  
National Security Strategy, September 2002

“The United States will transform America’s national security institutions to meet the challenges and opportunities of the twenty-first century.”<sup>8</sup> Transformation, is a current buzzword used to describe radical changes in doctrine, operational concepts, and technology applied over a relatively short time period. The Navy’s employment of the P-3 and rapid advances in technology over the last decade have demonstrated an unprecedented adaptation of military forces. This adaptation was one of necessity and survival for the P-3 community. With the collapse of the Soviet Union and the Cold War won, the U.S. has shifted its focus from an unlimited warfare scenario, to one of power projection within regional conflicts.<sup>9</sup> In the midst of the Cold War, the P-3 community kept its hands tightly squeezed around the Soviet submarine threat and required little more justification for existence. However, as the Cold War came to a close, military cutbacks reduced the P-3 community by half and left the remaining P-3 fleet searching for new missions and areas of war fighting.

The P-3 aircraft has always proved itself versatile. With exceptional endurance and range, the P-3 soon found itself performing missions ranging from armed reconnaissance to drug interdiction. The addition of ISAR and AIP, placed the Maritime

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<sup>8</sup> The National Security Strategy of the United States of America, September 2002, - 2.

<sup>9</sup> The National Security Strategy of the United States of America, September 2002, - 7.

Patrol Reconnaissance Force (MPRF) in the Navy's lead role of airborne Command and Control / Intelligence, Surveillance, and Reconnaissance (C<sup>2</sup>ISR) missions. Arguably, the MPRF maintained its core competency of Anti-Submarine Warfare (ASW), however it soon found many of its fall-out capabilities rivaling ASW. The MPRF has done a remarkable job adapting its tools to new missions and employment during the last decade. The community must however, maintain its proficiency and expertise in ASW operations. "If we don't do ASW, no one will do ASW."<sup>10</sup>

MMA will be the cornerstone of the transformed MPRF, providing real time data and visual connectivity between the commander and his striking forces. MMA will enable Sea Basing by providing persistent ASW and ASU capabilities. Additionally, MMA will provide an enhanced ISR capability that is necessary for Sea Shield and the protection of the notional Expeditionary Strike Group (ESG).

A new platform would certainly allow the Navy to attain Mission Capable (MC) rates unrealized over the last decade. A typical Patrol Squadron achieves approximately 74 %MC rates during a six-month deployment.<sup>11</sup> These numbers are only achieved with a tremendous maintenance effort. With a new platform the Navy would enjoy MC rates above 90%.<sup>12</sup> Additionally, the acquisition of a commercial derivative MMA would allow the Navy to take advantage of the existing maintenance and parts distribution infrastructure already established by the commercial airline industry. It is quite possible a commercial derivative MMA could receive crucial repairs at any aerodrome that supports commercial air traffic. By out-sourcing a portion of its scheduled and

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<sup>10</sup> VADM Dennis McGinn at the Naval Institute's forum on Transformation, 2002.

<sup>11</sup> Snapshot look at a VP squadron during a 6-month Persian Gulf deployment.

<sup>12</sup> The author has over 1300 hours in older 737-200 aircraft and during the 3 years flying 737's experienced MC rates well above 90%.

unscheduled maintenance, the Navy would enjoy the additional savings by reducing the manpower required to support a typical squadron, hence realized savings in Total Ownership Costs (TOC).

Imagine a scenario of a commercial derivative MMA diverting into foreign airfields such as Dubai, Hong Kong, or Guam, and then receiving parts and maintenance from a commercial source. A commercial derivative MMA having a significant parts commonality with an existing commercial aircraft would greatly reduce the cost of pre-positioning parts or having them flown into theater. Although specialized sensor equipment would be unique and in need of its own support mechanism, airframe and power-plant items such as engines, engine accessories, tires, and hydraulic equipment would enjoy significant commonality with the commercial industry. The worldwide availability of parts and maintenance would also dramatically reduce the time an aircraft spends on the ground and enable a more persistent ISR capability.

The Navy is not currently envisioning a one for one replacement of MMA aircraft with the P-3. Dramatically higher MC rates may enable this vision. With notional changes to the typical Patrol Squadron's aircraft composition of 9 aircraft, to perhaps 7 aircraft and the utilization of Unmanned Aerial Vehicles (UAV's) which are permanently forward deployed, the Navy would quite easily increase its ISR capability, while simultaneously maintaining its ASW capability.<sup>13</sup> The synergistic coupling of UAV technology to the MMA program would act as a force multiplier and once again allow the Navy to enjoy reduced costs in manpower, by manning and maintaining less aircraft per

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<sup>13</sup> The author believes the MMA program should focus on its core competency of ASW and that the UAV program would be an adjunct capability that supports MMA during ISR missions. Although funding for MMA and the UAV programs are inextricably linked, UAV funding must not inflict unacceptable constraints to the MMA program since UAV's are at this time incapable of performing ASW.

squadron. Although UAV's are somewhat capable fulfilling an ISR role, they currently lack the capability for ASW, thus a sufficient number of manned aircraft must be employed. The Navy needs to proceed cautiously when contrasting UAV and MMA funding, especially with the need to refocus on the core competency of ASW, in which UAV technology is inadequate.

The future MMA platform should have an aerial refueling capability,<sup>14</sup> however, the addition of a fuel receiving system must fall within realistic cost expectations and not be an eliminating factor in the consideration of a commercial derivative aircraft.<sup>15</sup>

MMA must also possess the ability to communicate with all entities of the joint and coalition force. With great endurance and systems commonality, a fully integrated MMA will provide global connectivity between shooters deep in the battle space and Sea Based commanders. Incorporating systems such as the Joint Tactical Radio System (JTRS) and the Tactical Common Data Link (TCDL), MMA will link the netted force and improve the commander's situational awareness by providing live streaming video and a full spectrum of communications.

Long-term development and modernization savings will become evident by using an open flexible architecture system onboard the MMA. By designing a system that initially expects and anticipates future technology growth, the MMA program will be capable of utilizing Commercial Off The Shelf (COTS) systems and tie them into the MMA without major overhauls. Although the use of COTS type hardware provides

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<sup>14</sup> CONOPS for the Search & Attack Variant of the Multi-Mission Maritime Aircraft (MMA), November 2001.

<sup>15</sup> The author recommends that MMA be capable of receiving fuel only and has concerns that the capability to provide fuel, although an added benefit, would detract from the primary missions of ASW and ISR. History has demonstrated the ASW role contrasted to the in-flight refueling role with the demise of the S-3 Viking.

savings by reducing research and development costs, they do not offer cutting edge technology. The future will undoubtedly hold many technological improvements and MMA will exploit these with software updates vice hardware changes, in many cases.

As technology improves, the operational commander will be faced with greater challenges regarding training and retention. Training an aircrew to be proficient in the perishable art of ASW and making that same crew capable of the numerous fallout missions such as strike, reconnaissance, and interdiction (leadership, arms, and drug) will be a challenge. However, by maintaining a focus on the core competencies of ASW / ASU, the Navy will enjoy a reemergence of excellence in these areas of war fighting. The skills necessary to perform ASW and ASU are similar, and in many ways compliment those required to perform the secondary missions. Fallout capabilities will always be present with a long-range, persistent, ISR capable aircraft and the operational commander has the flexibility to adjust training as necessary to meet these requirements.

The retention of quality operators and maintainers will be even more of a concern in the future. The expertise required in operating and maintaining technologically advanced systems necessitates years of training. There is and will continue to be a great challenge in retaining these systems experts.

It is imperative that the MPRF keeps its sight on the core competency of ASW. With more than 500 submarines throughout the world and a reemergence of diesel and miniature submarine technologies, the U.S. Navy is forced to keep this threat at bay in order to support the concept of Sea Power- 21.<sup>16</sup> China's new procurement of Kilo class diesel submarines and the rapid improvement of its indigenous SSN class demonstrates

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<sup>16</sup> World Navies Today, January 2003, [URL:<http://www.hazegray.com>](http://www.hazegray.com). Accessed 10 February 2003.

that future Sea Basing may not go unchallenged.<sup>17</sup> By minimizing the submarine threat, MMA can enable the U.S. Navy to realize the full potential of Sea Basing concepts. The world submarine threat has evolved from a blue water nuclear capability to a littoral diesel threat. With improved technologies the diesel submarine can now stay submerged for days without the need to surface. The Navy needs to readdress its tactics regarding ASW and consider a more active mode of prosecution. Passive tracking on today's quiet diesel submarines proves insufficient and must be enhanced to protect the Striking Force or Sea Based support system.

The MMA platform of the future will be able to clear the path for an Expeditionary Strike Group by conducting ASW and littoral mining missions, which support an amphibious landing, while simultaneously controlling and exchanging data with a UAV, deep within the battle space. The very same MMA will possess the capability to perform armed reconnaissance and strike missions using information received by its linked UAV. Regardless of the mission, the operational commander will have a more robust and persistent Multi-Mission platform at his disposal, enabling quick and accurate decisions.

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<sup>17</sup> Dr. Lyle Goldstein and LCDR Bill Murray, USN. "China's Subs Lead the Way." Proceedings, March 2003.

## V. COMPETITION

The Navy reached its first milestone regarding MMA in March 2000 when it was permitted to explore concepts to replace the ageing P-3. The P-3 requirements office located in the Pentagon and the NAVAIR acquisitions team located at Patuxent River, Maryland analyzed numerous manned and unmanned concepts. Of these, only four concepts made it to the formal proposition stage:

- Lockheed Martin's remanufactured P-3 derivative (Orion 21)
- Raytheon refurbishing P-3's stored in the desert (Procyon)
- Boeing's 737-700 derivative
- Northrop Grumman's Global Hawk UAV

The team conducted an analysis of alternatives that determined manned aircraft were required to perform ASW and that UAV's have an adjunct role supporting MMA in its ASW and ISR role. The MMA program completed the concept exploration phase in January 2002 and in September 2002 contracts were awarded to Boeing and Lockheed Martin aircraft companies, which brought the MMA acquisition process into the Component Advanced Development (CAD) Phase. The two competitors were awarded money to produce their concepts for replacing the P-3. The CAD phase will further evaluate systems architecture and the interoperability requirements associated with UAV's. After reviewing both of the proposals, the Navy will select a single prime contractor in 2004. Once a single prime contractor has been chosen the program enters what is called the System Development & Demonstration (SDD) phase. The SDD phase is currently scheduled to begin in 2004 and continue through 2008, in which it will bring the first developmental test aircraft. Low Rate Initial Production (LRIP) is scheduled to

begin during the Production and Deployment (P&D) phase, slated for 2008, and the Navy expects Initial Operating Capability (IOC) no later than 2012.

The Boeing aircraft company is offering a 737 variant aircraft. Boeing intends to take a newly manufactured 737 series aircraft and add 737-800 wings and landing gear to the fuselage, while still on the production line. This is not a disruption to the normal assembly line process and will enable Boeing to continue the manufacturing process as it stands today.<sup>18</sup> Once the Boeing MMA rolls off the assembly line Boeing expects to modify the commercial jet by installing a bomb bay and additional fuel tanks. Additional modifications will include a hole cut into the fuselage to support an EO/IR system and the addition of a digital Magnetic Anomaly Detector (MAD) somewhere in the tail section. Once these airframe modifications are complete Boeing plans on adding the avionics and crew stations to the aircraft.

Boeing's project has several major selling points. Boeing 737 aircraft are already in production and flown throughout the world. The support infrastructure is already in place and operated to near perfection. Boeing aircraft are maintained and flown worldwide and the support mechanism offers considerable savings to the Navy. Boeing maintains a supply of parts at many aerodromes, but when they are not on hand, Boeing has a highly efficient and respected spare part distribution network that can have parts flown worldwide in minimal time. The Navy could foresee a substantial savings in having to support these aircraft, both with labor and parts. The use of the CFM-56 turbo-fan engine on the 737 presents a history of performance and reliability. There are questions however of how the engine will perform in a salt air environment but most

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<sup>18</sup> Author toured Boeing 737 production line and witnessed first hand how the major components such as the wing and tail sections are attached to the fuselage.

experienced pilots believe this will not present a problem. It has been noted that Hawaiian Airlines is a user who routinely flies in such an environment.<sup>19</sup>

A Boeing MMA would not require the use of a flight engineer. Systems monitoring and routine servicing will have to be completed by the pilots and sensor operators.<sup>20</sup> This elimination of a crew station will also offer financial savings to the Navy. It is unclear as of yet how many sensor operators the MMA will require but one can imagine the need for at least 3 or possibly 4.

Boeing still must answer many questions. These issues relate to fuel capacity, endurance, and range with its converted airliner. Adding external wing mounted weapons and managing to keep the current inventory of Navy torpedoes above freezing temperatures, will also certainly present a challenge for the company. Locating a MAD head just below the vertical stabilizer and rudder may also be difficult since the Auxiliary Power Unit (APU) is presently occupying that space. Placing the MAD head in an alternate location such as at the end of a horizontal stabilizer may prove feasible. The increased electrical load will probably require the addition of higher output generators, which should be surmountable. G loading with a commercial variant may pose challenges to Boeing, since the airframe was designed for passenger comfort and economy and not for combat patrols.

Lockheed Martin is planning to offer the Navy an improved P-3 named Orion-21. The Orion – 21 venture is a fully modernized production aircraft that boasts new engines and propellers. Although Lockheed Martin lacks the existing commercial support

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<sup>19</sup> The author believes that comparing airline use to Navy use is insufficient and that more testing needs to be accomplished. The author does however believe the CFM-56 engine is reliable in a salt environment and in a worst-case scenario the engine would require slightly more preventative maintenance.

<sup>20</sup> During the author's assignment flying 737's, pilots accomplished routine servicing such as fueling and maintaining oil levels.

network, they do have a strong reputation built on the longevity of the current P-3. Lockheed Martin's version will offer a new turbo propeller power-plant that would be more fuel-efficient than a jet driven engine when operated at low altitudes. Endurance and range will probably not be much of an issue for the veteran builders of patrol aircraft. The Orion-21 is envisioned to have a completely new and modernized flight station utilizing the latest technologies. The Orion-21's crew composition is expected to remain very similar to that of the existing P-3. Slow speed flight and maneuvering characteristics should also be expectedly comfortable since Orion-21 will capitalize on the existing P-3 performance.

From a systems architecture standpoint the Lockheed Martin offer should fair well with its history in military avionics, however, there are doubts as to how cost effective it will be to start up a new production line for the airframe. The new Orion-21 will require a completely new airframe, hydraulic, and electrical system: an airframe not currently in production. Undoubtedly, Lockheed has the reputation and the capacity to build a superb ASW aircraft. However, the cost to benefit ratio may exceed Navy allocations.

## VI. UNMANNED AERIAL VEHICLES

The Navy is currently searching for a long range, long endurance UAV to serve as an adjunct support mechanism for the MPRF and desires an IOC of 2008. The Navy's Broad Area Maritime Surveillance (BAMS) UAV program is currently conducting briefings to potential bidders and hopes to have the UAV program up and running as soon as possible. Funding problems have already hit the UAV program during its initial stages and may prevent the UAV from operating within the fleet by its desired date. The Navy would like to use existing UAV technology and make only minor adjustments. The UAV acquisition process is linked to MMA in that any money put forward for UAV growth most likely will come out of the MMA budget.

The Navy is purchasing two, Global Hawk UAV's and expects delivery in 2005. The initial purchase is being called the Global Hawk Maritime Demonstration (GHMD) and will be utilized for Training, Tactics, and Procedures (TTP). The TTP will allow the Navy to utilize the UAV in real life operations and develop future doctrine as they gain experience. TTP will provide insights in order to determine the optimum employment practices and to familiarize the fleet with the capabilities the UAV has to offer. Although the Navy is purchasing the Global Hawk UAV, it has not ruled out other options. The Navy has not yet determined how and what manner the UAV will be deployed, although some have suggested the pairing of UAV and MMA, since both would be providing a large portion of the Navy's and Joint Force's ISR information. It does make sense to at least base the two assets at the same location, since they both provide the same type of information in relatively the same format.

The Navy desires an adjunct ISR platform that supports MMA in many regards. The BAMS UAV project will notionally provide persistent ISR of both maritime and land targets. Desired capabilities include; minimal strike support, Signals Intelligence (SIGINT), and SAR/ISAR imagery. The Navy envisions a direct exchange and interface between manned and unmanned platforms in order to enhance battle space awareness. There is not a clear need, at least not from a Naval standpoint, that the Navy's UAV's will need to be flown in the continental United States. Homeland Defense ISR will probably be directed towards Coast Guard or Air Force units. The more likely scenario is that the Navy will employ shore based UAV's co-located with current P-3 deployment sites. The co-location should provide a synergistic effect, especially if MMA achieves interoperability with the UAV's.

The Navy has recently demonstrated successful airborne control of an Aerolight UAV. Using a NP-3C (modified P-3 Orion) named "Harry Buffalo", the Navy achieved Level IV control of the UAV and its sensors. Level IV entails full control except for the take off and landing portion of flight. The modified P-3 acted as the airborne command and control platform, utilizing the UAV and its sensors in a test and evaluation flight. During the test flight the UAV successfully relayed imagery and other ISR data. UAV's have the potential to fully support MMA in ISR operations, especially in areas in which crew safety may become jeopardized.

A detachment of UAV's could support the regional Combatant Commander and provide continual ISR coverage with minimum risk to personnel and considerable savings to the Navy. The full potential of UAV employment and its role within MMA

remains unclear. However, a safe assumption can be made that future UAV employment will marry to MMA in some form or another.

## VII. FUTURE OPERATIONS / RECOMMENDATIONS

Doctrinally, the MPRF must continue to focus on its core competency of ASW. The fallout capabilities such as strike, ISR, and interdiction (leadership, drug, or arms) will always be inherent in a multi sensor – long-range capable airframe. ASW is a perishable skill and maintaining a solid proficiency in ASW will support the secondary missions of the MPRF. The MPRF must be experts in ASW. This expertise will fully support and enable Sea Basing concepts. Sea Basing will not be possible as long as there is a realistic submarine threat. Just as mining has the capability to deter or reduce U.S. Naval presence within the littorals, submarine warfare has the very same effect upon a blue-water, sea based Navy.

The Navy needs to continue funding the AIP upgrades. AIP aircraft are in demand by commanders and we simply do not have enough to meet current commitments. Present AIP aircraft procurement rates make it difficult to maintain the same capabilities without placing flight restrictions on aircraft in use. Many of the AIP aircraft have exceeded their FLE and will continue to do so without intervention, such as early retirement or imposing flight restrictions. The answer should not entail flying the aircraft more gingerly, rather rectifying the current corrosion problems and expediting the MMA procurement process. The Navy has identified dozens of prospective airframes that have sufficient flight hours remaining to make it economically feasible for the installation of AIP. A long-term plan needs to be identified and approved by Congress so the optimum use of money and airframes can be set in motion.

The Navy should procure the Boeing 737 variant. The two factors that drive this decision are Boeing 737's are currently in production and the support infrastructure that Boeing offers. A commercial derivative aircraft is truly transformational and the Navy's use of an existing commercial maintenance support mechanism is a step in the right direction, regarding fiscal shrewdness. The 737 is a capable and very reliable aircraft. If Boeing can meet the Navy's requirements within the MMA concept the Navy will procure an aircraft that truly meets the expectations of Multi-mission.

Challenges remain:

- A. Adding weapons to a commercial variant will be a challenge. Additionally, attempting to maintain torpedoes within an operable temperature range will also present a difficult task. By cutting a bomb bay into the 737 the manufacturer will no doubt face structural constraints and added costs. Perhaps a method of externally maintaining temperatures within limits while the torpedo is hung from a wing station may be the solution.
- B. G loading and tolerances will be an issue. A 737-700 variant has original limitations designed for fuel economy and passenger safety. Performing passive ASW at low altitudes currently requires significant maneuvering abilities. Engineers may have to strengthen the airframe and wings in order to improve maneuvering ability. Changing ASW tactics from a passive to a more active prosecution may relax the requirement for current maneuverability. With the reduced noise signature of today's submarine

threat, Extended Echo Ranging (EER) and traditional active tactics may be the wave of the future.

- C. Endurance and range will raise questions. Competing against the P-3 Orion in terms of fuel economy and endurance is a difficult task. However, technology has made the jet engine more fuel efficient than previous years. The additional fuel storage capability will allow the 737 to fall within Navy requirements and aerial refueling greatly reduces limitations. Low-level flight will of course result in greater inefficiencies for the jet engine (CFM-56), however, the speed advantage presented by the 737 greatly enhances available on station time. A fully loaded 737 MMA should reach cruise altitudes between FL310 and FL370. The maximum range airspeed will greatly exceed a propeller driven aircraft resulting in improved fuel economy.

The MMA must incorporate systems that enable it to fight within the joint and coalition community. Installing systems such as the Tactical Common Data Link (TCDL) and Joint Tactical Radio System (JTRS) is essential for joint operations in today's world. Joint warfighting requires interoperability and broad-spectrum communications. "MMA will be capable of searching, detecting, locating, classifying, identifying, targeting, and conducting limited battle damage assessment on electronic emitters."<sup>21</sup> The Joint Requirement Oversight Council (JROC) can utilize MMA as a

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<sup>21</sup> CONOPS for the Search and Attack Variant of the Multi-Mission Maritime Aircraft (MMA), November 2001.

benchmark for joint acquisitions and at a very minimum ensure interoperability within the joint battle space.

MMA has the potential to offer transformational warfighting capabilities utilizing portions of a commercial support infrastructure. The capabilities contained within MMA paired with the endurance of a long range / long endurance aircraft will provide the Combatant Commander with previously unrecognized ASW and ISR superiority. The open architecture of MMA provides for technological growth and improvement, extending operational superiority for decades.

## VIII. CONCLUSION

Although the Lockheed P-3 has proven itself as an all weather warrior and helped win the Cold War, she has reached the effective end of her service life. Joint warfighting requires transformational concepts and the application of new technologies. “MMA is envisioned to address three main elements of the Defense Strategy: shape the international security environment, respond to a full spectrum of crisis, and prepare for an uncertain future.”<sup>22</sup> The Boeing 737 variant and associated support infrastructure will provide the Navy the capability to fully support the current National Defense Strategy, and those to follow. Open architecture permits system growth, flexibility, and adaptability with minimum cost. The MPRF will undoubtedly undertake many changes over the next few decades. Investing in MMA at this juncture will enable maritime and littoral superiority with regards to ASW, ASU, and ISR type missions. “We must build and maintain our defenses beyond challenge.”<sup>23</sup>

ASW and ISR will be the mainstays for the MPRF for the foreseeable future. As MMA technologies develop, so will the proliferation of world submarines and asymmetric threats. To counter the asymmetric threats against the U.S. and her partners, the Navy will require enhanced ISR capabilities. Sea basing will require a return to ASW excellence and quite possibly a change in tactics and doctrine. The sea based Navy can’t afford or permit an enemy submarine to become unlocated within their battle space. Accurate and aggressive tactics must be sought in order to create a submarine free area, which enables the fleet to operate at will.

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<sup>22</sup> CONOPS for the Search and Attack Variant of the Multi-Mission Maritime Aircraft (MMA), November 2001.

<sup>23</sup> The National Security Strategy of the United States of America, September 2002, - 29.

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