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14. ABSTRACT

The procurement of the Amphibious Combat Vehicle (ACV) into the USMC's armor community facilitates an opportunity to capitalize on a modern armored vehicle to develop a Family of Vehicles (FoV) that can fulfill the community specific requirements of the Tank, Assault Amphibian, and Light Armored Vehicle Community's. Faced with an obsolete inventory of armored vehicles coupled with languishing Joint supporting capabilities to conduct an amphibious assault of a hostile shoreline, the USMC must take the opportunity now, to develop its armored vehicle fleet into a self-deploying, self-sustaining, interoperable fleet of vehicles. The Amphibious Combat Vehicle's ability to add additional weight in the form of weapon and armor requirements while still remaining buoyant allows a mutually supporting group of vehicles to be developed that can reinvigorate the USMC's ability to conduct surface amphibious assaults.

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Armor Evolution 2025: Surface Assault in the Littorals

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Executive Summary

Title: Armor Evolution 2025: Surface Assault in the Littorals

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Thesis: The USMC must develop the Amphibious Combat Vehicle (ACV) into a Family of Vehicles (FoV) with complementary capabilities that can be used as a catalyst to recapitalize the ability to conduct a surface amphibious assault.

Discussion: The USMC armor community is presently comprised of three vehicle families: M1A1 Tank, Amphibious Assault Vehicle (AAV), and Light Armored Vehicle (LAV). These platforms were developed in the 1970's and 1980's and are now approaching obsolescence or are not suitable for current or future operations in the littorals. The USMC historically maintained an armored force that was capable of conducting surface amphibious assaults; that armored force diminished prior to the Gulf War and has never regained prominence. The 1990's brought about the recognition for an amphibious triad capable of over-the-horizon operations for ship-to-objective or ship-to-shore operations. This came to partial fruition with the MV-22 Osprey and Landing Craft Air Cushion (LCAC). The Advanced Amphibious Assault Vehicle (AAAV)/Expeditionary Fighting Vehicle (EFV) was cancelled and with it went the USMC's hopes of fighting its way ashore via surface combat. Since that cancellation, amphibious warfare has taken a back-seat to protracted land operations. Recently, via the publishing of multiple service-level concepts, the USMC is attempting to re-orient itself on amphibious warfare. In doing so it finds that itself and the Navy have allowed their capabilities and capacities to conduct a surface amphibious assault to diminish. The 2000's thus far have seen the USMC place great emphasis on the procurement of vertical assault support assets. The USMC was not alone in this endeavor: the Joint force as a whole has placed great emphasis on aircraft, much to the detriment of surface capabilities. As a result, potential adversaries have diligently procured anti-air weapons that will make the skies above hostile objectives increasingly risky for the employment of helicopters and fixed-wing aircraft. This partially facilitates the requirement for a reinvigorated surface, amphibious assault force. With languishing capability and the increased competencies of adversarial actors, now is the time for the USMC to rethink its approach to a surface amphibious assault. Fortunately, a new vehicle in the form of the Amphibious Combat Vehicle (ACV) allows it to do just that. It can conduct ship-to-objective maneuver without pause, in multiple configurations, and can be purchased at relatively low costs.

Conclusion: ACV FoV should replace current M1A1, AAV, and LAV platforms in the USMC inventory to achieve a credible surface amphibious assault force with type commonality. This will economically modernize the armored vehicle inventory and subsequently create a force with which to conduct a surface amphibious assault against a contested beachhead. This will generate enhanced capability to the joint service while posturing the USMC armor community for the next several decades of amphibious combat.

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A Vision towards the Future

The United States Marine Corps (USMC) holds a unique position in the Department of Defense (DOD) as the advocate for amphibious operations. Unique within its roles and responsibilities lies the capability to conduct surface amphibious assault operations. The amphibious assault is an inherently complex and risky operation that has become increasingly difficult to execute with the proliferation of area denial weaponry that mitigates the Joint-force's surface and vertical assault elements. While the USMC claims to be able to accomplish a surface amphibious assault, it is not appropriately equipped to do so. There are existing capability gaps that will only increase in the future as adversarial abilities increase. In the surface realm, this requires an honest assessment of the USMC's armor capabilities and their purpose. The realization must be made that the current inventory of armored vehicles does little to support the current and future necessity to be able to execute a surface penetration of an enemy defense as part of a littoral campaign. Although not operating in isolation, the forthcoming Amphibious Combat Vehicle (ACV) offers a solution with which to vigorously renew surface capabilities to conduct an amphibious assault. The USMC must develop the ACV into a Family of Vehicles (FoV) with complementary capabilities that can be used as a catalyst to recapitalize the ability to conduct a surface amphibious assault.

In order to understand how the USMC entered into its current languished state to conduct surface amphibious assaults, a historic lens is required to look at the development of armored platforms from their advent in 1916, through the fast developments of the mid 1900's, up until their complete stagnation in the 1990's. After analysis of the current state of the USMC armor community, a look at responsibilities, doctrine, and concepts is required to review one of the fundamental missions of the USMC; seizing, securing, and defending lodgments. Furthermore,

the prominence of the amphibious assault against adversaries has been re-hashed in recent media events involving senior USMC leadership and is key to future developments. In addition, knowing the USMC will never conduct a surface amphibious assault in isolation, a review is required of the Navy's deteriorating capabilities that have partially contributed to the development of the precarious state that the USMC finds itself in. Finally, a cost effective solution will be offered that recapitalizes the armored force of the USMC and reorients it in whole for the execution of littoral region combat.

A Historical View of Marine Armor

In 1916 the USMC delved into armor experimentation with an armored car; the King 1917 Armored Car, which was subsequently used in operations in Haiti.[1] In 1923, it obtained Six Ton Tanks for experimentation, and thus saw the birth of the Tank Community.[2] Further development in tank platforms in the late 1930's saw the USMC attached to the Army for tank procurement in the form of the M3A1 light tank, a reliance that continues to this day.[3] In 1939, General Moses, the President of the USMC equipment board, convinced the Roebling brothers to militarize a version of their Alligator platform, which became the Landing Vehicle Tracked - 1 (LVT-1)[4] to be utilized as a support vehicle. The Assault Amphibian Community was born. During the island hopping campaign through the Solomon Islands, the M3A1 and LVT-1 displayed their limitations, most notably in their light armor and armament. Both platforms were too thinly armored for the vicious combat at close proximity that occurred with Japanese Forces. As a result, the USMC procured the M4A1 medium tank while the LVT-1 saw hastily applied armor improvements in preparation for fighting in the Gilbert Islands.[5]

The advance into the Gilbert Islands saw the advent of new Japanese tactics, defense at the water's edge. After the bloodshed at the Battle of Tarawa, with many LVT-1s and M4A1

tanks destroyed and inoperable, the USMC realized that it needed amphibious firepower, firepower that could fight its way into a contested beach-head. The machine guns mounted to LVT-1s had proven their limitations against fixed fortifications and the inabilities of the M4A1 tank to ford ashore had proven disastrous, to the detriment of Marine infantrymen.[6] Furthermore, the Battle of Tarawa showed the inherent limitations of naval gunfire support. Naval gunfire and aircraft delivered thousands of tons of naval ordnance to little effect on the defenders who were well prepared to withstand the bombardment.[7] What was required was firepower in support of infantrymen that could be used from the seaward side of the landing, through subsequent operations ashore. Subsequently, the M5A1 light tank turret was adapted to the LVT-1 platform, facilitating an amphibious tank platform termed the Amtank or LVT(A)-1.[8] Doctrinal changes were required with the advent of the new platform. The Amtank led assaults as Wave 0, providing direct fire onto the enemy held beachhead. At the surf zone they would maneuver left or right, out of the boat lane while continuing to provide fire support while Wave 1 and subsequent follow-on waves hit the beach with LVT's and deployed the infantry.[9] Fire support was continuous although inaccurate given the lack of weapon stabilization, but the concept proved itself. Follow-on waves would bring M4A1 tanks ashore via traditional landing craft. Due to its light weight and firepower, the Amtank could not supplant the M4A1 tank in land warfare, but it did give an unprecedented capability in firepower from the water.

As the Pacific Campaign continued into the Marianas Islands, the Amtank gained in lethality. The M8 howitzer was coupled to the newly enhanced LVT-4 platform giving the infantryman support in the form of a 75mm howitzer to be utilized in the direct or indirect fire support role while maneuvering, further enhancing the ability to reduce Japanese fortifications.[10] At the conclusion of World War II, the USMC had extensive capabilities for surface amphibious

assaults. The LVT(A)-4 gave the infantryman an amphibious tank; the LVT-4 gave them an amphibious armored personnel carrier and the M4A1 gave them a tank for protracted land operations.[11] This was the heyday of Marine Armor; the leaps and bounds made in six years surpassed any other period of armored platform development to this day.

When the Marines went ashore at Inchon early in the Korean War their capability pertaining to armored vehicles and their use in amphibious operations had not advanced.[12] Only the introduction of the M26 Pershing to replace the M4 had advanced the tank platform. In the following interwar period prior to the Vietnam War, the USMC replaced its amphibious LVT-4s and LVT-5s with a new LVTP-5 and LVTH-6, personnel, and fire support variants. The new LVTH-6 incorporated a stabilized 105mm howitzer, continuing the capability of providing fire support through all aspects of an amphibious assault.[13] Tank units saw the replacement of the M26 with the M48. Although a few unimpactful amphibious assaults were conducted in the Vietnam War, the vehicles served with distinction in protracted land warfare.

1. A Vietnam era LVTH-6 (Source: Zonwar)

2. A Gulf War era AAV-7 (Source: Military Factory)

The post-Vietnam War era saw drastic reductions in capabilities to conduct surface amphibious assaults as the advent of the LVTP-7, later to become the Amphibious Assault Vehicle (AAV) -7 was strictly developed as an Armored Personnel Carrier (APC).[14] Gone was the Amtank and with it, heavy fire support to the infantry during an amphibious assault. Tank

units advanced from the M48 to the M60, and the introduction of the Light Armored Vehicle (LAV) to USMC units in 1983 added an armored reconnaissance asset to the force and gave birth to the Light Armored Reconnaissance Community.[15] The M60, AAV-7, and LAV would form the nucleus of USMC armor for the Gulf War. During planning, USMC amphibious assault capability was deemed inadequate by General Schwarzkopf's staff due to the AAVs thin armor which was unsuitable in the assault role against modern-day defensive measures employed by the Iraqis.[16] The Iraqi Army had seeded the Kuwaiti and Iraqi coastline with obstacles reinforced with sixty-eight thousand troops, tanks, and artillery. In essence, the Iraqis defended everywhere along the coastline, and the lack of armored amphibious assets to penetrate this defense shelved the plans for an amphibious assault. The 1991 Gulf War exposed the ugly truth that the USMC did not possess the requisite equipment to penetrate an enemy defense utilizing a surface amphibious assault. The implications of this decision should have enlightened USMC leadership as to its languishing capabilities to conduct such an operation. This was the last opportunity for a major amphibious assault in decades and the USMC was seen as incapable of doing it, and since, has done nothing to rectify the capability gap. The inability to overcome an enemy land and water-based obstacle plan and penetrate a defense must be rectified and must be done so by the USMC and its armor community.

The Present State of Marine Armor

USMC armor platforms are currently inadequate in their ability to conduct a surface amphibious assault. The AAVP7 still soldiers on from its inception in 1970 as the asset to conduct ship-to-objective maneuver, it is still predominantly the same platform it was a half-century ago.[17] [18] It has been misused on occasion as an Infantry Fighting Vehicle (IFV) instead of an APC. An IFV should possess similar capabilities to an MBT in mobility and survivability,

with lethality to fight with the infantry, characteristics not inherent in the AAV.[19] The label 'Amphibious Assault Vehicle' is misleading, it is not truly an assault vehicle, nor were its forbearers. The ACV, planned as a supplemental vehicle to the AAV will enhance mobility and survivability while doing little to advance lethality in its current APC variation.[20]

The M1A1 Main Battle Tank (MBT) continues its service and has received multiple upgrades since its inception in the Gulf War.[21] The M1 is arguably the best MBT in service today. Nevertheless, its extreme weight and exorbitant sustainability requirements deprive the USMC of a vehicle light and lethal enough to enhance littoral combat. Requiring Naval connectors to get the M1 and its sustainment from amphibious shipping to shore further exacerbates the issue of an MBT's relevance to the USMC. An option would be to pursue a vehicle that provides infantry support similar to that of the historic Amtank. In doing so, the USMC can unhinge itself from the reliance on Army tank procurement that it has had since the 1930's and create its own.

The Light Armored Reconnaissance community and its LAV platform are also aging. It too has received upgrades to remain relevant in current conflict but has displayed limitations.[22] Originally designed with a minor amphibious capability, this has been negated with additional survivability measures. The LAV, like the M1A1, does nothing to meet the USMC's requirements to conduct surface amphibious combat. It relies on naval connectors for amphibious mobility and its light weight armor degrades its survivability. A unique platform, purposely built like the AAV to address USMC specific requirements, the community must procure a new vehicle to make it relevant to amphibious operations.

The overarching theme throughout the USMC armor community is obsolescence. At the recent Ground Combat Element (GCE), Operational Advisory Group held in September 2017, the Assault Amphibian Community ranked obsolescence and modernization as their first priority, the Light Armored Reconnaissance Community ranked it as their second priority, and the Tank Community ranked it as their third priority.[23] [24] [25] The commanders in the operating forces are voicing their concerns; their vehicles need replacing now.

Governance of Future Surface Combat Strategy

The USMC is mandated to have the capability to successfully conduct amphibious assaults. It is bound by its United States Code, Title 10 requirements to "seize and defend advanced naval bases and conduct land operations as may be essential in the prosecution of a naval campaign."[26] DOD Directive 5100.1 stipulates that the USMC will conduct "amphibious operations to assure access."[27] Seize, defend, and access are terms that have terrain implications. Therefore, it requires a surface assault force to access and seize terrain and when permissible, defend it. Joint Publication (JP) 3-18, Joint Forcible Entry Operations, states the requirement for "the entry, seizure, and holding of lodgments against armed opposition requires synchronized, violent, and rapid execution."[28] Despite the requirements, the Navy/USMC team does not possess the requisite equipment to penetrate coastal defenses. It should be able to dominate its opponents in littoral combat; currently it cannot due to inadequate armor and Naval capabilities.[29] JP 3-18 further states that "initial assault forces are vulnerable, due to their lack of fire support from naval platforms and aircraft."[30] This begs the question, why is the USMC reliant upon Naval fires for the prosecution of surface amphibious assaults? The Marines of World War II developed their own direct and indirect fire capabilities with the LVT(A)-1 and 4 so they didn't have this excessive dependence on the Navy. As the World War II and Gulf War

experiences demonstrated, amphibious fire support should be inherent in USMC armor platforms.

The requirement to conduct surface amphibious assault operations has been further outlined in the concepts *Marine Corps Operating Concept (MOC)* and *Littoral Operations in a Contested Environment (LOCE).* A vignette in the *MOC* states a surface littoral force "had to contest with mines and obstacles, which were overcome with massed fires" and they had the ability to "block an advancing enemy mechanized force."[31] [32] The current USMC armor community does not possess organic waterborne mobility with the requisite firepower to support these statements. The *LOCE* acknowledges that "following the Cold War, some surface force capabilities and capacities for sea control were de-emphasized and have eroded over time."[33] This acknowledgment in a service-defining concept emphasizes the need to redevelop amphibious warfare. A new armor platform could revitalize the Navy/USMC team's abilities with new capabilities in the seaward and landward dimensions of a Naval campaign outlined in the LOCE's central idea.[34] An armor platform can deliberately answer the proposed capabilities of enhanced fires, maneuver, protection, and sustainment.[35]

The USMC Ground Combat and Tactical Vehicle Strategy (GCTVS), aligns the armor community's acquisition and sustainment plans with concepts such as the *MOC* based on affordability and risk analysis.[36] The most recent version, published 1 December 2017, maintains the AAV and LAV to 2035 and M1A1 to 2050. Preserving these aging platforms contradicts the aspirations of the strategy that "the USMC must proactively change to meet the demands of the future operating environment of 2025 and beyond."[37] For the M1A1, the USMC has nested its future in reliance on the Army for MBT development. While vehicle upgrades will continue, the M1A1 currently does little to enhance the ability to project power in the littorals.[38] The USMC

must analyze its need for an MBT when the Army is questioning its replacement of the M1 and moving to lighter platforms to enhance strategic mobility. The LAV's future looks slightly less bleak, spanning to 2035.[39] Yet, the LAV has already been proclaimed by its community to be obsolete, today. The Assault Amphibian Community fares only slightly better, with supplemental ACVs receiving Initial Operating Capability (IOC) in 2020 while enhanced AAVs are projected to have IOC in 2019.[40] The GCTVS does articulate the requirements for "a surface, amphibious assault capability in the littoral environment that must be deployable, employable, and sustainable given the power projection means available."[41] It does not give a solution to that requirement through its continued use of antiquated platforms. The USMC needs an evolutionary GCTVS that recognizes the need for community integration into a single platform with multiple mission variants that restores the viability of a surface amphibious assault.

The USMC's senior leadership has signaled the need to develop new capabilities that allow the service to fight their way into opposed areas. General Neller, recently opined that the forces would have to "operate seamlessly over land and sea."[42] This implies that a surface amphibious assault force will have to contest with numerous threats as it transitions from shipping to the objective. He further proclaimed "Marines moving from ship to land will be ever more reliant on the vehicles that get them there" and "sustainment associated with landings must be reduced to avoid targeting."[43] General Neller's acknowledgment of the requirement for vehicles that are amphibious capable is further proclamation to the inherent necessity for the USMC to acquire new vehicles that can conduct sea and land maneuver with reduced signatures. Lieutenant General Walsh recently stated that he wants to see "major advancements in armored platforms, similar to what the F-35 Lighting was to the AV-8B Harrier."[44] He was speaking in reference to the LAV replacement however, his remarks are relevant to the whole armor

community. The technological leap from the AV-8B to the F-35 depicts the leap required within the armor community. Furthermore, during recent amphibious experimentation, his stated priorities were: "ship-to-shore maneuver, amphibious fire support and effects, clearance of amphibious assault lanes, amphibious command and control, and amphibious information warfare."[45] New armored platforms could accomplish many of these tasks. The requirements and recommendations for a surface force to project itself onto a contested beach head is currently unachievable and requires material solutions which are available today in armored platforms.

Drivers of Change: The Enemy

The current focus of joint military capability is on the preparation for conflict based on inter-state strategic competition with China, Russia, Iran, and North Korea.[46] These four countries have vast coastlines, defensible by conventional means. All four have gained technology proliferation in area denial weapon systems; from anti-ship missiles to large caliber weapon systems to mines and IEDs, with which to counter a naval flottila.[47] If the Navy and USMC desire to compete in the littoral domains they must accept risk in maneuvering a surface assault force close enough to project itself onto an adversary coastline. Exploitable gaps would be ideal however, adversaries will likely deny that freedom by conducting a linear defense coupled with a mobile reserve in an attempt to rupture any amphibious assault attempted. The Navy/USMC team will have to directly assault a defense, a seam in an adversary's defense may not be prevalent. This lends the requirement to have a viable amphibious armor capability to penetrate defended coastlines and conduct immediate exploitation.

The proliferation of sophisticated Integrated Air Defense Systems and cost-efficient Man-Portable Air-Defense Systems that are difficult to detect and neutralize, will make it increasingly difficult to conduct airborne assault operations without the possibility of drastic losses.

Adversarial abilities to down assault support helicopters may render a vertical assault option untenable. In addition to air-to-air and surface-to-surface missile and projectile usage, the employment of small boat and drone swarming tactics by adversaries is worrisome. Currently, no platform exists to defend a surface amphibious assault from this threat. Aviation assets could provide a level protection but they too would be targeted and are limited in loiter time and munitions. The Joint force, particularly via shaping fires, will play a large role in the neutralization of many adversarial systems. A surface amphibious assault force will never operate in isolation. However, the Joint-force's ability to obtain air and sea supremacy is highly debatable in the future and even the ability to gain superiority for a desired duration in a particular area is questionable. Thus, there is a requirement for a surface amphibious assault force to be able to defend itself from air and waterborne threats during sea and land maneuver. These threats require the adoption of stabilized weapons to defend surface formations during maneuver, thus facilitating self-defense and force protection internally to the formation.

Drivers of Change: Naval Fires

Historically, surface amphibious assault operations have relied upon fires from sea-based platforms that typically used large-caliber shells fired at high velocity with a flat trajectory, which are undesirable characteristics when used against land targets.[48] Naval gunfire's role in support of an amphibious assault is undeniable. From Gallipoli to the Gulf War, the planning for, and execution of, surface amphibious assaults incorporated a robust naval gunfire plan. Currently, the Navy is inadequately postured to facilitate this support. The largest surface warfare combatants fielded by the Navy have shrunk from Iowa class Battleships armed with nine, sixteen-inch cannons to Ticonderoga class Cruisers armed with two, five-inch cannons.[49] Ticonderoga class Cruisers are scheduled to begin retirement at a rate of two per year beginning

in 2020 with no replacement planned.[50] Additionally, Arleigh Burke class Destroyers employ one, five-inch cannon in contrast to their predecessors of the Spruance class that maintained two.[51] The volume and scale of firepower that could be delivered during a surface amphibious assault is minuscule in comparison to what it once was. Vertical Launch Systems employing precision missiles have replaced cannons aboard surface combatants. Unfortunately, these weapon systems cannot actively conduct suppression and are extremely expensive. The complete decline of Naval gunfire has left surface assault elements with inadequate support. As a result, the USMC has no choice but to rely on its own direct and indirect weapon systems to provide fires. Armor platforms with large caliber direct and indirect cannons and mortars that can fire while conducting water maneuver are required. A move away from reliance on Naval fires and establishing the capability within the armor community will address this critical USMC vulnerability.

Drivers of Change: Connectors

The USMC relies on Naval connectors to transport M1A1's and LAV's from ship to shore. Connectors currently consist of thirty-two Landing Craft Utility's (LCU) and seventy-two Landing Craft Air Cushion's (LCAC).[52] Both platforms have provided decades of invaluable heavy-lift service, but the LCU is now over forty years old while the LCAC is almost thirty years old.[53] The LCAC trades capacity for speed and is limited to a seventy-ton payload while maneuvering at over forty knots. By comparison, the LCU trades speed for capacity, being able to lift up to one hundred and eighty tons but is limited to a speed of eleven knots.[54] While these platforms do provide lift, their employment is cumbersome, they require swaths of well-deck storage space, and are relatively defenseless. They archaically bring one to two tanks ashore at a time and take significant time to unload thus negating speed and tempo. While the LCAC and the

LCU are scheduled for replacement with modernized versions, LCAC-100 and LCU-1700 respectively, their funding priority rests at the bottom of the Navy's priority list and it is highly unlikely either program will remain fully funded in light of continuing budget compression.[55] Neither program will adequately address the inadequacies of their predecessors, each only having marginal speed and tonnage capacity increases.[56] The insistent reliance upon Naval connectors hamstrings the USMC and its ability to exert influence in littoral region combat. Connectors have their place in littoral region operations, just not in bringing front-line combat units ashore. Their role as an intermediate enabler for sustainment operations is much more suitable to what their capabilities and capacities offer. As such, M1A1 and LAV replacements coupled with the ACV should possess self-deployable abilities to mitigate the reliance on connectors.

The Way Forward, Now

Current and future surface amphibious assault will inherently be highly complex, material intensive, and risky operations. Regardless, the USMC as its nation's premiere amphibious force and advocate for amphibious warfare must develop the capabilities in concert with the Navy to conduct such an intensive operation. An armored flotilla approaching a contested shore that has the capabilities to fight in the air, sea, and land domains may compel adversarial capitulation prior to hostilities. However, it is highly likely they will need to execute an assault, in which case they will require overwhelming firepower and mass in time and space to execute a penetration into an adversary's coastline. The USMC needs new armor platforms that prioritize amphibious combat and possess self-deploying abilities. New platforms should also include significant progress to reducing logistical burdens. As such, the USMC cannot wait to procure new armored platforms. It must do so now and recapitalize the ability to dominate contested amphibious

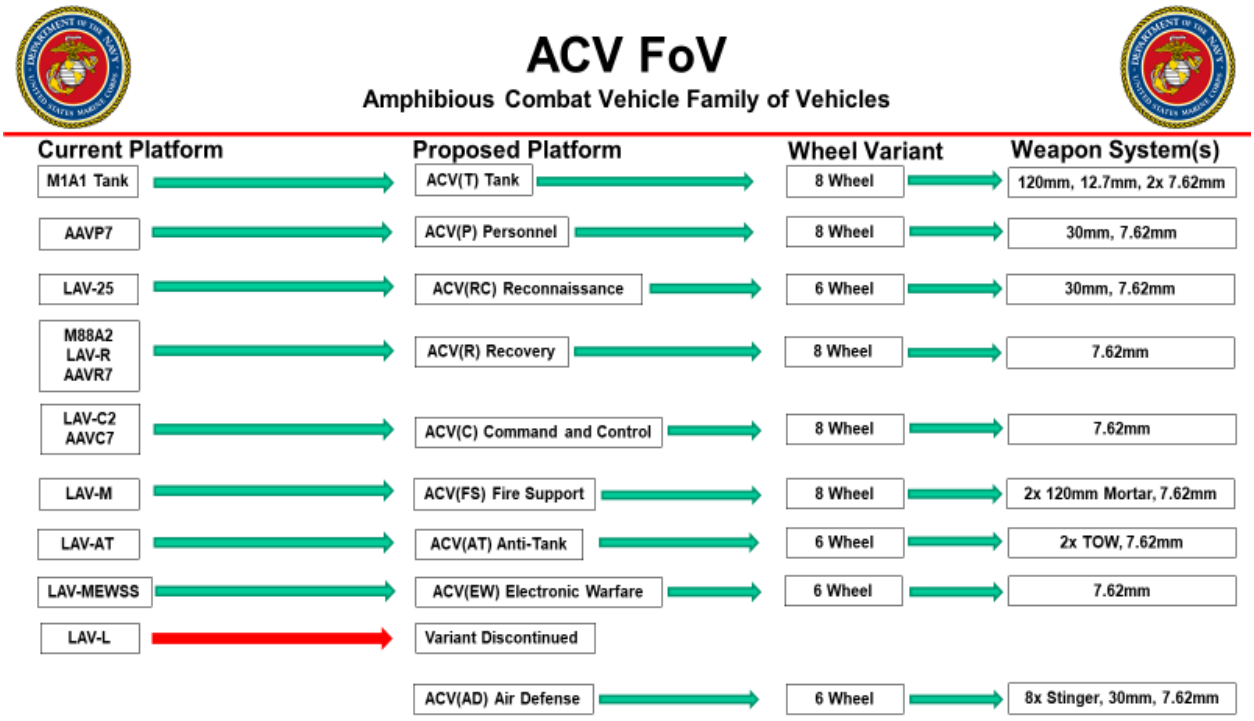
assaults. A force with complementary vehicles would allow an armored amphibious force to operate in multi-domain amphibious combat. With the onset of the ACV, this platform must be used as a catalyst to pursue a Family of Vehicles (FoV) to fulfill the armor community's needs with a focus on littoral operations. ACV FoV must nest the requirements for amphibious combat as the driver for the strategy, design, and procurement of the platform.

3. BAE's entry into the ACV 1.1 Program (Source: BAE)

4. SAIC's entry into the ACV 1.1 Program (Source: SAIC)

The ACV marks a major shift in armored vehicles as it employs wheeled technology instead of tracked technology typically associated with armored vehicles. The adaptation of wheeled technology to a chassis that can be used as an armored vehicle, drastically diminishes the overall weight of the vehicle by deleting steel track, road wheel, and suspension componentry. In this instance, it frees the ACV of weight to bring an optimal solution to amphibious requirements. Both tenders for the ACV, submitted by British Aerospace Engineering (BAE) and Science Applications International Corporation (SAIC) rely on mature, wheeled platforms that are currently in use. These vehicles, originally developed by Iveco Defense Systems and ST Engineering respectively, possess modern survivability and amphibious mobility capabilities that give them a marked advantage over current platforms. The ACV offers a single, chassis platform with the ability to achieve an optimal balance of lethality, mobility, and survivability based on community specific requirements. It facilitates complementary variants

that rely on the same basic hull but varied in optimization for specified roles, all developed to support littoral access. Both manufacturers vying for the ACV contract have built in additional weight capacity in anticipation of additional enhancements to the base vehicle. This additional capacity can be used to develop variants that should include reconnaissance, tank, personnel, command and control, recovery, anti-tank, fire-support, air defense, and electronic warfare platforms.



5. Table of ACV FoV to replace current platforms (Source: Maj, Davis, Justin D. USMC)

Optimized variants of the ACV can replace the three hundred and sixty-five M1A1's, nine hundred and sixty-four AAVs, and six hundred and fifty-five LAVs within the inventory.[57] The tank community currently utilizes two platforms: M1A1 and M88 Recovery Vehicle; the assault amphibian community utilizes three platforms: AAVP7 (Personnel), AAVC7 (Command and Control), and AAVR7 (Recovery); while the light armored reconnaissance community utilizes six platforms: LAV-25 (Reconnaissance), LAV-M (Mortar), LAV-R (Recovery), LAV-

MEWSS (Electronic Warfare), LAV-L (Logistics), LAV-C2 (Command and Control). The use of an ACV Family of Vehicles (FoV) would significantly reduce the number of platforms and logistical demands on the force. For example, the Marines could replace all three recovery vehicle variants with just one platform. Two Command and Control variants can be replaced by one platform. The LAV-L would no longer be required due to the enhanced capacity inherent in all ACV variants. The addition of an air defense platform is recommended to enhance force protection from air threats.

Improve Mobility/Lethality/Survivability

Any armored platform must take into account a triad of factors: mobility, lethality, and survivability. There will inevitably be trade-offs in these categories as one sacrifices for the other to achieve optimization. Finding the optimal solution to cover all mission sets currently executed by the armor community is key. Vehicle mobility in a new armor platform begins with the mass adoption of wheeled technology. A major international growth area in the armored fighting vehicle sector has been the development of six by six and eight by eight armored vehicles.[58] Mobility comes in several forms; that which the vehicle inherently possesses to operate in different terrain and climates, and that required to move it throughout theaters. Water maneuverability from ship-to-shore is imperative in all future USMC armor platforms. The ability for all platforms to have water operability will maximize the commanders' options of where and when to conduct a surface amphibious assault.

Current ACV contenders possess water capability similar to the AAV, with the likelihood for further enhancements prior to mass fielding. While the canceled EFV offered high water speed to conduct water-borne maneuver, the lack of maturity in this technology relegates the USMC to field current capability; water speed already possessed by ACV contenders. The ACV

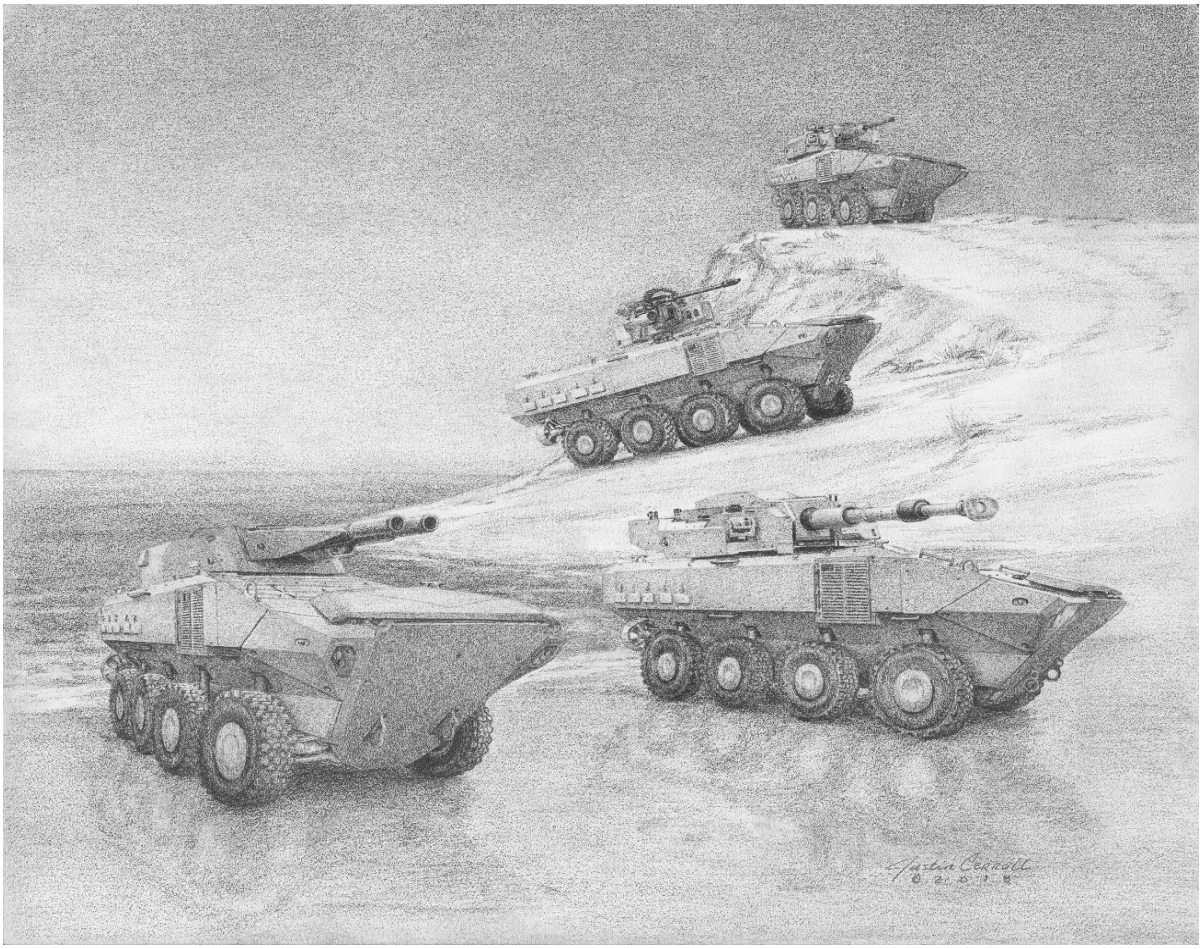
possesses water propulsion systems that operate independently from its suspension and wheel system, therefore adding water mobility to all ACV variants does not detract from land capabilities. Mobility on land must not delve below the current standard that the M1A1 has set, nor does it need to. The ACV has proven it can maintain speed with M1A1's in cross country maneuvers in testing thus far. Its modern-day suspension relies on lessons learned in Iraq and Afghanistan conflicts, utilizing independent suspension systems with multiple drive trains facilitates system redundancy, expedient field repair, and relatively simple upkeep. Switching from a heavy platform like the M1A1 weighing roughly seventy tons, to a lighter and more nimble ACV tank variant that weighs only thirty-five tons, will reduce ground pressure and make more maneuver opportunities accessible to the commander. Furthermore, wheeled vehicles offer the use of many significant operational advantages such as greater strategic mobility and diminished operating and support costs.[59] Strategic mobility through a wheeled platform will be greatly enhanced; its lighter weight equates to increased capacity aboard aircraft, rail, and shipping to move equipment around the world prior to operational employment. The ACV can be developed in six and eight-wheeled models, six for variants of lighter stature, eight for heavier variants. Once deployed, the ACV can utilize a great many roads and bridges that are currently inaccessible by M1A1 tanks. This will directly enhance the maneuverability of Marine armored units while decreasing the need for costly transport vehicles. Wheeled technology is the future of armored vehicle development, its embracement across the armor community will yield dividends in executing operations in the future.

6. ACV(T) and ACV(RC) would look very similar (Source: Cockerill)

7. Potential ACV(T) (Source: Global Security)

Lethality across all armor platforms requires upgrade and subsequent incorporation into the ACV platform, thus facilitating the multiple variants required by tank, assault amphibian, and reconnaissance communities. Three manned turret versions must be developed: ACV Tank (T), ACV Reconnaissance (RC), and ACV Fire Support (FS). The M1A1 currently incorporates a 120mm smoothbore gun coupled with multiple machine guns as secondary armament. The tank version of the ACV would incorporate these weapons systems into an eight wheel platform with similarities to the Italian Centauro II platform, which presently fields a similar weapons arrangement.[60] There are multiple manned turrets currently used on wheeled vehicles that support the use of a 120mm gun, its incorporation into the ACV(T) would provide a stabilized, direct fire gun out to eight thousand meters dependent on the munition used.[61] The recommended turret must achieve commonality with the ACV(RC) variant, therefore a turret solution like that provided by CMI Solutions is recommended (Cockerill XC-8 120HP/CPWS 25-30).[62] The maintaining of a 120mm gun on a tank platform allows for continued commonality with NATO standard ammunition. This vehicle, placed at the lead of any surface amphibious assault, will partially assist in reinvigorating fire support lost by the diminishment of Naval surface fires, thus giving the commander the ability to penetrate with fires, any beach head where vehicles can maneuver.

The ACV(RC) will replace the LAV-25 as the primary mobile ground reconnaissance asset. It will incorporate improved lethality through the use of a 30mm variant of its current M242 25mm Chain Gun. The MK44 30mm variant has already been developed and can be incorporated into a manned turret that will include secondary armament.[63] Secondary armament would consist of either a co-axil or roof mounted 7.62mm Medium Machine Gun (MMG). This turret would look like the current Cockerill CPWS 25-30 and share commonality with the ACV(T) turret system. The final ACV variant with a manned turret will be the ACV(FS) which will replace the LAV-M. ACV(FS) will incorporate a turret equipped with dual stabilized 120mm mortars, similar to the AMOS system currently integrated on Patria eight-wheeled vehicles.



8. (From foreground) Artist rendering of the proposed ACV(FS), ACV(T), ACV(P) and ACV(RC) (Source: Justin Carroll)

This weapon system's high angled trajectory coupled with guided and unguided munitions will provide unparalleled indirect fire capabilities that is appropriate for attacking fortifications and obstacles in comparison to current Naval gunfire. The ability for this vehicle to fire, while maneuvering in the water, from a stabilized platform at targets up to ten thousand meters away, will give a waterborne maneuver force an over the horizon indirect fire capability with far greater effects on targets than Naval gunfire could hope to achieve.[64] ACV(T), ACV(RC), and ACV(FS) will evolve the ability to conduct a surface amphibious assault, no longer reliant on Naval gunfire or connectors and with the ability to achieve greater fire power, shock, and mass while facilitating more options to the force commander.

9. ACV(FS) would look very similar with AMOS turret (Source: Defense Industry Daily)

10. Similarities with the ACV(AD)(Source: 21st Century Armor)

Six turretless versions of the ACV are recommended to be fielded to replace the remaining LAV and AAV variants. All variants will have some form of armament, many only defensive in nature. The ACV Personnel (P) currently planned as ACV 1.1 would feature a stabilized Remote Weapon Station (RWS) reducing the profile of the vehicle while incorporating the same MK44 30mm variant as found in the ACV (RC) coupled with a co-axil MMG. The Kongsberg RWS L-30 provides an off-the-shelf solution to be adapted to the ACV platform, thus finally giving the infantry the firepower they deserve when supported by the ACV(P).[65]

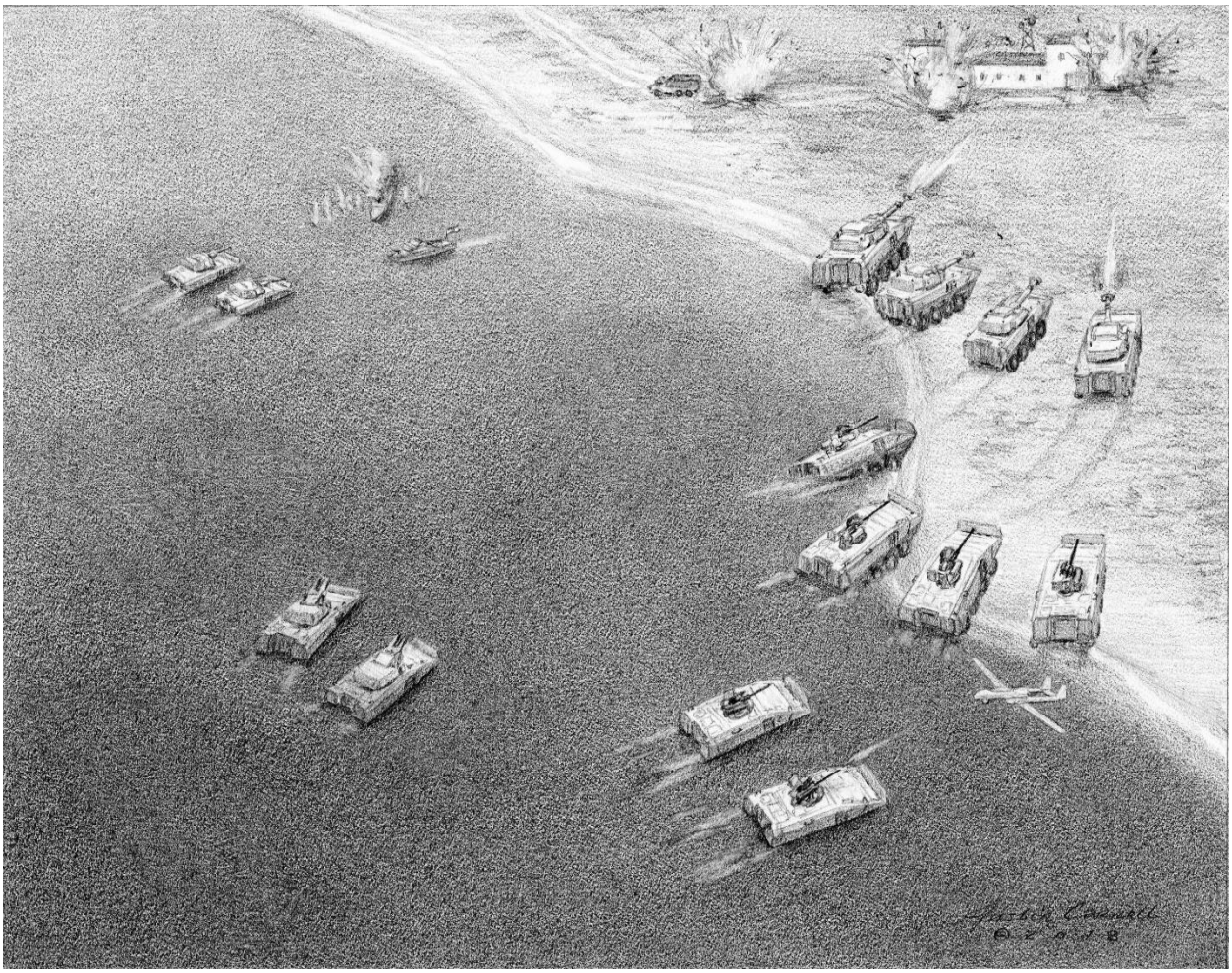
Additionally, the same RWS can be utilized in the ACV Air Defense (AD) variant. This RWS already has provision for Stinger missiles to be matched with the 30mm cannon. The addition of an air-defense platform will greatly expand the force protection of the GCE. The air-defense vehicle will not just be one dimensional, it will be able to provide direct fire gunnery in support of land combat as required. The ACV Anti-Tank (AT) will incorporate the newly developed Raytheon, Tube Launched Optically tracked, Wire-Guided (TOW) M22OE3 launcher system that is presently being incorporated into the obsolete LAV platform, replacing the 1960's era Emerson 901 launcher.[66] Using this new launcher on the ACV(AT) will reduce cost and utilize a modern system. Furthermore, the ACV(AT) will incorporate a MMG for defensive measures. Finally, the ACV Recovery (R), ACV Command and Control (C2), and ACV Electronic Warfare (EW) will incorporate only defensive weaponry in nature due to their role on the battlefield. The turretless versions of the ACV will bring enhanced lethality, force protection, and command and control to the GCE with their vastly superior weaponry and optics from those currently fielded.

The final piece of the armored platform triad is survivability. Recent conflict has shown that modern armor must provide force protection and survival to its crew from a seemingly endless multitude of threats. Potential adversaries possess a myriad of capabilities, from modern cannons to advanced Anti-Tank Guided Missiles (ATGM). Additionally, the threat is not just from direct fire, other devices such as IED's and mines from varying categories have proliferated on the battlefield. Modern armored vehicles have transitioned from flat-bottomed hulls that can only absorb the blast of an under-belly explosion upwards to a V-shaped hull or in some cases a double V-shaped hull to mitigate and redirect blast effects outwards. Lessons learned with the use of Mine Resistant Ambush Protected (MRAP) vehicles has greatly improved survivability and has been incorporated into the ACV. Both variants from BAE and SAIC incorporate a V-

shaped hull. An issue is the composition of armor that should protect the top-side of the vehicle. Inherently there will be trades in armor and weight for mobility to give the ACV FoV water mobility thus mitigating maximum vehicle weight to no more than thirty-five tons. Fortunately, great strides in the advancement of passive and active armor systems have taken place, mitigating the requirement for heavy armor. In passive armor, the movement from traditional steel and aluminum to ceramics has yielded reductions in weight while still maintaining protection against medium-caliber weapon systems up to 30mm Armored Piercing Rounds on eight wheeled vehicles.[67] Additionally, spaced ceramic armor plates and bars add protection against hollow shaped charges typically found in many guided missile and unguided rocket systems. Active Armor Systems or Active Protection Systems such as the Rafael Trophy and Raytheon Quick Kill systems have advanced immensely in the last decade and have proven themselves on the battlefield as force protectors. These light-weight protection systems are being incorporated into Army M1A2 Abrams, M2A1 Bradley, and Stryker platforms while the USMC has planned to deploy the system on the M1A1. Traditional passive armor coupled with active systems facilitate reduced weight and thus water mobility. While these systems will not provide the protection required against an enemy tank main gun round, the likelihood of these systems being deployed against USMC armor is historically low. However, if the USMC desires additional armor for protracted land operations, potentially against enemy tanks, these can be readily supplied in additional armor applique kits that take minimal time to install on the vehicle.

The triad of armored vehicle capabilities belies the requirement to balance mobility, survivability, and lethality. Great advancements in wheeled chassis and tire technology have allowed this type of vehicle to now be fielded at weights previously relegated to the realm of tracked vehicles. These weight gains have been foreseen as being useful in the ACV model and

expandability in increased weight has been pre-built into the current ACV contenders. The USMC's main requirement must be that all variants of the ACV are amphibious capable and can self-deploy from amphibious shipping. Trading weight in traditional armor is required to elevate mobility and lethality. Aside from the survivability provided by the M1A1 in a traditional tank versus tank contest, the levels of mobility, lethality, and survivability afforded by the envisioned ACV FoV far outclasses currently fielded armor platforms. Employing the ACV FoV in a contested surface amphibious assault will allow the commander to conduct a penetration, where and when, of their choosing, thus restoring capability to the USMC and the joint force.



11. Artist rendering of a conceptual amphibious assault against a contested beachhead with proposed ACV variants. Reconnaissance was conducted by ACV(RC) variants that ensured the tenability of the beach for landing. ACV(RC's) have moved to the flank and are engaging enemy small boats while assessing landing sites for follow-on forces. The assault is led by the (ACV)T. Indirect fire support is provided by ACV(FS) located in a waterborne Mortar Firing Position. The initial assault wave is followed by ACV(P's) with embarked infantry Marines. Meanwhile ACV(AD) provides force protection to the formation by engaging an enemy drone overhead[11] (Source: Justin Carroll)

Commonality

By utilizing the envisioned ACV FoV to replace all current armor platforms, the USMC's Ground Combat Element (GCE) will realize the full extent of budget savings associated with platform commonality. Utilizing the same single eight and six wheel chassis and hull structure for a FoV consisting of nine variants to replace the current three different chassis vehicles with twelve different variants will have major cost advantages in development, procurement, and life-cycle sustainment. Wheeled armored vehicle manufacturers are including this major benefit in their cost analysis. Manufacturers Iveco Defense, ST Kinetics, General Dynamics, Mowag, Steyer, Patria, and Rheinmetall have all created wheeled FoV that share the cost benefits from the utilization of a common hull with multiple variations.[68] Manufacturers greatly realize the cost benefits to the using entity of a single chassis to produce multiple variants for reduced procurement and life-cycle costs.

Correlations can be drawn between platform commonality required within the armor community to what is transpiring in the Air Combat Element (ACE) of the USMC. The ACE has realized the benefits of economies of scale reaped from commonality across multiple airframes. The F/A-18A/B/C Hornet, AV-8B Harrier II, and EA-6B Prowler are being replaced by the F-35B/C, a single airframe with variations. The benefit lies in at least twenty five percent commonality with Air Force, Naval, and Allied models in associated airframe parts, software, hardware, and electronics.[69] The ACE is also fielding the AH-1Z Cobra and UH-1Y Huey in which Bell Helicopters achieved eighty-four percent component commonality between the two airframes even though the roles of the aircraft differ.[70] Through the expected life cycle of forty years, the USMC is poised to reap the rewards in supply chain and parts procurement expense mitigation to facilitate diminished life-cycle costs. American and Allied equipment commonality

continues to expand as nations realize the increasingly expensive, old-age thought of producing specific platforms for a singular role is no longer economically viable. Commonality must be embraced by the GCE and in its future armor procurements, it begins with the ACV platform.

The administrative burden associated with three different platforms only exacerbates over the course of their remaining service life. Personnel savings can be found in manpower by transitioning from three current Program Managers and their staffs to one.[71] The elimination of command structures and supporting billets can transition Marines back to the operating forces. While current Military Occupational Specialty's (MOS) would remain in place, positions would be interchangeable due to platform commonality; an ACV(T) Marine could transition to a ACV(RC) Marine and vice versa. ACV drivers would be interchangeable across the whole armor community. The USMC could transition to a single armored mechanic MOS, eliminating at least two. The benefits of moving to a single platform would be immensely positive and would greatly assist manpower management by allowing interchangeability across Tank, Amphibious Assault, and Armored Reconnaissance communities. In addition, the current three school houses that support the armor community could transition to one, centralized, School of Armor, henceforth deleting manpower redundancy and infrastructure costs. These recommended changes in personnel structure would free billets for emerging requirements and reap fiscal benefits.

Logistics burdens associated with maintaining the current three obsolete platforms is unnecessary. The simplicity of going from three chassis to one will simplify parts and supply chain management over the projected life cycle. Both consumable and non-consumable parts inventories would holistically be managed by one service. Maintaining one common type chassis with economical drivetrain features will greatly reduce running costs and logistics requirements. Furthermore, modern diesel engines offer vastly lower consumption rates than that attributed by

vehicles today which will reduce the logistical burden on commanders and mitigates the need for "iron mountain" sustainment. Parts block simplicity in a multi-use platform will further reduce expeditionary supply chains and stockpiles. While the current three platforms maintain some commonalities with Army ones, the USMC is reliant on another service for sustainment versus having a stand-alone vehicle that the USMC develops, therefore, providing a single service dominated, armor program. The benefits of a new modern, multi-variant platform based on the ACV are limitless, the opportunity for this vehicle to replace obsolete armored vehicles in the USMC inventory must be exploited.

Cost

Initial procurement of any piece of military equipment involves great capital investment. Costs can be mitigated by utilizing off-the-shelf technology in pre-existing chassis, turrets, weapons, and communication equipment. Both BAE and SAIC have been awarded contracts of $103.8 million and $121.5 million respectively to each build sixteen vehicles of their ACV contenders.[72] While the individual cost of vehicle per manufacturer remains unknown, based on the contract provided, estimated costs are roughly $6.5 million per developmental vehicle. The final cost per vehicle will be driven significantly lower as the requisition of hundreds of vehicles begins. It would not be unreasonable to expect ACV(T), (RC), and (FS) versions to cost upwards of $6 million per vehicle when system integration and developmental costs have been factored in. In comparison, an M1A2 variant today costs $8.5 million per vehicle.[73] Furthermore, the other six variants of ACV would also increase in cost with mission specific systems integration. These costs would include an active armor system, estimated to cost $350 thousand per vehicle based on current Army contracts.[74] In a direct cost comparison, an ACV(T) would be approximately 25% cheaper than the M1 tank that it would replace. Even with increased costs over the baseline ACV,

these figures pale in comparison to other USMC procurements such as the F-35B/C at $123 million and the CH-53K Heavy lift helicopter at $131 million per airframe.[75] The USMC could outfit its ten armor battalions, depots, and pre-positioned stocks with all new vehicles for the cost of five to six CH-53K or F-35B/C Squadrons. Costs could be further reduced by program integration with Allied nations, that desire an amphibious armored vehicle that currently possess the M1A1, AAV, or the LAV. Australia, Japan, South Korea, Italy, Spain and others, many of whom are members of the F-35 program would likely participate in the program to evolve their amphibious capability. Initial up-front capital expenditure would be significant however, reduced life-cycle costs associated with platform commonality is an appealing benefit over the life span of the vehicle.

Conclusion

The advent of the ACV presents a remarkable opportunity for the USMC and its armor community. The ACV provides the USMC with an effective and timely option to address an existing and critical capabilities gap. A historical context must be applied to present capabilities and capacities, or lack thereof, for the USMC to truly understand how it found itself in the predicament it now faces. Faced with foreseeable, non-permissive littoral operations against adversaries with the ability to develop a robust defense, coupled with the USMC's languishing current armor platforms and a supporting Navy that does not possess the capabilities to adequately support a surface amphibious assault, the USMC must evolve its armored vehicles, now. Recapitalizing its capabilities with a mutually supporting ACV FoV, is the only way the USMC will be able to conduct contested amphibious operations right now and for the next several decades. The ACV FoV provides a multi-variant platform that can fulfill the USMC's need for tank, amphibious assault, and light armored reconnaissance vehicle replacements that will produce a truly amphibious armored force. It will bring unsurpassed maneuver options for a

commander, the ability to generate heavy to light armor forces, the ability to attack where and when of their choosing and above all, the ability to mitigate external reliance. An armor force maneuvering from the sea that can defend itself and exert influence in contested littorals will restore the USMC's ability to conduct surface amphibious assaults and enhance its ability to conduct subsequent operations ashore.

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