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The Army's M-1 Abrams, M-2/M-3 Bradley, and M-1126 Stryker: Background and Issues for Congress

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Summary

The M-1 Abrams Tank, the M-2/M-3 Bradley Fighting Vehicle (BFV), and the M-1126 Stryker Combat Vehicle are the centerpieces of the Army's Armored Brigade Combat Teams (ABCTs) and Stryker Brigade Combat Teams (SBCTs).

In addition to the military effectiveness of these vehicles, Congress is also concerned with the economic aspect of Abrams, Bradley, and Stryker recapitalization and modernization. Due to force structure cuts and lack of Foreign Military Sales (FMS) opportunities, Congress has expressed a great deal of concern with the health of the domestic armored combat vehicle industrial base.

ABCTs and SBCTs constitute the Army's "heavy" ground forces; they provide varying degrees of armored protection and mobility that the Army's light, airborne (parachute), and air assault (helicopter transported) infantry units that constitute Infantry Brigade Combat Teams (IBCTs) do not possess.

These three combat vehicles have a long history of service in the Army. The first M-1 Abrams Tank entered service with the Army in 1980; the M-2/M-3 Bradley Fighting Vehicle in 1981; and the Stryker Combat Vehicle in 2001. Under current Army modernization plans, the Army envisions all three vehicles in service with Active and National Guard forces beyond FY2028.

There are several different versions of these vehicles in service. The Marines, for example, have an older version of the M-1 Abrams tank and the Active Component of the Army has the most modern version of the Abrams while some Army National Guard units have an older version of the M-1. There are also different M-2/M-3 Bradley versions in the Active and Reserve Components and some have called for "pure fleeting" (i.e., all components using the same variant) in both the Active and Reserves so they have the same models.

There are plans to upgrade and modernize these weapon systems but currently only the M-2/M-3 Bradley is scheduled to be replaced by the Future Fighting Vehicle (FFV) sometime after FY2029. The Army has not said much publicly about eventual successors for the M-1 and M-1126.

Potential issues for Congress include "up-gunning" the entire Stryker fleet and the Active Protection Systems (APS) for the Abrams, Bradley, and Stryker.

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Why This Issue Is Important to Congress

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These three combat vehicles have a long history of service in the Army. The first M-1 Abrams Tank entered service with the Army in 1980; the M-2/M-3 Bradley Fighting Vehicle in 1981; and the Stryker Combat Vehicle in 2001. Under current Army modernization plans, the Army envisions all three vehicles in service with Active and National Guard forces beyond FY2028.

Congress is concerned with the long-term military effectiveness of these vehicles. It is also sensitive to the economic aspect of Abrams, Bradley, and Stryker modernization and recapitalization which are necessary to keep these vehicles operationally effective and in service. Recapitalization and modernization also have an economic impact on the defense industrial base in terms of keeping depots and maintenance facilities operational as Abrams and Bradleys are no longer being manufactured.

A Brief History of the Abrams, Bradley, and Stryker

Figure 1. M-1 Abrams Battle Tank

Source: Taken from http://www.armyrecognition.com/images/stories/news/2014/december/New_$120_million_upgrade_program_for_the_US_M1_Abrams_main_battle_tank_640_001.jpg, accessed April 13, 2015.

The M-1 Abrams Tank[1]

The M-1 Abrams Tank is designed to close with and destroy enemy armored forces on the battlefield by means of mobility, survivability, and firepower. The M-1 is named for General Creighton Abrams, a noted World War II armored battalion commander who later served as Army Chief of Staff from 1972 to 1974. As Chief of Staff, he led the Army in the final stages of the Vietnam War, supervised Army force reductions, and oversaw the restructuring of the Army. M-1 Abrams Tanks are found in Armored Brigade Combat Teams (ABCTs).

The M-1 program was initiated in December 1971. In June 1973, two contracts were awarded for prototype development to the Defense Division of Chrysler Corporation (which in 1982 became General Dynamics Land Systems) and the Detroit Diesel Allison Division of General Motors. In February 1976, the Army accepted prototype vehicles from both vendors and operational and engineering testing was conducted through April 1976. In November 1976, the Secretary of the Army announced that the Chrysler Corporation prototype had been selected for Full Scale Engineering Development. The first M-1 tanks—mounting a 105 millimeter main gun—were delivered to the Army in 1980. A total of 2,374 tanks were produced for the Army until February 1985, when production was shifted to the Improved M-1[2], which was completed in May 1986. The Army then began acquiring the M-1A1 version, which included a 120 millimeter smoothbore main gun, an integrated Nuclear, Biological, and Chemical (NBC) protection system, and a number of improvements to the tank's armor protection, transmission, and drive train. A total of 4,796 M-1A1 tanks were built for the Army and 221 for the U.S. Marine Corps. In 1988, General Dynamics Land Systems was awarded a contract for the M-1A2 version, which included improvements such as an Improved Commander's Weapons Station (ICWS); a Commander's Independent Thermal Viewer (CITV); a Position/Navigation System (POS/NAV) and several survivability features. The first M-1A2s began to enter service in late 1992. The Army also upgraded more than 600 M-1s to the M-1A2 configuration between 1996 and 2001.[3] The M1-A2 is the baseline export version of this tank; depending on which country purchases the vehicle, a variety of armor and communications packages are available.

The M-1 saw its first combat service during Operation Desert Storm in 1991. The majority of the M-1s were the M-1A1 model. A January 1992 Government Accounting Office (GAO) report on the "Early Performance Assessment of Bradley and Abrams," noted:

> During the war, the Abrams tank exhibited good reliability, lethality, survivability, and mobility, but limited range, according to the observations of commanders, crews, maintenance personnel, and Army after action reports. Reported Army readiness rates for the Abrams were 90 percent or higher during the ground war-indicating a high availability to move, shoot, and communicate during combat. The Abrams was lethal, as crews said its 120-mm gun was accurate and its ammunition deadly against all forms of Iraqi armor. Army observers attribute the gun's high degree of accuracy to superior sights, high levels of tank readiness, and soldier training. The Abrams also survived well on the battlefield. For example, according to officials from the Center for Army Lessons Learned, several M-lAl crews reported receiving direct frontal hits from Iraqi T-72s [tanks] with minimal damage. In fact, the enemy destroyed no Abrams tanks during the Persian Gulf War,

[1] Information from this section, unless otherwise noted, is taken from Jane's Armour and Artillery, 2011-2012, pp.177-185, and the author's personal knowledge.

[2] The Improved M-1 is essentially the same vehicle as the M-1 but with improved armor. A total of 894 Improved M-1s were built.

[3] M1A1/2 Abrams Main Battle Tank—Army Technology, http://www.army-technology.com/projects/abrams, accessed April 13, 2015.

according to the Army. Crews said Abrams tanks were fast and maneuvered well in the sand. Abrams crews were impressed with the power and performance of the Abrams' turbine engine, but they were concerned about its high fuel consumption and the need to frequently clean air filters in the sandy desert environment. Refueling was a constant concern, and faulty fuel pumps further compounded the problem. The harsh desert environment demanded frequent air filter cleaning because sand-clogged filters reduced engine power and speed.[4]

Basic Characteristics—M-1A2 Abrams Tank

Table 1. Selected Basic Characteristics—M-1A2

Armament	1 x turret mounted 120 mm M-256 smoothbore gun 1 x coaxial mounted 7.62 mm M-240 machine gun 1 x roof mounted 12.7 mm M-2 HB machine gun 1 x roof mounted 7.62 mm M-240 machine gun 12 x turret mounted smoke grenade launchers
Crew	4
Maximum Speed	42 mph
Maximum Cross Country Speed	30 mph
Range (unrefueled)	264 miles
Weight	69.54 tons

Source: Jane's Armour and Artillery, 2011-2012, p. 185.

[4] United States General Accounting Office (now Government Accountability Office), Report to the Chairman, Subcommittee on Regulation, Business Opportunities, and Energy, Committee on Small Business, House of Representatives, *Operation Desert Storm: Early Performance Assessment of Bradley and Abrams*, GAO/NSIAD-92-94, January 1992, pp. 3-4.

Figure 2. M-2/M-3 Bradley Fighting Vehicle

Source: Taken from http://olive-drab.com/images/id_m2bradley_pettit_4id_20051202_348_700.jpg, accessed April 15, 2015.

The M-2/M-3 Bradley Fighting Vehicle[5]

The M-2 Bradley is an Infantry Fighting Vehicle (IFV) used to transport infantry on the battlefield and provide fire support to dismounted troops and suppress enemy fighting vehicles. The M-2 has a crew of three—commander, gunner, and driver—and carries six fully equipped infantrymen. The M-3 Bradley Cavalry Fighting Vehicle (CFV) performs scouting missions. The M-3 has a three-person crew and carries two scouts. M-2/M-3 Bradley Fighting Vehicles are primarily found in Armored Brigade Combat Teams.

In April 1972, the Army issued a Request for Proposal (RFP) for a new IFV. In November 1972, an Engineering Development and Advanced Production Engineering contract was awarded to the Ordnance Division of the FMC Corporation (now BAE Systems, U.S. Combat Systems). The program was later renamed the Fighting Vehicle System (FVS) program and under this program, the M-2 IFV and M-3 CFV were to be developed and produced. The first M-2 prototypes were turned over to the Army in December 1978 and the first delivery of M-2s for Army units started in May 1981. In October 1981, the M-2/M-3 Fighting Vehicles were named the Bradley Fighting Vehicle after the late General of the Army, General Omar N. Bradley.

In May 1986, the Army began to receive the M-2A1 and M-3A1 Bradley versions, which included an improved NBC protection system and a number of ergonomic improvements. In 1986, the Army began the M-2A2 and M-3A2 upgrade program, which included upgraded survivability features as well as transmission modifications and a new engine. In 1995, as a result of Operation Desert Storm, a number of improvements began to be incorporated into the M-2A2/M-3A2 Operation Desert Storm (ODS) version. While existing Bradleys were being modified to the ODS version, the last production version of the Bradley was handed over to the

[5] Information from this section, unless otherwise noted, is taken from Jane's Armour and Artillery, 2011-2012, pp.458-464 and the author's personal knowledge.

Army in February 1995 with a total of 6,385 M-2/M-3 Bradleys being produced for the Army. Since February 1995, all "new" Bradley fighting vehicles have been refurbished vehicles.

The M-2/M-3 Bradley saw its first combat service during Operation Desert Storm in 1991. The majority of the M-2/M-3s were the A2 model and many units that deployed with the A1 version were provided the A2 versions when they became available. A January 1992 Government Accounting Office (GAO) report on the "Early Performance Assessment of Bradley and Abrams," noted:

> The Bradley Fighting Vehicle performed well during the war, according to the observations of commanders, crews, maintenance personnel, and Army after action reports. It exhibited good reliability, lethality, mobility, and range, and crews perceived the A2 model to have good survivability. The Army reported readiness rates for the Bradley that were generally 90 percent or higher during the ground war-indicating its high availability to move, shoot, and communicate during combat. The Bradley proved to be lethal, as crews reported that its 25-mm automatic gun was effective against a variety of targets and that its Tube-Launched, Optically-Tracked, Wire-Guided (TOW) missile system was able to destroy tanks. Crews also said the Bradley was fast, maneuvered well in the desert terrain, and exhibited good range. The A2 high survivability model Bradley was praised for its added engine power and maneuverability, and crews felt safer with its increased armor protection.
>
> Although crews were very satisfied with the Bradley's performance, they identified various hardware deficiencies that they believe should be fixed, though these problems usually did not stop the system in combat. Army officials were aware of most of them-leaking radiators, unreliable heaters, and misdirected exhaust-and are planning or are implementing corrective actions. Army crews also identified other needed vehicle improvements, such as the addition of a laser range finder and an identification of friend or foe system, better sight magnification and resolution, and a faster reverse speed.[6]

Basic Characteristics—M2/3-A2 Bradley Fighting Vehicle

Table 2. Selected Basic Characteristics—M2/3-A2

Armament	1 x turret mounted M-242 25mm "Bushmaster" chain gun 2 x turret mounted TOW anti-tank missiles 1 x coaxial mounted 7.62 mm M-240C machine gun 8 x turret mounted smoke grenade launchers
Crew	M-2: 3 crew, 6 infantrymen M-3: 3 crew, 2 scouts
Maximum Speed	36 mph
Maximum Cross Country Speed	—
Range (unrefueled)	248 miles
Weight	36-40 tons

Source: Jane's Armour and Artillery, 2011-2012, p. 463.

[6] *United States General Accounting Office (now Government Accountability Office), Report to the Chairman, Subcommittee on Regulation, Business Opportunities, and Energy, Committee on Small Business, House of Representatives, Operation Desert Storm: Early Performance Assessment of Bradley and Abrams, GAO/NSIAD-92-94, January 1992*, p. 3.

Figure 3. M-1126 Stryker Combat Vehicle

Source: http://www.army-technology.com/projects/stryker/images/stryker_10.jpg, accessed April 16, 2015.

M-1126 Stryker Combat Vehicle[7]

The Stryker is a family of eight-wheeled combat vehicles based on the Canadian LAV III 8x8 light armored vehicle. The U.S. Army, perceiving a gap between light and heavy forces, developed a medium-weight brigade combat team in 2003. The Army's original goal was to structure these brigades light enough to deploy anywhere in the world within four days. These medium-weight brigades would supplement light and heavy forces and were not intended to fight heavy armored and mechanized forces but instead move infantry forces rapidly around the battlefield. The Army, wanting to get these medium-weight units in service as soon as possible, and looking for a vehicle that could be transported by a U.S. Air Force C-130 transport aircraft, opted to take a nondevelopmental approach and select and modify a combat vehicle already in production and service. Stryker vehicles are found in Stryker Brigade Combat Teams (SBCTs).

In November 2000, following an international competition, the Army selected the now General Dynamics Land Systems (GDLS)—Canada LAV III 8x8 Light Armored Vehicle for its new medium-weight brigade combat teams. There are eight versions of the Stryker Combat Vehicle, which will be discussed in greater detail later in this report. In 2002, the Army decided to name the LAV III 8x8 Light Armored Vehicle the Stryker Combat Vehicle in honor of two enlisted Medal of Honor recipients—PFC. Stuart Stryker from World War II and SPC. Robert F. Stryker, who served in Vietnam. In September 2002, the Army received its first ICV variant Strykers and the Army's first Stryker Brigade Combat Team—the 3rd Brigade of the 2nd Infantry Division—was ready for operations in May 2003. There are currently eight Active and one Army National Guard (ARNG) SBCTs.

[7] Information from this section, unless otherwise noted, is taken from Jane's Armour and Artillery, 2011-2012, pp.733-737; Stryker Armoured Combat Vehicle Family, Army Technology, http://www.army-technology.com/projects/stryker/, accessed April 16, 2015, and the author's personal knowledge.

The M-1126 Stryker saw its first combat service in October 2003 during Operation Iraqi Freedom. Although Army officials and many soldiers praised the Stryker's performance, the *Washington Post* reported a number of problems, including

> for example, that an armor[ed] shield installed on Stryker vehicles to protect against unanticipated attacks by Iraqi insurgents using low-tech weapons works against half the grenades used to assault it. The shield, installed at a base in Kuwait, is so heavy that tire pressure must be checked three times daily. Nine tires a day are changed after failing, the report says; the Army told The Post the current figure is 11 tire and wheel assemblies daily.
>
> "The additional weight significantly impacts the handling and performance during the rainy season says the report," which was prepared for the Center for Army Lessons Learned in Fort Leavenworth, Kansas. "Mud appeared to cause strain on the engine, the drive shaft and the differentials," none of which was designed to carry the added armor.
>
> Commanders' displays aboard the vehicles are poorly designed and do not work; none of the 100 display units in Iraq are being used because of "design and functionality shortfalls," the report states. The vehicle's computers are too slow and overheat in desert temperatures or freeze up at critical moments, such as "when large units are moving at high speeds simultaneously" and overwhelm its sensors.
>
> The main weapon system, a $157,000 grenade launcher, fails to hit targets when the vehicle is moving, contrary to its design, the report states. Its laser designator, zoom, sensors, stabilizer and rotating speed all need redesign; it does not work at night; and its console display is in black and white although "a typical warning is to watch for a certain color automobile," the report says. Some crews removed part of the launchers because they can swivel dangerously toward the squad leader's position.
>
> The vehicle's seat belts cannot be readily latched when troops are in their armored gear, a circumstance that contributed to the deaths of three soldiers in rollover accidents, according to the report. On the vehicle's outside, some crews have put sand-filled tin cans around a gunner's hatch that the report says is ill-protected.[8]

Basic Characteristics—M-1126 Stryker Combat Vehicle

Table 3. Selected Basic Characteristics—M-1126

Armament	1 x 12.7 millimeter M-2 HB machine gun 16 x smoke grenade launchers
Crew	2 crew, 9 infantrymen M-3: 3 crew, 2 scouts
Maximum Speed	60 mph
Maximum Cross Country Speed	—
Range (unrefueled)	329 miles
Weight	20-23.5 tons

Source: Jane's Armour and Artillery, 2011-2012, p. 735.

[8] R. Jeffrey Smith "Study Faults Army Vehicle: Use of Transport in Iraq Puts Troops at Risk, Internal Report Says," *Washington Post*, March 31, 2005.

Wheeled or Tracked Fighting Vehicles?

When comparing fighting vehicles, the question often arises: Which is better—a tracked combat vehicle or a wheeled combat vehicle? While no single criterion can answer this question, tests and studies suggest tracked vehicles offer the following advantages:

- Cross country mobility.
- Traction on slopes.
- Survivability.
- Gap and obstacle crossing.
- Ability to modify (add more components).

For wheeled vehicles, the following advantages are cited:

- Road speed.
- Fewer logistics requirements.
- Cheaper operational and support costs.

Information is taken from Paul Hornback, "The Wheel Versus Track Dilemma," *Armor Magazine*, March-April 1998, pp. 33-34.

Vehicle Variants Currently in Service

M-1 Abrams

The Army's Active Component (AC) ABCTs are currently receiving M-1A2 Systems Enhancement Package (SEP) Version 2 (v2) tanks.[9] The M-1A2 SEPv2 tank is described as follows:

> The M1A2 SEP v2 is an all-digital tank, with a new electronic backbone and powerful new computers that provides split-second command and control over the entire spectrum of combat. The M1A2 SEP's open architecture is designed to accept spin-off technologies without the need for significant re-design. The Built-In Test system ensures that diagnosis and repair are fast and efficient, improving combat availability and saving operational costs. Improved digital displays provide tank commanders and crews with a better understanding of their tank's operational status and their situation on the battlefield.[10]

With the exception of two ARNG ABCTs (155th ABCT [MS ARNG] and the 116th ABCT [ID ARNG]) and one battalion (2-137th Combined Arms Battalion [KS ARNG]) that are equipped with the M-1A2 SEPv2 tank, the remaining five ARNG ABCTs are equipped with the M-1A1 Situational Awareness (SA) tank. The M-1A1 SA is an upgraded version of the basic M-1A1 variant. These tanks are configured with additional technologies to improve crew situational awareness (SA). The situational awareness package increases the tank's fighting capability by providing soldiers with Blue Force Tracker, a Global Positioning System (GPS)-based system which provides commanders and units with location information about friendly and hostile military forces. Additional enhancements to the M-1A1 include a second generation Forward-

[9] U.S. Army Program Executive Office Ground Combat Systems Fact Sheet, Abrams Family of Vehicles: M-1A1SA & M-1A2 SEPv2, http://www.peogcs.army.mil/documents/ABCT-Abrams.pdf, accessed April 17, 2015.

[10] National Guard Association of the United States (NGAUS) Fact Sheet, M-1A2 SEP v2 Abrams, 2014, http://www.ngaus.org/sites/default/files/AbramsFactSheetFY14.pdf, accessed April 17, 2015.

Looking Infrared Radar (FLIR) thermal site, Tank Urban Survivability (TUSK)[11] enhancements, and a driver's thermal viewer.

M-1 Abrams in the U.S. Marine Corps

As of March 2016, the Marines had 445 M-1A1 tanks in service.[12] The Marine version of the M-1A1 includes a Deep Water Fording Kit (DWFK), hardware to accommodate the Position Location Reporting System (PLRS), and additional tie-down points for storage on U.S. naval vessels.[13]

Why the Active Component and National Guard Have Different Versions of the M-1 Abrams[14]

Many, including some in Congress, have expressed concern that there are different versions of the M-1 Abrams in service with the Active Component (AC) and the Army National Guard (ARNG). The following arguments are presented by the Army Staff and the National Guard Association of the United States.

The Army's Explanation

During the Army's modular reconfiguration[15] in 2005, the Army decided to narrow down the number of variants of Abrams and Bradleys as, at that time, there were about five variants of each vehicle in service. The goal was to get to two variants of each vehicle. Over time, the heavy brigade (now referred to as ABCT) force structure changed (the Army had fewer ABCTs and the remaining ones became smaller), and the Army increased the recapitalization of combat vehicles through Global War on Terror/Overseas Contingency Operation funding. The Army's initial plans called for M-1A1 SA tanks in both the AC and ARNG. As the Army's number of heavy brigades continued to decrease and Abrams recapitalization[16] continued, the Army was able to provide M-1A2 SEPv2's to all AC ABCTs, Army Prepositioned Stocks and the 116th ABCT (ID ARNG). Also during this time the Army reset 791 M-1A1's to a common configuration with second generation FLIR (M-1A1 SA). Further force structure changes such as withdrawal of ABCTs

[11] From U.S. Army Program Executive Office Ground Combat Systems Fact Sheet, Abrams Family of Vehicles :M-1A1SA & M-1A2 SEPv2, http://www.peogcs.army.mil/documents/ABCT-Abrams.pdf, accessed April 17, 2015, "The Tank Urban Survivability Kit, or TUSK, improves force protection, lethality, survivability and situational awareness on the Abrams main battle tank. The inclusion of reactive armor tiles, gun shields, a mine-resistant driver seat, a stabilized commander's weapon station, counter sniper / anti-materiel mount and loader's thermal weapon sight, and underbelly armor provide enhanced capabilities for the urban fight."

[12] Information on the number of Marine M-1s was provided to CRS by the Marine Corps Legislative Liaison Office on March 4, 2016.

[13] Jane's Armour and Artillery, 2011-2012, 2012, pp. 181-182.

[14] CRS discussions with U.S. Army G-8 Staff, April 24, 2015.

[15] For additional information on Army modularity, see CRS Report RL32476, *U.S. Army's Modular Redesign: Issues for Congress*, by Andrew Feickert.

[16] According to the Defense Acquisition University, there is no official Federal or DOD definition of recapitalization. Recapitalization is generally considered as the major reconstruction needed to keep existing weapon systems modern and relevant in an environment of changing standards and missions. Recapitalization extends the service life of weapon systems or restores lost service life. It includes restoration and modernization of existing weapon systems as well as their replacement.

from Europe and congressional "adds"[17] permitted the Army to field M-1A2 SEPv2 to the 155th ABCT and the 2-137th Combined Arms Battalion.

With the large investment in Abrams over the last 10 years and the young age of the fleet (based on reset /recapitalization of the vehicles), the Army decided not to fund continued M-1A2SEPv2 production and instead decided to focused its resources on research, development, testing, and evaluation (RDT&E) and upgrade all tanks to the M-1A2SEPv2 starting in FY2017.

An Argument for Full Fielding of M-1A2 SEPv2s to the ARNG

From the National Guard Association of the United States (NGAUS)[18] 2104 Fact Sheet: *M-1A2 SEP v2 Abrams*:

> The M-1A2 SEP v2 Abrams main battle tank is the Army's premier ground combat system and has demonstrated its value on the battlefields of Iraq. With its advanced thermal sights and Commander's Independent Thermal Viewer (CITV), this tank is 110% better than an M-1A1 in the defense, and 50% better in the offense. The CITV provides the crew with a hunter-killer capability, which means that the M-1A2 SEP v2 can acquire targets 45% faster and hand off targets 50-75% faster, thus giving it a percent of hit on evasive targets that is 80% better than an M-1A1.
>
> The M-1A2 SEP v2 is an all-digital tank, with a new electronic backbone and powerful new computers that provides split-second Command and Control over the entire spectrum of combat. The M-1A2 SEP's open architecture is designed to accept spin-off technologies without the need for significant re-design. The Built-In Test system ensures that diagnosis and repair are fast and efficient, improving combat availability and saving operational costs. Improved digital displays provide Tank Commanders and crews with a better understanding of their tank's operational status and their situation on the battlefield.
>
> All-digital M-1A2 SEP v2s will be easier for the National Guard to maintain and to train on than M-1A1s. Digital tanks have embedded diagnostics and Vehicle Health Management Systems that provide critical maintenance data on the current status of key systems in the tank through its computers. Digital tanks will also be easier for the National Guard tankers to train on. Digital tanks allow for embedded training on the tank's computers, and laptop and desktop trainers that simulate the tank's operating systems. Army schools currently provide training solely on M-1A2 SEP v2s, meaning that any National Guard tankers attending an Army school will only be trained on M1A2s, not the vehicle they will be assigned.
>
> The National Guard, as the Army's Operational Reserve, must be equipped with tanks that are superior to the M-1A1s that the Army is providing to countries like Egypt and Iraq. This potential upgrade of National Guard tanks also comes at a critical time for the tank industrial base. Tank upgrades for the National Guard will help maintain the industrial base, bridging a gap between current tank upgrades and future tank developments. Congress recognized this and passed funding to the Army to upgrade about 50 more M-1A1 tanks to the M-1A2 SEP Configuration, both in FY2012 and FY2013. This adds more than 100 M-1A2 SEP tanks to the Army's inventory.[19]

[17] Additional funding over and above the President's Budget request authorized and appropriated by Congress.

[18] From the NGAUS Website: "The National Guard Association of the United States is the nation's oldest military association lobbying solely for the benefit of the National Guard of the United States and educating the public about the Guard's role and history in the Armed Forces of the United States. It was formed by militia officers in 1878 to obtain better equipment and training by petitioning Congress for more resources." http://www.ngaus.org/united-voice-national-guard, accessed April 24, 2015.

[19] National Guard Association of the United States (NGAUS) Fact Sheet, M-1A2 SEP v2 Abrams, 2014,

M-2/M-3 Bradley[20]

There are currently four types of Bradleys serving in ABCTs:

- M-2A3 Bradley IFV;
- M-3A3 Bradley Cavalry Vehicle;
- M-2A3 Fire Support Vehicle (BFIST); and
- M-2A3 Engineer Squad Vehicle.

According to the Army's Program Executive Office Ground Combat Systems:

> The Bradley Fighting Vehicle Family continues to field upgraded, digitized vehicles to the Active Army and National Guard in the form of the Bradley A3 and Bradley Operation Desert Storm-Situational Awareness (ODS-SA) vehicles.... The Bradley has received increased force protection in the form of upgraded add-on-armor, improved reactive armor tiles, and the Bradley Urban Survivability Kit (BUSK). The Bradley Fire Support Team (BFIST) Vehicle recently equipped its first unit with the Fire Support Sensor System (FS3), enabling the FIST team to conduct precision targeting and designation missions from under armor with significantly increased observation range. PM Bradley is in the process of integrating the FS3 on the M7 BFIST SA platform for the National Guard. PM [Program Manager] Bradley is pursuing additional vehicle upgrades via an Engineering Change Proposal (ECP) program to restore space, reduce weight, increase electrical power and recover mobility to be able to support integration of future network and other programmed capabilities.[21]

FY2015 M-2/M-3 Allocation by Component

Table 4. FY2015 M-2/M-3 Allocation by Component

	M-2A3	M-3A3	M-2A2 ODS SA	M-3A2 ODS SA
AC ABCTs	1,199	453	—	—
ARNG ABCTs	162	62	477	197

Source: Information provided to CRS by Army G-8, April 24, 2015.

Notes: (1) These figures do not include M-2/M-3 versions maintained by the Army for Army Prepositioned Stocks (APS), training, and testing and evaluation. (2) CRS was unable to obtain updated information on the allocation of Bradley Fighting Vehicles.

M-1126 Stryker[22]

There are currently eight Stryker variants in service with SBCTs as discussed below.

- **M-1126 Infantry Carrier Vehicle (ICV).** The ICV is a nine-man infantry squad carrier that provides protected battlefield transport and direct fire support for

http://www.ngaus.org/sites/default/files/AbramsFactSheetFY14.pdf, accessed April 17, 2015.

[20] Unless otherwise noted, information in this section is taken from U.S. Army Program Executive Office Ground Combat Systems Fact Sheet: Bradley Fighting Vehicle, http://www.peogcs.army.mil/documents/ABCT-Bradley.pdf, accessed April 24, 2015.

[21] Ibid.

[22] Information in this section, unless otherwise noted, is taken directly from U.S. Army Program Executive Office Ground Combat Systems Fact Sheet: Stryker Family of Vehicles, http://www.peogcs.army.mil/documents/SBCT.pdf, accessed April 29, 2015.

dismounted operations. Each ICV has a crew of two (vehicle commander and driver) who operate and maintain the ICV to help insure protected delivery of infantry squads to dismount locations.

- **M-1127 Reconnaissance Vehicle (RV).** The RV is used by reconnaissance, surveillance, and target acquisition squadrons and battalion scouts to perform reconnaissance and surveillance operations. The RV carries a crew and a scout squad for dismounted reconnaissance. The main reconnaissance asset is the Long Range Advanced Scout Surveillance System (LRAS3), which has a capability to detect targets at long range. Armament includes a commander's cupola that can mount a .50 caliber M2HB machine gun or MK19 40 mm grenade launcher.
- **M-1128 Mobile Gun System (MGS).** The MGS provides direct supporting fires to assault infantry in order to destroy or suppress hardened enemy bunkers, machine gun positions, and sniper positions in urban, restricted, and open rolling terrain. The M-1128 mounts a 105 mm main gun.
- **M-1129 Stryker Mortar Carrier (MC).** The MC provides accurate, lethal, high angle fire to support operations in complex terrain and urban environments. The MC accommodates a 120 mm mortar system that fires a full family of mortar ammunition while mounted, including high explosive (HE), illumination, infra-red (IR) illumination, smoke, precision guided, and Dual Purpose Improved Conventional Munitions (DPICM).
- **M-1130 Commander's Vehicle (CV).** The CV provides commanders with communication, data, and control functions to analyze and prepare information for combat operations. The CV integrates command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) equipment for the unit commanders and can also link to aircraft antenna/power for planning missions while en route aboard aircraft. Commanders have the capability to see and direct the operations continuously, by means of the Common Relevant Operating Picture (CROP) system, which tracks all friendly forces within their respective areas of operation.
- **M-1131 Fire Support Vehicle (FSV).** The FSV provides enhanced surveillance, target acquisition, target identification, target designation, and communications supporting the SBCT with "first round" fire-for-effect capability. The FSV provides the Fire Support Teams (FIST) with the capability to automate command and control functions, to perform fire support planning, directing, controlling and cross-functional area coordination, and execution of fire support missions.
- **M-1133 Medical Evacuation Vehicle (MEV).** The MEV is an ambulance variant of the Stryker capable of transporting four patients on standard litters, or six ambulatory patients, in addition to an ambulance team of three. The MEV provides protection for the patient and medical team and can additionally provide medical evacuation to casualty collection points to higher-level treatment centers.
- **Nuclear, Biological, Chemical, Reconnaissance Vehicle (NBCRV).** The NBCRV detects and identifies chemical, biological, and radiological hazards. It warns units of contamination, reports the location of hazards, marks areas of contamination, locates and marks clean bypass routes, and collects and transports samples of radiological, biological, and chemical material for later analysis.[23]

[23] Ibid.

Abrams, Bradley, and Stryker Allocation by BCT Type[24]

Table 5. ABCT Allocations

ABCT = 4,694 soldiers

M-1 Abrams	87
M-2 Bradley Fighting Vehicle	102
M-3 Bradley Cavalry Vehicle	50
TOTALS	**239**

Source: U.S. Army Briefing: Maneuver Warfighter Conference: Concept Implications on BCT Design Workgroup BCT 2020 Design Read Ahead, September 11, 2014.

Notes: Table does not differentiate by variants.

Table 6. SBCT Allocations

SBCT = 4,454 soldiers

M-1126 ICV	128
M-1127 RV	51
M-1128 MGS	27
M-1129 MC	36
M-1130 CV	26
M-1131 FSV	13
M-1133 MEV	16
NBCRV	3
M-1126 Engineer	12
M-1126 Anti-Tank Guided Missile (ATGM)	9
TOTALS	**321**

Source: U.S. Army Briefing: Maneuver Warfighter Conference: Concept Implications on BCT Design Workgroup BCT 2020 Design Read Ahead, September 11, 2014.

Vehicle Modernization, Recapitalization, and Reset

In order to keep the Abrams, Bradley, and Stryker operational and effective over a prolonged period, a variety of activities have been undertaken over the lives of these vehicles. The most common terms used to describe these activities are modernization, recapitalization, and reset. Although there is a lack of formal DOD and Army definition for these terms, the following descriptions can be considered representative of how the Army uses these terms:

[24] Information in this section is taken from U.S. Army Briefing: Maneuver Warfighter Conference: Concept Implications on BCT Design Workgroup BCT 2020 Design Read Ahead, September 11, 2014.

Modernization, Recapitalization, and Reset

Modernization: "Efforts undertaken related to current weapon systems to meet current and future capability needs through upgrade, replacement, recapitalization, refurbishment, and technology insertions."[25]

Recapitalization: "Recapitalizing systems, involves either completely overhauling and rebuilding an item (such as a tank or truck) so that it is returned to an 'as-new,' zero-mile condition; or upgrading a system—a more extensive makeover that also includes substantial improvements in the system's capabilities."[26]

Reset: "The Army's reset program is designed to reverse the effects of combat stress on equipment. The program encompasses several activities:"

- "Replacing equipment lost in the theater or deemed irreparable on its return. (The latter is known as a washout.)"
- "Repairing and reconditioning systems to bring them back to a satisfactory operating condition either at the field level, by soldiers in the units once they have returned to their home stations, or, in the case of more-extensive repairs, by Army personnel at depots or by contractors at their own sites. (Repairs may have been made to a piece of equipment while it was in the theater, but that activity is not part of the reset program, which comprises only repairs made after equipment has been brought home.)"[27]

Upon comparison, it might appear these terms describe somewhat similar activities. It has been a common criticism by some that the Army frequently uses these terms interchangeably when describing its efforts and activities related to these and other weapon systems. This indiscriminate use of terminology and lack of specific definitions can cause confusion, particularly when conducting oversight of funding. Traditionally, modernization and recapitalization efforts are funded by Operations and Maintenance (O&M) funds, while reset has been funded as part of Overseas Contingency Operations account.

A Fully Modernized Force?

It has been suggested that as a result of the wars in Iraq and Afghanistan, the Army has been able to significantly modernize its Abrams and Bradleys in a manner that would not likely have been possible in a peacetime environment. One study, summarized in the following section, suggests that the Active Component is comparatively speaking almost "fully modernized."

> At the start of the past decade, the Army intended to upgrade about 1,806 Bradleys, 1,100 of them to the most advanced A3 variant. The Army had upgraded 266 by the end of FY00. By the end of FY09, however, the Army far exceeded its goal and had upgraded 4,372 Bradleys, 2,446 of them to the A3 variant—leaving the less capable ones mostly in the National Guard. The upgrade gives the Bradley a modern optics package, with a sight for the commander independent of the gunner, a communication suite including the Army's networked situational awareness package, and a fully integrated GPS navigation system. In other words, the upgrade gives the Bradley state-of-the-art digital technology. As the Army's own justification says, "the Bradley A3 will maintain combat overmatch over current and future threat forces and complements the M1A2 Abrams SEP (System Enhancement Program) tank." The Army completed its Bradley upgrade program in FY11, having modernized the bulk of the fleet.
>
> The Abrams record is similar. In the FY00 budget justification, the Army stated its intention of modernizing about 1,700 tanks divided between the M1A2 upgrade and the M1A2 System Enhancement Program (SEP) that was entering production. By the end of

[25] Army Equipment Program in Support of the President's Budget: Formerly Army Equipment Modernization Plan, May 2014, p. 2.

[26] Congressional Budget Office Paper, Replacing and Repairing Equipment Used in Iraq and Afghanistan: the Army's Reset Program, September 2007, pp. xiii-xiv.

[27] Ibid.

> FY00, they'd converted 360, all to the lower upgrade. In its FY12 budget justification, the Army reports to have upgraded 1,158 tanks—all to the more advanced SEP configuration—and plans to upgrade only 42 more in FY11 and FY12 to complete the program. As with the Bradley, the M1A2 SEP has modernized digital technology, including new optics and communications suites.
>
> In the past decade, the Army has modernized nearly its entire fleet of ground combat vehicles despite its original intent to pursue a much more limited modernization plan. It did so because of the unexpected bonuses from the supplemental war funding. The Abrams and Bradley programs each received more than $1B in both the FY07 and FY08 supplementals. Coupling that extra funding with a decade of procurement growth, the Army has now equipped its entire active force structure with the most modern variants of its basic vehicles.[28]

The Army generally agrees that its vehicle fleet is in relatively good shape as a result of war. However, the Army cautions about the necessity to modernize and upgrade its fleet on a regular basis which could be challenging in a fiscally constrained environment.

A Summary of M-1 Abrams and M-2/M-3 Bradley Modernization

The following excerpts from an article in *National Defense* magazine provide a useful summary of current and planned M-1 Abrams and M-2/M-3 Bradley Modernization efforts:

> More than 1,600 Abrams tanks and 2,500 Bradley infantry combat vehicles would be overhauled over the next decade.
>
> The work will be done in stages. Each phase, called an "engineering change proposal," or ECP, will tackle different parts of the vehicle that need to be modernized, including engines, transmissions, electrical power systems, communications networks, sensors and weapons.
>
> This month [May 2015], the Army expects to unveil the first Bradleys with updated suspensions and tracks. "It will bring the vehicle back to where it was before the war," said Col. James W. Schirmer, Army program manager for armored fighting vehicles. The next ECP will deal with engines and transmissions, and will increase electrical power. Then comes the more challenging upgrade, called "lethality ECP," when the Army will seek to install a new targeting sensor, known as third-generation forward-looking infrared, or 3rd generation FLIR.
>
> The Army expects to release this month a solicitation for industry bids for the new sensor. FLIR technology detects heat and creates images from it, allowing operators to see through darkness, smoke, rain, snow and fog.
>
> Current ground platforms use a single-band FLIR that was designed in the 1990s, Sullivan said in an interview. "But with advances in technology we were able to incorporate an additional waveband—another band of the non-visible IR spectrum—to get more clarity. This allows the soldier not only to see through the dirty battlefield but also see more clearly."
>
> The new FLIR will be "horizontal technology integration," meaning that Sullivan's office will develop a set of common components that will fit in different sights. There are two sights on the Abrams and two on the Bradley. The 3rd generation FLIR components will be common across the four sights.

[28] Russell Rumbaugh, The Stimson Center, Washington, D.C., "What We Bought: Defense Procurement from FY01 to FY10," October 2011, pp. 8-9.

The Army soon will request industry bids and expects to award a 3rd generation FLIR development contract during fiscal year 2016. Production would begin in 2023.

The FLIR program is a significant opportunity for defense contractors. Industry sources estimate it could be worth more than $2 billion if all Abrams and Bradleys in the current plan are upgraded.

Vendors said 3rd generation FLIR technology is relatively mature and should not pose difficulties for the Army. "It is ready for engineering and manufacturing development," said Clay Towery, business development manager at Raytheon. The company teamed with DRS Technologies for the new FLIR program. Both firms have spent their own funds on prototypes in preparation for the upcoming competition.

Upgrading electronics onboard vehicles is a hard job. "Technology evolves much faster than automotive components. We face obsolescence problems with electronic components in vehicles we just finished designing."

In addition to the Abrams and the Bradley, the Army is looking to upgrade its Stryker light armored vehicles and Paladin howitzers. It remains to be seen if there will be enough money to refurbish every vehicle.[29]

[29] Taken directly from Sandra I. Erwin, "Army Begins Massive Makeover of Combat Vehicle Fleet, *National Defense Magazine*, May 6, 2015.

Abrams and Bradley Upgrade Plans

Abrams Upgrade Plan

Engineering Change Proposal 1a

ECP-1a will address the system architecture (power and data management systems) to support inbound technology, specifically the Army's network requirements. It is scheduled to begin production in FY2017.

Improvements include network compatibility, mass memory upgrade, power generation and distribution. Upgrades to the tank's electronic architecture and power distribution system enable integration of the Army's future battle command and communication systems. Protection improvements include armor upgrade and integration of counter radio-controlled IED electronic jammers. A new auxiliary power unit and advanced on-board diagnostics will improve sustainability by reducing the fuel usage and the cost of spare parts.

Engineering Change Proposal 1b

ECP 1b is scheduled to begin development in FY2016 and enter production in 2024. This upgrade will improve the tank's lethality through enhancements in sights and sensors that are centered on the integration of the next generation of forward looking infrared (FLIR) technology, a color camera and a laser range finder.

Bradley Upgrade Plan

Engineering Change Proposal 1

ECP 1 focuses on mobility and survivability, increases movement and restores lost ground clearance. A production contract award was made in 2014 and fielding will begin in the third quarter of FY2015.

Engineering Change Proposal 2

ECP 2 addresses embedded digital systems. A later effort will focus on integration of technologies currently in development: Mounted Family of Computing Systems, Net-Ready, Integrate Counter Remote-Controlled Improvised Explosive Device Electronic Warfare (CREW) Duke v3 and Vehicle Health Management System. ECP 2 consists of a power pack upgrade to enable enough power to run the current approved counter IED and mission command components. ECP 2 production award is scheduled for FY2017 with fielding beginning in 2018.

Engineering Change Proposal 2b

ECP 2B is about lethality, and parallels the Abrams ECP1b program. They are being developed together to take advantage of as much commonality as possible. The Bradley ECP2b program includes the Improved Bradley Acquisition System and the Commander Independent Viewer with 3Gen FLIR, a color camera and a laser pointer that works at standoff distance.

Source: Sandra I. Erwin, "Army Begins Massive Makeover of Combat Vehicle Fleet, *National Defense Magazine,* May 6, 2015

Issues Concerning the Army's M-1 Abrams Modernization Plans[30]

The Army began upgrading M-1A2s to the M-1A2SEPv2 version in 2007. In 2011, the Army proposed suspending the upgrade of M-1A2s to the M-1A2SEPv2 variant between FY2013 and FY2017 to save funds that could instead be used to develop the new M-1A3 variant. The Army argued that $1.3 billion could be saved in the FY2012 defense budget if the upgrade work, which would be conducted at the Joint Systems Manufacturing Center[31] in Lima, OH, was suspended until 2017, when work would begin on the M-1A3 variant. The Army estimated that shutting down the Lima Army Tank Plant in 2013 and reopening it in 2017 would cost $800,000 whereas keeping the plant open during this period would cost $2.1 billion.

Some Members, concerned about the potentially adverse impact of the Army's proposal on the U.S. industrial base, sent a letter to Secretary of the Army John McHugh, urging instead the limited production of 70 M-1A2SEPv2 tanks per year from FY2013 to FY2017.[32] Congress subsequently decided to include an additional $225 million in the FY2012 defense budget to upgrade 49 M-1A2s.

In 2012, the Army again proposed postponing M-1A2 upgrade work until FY2017. Some Members, concerned about the impact on the industrial base, sent Secretary of Defense Leon Panetta a letter on April 20, 2012 urging him to support the upgrade of additional tanks. Congress decided to include $136 million in the FY2013 defense budget to upgrade an additional 33 M-1 A2s.

In 2013, Army leadership reaffirmed their position that they did not require any additional M-1 A2 tanks. In May 2013, a number of House Members sent a letter to Secretary of the Army McHugh expressing concern over the Army's failure to fund production of the M-1A2. Congress included $346 million in the FY2014 defense budget to fund M-1 upgrades.

In FY2014 Congress included $90 million for M-1A2 upgrades and $120 million in FY2015.[33] As the Army had repeatedly emphasized they did not require additional M-1A2 tanks, some have criticized Congress for "making the Army buy tanks that it did not need."[34]

During a January 20, 2015, conference at the American Enterprise Institute (AEI), House Armed Services Committee Chairman Mac Thornberry provided a congressional perspective on this issue:

> Some of you have heard that the House and the Senate are forcing the Army to buy tanks that it doesn't want to satisfy some donor, or some lobbyist or some parochial interest. Now here's the reality. We made a judgment call.

[30] Information in this section is taken from Alexander Pearson, "Fact Sheet: M-1 Abrams Tank," Center for Arms Control and Non-Proliferation, December 4, 2013.

[31] The Joint Systems Manufacturing Center—also known as the Lima Army Tank Plant (LATP)—is a government-owned, contractor-operated (GOCO) facility operated by General Dynamics Land Systems (GDLS).

[32] Letter to Secretary of the Army John McHugh by Rep. Sander Levin and Rep. Mike Rogers, May 6, 2011.

[33] See CRS Reports CRS Report R43323, *Defense: FY2014 Authorization and Appropriations*, by Pat Towell and Amy Belasco, and CRS Report R43788, *Defense: FY2015 Authorization and Appropriations*, by Pat Towell.

[34] See, for example, NBC News, "The M1 Abrams: The Army Tank that Could Not be Stopped," July 28, 2012, http://investigations.nbcnews.com/_news/2012/07/28/12991946-the-m1-abrams-the-army-tank-that-could-not-be-stopped and Matthew Cox, "Pentagon Tells Congress to Stop Buying Equipment it Doesn't Need," *Miltary.com*, January 28, 2015, http://www.military.com/daily-news/2015/01/28/pentagon-tells-congress-to-stop-buying-equipment-it-doesnt-need.html.

> There's one plant left in America that builds tanks. The Army said foreign sales would keep it open until 2019 when they needed it to start upgrading our own tanks. The House and Senate Armed Services Committees and the House and Senate Appropriations Committees looked into it and all decided their math didn't work. So we started upgrading our tanks earlier than planned to make sure the plant stayed open, the trained workforce stayed engaged and improved tanks could get into the field even faster.[35]

M-1126 Stryker Modernization Plans[36]

From the Army's Program Executive Office Ground Systems:

> In response to a need to better protect Stryker soldiers from the threat of mines and improvised explosive devices, the Stryker Double V-Hull (DVH) effort emerged. DVH includes: a new hull configuration, increased protection, upgraded suspension and braking system, wider tires, blast-attenuating seats and a Height Management System (HMS) designed to increase ground clearance and improve both survivability and mobility.[37]

The DVH Engineering Change Proposal project also will provide a variety of other upgrades described below:[38]

Automotive

DVH Strykers will receive a new engine and suspension. A 450 horsepower engine will increase vehicle mobility and power generation and a new driveline will be installed to match the new engine. New tires will also be added. These chassis upgrades will increase the vehicle's gross weight.

Electrical/Digital

The DVH Stryker's electrical system will be upgraded to a 910 amp alternator to meet current power requirements and will leave room for future power growth. On the digital side, the Stryker's driver and commander's stations will receive smart displays and an upgraded Ethernet and the vehicle's digital infrastructure will be set up for future upgrade.

Request to "Up-Gun" European-Based Strykers[39]

The Army requested the European-based 2nd Cavalry Regiment—a SBCT—be equipped with a 30 mm weapon systems in order to provide enhanced "direct fire support for dismounted

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[35] "A Congressional Roadmap for Rebuilding our Nation's Military: A Conversation with House Armed Services Committee Chairman Mac Thornberry," AEI, January 20, 2015.

[36] Information in this section is taken from Army Program Executive Office Ground Combat Systems Fact Sheet: Stryker Family of Vehicles, http://www.peogcs.army.mil/documents/SBCT.pdf,accessed, April 29, 2015, and Ann Roosevelt, "Army Upgrading Stryker, Abrams for Improved Performance, Future Growth," *Defense Daily*, October 22, 2014.

[37] Army Program Executive Office Ground Combat Systems Fact Sheet: Stryker Family of Vehicles, http://www.peogcs.army.mil/documents/SBCT.pdf,accessed April 29, 2015.

[38] Ann Roosevelt, "Army Upgrading Stryker, Abrams for Improved Performance, Future Growth," *Defense Daily*, October 22, 2014.

[39] Sydney J. Freedberg Jr., The 30 Millimeter Solution: Army Upgunning Strykers vs.Russia, *Breaking Defense*, April 23, 2015, and John Vandiver, "Germany-Based Stryker Brigade Gets Provisional OK for More Firepower, *Stars and Stripes*, May 4, 2015.

infantrymen when engaging like units."[40] This request was characterized as an "operational need to fill an urgent requirement" and would outfit 81 of the 2nd Cavalry Regiment's M-1126 ICV variants with 30 millimeter cannons. The Army contends it would cost $3.8 million per Stryker including both the 30 millimeter cannon as well as other selected improvements such as a new suspension. Work on the upgraded Strykers would be conducted at both Anniston Army Depot in Alabama and the Joint Systems Manufacturing Center in Lima, OH. Reports suggest the Army will begin receiving 83 up-gunned Strykers (up from the aforementioned 81 vehicles) starting in July 2017, with the fielding completed by July 2018.[41] Congress authorized and appropriated funds for the Army's request as part of the FY2016 Defense Authorization and Appropriations Acts.[42]

"Up-Gunning" the Entire Stryker Fleet[43]

The Army reportedly is considering upgrading the lethality of the entire Stryker fleet. According to a March 1, 2016, Army Request for Information (RFI) on Stryker lethality:

> The next major upgrade to the entire Stryker Family of Vehicles (FOV) (to include Flat Bottom Hull platforms), will focus on lethality improvements. These enhancements will not be limited to cannon application and improvement for designated platforms with the Stryker FOV. Sensor, protection and platform network improvements are key features in this upgrade strategy. These upgrades will bring more than enhanced firepower. They will allow the entire FOV to sense threats earlier and survive longer, and will enable Stryker Brigades to survive, to move, and to destroy enemy targets at greater range.[44]

In addition to the 30 mm cannon, the Army is reportedly considering adding Javelin anti-tank guided missile (ATGM)-capable remote weapons stations to selected Stryker vehicles to enhance their anti-armor capabilities.[45] Both the 30 mm cannon (developed as part of the Army's cancelled Future Combat System (FCS) program)[46] and Javelin are considered "mature" technologies by the Army and their integration on the Stryker vehicle could prove to be quicker and perhaps less costly than if these weapons had to be custom-designed. In addition, if the Army does upgrade the entire Stryker fleet, it could drive down the modernization cost per vehicle.

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[40] John Vandiver, May 4, 2015.

[41] Sebastain Sprenger, "Army Expects to take Delivery of Up-Gunned Strykers in July 2017," *InsideDefense.com*, February 19, 2016.

[42] H.Rept. 114-102, Report of the Committee on Armed Services House of Representatives on H.R. 1735, National Defense Authorization Act for Fiscal Year 2016, May 5, 2015, pp. 16-17; H.Rept. 114-63, Report of the Committee on Appropriations, Department of Defense Appropriations Bill, 2016, June 11, 2015, p. 73; and Conference Report to Accompany H.R. 1735, National Defense Authorization Act for FY2016, September 29, 2015, pp. 2-3.

[43] Sebastian Sprenger, "Army Plans Yet Another Cannon Upgrade for Stryker Vehicles," *InsideDefense.com*, March 1, 2016.

[44] Sources Sought Notice, Project Management Office Stryker Brigade Combat Team (PMO SBCT), Market Research for the Stryker Family of Vehicles (FoV) Lifecycle Requirements in the Areas of (1) Lethality; (2) Survivability; (3) Logistics; (4) In Vehicle Network; (5) Automotive Enhancements; and (6) Industry Outreach Initiatives, March 1, 2016, http://insidedefense.com/sites/insidedefense.com/files/documents/mar2016/03012016_fov.pdf.

[45] Sebastian Sprenger, "Army Plans Yet Another Cannon Upgrade for Stryker Vehicles," InsideDefense.com, March 1, 2016.

[46] Sydney J. Freedburg Jr., "Army to Upgun all Strykers: 30 mm & Javelin," *Breaking Defense*, February 29, 2016.

Active Protection Systems (APS) for the Abrams, Bradley, and Stryker

The Army reportedly intends to begin testing Active Protective Systems (APS)[47] on a number of its combat vehicles, including the Abrams, Bradleys, and Strykers, before FY2019.[48] The Army's program, designated the Modular Active Protection Systems (MAPS), will initially focus on "soft- kill" technologies such as vehicle obscurants and electronic defeat systems and then progress to "hard-kill" technologies like the ability to shoot down missiles fired at vehicles.[49] As part of developing MAPS, the Army is looking at existing, non-developmental APS technologies both domestically and foreign-produced, such as Israel's Trophy APS currently in use with Israeli forces. As part of the Army's FY2017 budget proposal, the Army reportedly will experiment with commercially available APS systems as part of Abrams, Bradley, and Stryker survivability enhancements.[50]

Successors to the Abrams, Bradley, and Stryker

The *Army's Equipment Program in Support of the President's Budget 2015* describes the Abrams, Bradley, and Stryker as part of the operational force until at least FY2029 and perhaps beyond.[51] Regarding the Abrams and Stryker, Army plans call for an upgraded M-1A3 Abrams and an upgraded Stryker vehicle. The Army, however, is planning for a successor to the Bradley—the Future Fighting Vehicle (FFV). The FFV succeeds the Army's previous attempt at a Bradley successor—the Ground Combat Vehicle (GCV)—which was deemed too heavy and impractical by many defense analysts and cancelled by the Defense Department in early 2013. The FFV could be either a completely new vehicle design or could come in the form of an upgraded Bradley.

The Army reportedly plans to relax its previous GCV requirement that the proposed vehicle carry an entire nine-man infantry squad—a requirement many believe made the GCV too large, too heavy, and potentially unaffordable. In May 2015, BAE Systems and General Dynamics Land Systems received contracts—$28.9 million and $28.3 million, respectively—to develop design concepts for the FFV.

[47] According to the U.S. Army Tank and Automotive Command, "Active protection systems (APS) feature semi-autonomous or autonomous systems that can be integrated onto vehicles to give soldiers the capability to detect, classify, receive warning cues, and use countermeasures to address threats or imminent threats in the field. For instance, if a combatant fires a rocket-propelled grenade at a vehicle equipped with APS, the system can detect the threat in the air and defeat it faster than soldiers could react. The system also enhances a soldiers' ability to return fire by indicating where the threat came from, allowing them to maintain an offensive position."

[48] Dan Parsons, "Army to Field Non-Developmental Vehicle Missile Shields Before 2019," *Defense Daily*, March 4, 2016.

[49] Ibid.

[50] Sebastian Sprenger, "Abrams, Bradley, Stryker are in Line for Active-Protection Pilot Projects," *InsideDefense.com*, February 12, 2016.

[51] Army Equipment Program in Support of the President's Budget 2015, February 2015, p. 32.

Foreign Military Sales (FMS)[52]

According to the Army, "Foreign Military Sales is a form of security assistance authorized by the Arms Export Control Act (AECA) [Public Law 94-329]. Under Section 3 of the AECA, the U.S. may sell defense articles and services to foreign countries and international organizations when the President of the United States formally finds that to do so will strengthen the security of the U.S. to promote world peace."[53] According to the Army, FMS is important because:

- Foreign Military Sales are vital and beneficial in supporting U.S. national security and foreign policy objectives by allowing allies to promote peace and stability in their region;
- FMS allows for weapon system interoperability between allies which can be valuable during joint operations; and
- Industry benefits from FMS by keeping production lines warm when there is a decrease or gap in production from U.S. Government sales.[54]

M-1 Abrams Foreign Military Sales[55]

The United States has sold M-1A1 Abrams to Australia, Egypt, and Iraq under the provisions of FMS. Also under FMS, the United States has provided M-1A2s to Kuwait and Saudi Arabia. Since 2002 when the U.S. Army Tank, Automotive, and Armaments Command awarded a contract to General Dynamics Land Systems to support the co-production of M-1A1s at the Egyptian Tank Plant near Cairo, Egypt has been producing M-1A1s. As of July 2011, Egypt had a fleet of 1,005 M-1A1s with their stated long-term objective of 1,500 M-1A1 tanks. As part of an Excess Defense Article grant, Morocco was provided 200 M1-A1 SA Abrams tanks in 2011.[56]

M-2 Bradley and M-1126 Stryker Foreign Military Sales[57]

Under FMS, Saudi Arabia acquired 400 M-2 Bradleys. Although there are no known FMS actions for the Stryker, Israel once expressed interest in the Stryker possibly to equip two brigades. The Israelis decided instead in 2005 to develop their own vehicle based on existing Israeli combat vehicles.

Industrial Base Issues

The viability of the Army's combat vehicle industrial base is a crucial consideration for DOD, the Army, and Congress. DOD's 2013 Annual Industrial Capabilities Report to Congress notes:

[52] Information from this section is taken from Army Program Executive Office Ground Combat Systems Fact Sheet: Foreign Military Sales (FMS), http://www.peogcs.army.mil/documents/ABCT-FMS.pdf, accessed July 2, 2015.

[53] Ibid.

[54] Ibid.

[55] Information from this section, unless otherwise noted, is taken from Jane's Armour and Artillery, 2011-2012, 2012, pp.177-185.

[56] Defense Security Cooperation News Release, *Kingdom of Morocco—M1A1 SA Abrams Tank Enhancement, Support and Equipment,* June 18, 2012.

[57] Information from this section, unless otherwise noted, is taken from Jane's Armour and Artillery, 2011-2012, 2012, pp.458-459.

> The Department has not acquired new combat tracked vehicles for many years, instead choosing to remanufacture and update legacy platforms. The Army upgrades and maintains its existing fleet of tracked vehicles using a combination of organic capabilities and the private sector. As a result, the average age of refurbished Abrams Tanks and Bradley Fighting Vehicles is only a couple of years. With the drawdown of the military, there are few requirements to continue remanufacturing these platforms, with the possible exception of Foreign Military Sales. Unlike combat tracked vehicles, the Stryker combat wheeled vehicle is still in production, but its quantities have also dropped off—from 292 in 2011, to 100 in 2012, to 58 in 2013.
>
> Despite a lack of operational requirements, the Army is considering the need to bear the cost of continuing Abrams, Bradley, and Stryker production lines at a minimum sustainment rate (MSR) to maintain manufacturing capabilities and to avoid shutdown and startup costs resulting from a three-year production gap. Abrams ECP [Engineering Change Proposal] 1 (FY17-FY18) and BFV ECPII (FY17) will help to revitalize the Combat Vehicle Industrial Base.[58]

Congress has an enduring interest in the oversight of the Army's combat vehicle industrial base, particularly in light of decreased production of combat vehicles. A June 2015 Government Accountability Office (GAO) report details their response to decreased production:

> In response to questions raised over the effect of this planned decrease in production, the Senate Armed Services Committee and conferees for the National Defense Authorization Act for Fiscal Year 2013 directed the Army to report on the status of the combat vehicle industrial base In October 2012, the Army issued a contract with A.T. Kearney, a private independent management consulting firm, to complete an assessment of the combined commercial and government combat vehicle industrial base that supports the United States Army and delivered the final report to the congressional defense committees in April 2014.[59]

GAO's report summarizes the Kearney report's findings as:

- There is excess capacity in facilities with the ability to machine large, complex metal structures for the ground combat vehicle industrial base;
- Unique capabilities exist at each production and sustainment facility within the combat vehicle industrial base, but there is a significant overlap of similar capabilities across the facilities;
- A small number of skills such as armor steel welding are critical to the production and sustainment of combat vehicles;
- There are a small number of high-risk critical and fragile suppliers, such as those that provide certain engines and transmissions, and the risk to these suppliers can be mitigated by individual company action or limited Army intervention;
- Production and sustainment demand is the factor that has the most impact on the industrial base; and
- There is a lower financial impact to the Army for potential production breaks—specifically, stopping all Bradley Fighting Vehicle production work at a particular

[58] Under Secretary of Defense for Acquisition, Technology and Logistics Office of the Deputy Assistant Secretary of Defense for Manufacturing and Industrial Base Policy, "Annual Industrial Capabilities Report to Congress," October 2013, p. 22.

[59] United States Government Accountability Office, Report to Congressional Committees, *Army Combat Vehicles: Industrial Base Study's Approach Met Research Standards*, June 2015, p. 1.

facility—than previously identified by the original equipment manufacturer in a 2012 report.[60]

These findings suggest a relatively healthy Army combat vehicle industrial base provided the existence of adequate production and sustainment demand. The question then becomes what is considered adequate if the only production of M-1s, M-2s, and M-3s is for military sales or newer vehicle versions?

FY2017 Budget Request[61]

Table 7. FY2017 Presidential Budget Request: Abrams, Bradley, and Stryker

($ in thousands)

Budget Activity	Amount
M-1 Abrams Tank (Modification)	$480,166
Abrams Upgrade Program	$0
Abrams Total	**$480,166**
Bradley Program (Modification)	$225,042
Bradley Upgrade Program	$0
Bradley Total	**$225,042**
Stryker Procurement	$71,680
Stryker Modification	$74,348
Stryker Upgrade	$444,561
Stryker Total	**$590,589**

Source: Army Justification Book, Procurement of Wheeled and Tracked Combat Vehicles (W&TCV), Department of Defense Fiscal Year (FY) 2017 President's Budget Submission, February 2016, p. A-3A.

Notes: (1) All requested amounts are from the Base Budget request. There were no Overseas Contingency Operations requests for these systems. (2) In terms of differentiating between *upgrades* and *modifications* in the budget request: *Upgrades* generally involve adding additional capabilities to a weapons system such as a larger main gun or additional armor, for example. *Modifications* address vehicle issues such as obsolescence, reliability, capability, performance degradation, safety, and operationally related issues.

Potential FY2017 Overseas Contingency Operations (OCO) Request[62]

The Army reportedly plans to request a "reprograming action," which requires congressional approval, for $245 million from the European Reassurance Initiative (ERI)[63] budget request to

[60] Ibid., p. 6.

[61] Army Justification Book, Procurement of Wheeled and Tracked Combat Vehicles (W&TCV), Department of Defense Fiscal Year (FY) 2017 President's Budget Submission, February 2016, p. A-3A.

[62] Sebastian Sprenger, "Army Preparing War-Budget Revision to Jump Start Abrams, Bradley Upgrades," *InsideDefense.com*, March 14, 2016.

[63] For additional information on the ERI see CRS Report R43478, *NATO: Response to the Crisis in Ukraine and Security Concerns in Central and Eastern Europe*, coordinated by Paul Belkin.

accelerate the production of upgraded M-1 Abrams and M-2 Bradleys.[64] This requested reprogramming is intended to fund "the expansion by one fully modernized Armored Brigade Combat Team (ABCT) equipment set in Army Prepositioned Stocks in Europe by providing one tank company of M-1A2 SEPv3 Abrams tanks and one mechanized infantry company of M-2A4 Bradley fighting vehicles."[65]

Potential Issues for Congress

"Up-Gunning" the Entire Stryker Fleet

As previously noted, the Army reportedly is considering upgrading the lethality of the entire Stryker fleet. If the Army does eventually "up-gun" the Stryker fleet, Congress might wish to consider a number of questions, including but not limited to the following:

- What is the estimated total program cost?
- How long would it take upgrade the entire Stryker fleet?
- What modifications to the basic Stryker vehicle would be required to accommodate proposed lethality upgrades and how will these changes affect vehicle operational capabilities?
- How would the Stryker lethality modifications affect the deployability of Stryker Brigade Combat Teams (SBCTs)?
- Would additional maintenance and support units/troops be needed in Stryker units to accommodate proposed lethality upgrades?
- Is the decision to upgrade Stryker lethality—as opposed to upgrading for protection and maneuverability—consistent with current and future threats?

Active Protection Systems (APS) for the Abrams, Bradley, and Stryker

The successful development and deployment of "soft- kill" and "hard-kill" APS technologies has the potential to significantly change current and future designs of armored fighting vehicles. By integrating APS into Abrams, Bradleys, and Strykers, as well as future fighting vehicles, the potential exists to not only increase survivability but also to reduce armor protection and vehicle weight. Adopting APS for use might also present challenges in terms of vehicle power sufficiency to run the APS, physical space (internal and external) requirements to mount the APS, and possibly enhanced vehicle vulnerability if the APS fails to operate as intended. Before the Army embarks on a more ambitious effort to develop and field APS, Congress might wish to examine with the Army the potential benefits and risks associated with adopting APS for operational use on Abrams, Bradley, and Stryker fighting vehicles.

[64] Ibid.

[65] Ibid.

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