Joint Air-to-Ground Missile (JAGM)

Executive Summary
- In pre-Milestone C testing, the Joint Air-to-Ground Missile (JAGM) met the Key Performance Parameter (KPP) for probability of hit and met the inflight reliability requirement.
- The pilot vehicle interface for launching JAGM from legacy Apache aircraft was adequate for testing but not suitable for combat, training, or fielding.
- The Army discovered minor vulnerabilities during cybersecurity and electromagnetic environmental effects (E3) testing. The cybersecurity Adversarial Assessment (AA) confirmed that a missile vulnerability discovered during the Cooperative Vulnerability and Penetration Assessment (CVPA) had been eliminated. The vulnerability discovered during E3 testing was eliminated. The AA highlighted a new vulnerability to the missile when mounted on the Apache.
- JAGM maintains the lethality of the legacy HELLFIRE Romeo against target-representative light and heavy armored ground combat vehicles, trucks, and boats. The Army is working on adjusting the fuse delay timing to improve JAGM lethality against bunkers, adobe walls, and personnel in the open to either meet or exceed legacy lethality against these targets.

System
- JAGM is an air-to-ground, precision-guided missile with two new seekers that replicate and combine capabilities of the existing laser-guided HELLFIRE Romeo and radar-guided Longbow HELLFIRE missiles.
- Attack helicopter aircrews using JAGM will have added flexibility to engage targets with dual-seeker engagement modes to optimize missile performance while minimizing aircraft exposure to enemy observation and fire.
- JAGM dual-seeker modes enable aircrews to destroy targets obscured by countermeasures or obscurants, provide target location updates to an inflight missile, avoid alerting enemy vehicles of imminent attack, avoid unwanted collateral damage, and engage multiple targets quickly.
- The JAGM design combines two sensor technologies – semi active laser and millimeter wave (MMW)

radar – into a single seeker and guidance system and mated it to the HELLFIRE Romeo warhead, motor, and flight control systems.
- The HELLFIRE Romeo warhead Integrated Blast and Fragmentation Sleeve (IBFS) detonates with a programmable delay fuse and a Height-of-Burst (HOB) feature. This updated warhead blast provides a capability to engage armored vehicles while the IBFS and HOB feature is designed to engage personnel in the open. The programmable delay allows time for the warhead to penetrate deep into a building, bunker or lightly armored vehicle before detonating to incapacitate the personnel and destroy the equipment inside.

Mission
Army and Marine Corps commanders intend to employ JAGM from rotary-wing and unmanned aircraft to engage enemy combatants in stationary and moving armored and unarmored vehicles, within complex building and bunker structures, in small boats, and in the open.

Major Contractor
Lockheed Martin Corporation, Missiles and Fire Control Division – Grand Prairie, Texas

Activity
- The Army conducted environmental testing in 2016 and 2017 by exposing JAGM missiles to extreme but realistic temperatures and repeated handling and transportation stresses. The Army fired seven of these missiles during missile flight testing without failure.
- The Army completed E3 testing, a logistics demonstration, and chemical agent testing. The Navy conducted shipboard

compatibility testing. Soldiers loaded and unloaded JAGM from an AH-64D Apache helicopter while wearing chemical protection gloves and clothing during the logistics demonstration. Army laboratories tested the resilience of the JAGM dome to chemical agents and to chemical decontamination. The Navy tested the suitability of shipboard equipment for storing JAGM and arming aircraft.

- The JAGM Program Office developed a high-fidelity, all-digital simulation model to complement the test program and estimate hit performance throughout the engagement envelope. The Integrated Flight Simulation (IFS) includes a six degree-of-freedom missile model, tactical flight software, scene generation models for laser and MMW scenes, target models, clutter models, aircraft models, atmospheric models, and countermeasure models.
- Cybersecurity testing included a CVPA and an AA; both conducted at Redstone Arsenal, Alabama. The Army Research Laboratory Survivability/Lethality Analysis Directorate conducted the CVPA in a laboratory using a JAGM guidance section attached to a missile launcher. The Threat Systems Management Office conducted an AA in an aircraft hangar with a JAGM and missile launcher attached to an AH-64D aircraft.
- The JAGM Program Office conducted integrated developmental/operational test shots of 49 missiles before Milestone C. The missile shots spanned the engagement envelope for target type, target speed, aircraft maneuvers, and range to target.
- The Army Test and Evaluation Command conducted a Limited User Test in January 2018 at Yuma Proving Ground, Arizona. Experienced pilots fired 10 missiles in all 4 JAGM engagement modes against stationary and moving targets in daytime conditions.
- During all phases of the Engineering and Manufacturing Development (EMD) live missile testing, 13 of the armored targets were obscured or covered by threat countermeasures (smoke, dust, radar reflectors, camouflage netting).
- Live fire testing in FY18 included flight tests against light and heavy armored ground combat vehicles, trucks, boats, and personnel in the open, in bunkers and behind adobe walls. These tests were adequate to characterize any performance effects of the newly integrated seeker on the existing, HELLFIRE Romeo-based warhead, as well as to demonstrate JAGM lethality against the intended targets.
- The Army conducted all pre-Milestone C operational and live fire testing in accordance with DOT&E-approved TEMP and test plans.

Assessment
- In pre-Milestone C testing, JAGM met hit performance and reliability requirements. JAGM demonstrated performance requirements for probability of hit, even though many of the targets were obscured by countermeasures or dust. The IFS provided valid hit-point estimates for 23 shots; information that was used to confirm that JAGM maintains lethality of the HELLFIRE Romeo missile. JAGM demonstrated its inflight and overall reliability requirements with the live missile shots.
- JAGM maintains the lethality of the HELLFIRE Romeo missile against light and heavy armored vehicles, trucks, and boat targets. JAGM met its lethality requirements against bunkers, adobe walls, and personnel in the open. The Army is working on optimizing the fuse delay timing to improve lethality against these targets to either match or exceed HELLFIRE Romeo performance.
- The pilot vehicle interface for launching JAGM from legacy Apache aircraft enabled operational testing but is not suitable for combat, training, or fielding. Programming the aircraft and missile to fire a single missile requires approximately 40 steps and 5 minutes of dedicated operator attention. The Apache program has developed software to recognize JAGM and enable pilots to efficiently employ all JAGM operational modes. The new Apache interface will support integrated and operational testing of JAGMs in 2019.
- Minor vulnerabilities were discovered during cybersecurity and E3 testing. The cybersecurity AA confirmed that a missile vulnerability discovered during the CVPA had been eliminated. The vulnerability discovered during E3 testing was eliminated. The AA demonstrated a new vulnerability to the missile when mounted on the Apache.

Recommendations
The Army should:
1. Complete development and testing of an efficient pilot vehicle interface for employment of JAGM from the AH-64E aircraft.
2. Complete development and validation of the IFS to estimate JAGM performance and lethality across the employment envelope and in expected operational terrain and conditions.
3. Investigate JAGM performance in flight testing against targets in realistic expected operational terrain and conditions.
4. Optimize and demonstrate adjusted JAGM fuse timing to further improve JAGM lethality against personnel in the open, personnel behind adobe walls, and personnel in bunkers.
5. Coordinate between the JAGM and AH-64E Program Managers to address the vulnerability found during the AA.