



Army Futures Command Concept for Fires 2028

COMPLETE

DIS-INTEGRATE

DIS-INTEGRATE

EXPLOIT

RE-COMPETE



15 September 2021

Distribution Statement A.
This document is approved for public release; distribution unlimited.

This page intentionally left blank

Preface

From the Commander, Fires Center of Excellence and Fort Sill

The Army, as a critical component of the joint force, faces complex, advanced threats that will challenge the country's ability to compete with peer adversaries and dominate in future warfare. To address these challenges, the Army must identify and anticipate capability gaps and develop solutions that will allow us to deter conflict and, if necessary, prevail in combat. Success in future warfare requires a grounding in lessons of the past coupled with thoughtful, innovative, and leading-edge solutions to address the emerging conditions that will define the future battlefield.

The *Army Futures Command Concept for Fires* (AC-Fires) describes how Army fires will support future Army, joint, and multinational forces in Multi-Domain Operations (MDO). This concept expands on a central idea that Army fires enables deterrence in competition, and in armed conflict shapes throughout the depth of the MDO battlefield framework, to penetrate and dis-integrate antiaccess/area denial capabilities, defend critical assets, and defeat threat capabilities to enable joint force maneuver. This idea serves as a foundation for the development of required capabilities that will drive future capability development and DOTMLPF-P changes.

This concept expands on the doctrinal definition of Army fires established in Army Doctrinal Publication 3-19 *Fires*, published in July 2019, which describes the broad role of Army fires integrated and employed across the five domains of land, air, sea, space, and cyberspace as well as the electromagnetic spectrum and information environment. This concept not only provides detailed requirements for how the Army will employ fire support and air and missile defense in the future, but also describes the need for seamless integration with other Army, joint, and multinational fires capabilities, including cyberspace, electromagnetic warfare, special operations forces (SOF), and space to provide a comprehensive range of lethal and nonlethal fires to support of the commander's objectives.

This concept introduces four components of the solution that are critical to success in MDO: echeloned fires capabilities, enhanced sensor-to-shooter linkages, multi-domain targeting, and leverage joint, intergovernmental, interagency, and multinational (JIIM) capability. These four components form the core ideas that describe the essential role of fires in the future operational environment and support the key tenets and solutions described in the Army Operating Concept, TRADOC Pamphlet 525-3-1 *The U.S. Army in Multi-Domain Operations 2028*. Rooted in each solution are requirements to leverage emerging technologies that advance the role of fires, including artificial intelligence, robotics and autonomous solutions, advanced targeting capabilities, and technologies that expand range, enhance lethality, and improve survivability.

Echeloned Capabilities. The Army fights in echelons, from tactical to strategic, each dependent upon the other for success. Fires formations at all echelons must provide responsive and effective fires to win in MDO. The Army requires the right fires capabilities and force structure to range throughout the depth and breadth of the battlefield, which includes layered capabilities to defeat the complex array of threat targets in all domains. Success on the future battlefield requires capabilities with the range, lethality, effectiveness, and survivability to provide overmatch.

Enhanced sensor-to-shooter linkages. The Army must move toward *any sensor, best shooter* as a state of being. The temporary and ad-hoc arrangements between sensors and shooters that have been the norm for decades will not be effective in future warfare where the scale, scope, and rapid decision cycle required to employ effective fires are the determining factors between success and failure. These enhanced linkages move the Army beyond simple kill-chains and help establish the creation of “joint kill-webs” that push and pull targeting data from a wide array of available sensors to the desired capability that can create the desired effect on the target.

Multi-Domain Targeting. MDO does not drive a departure from the Army or joint targeting processes in current doctrine, but it does require a unified approach to targeting at echelon including the integration and synchronization of lethal and nonlethal effects in all domains to enable convergence. This includes improving the ability to conduct thorough and continuous target development against threat high payoff targets during the competition period as well as introducing greater flexibility in both deliberate and dynamic targeting procedures to meet the time-sensitive demands of targeting in MDO.

Leveraging JIIM capability. Army-only solutions are insufficient to address problems of the future. Army fires must be enabled by JIIM sensors and shooters to integrate and converge fires seamlessly in MDO. This requires improved information sharing with JIIM partners to integrate the full range of capabilities available and enable convergence. Interoperable systems and the implementation of cross-domain solutions are required to optimize operations and facilitate real-time coordination of fires. Ultimately leveraging JIIM capability allows the Army to increase the magazine depth of multi-domain capabilities available to address the threat.

The vision is a suite of fires capabilities and necessary capacity that enables the commander’s freedom of maneuver across all domains. Fires plays a critical role in how the joint force will conduct operations in all domains to counter complex, advanced threats. This concept provides the broad framework to pursue future technologies, develop capabilities, and drive DOTMLPF-P changes.



Kenneth L. Kamper
Major General, USA
Commanding

The U.S. Army Concept for Fires 2028-2040

The *fires warfighting function* is the related tasks and systems that create and converge effects in all domains against the threat to enable actions across the range of military operations.

Operational Environment

- Russian and Chinese long, mid, and short-range missile capabilities overmatch U.S. Army fires capabilities with advantages in capacity, range, and lethality
- Air/Land/Maritime superiority is not assumed. Russian and Chinese A2/AD capabilities limit USAF/USN/USMC/USA access in the operational and strategic fires areas
- Russia and China employ an integrated long-range fires complex, protected by integrated air defense systems (IADS), designed to mass fires on friendly maneuver from stand-off ranges
- Russia and China can contest in all domains with cyber, information warfare, and space-based ISR capabilities integrated with long range surface to surface and surface to air systems

Russian and Chinese Threat Capabilities

- Ballistic, Cruise, & Hypersonic Missiles
- Cyber & Information Warfare
- Unconventional Warfare
- Fixed & Rotary Wing Aircraft
- Integrated Air Defenses
- Recon-Fires-Strike Complex
- Long/Mid-Range Massed Artillery
- Unmanned Aircraft Systems
- Electronic Attack
- Counter Space & PNT
- Directed Energy
- CBRNE & WMD

Military Problem: How does Army fires enable the joint force to compete below the threshold of conflict and, if necessary, during conflict employ and converge multi-domain effects throughout the depth of the battlefield to target and counter A2/AD capabilities, defeat threats, enable joint maneuver in MDO, and return to competition on favorable terms?

Central Idea: Army fires contributes to the joint force by enabling deterrence in competition, and in armed conflict integrates and employs fires at all echelons, throughout the depth of the MDO battlefield framework, to penetrate and dis-integrate A2/AD capabilities, defend critical assets, and defeat threat capabilities to enable joint force maneuver. During return to competition, Army fires contributes by posturing capabilities and reconstituting forces to preserve the favorable condition established during conflict.

Components of the Solution

<u>Echeloned Capabilities</u>	<u>Enhanced Sensor-to-Shooter</u>	<u>Multi-Domain Targeting</u>	<u>Leverage JIIM Capabilities</u>
<ul style="list-style-type: none"> • Army fires structure and capabilities at all echelons • Shaping in depth/layered defenses • Improved range, lethality, mobility, and survivability • Enables convergence of fires 	<ul style="list-style-type: none"> • Any sensors, best shooter • JIIM network integration • Redundant and assured communications • AI enabled targeting, airspace and information management 	<ul style="list-style-type: none"> • All-domain target development in competition • Improved deliberate and dynamic target execution • Lethal and nonlethal fires convergence 	<ul style="list-style-type: none"> • Access to JIIM sensors and shooters • Shared understanding • System and network interoperability • Seamless integration

Key Fires Actions in Multi-Domain Operations by Echelon

<div style="border: 1px solid black; padding: 2px; width: fit-content;">XXXX THEATER ARMY</div> <ul style="list-style-type: none"> • Support targeting in all domains • Set the theater for fires (calibrated force posture) • Establish theater fires architecture and linkage to supported CJTF / GCC • Conduct strategic attack, J-SEAD • Penetrate and dis-integrate A2/AD capabilities 	<ul style="list-style-type: none"> • Assist development/prioritization of critical asset lists • Assist development and dissemination of AADP, ACO, ACP, SPINS • Provide AIAMD SA/SU to all echelons and JIIM partners • Provide AMD forces for theater asset defense • Provide theater AMD early warning
<div style="border: 1px solid black; padding: 2px; width: fit-content;">XXX CORPS</div> <ul style="list-style-type: none"> • Defeat threat long-range fires and conduct shaping fires • Penetrate and dis-integrate A2/AD capabilities • Integrate cross-domain fires (CEMA/IO) • Employ J-SEAD 	<ul style="list-style-type: none"> • Develop Corps CAL/ADP in coordination with Theater/JIIM • Recommend ACMs for ACO inclusion • Integrate sensors into common operational picture • Develop Corps EMCON plan
<div style="border: 1px solid black; padding: 2px; width: fit-content;">XX DIVISION</div> <ul style="list-style-type: none"> • Employ proactive and reactive counterfire, SEAD • Reinforce BCT fires • Integrate cross-domain fires (CEMA/IO) • Set conditions for BCT cross domain maneuver 	<ul style="list-style-type: none"> • Develop Division CAL/ADP in coordination with Corps/JIIM • Assist in airspace deconfliction • Provide AMD forces to support Division Area Defense Plan • Integrate sensors into common tactical picture
<div style="border: 1px solid black; padding: 2px; width: fit-content;">X BCT</div> <ul style="list-style-type: none"> • Employ direct support fires in support of the BCT • Employ reinforcing cannon and rocket fires • Integrate cross-domain fires (CEMA/IO) 	<ul style="list-style-type: none"> • Detect and defeat aerial threats • Provide early warning • Manage BCT airspace

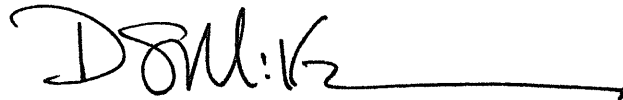
This page intentionally left blank

**U.S. Army Futures Command
Futures and Concepts Center
Austin, TX 78701-2982**

15 September 2021

Force Management

ARMY FUTURES COMMAND CONCEPT FOR FIRES 2028



D. SCOTT MCKEAN
Lieutenant General, U.S. Army
Director, Futures and Concepts
Center

History. The *Army Futures Command Concept for Fires* (AC-Fires) is a product of the Army Concept Framework, fully nested with and expanding on the central and supporting ideas of TRADOC Pam 525-3-1, *The U.S. Army in Multi-Domain Operations 2028*. Because this publication changes extensively, only broad changes are highlighted in the summary of change.

Summary. This pamphlet broadly describes capabilities the Army will require in 2028 to enable the employment of fires capabilities. This concept will lead force development and modernization efforts by establishing a common framework within which to develop the specific capabilities required to fully enable fires during the conduct of future multi-domain operations in uncertain, highly-competitive, and dynamic operational environments.

Applicability. This concept applies to all Department of the Army (DA) activities that develop doctrine, organizations, training, materiel, leadership and education, personnel, facilities, and policy (DOTMLPF-P) capabilities. This concept guides future force development and informs subsequent supporting concepts and the Joint Capabilities Integration and Development System process.

Proponent and supplementation authority. The proponent of this pamphlet is the Army Futures Command Headquarters, Director, Futures and Concepts Center (FCC). The proponent has the authority to approve exceptions or waivers to this pamphlet that are consistent with controlling law and regulations. Do not supplement this pamphlet without prior approval from Director, Futures and Concept Center, 210 West 7th Street, Austin, TX 78701-2982.

*This publication supersedes TRADOC Pam 525-3-4, dated 25 January 2017.

Suggested improvements. Users are invited to submit comments and suggested improvements via DA Form 2028 (Recommended Changes to Publications and Blank Forms) to Director, Futures and Concept Center (FCFC-CE), 210 West 7th Street, Austin, TX 78701-2982.

Availability. This pamphlet is available on the FCC homepage at <https://www.army.mil/futuresandconceptscenter#org-resources>.

Summary of Change

AFC Pamphlet 71-20-6
Army Futures Command Concept for Fires 2028

This revision:

- Expands on the ideas in TRADOC Pam 525-3-1, *The U.S. Army in Multi-Domain Operations 2028* and the TRADOC Pam 525-3-8, *U.S. Army Concept for Combined Arms Operations at Echelons Above Brigade 2025-2045* focuses on fires capabilities required to support Multi-Domain Operations.
 - Adopts a new definition of the fires warfighting function: *The fires warfighting function is the related tasks and systems that create and converge effects in all domains against the threat to enable actions across the range of military operations.*
 - Provides the central idea: *Army fires contributes to the joint force by enabling deterrence in competition, and in armed conflict integrates fires at all echelons, throughout the depth of the multi-domain operations (MDO) battlefield, to penetrate and dis-integrate antiaccess/area denial (A2/AD), defend critical assets, and defeat threat fires to enable joint force maneuver.*
 - Updates Army fires required capabilities.
 - Provides fires warfighting function unique dependencies on other Army warfighting functions, joint, interagency, intergovernmental, and multinational partners.
 - Provides a science and technology appendix.
-

Table of Contents

Chapter 1 Introduction.....	5
1-1. Purpose	5
1-2. The Fires Warfighting Function	5
1-3. References	6
1-4. Explanations of abbreviations and terms.....	6
1-5. Linkage to the Multi-Domain Operations Concept	6
1-6. Linkage to the Echelons Above Brigade Concept.....	6
1-7. Implications for the fires warfighting function	7
Chapter 2 Operational Context	8
2-1. Operational Environment	8
2-2. Russia	9
2-3. China.....	10
2-4. Threat Capabilities.....	10
Chapter 3 Fires in Multi-Domain Operations.....	11
3-1. Introduction	11
3-2. Military problem.....	12
3-3. Central idea.....	12
3-4. Solution synopsis.....	13
3-5. Components of the solution.....	13
Chapter 4 Conclusion	18
Appendix A References	18
Section I Required References.....	18
Section II Related References.....	18
Appendix B Required Capabilities.....	20
B-1. Introduction.....	20
B-2. Fires required capabilities (RCs)	20
Appendix C Science and Technology	21
C-1. Introduction.....	21
C-2. Fires science and technology focus areas	22
C-3. Artificial intelligence (AI)	23
C-4. Robotics and autonomous platforms.....	24
C-5. Protection and survivability	24
C-6. Power management and distribution.....	24
C-7. Human performance improvement (HPI)	25
C-8. Quantum technology.....	25
C-9. Radio frequency electronic materials	26
C-10. Science of additive manufacturing	26
C-11. Nanotechnology	27
C-12. Improved munitions	27
C-13. Offensive / defensive hypersonics	28
C-14. Counter – Unmanned Aerial Systems (C-UAS)	28
C-15. Directed energy (DE).....	29
C-16. Railgun Weapons Technology (RGWT)	29
C-17. Next Generation Radars and Sensors.....	30
C-18. Soldier and Platform Based Precision Sensors	31

C-19. Next Generation Shooters and Platforms.....	32
C-20. Next Generation Fires Command Control	33
C-21. Diverse, Disruptive Effects for Artillery (DDEA).....	34
C-22. Alignment with Modernization Priorities	34
C-23. Long-Range Precision Fires.....	34
C-24. Air and Missile Defense	34
C-25. Conclusion	35
Appendix D Dependencies.....	35
D-1. Introduction	35
D-2. Dependencies on Army Warfighting Functions	35
D-3. Other Critical Dependencies.....	38
Glossary	39
Section I Abbreviations	39
Section II Terms.....	41

Table of Figures

1. Logic Chart	vii
3-1. MDO Framework.....	12
C-1. Fires S&T Focus Areas	23

Chapter 1 Introduction

1-1. Purpose

AFC Pam 71-20-6, the *Army Futures Command Concept for Fires* (AC-Fires) describes how fires formations and capabilities support and enable joint, interagency, intergovernmental, and multinational (JIIM) efforts, in support of Multi-Domain Operations (MDO) in the 2028 and beyond timeframe. The AC-Fires provides the broad conceptual framework that defines the future role of the fires warfighting function and guides development of future Army fires capabilities. This document expands on, and supports the ideas expressed in, TRADOC Pam 525-3-1, *The U.S. Army in Multi-Domain Operations 2028*, and TRADOC Pam 525-3-8, *U.S. Army Concept for Multi-Domain Combined Arms Operations at Echelons Above Brigade (EABC) 2025-2045*. The AC-Fires describes how the Army integrates and executes fires to conduct MDO against future peer threats. This document also describes conceptual fires actions at each Army echelon throughout the expanded MDO battlefield framework during periods of competition and conflict. The central idea and components of the solution offered in this concept will inform the development of required capabilities for Army fires.

1-2. The Fires Warfighting Function

a. This document refers to the term “fires” within the context of existing and emerging doctrinal definitions to clarify future fires actions and identify required fires capabilities. Joint Publication 3-0 defines **fires** as “the use of weapon systems to create specific lethal and nonlethal effects on a target.” Additionally, **joint fires** is defined as “fires delivered during the employment of forces from two or more components in coordinated action to produce desired effects in support of a common objective.” Army Doctrinal Publication (ADP) 3-19 *Fires*, dated 31 July 2019, defines the **fires warfighting function** as “the related tasks and systems that create and converge effects in all domains against the threat to enable actions across the range of military operations.” Under this broad definition, the fires warfighting function includes the integration and execution of fires across the five domains of land, air, maritime, space, and cyberspace as well as the electromagnetic spectrum and information environments.

b. The fires warfighting function includes planning and coordinating surface to surface fires; air to surface fires; surface to air fires; cyberspace operations and electromagnetic warfare; space operations; multinational fires; special operations; and information operations. This responsibility is not limited to a specific formation or Field Artillery and Air Defense Artillery personnel, but requires the coordination and integration of subject matter experts in each field. From ADP 3-19, the fires warfighting function must “integrate Army, multinational, and joint fires through the targeting and operations processes; fire support planning; airspace planning and management; electromagnetic spectrum management; multinational integration, rehearsals; [and] air and missile defense planning and integration.” This concept focuses on the integration of fires in MDO. This includes employment of fires at all echelons throughout the MDO battlefield framework to penetrate and dis-integrate threat A2/AD capabilities, defend critical assets, and defeat threat fires to enable joint force maneuver. It outlines the requirements for how the Army will conduct fire support, targeting, and air and missile defense in the future. The concept also substantiates the requirement to integrate information advantage capabilities (including: cyberspace, electromagnetic warfare (EW), military deception (MILDEC), special forces, psychological

operations (PSYOP), and civil affairs (CA) operations, operations security (OPSEC), select G2/G2X functions, special technical operations/ integrated joint special technical operation (IJSTO), and space) to ensure the seamless integration and employment of lethal and nonlethal fires in support of the commander's objectives.

1-3. References

Appendix A lists required and related references.

1-4. Explanations of abbreviations and terms

The glossary explains abbreviations and special terms used in the pamphlet.

1-5. Linkage to the Multi-Domain Operations Concept

a. Technologically advanced peer adversaries seek to create layered stand-off through the employment of A2/AD systems and are increasingly more capable of challenging U.S. forces in all domains. This challenge is addressed in the central problem of the Army Operating Concept, *The U.S. Army in Multi-Domain Operations 2028*. The concept requires the Army to compete and prevail below the threshold of armed conflict, and, if necessary, rapidly transition to armed conflict. Upon transition to armed conflict Army capabilities will penetrate and dis-integrate key A2/AD systems, the threat long-range and mid-range systems and integrated air defense systems (IADS), allowing the joint force freedom to exploit windows of superiority, defeat threat forces, and return to competition on favorable terms. To achieve these ends, the Army must evolve the force and shape operations around three core tenets:

- *Calibrated force posture* addresses the positioning of forces and the ability to maneuver across strategic distances.
- *Multi-domain formations* possess the capacity, endurance, and capability to access and employ capabilities across all domains to pose multiple and compounding dilemmas on the enemy.
- *Convergence* achieves the rapid and continuous integration of effects in all domains across time, space, and purpose to create windows of superiority for the joint force to exploit.

b. Underpinning these tenets are mission command and disciplined initiative at all echelons of command. Army fires is a key contributor to the success of MDO and the Army must organize and equip to maximize the seamless integration and timely and accurate employment of fires in all domains to defeat threat stand-off and enable joint force maneuver.

1-6. Linkage to the Echelons Above Brigade Concept

TRADOC Pamphlet 525-3-8, *U.S. Army Concept for Multi-Domain Combined Arms Operations at Echelons Above Brigade 2025-2045* (EABC) concept describes how Army warfighting formations at echelons above brigade (EAB) operate in competition and conflict to support the Army's four strategic roles: shape the operational environments, prevent conflict, prevail in large-scale ground combat, and consolidate gains. It also proposes how EAB formations might be structured and employed in the future and identifies the changes and capabilities required at each echelon to meet the land power demands of the future operational environment (OE). The EABC provides a future vision to guide near-, mid-, and far-term capability development efforts. The EABC describes six challenges in the expanded MDO battlefield and how future Army forces gain

and maintain the initiative in the competition period and across the full range of military operations. Fires capabilities contribute to all six of these challenges. The six challenges are:

- Gain and maintain contact to reveal threat areas of influence and enemy dispositions.
- Persistently compete below the threshold of armed conflict.
- Posture to reduce vulnerability and rapidly transition to large-scale combat.
- Converge multi-domain effects in depth to create windows of superiority.
- Exploit the initiative at tempo against critical vulnerabilities to dis-integrate threat systems, and enable maneuver forces to defeat enemy formations in close combat.
- Consolidate gains to develop and retain an enduring initiative.

1-7. Implications for the fires warfighting function

a. The MDO and EAB concepts describe operations based upon the future OE that have several implications which require Army fires responses.

(1) Future peer threats, specifically Russia and China require the U.S. Army to optimize for the possibility of conducting large scale combat operations. This requires increased capability and capacity at all echelons, from the tactical level of war to theater-strategic. The Army must have the capability and capacity in each echelon to shape with fires throughout the depth of the battlefield.

(2) The Army must consider fires requirements during the competition period. Critical actions required in competition include continuous target development against a threat's most critical capabilities or high payoff targets; positioning of fires units and capabilities to achieve deterrence and enable the rapid employment of fires; maintaining high standards of training and readiness requirements; and effective joint, multinational partner integration, development and interoperability.

(3) Because the Army will operate inside contested domains, it requires fires capabilities that are hardened, redundant, and able to operate effectively in degraded conditions.

(4) The increased complexity and speed of battle during MDO requires greater speed and flexibility in the processes and organizations conducting deliberate and dynamic targeting. Artificial intelligence (AI)-enabled, SE –driven weapon and information systems will be a cornerstone in wars of the future. While Army leaders and Soldiers are capable of making dozens of decisions a second, future warfare will require decision making at volume and speed exceeding human capacity. While leaders and staff may be more reliant on AI-enabled systems to achieve the demand of information management and timely decision making, they must still be very involved in command and control processes. More combat actions may be made automatically by these AI-enabled systems in the future, but commanders will continue to establish priorities and staffs will ensure the commander's guidance is met. Combat developers must demand approval authority for the logic behind software (SW) code development, validation and testing and they must involve warfighters in the review process so that automated systems act like a commander would if time and information were available.

(5) The joint force requires Army fires as a critical enabler to penetrate and dis-integrate threat A2/AD capabilities and must include them in planning and execution across the joint force. Army fires requires the capability to engage long range air and missile threats in order to defend forces, thus enabling penetration and dis-integration of enemy A2/AD assets. To accomplish this, Army fires requires increased ability to detect, classify, discriminate, identify, and engage aerial threats with varying flight kinematics at greater distances.

(6) To enable effective and responsive fires, the Army requires greater access and tailored authorities during completion and pre-approved response options for the transition to conflict for SOF, space, cyberspace, EW, and intelligence enablers with the ability to detect, identify, strike, and assess deep targets to achieve multi-domain convergence.

(7) The Army requires increased access to and integration of sensors in all domains with Army fires platforms to enable ‘any sensor, best shooter’ against time-sensitive, complex threat targets.

(8) Finally, to enable exploitation by friendly joint maneuver, the Army requires the ability to accurately mass lethal and nonlethal fires as well as employ layered air defense at the strategic, operational and tactical level.

1-8. Implications of the Combined Joint All Domain Command and Control (CJADC2) concept

The intent of CJADC2 is to enable any sensor to be linked to the best shooter, through any C2 node, in near-real time, with the appropriate authorities to employ combined, joint, and mission partners to work together rapidly and effectively in near-real time. CJADC2 enables the Army, joint force, and key international partners to maintain situational awareness and converge multi-domain effects at speed and scale. The time gained by increased interoperability will provide decision advantages over the threat during targeting. This enhances the ability to converge fires platforms from multiple domains onto a single target. CJADC2 enables Army fires to become lethal and effective by increasing interoperability and allow for the rapid convergence of multi-domain effects.

Chapter 2 Operational Context

2-1. Operational Environment

a. *TRADOC Pamphlet 525-92, The Operational Environment and the Changing Character of Future Warfare* (Oct 2019) and the *AFC Pamphlet 525-2, Future Operational Environment: Forging the Future in an Uncertain World 2035-2050* (Nov 2020) expect that by mid-century, warfare will likely be enhanced by more advanced, sophisticated capabilities such as robotics, AI, quantum computing and navigation, nanomaterials, synthetic biology, direct-energy weapons, and hypersonic missiles will all complicate warfare, increasing the complexity and speed of battle.

Operational imperatives will occur at even longer ranges, delivering a range of effects whose impact and destructiveness will be broader and more precisely delivered.

b. Technology changes will impact the character of warfare. Unmanned systems, including advanced battlefield robotic systems acting both independently and as part of a wider trend in man-machine teaming, will become increasingly common, and by 2040—or even earlier—could make up significant elements of a combatant force. In some cases, swarms of small, cheap unmanned systems, which will enter service before 2035, will be used in novel ways, both offensively and defensively, creating targeting dilemmas for sophisticated, expensive defensive systems. Laser and radiofrequency weapons drawing upon small, lighter, and much more portable sources of power, will become more practical, and will further increase the ranges and lethality of direct fire weapons, particularly defensive weapons designed to counter aircraft, unmanned aerial vehicles, and ground systems.

c. Communications will be critical, and advances in quantum computing, networking, and the Internet of Things will make the communications both easier, and more vulnerable in the face of the same technologies used to counter an enemy's communications capabilities. Advances in directed energy systems to include lasers operating at light speed, high-powered microwave weapons, hypersonic delivery systems, space systems, hypervelocity rail guns, and other systems, coupled with new types of conventional and unconventional warheads will dramatically increase the scope of battlefields, enabling intercept of air and missile threats delivered at tactical close ranges, within theater, or from ranges globally.

d. Precision strike effects will be capable of being delivered rapidly from a continent away. Precision weapons allow an enemy to regularly produce critical effects necessary to further their plan. Destruction of key nodes in an opposing force or adversary nation allows measured effects to produce desired conditions. These changes will impact fires capabilities and processes significantly.

e. Massed fires and weapons of mass effects retain great utility to produce cognitive shock and possibly dis-integrate the coherency of an armed force. Although mass effects do destroy the means for war, they are more properly viewed as an attack on the will to continue the fight. The speed of engagements in this era – which routinely involve lasers, hypersonic weapons, cyberspace attacks, and AI – will far exceed the reaction time of current Army decision making. The decision-making process will require much greater speed; information must be quickly gathered and assessed so that commanders can make decisions at increasingly rapid rates. The demand to make decisions in all phases of future conflict throughout the depth of the MDO battlespace requires an enhanced command and control (C2) capability to maintain an ever increasing operating tempo; it requires AI-enabled C2 to achieve the overmatch that will spell success in a battlespace saturated with robots, sensors, and drones. As a result, engagements will be fast, but campaigns could be a protracted series of lethal and nonlethal engagements or conflicts short of war.

2-2. Russia

Russia has demonstrated the intent and possesses the most effective combinations of systems and concepts to challenge the U.S. and its allies militarily in the near term. Russia's actions in Georgia, Ukraine, and Syria have demonstrated their intent to fracture the relationship between the U.S. and its partners and their ability to pursue strategic objectives. Russia uses unconventional and

information warfare to propagate a narrative that breeds ambiguity and delays the reactions of their adversaries. Over the last decade, Russia has increased its investments in A2/AD capabilities and systems intended to deny the joint force entry into a contested area and set the conditions for a fait accompli attack.

2-3. China

China possesses the vision and strategic depth to become the U.S.'s most powerful competitor surpassing Russia as the Army's new pacing threat by 2030. Unlike Russia, China has the economy and technological base, such as an independent microelectronics industry and world-leading AI development process, sufficient to overtake current Russian system overmatch in the next 10-15 years. China is rapidly building a world class military capable of projecting power globally in support of regional hegemony. The risk associated with this assumption will be assessed continuously to ensure the ability to adapt conceptually should China accelerate its capability development.

2-4. Threat capabilities

a. The U.S. will continue to face opponents who develop strategies by learning from past U.S. conflicts, as well as lessons from their own conflicts. The most prominent anticipated strategy is that of A2/AD: an approach that seeks to deny the U.S. and its multinational partners the use of wide geographic areas and global/regional force-generation assets. Use of long range and complex missiles systems, littoral watercraft, and unmanned aircraft systems (UAS) in complex, structured attacks are key components of this strategy. Another key component is the denial/disruption through the use of counterfire and proactive fires. Other potential emerging approaches include cyberspace attacks on U.S. military and global information networks and denial of the Global Positioning System (GPS) and other space-based capabilities. Weapons of mass destruction may be employed to escalate or deescalate conflicts.

b. Peer threats will seek to challenge U.S. and multinational partner air and missile defense forces with increased capabilities, which include hypersonic weapons, UAS, and ballistic and cruise missiles. Future threat capabilities will advance along with our own and in some cases, achieve overmatch. Intelligent, adaptive threat systems will utilize aerial platforms such as UAS and cruise missiles to exploit sectored defense systems. UAS in particular will proliferate rapidly as their cost to capability ratio decreases. UAS will challenge the ability of air defense systems to rapidly detect, identify, and engage large numbers of enemy aerial threats such as swarms and autonomous systems. The proliferation of UAS extends to friendly forces as well, which leads to increasingly congested airspace and the associated issues of friendly protection and target identification. Fixed and rotary wing manned aircraft and ballistic and cruise missiles will continue to proliferate worldwide while increasing their overall technical capabilities. Advanced countermeasures, low observability, precision attack, passive sensing, and standoff weapon engagement capabilities will challenge existing and future air defense sensors and interceptors.

c. Today's fires force lacks sufficient capacity, lethality and range to deter and defeat peer threats. Peer competitors will continue to seek overmatch of U.S. and partner fires capabilities with advanced technologies of their own, such as hypersonic munitions, massed indirect fires, and a highly responsive recon-strike complex. Peer threats have already demonstrated the ability to organize a highly effective fires complex (UAS, rocket artillery, and IADS) to detect targets, mass

fires, and protect themselves. Enhanced threat capabilities will enable engagement of friendly fire support elements at standoff weapon ranges, precluding or pre-empting friendly fire support operations. Threats will employ advanced electromagnetic attack technologies in both offensive and defensive roles and will attempt to deny or disrupt satellite-based command, control and communication and position, navigation and timing services. As technologies mature, threat artillery ranges will increase, development of threat GPS agnostic munitions will preclude friendly GPS jamming, development of advanced threat GPS jammers and point air defense systems will hinder our current precision guided munitions.

d. The U.S.'s most capable potential adversaries have taken advantage of new technologies and military thought to form niche, and in some select cases, even wide-spread overmatch against U.S. joint capabilities. These trends will only intensify as we progress towards 2035 and beyond. In this future operational environment the challenges are expected to get worse.

Chapter 3

Fires in Multi-Domain Operations

3-1. Introduction

a. Supporting MDO requires the U.S. Army to fundamentally shift its posture, readiness, and modernization efforts to counter highly capable threats posed by Russia and China, with the potential for conducting large scale combat against these threats. The challenge to the joint force is how to prevail in competition, and if necessary, rapidly transition and win in armed conflict, and return to competition on more favorable terms. Army fires are critical to success in each period and will support the Army and joint force in a number of critical ways, including defending critical assets against a variety of complex air and missile threats, holding threat forces at risk from stand-off ranges with long-range fires, and employing and converging a combination of lethal and nonlethal fires in multiple domains to achieve windows of superiority and enabling the joint force exploitation. This chapter focuses on the application of Army fires in MDO. To best comprehend the role of Army fires in this environment, it is critical to understand the battlefield framework proposed in the MDO concept, which expands the current doctrinal framework of deep, close, and rear into more definable areas that better describe how and where friendly and threat forces may employ capabilities, and helps leaders visualize the broad space required to operate in competition and armed conflict (see figure 3-1).

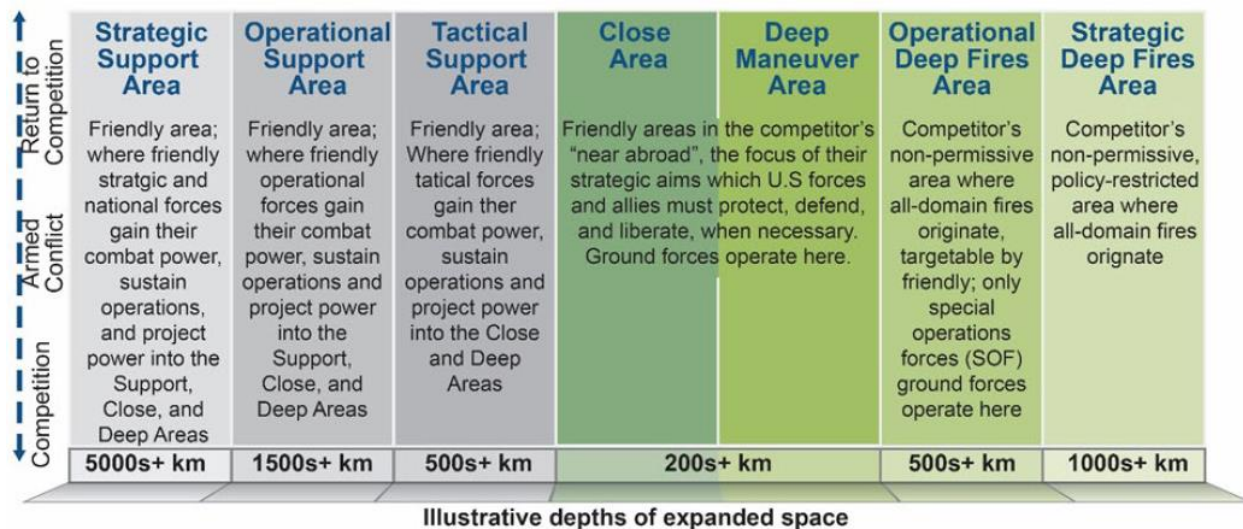


Figure 3-1. MDO Framework

b. In MDO, the support area is divided into three sub-areas: strategic, operational, and tactical. These areas are also the enemy’s deep area where they will likely employ long-range fires and attempt to disrupt strategic and operational deployment, sustainment operations, and critical command and control nodes. The support areas require adequate protection from various threats in all domains. The close area and deep maneuver area define the space where air, maritime, and land forces will most likely clash. It includes key terrain and objectives that must be defended, destroyed, or liberated. The deep area is sub-divided into an operational and strategic deep fires area. It is in this space where the enemy will employ high value targets from stand-off and where friendly forces must shape by employing lethal and nonlethal fires at great ranges to counter the enemy’s long-range capabilities. This expansion of the framework helps commanders visualize the battlefield and may help delineate the roles and responsibilities of Army formations at echelon. Procedurally fires throughout the expanded battlefield are planned, resourced, and integrated through the joint targeting process, and air and missile defense planning process. Army fires will support joint operations by providing lethal and nonlethal delivery of effects at echelon and enabling convergence of effects across multiple domains to strike targets throughout the expanded battlefield in armed conflict.

3-2. Military problem

How does Army fires enable the joint force to compete below the threshold of conflict and, if necessary, during conflict employ and converge multi-domain fires and effects throughout the depth of the battlefield to target and counter A2/AD capabilities, defeat threats, enable joint maneuver in MDO, and return to competition on favorable terms?

3-3. Central idea

Army fires contributes to the joint force by enabling deterrence in competition, and in armed conflict integrates and employs fires at all echelons, throughout the depth of the MDO battlefield framework, to penetrate and dis-integrate A2/AD capabilities, defend critical assets, and defeat threat capabilities to enable joint force maneuver. During return to competition, Army fires contributes by posturing capabilities and reconstituting forces to preserve the favorable condition established during conflict.

3-4. Solution synopsis

In MDO, Army fires must integrate with joint and multinational fires to achieve convergence and create synergistic¹ effects in all domains. The following components of the solution are critical to the Army's success in MDO: echeloned capabilities, enhanced sensor to shooter linkages, multi-domain targeting (lethal and nonlethal), and leveraged JIIM capabilities. These components describe how the Army applies fires to enable the success in competition, armed conflict, and return to competition.

3-5. Components of the solution

The components of the solution form the core ideas that describe the essential role of fires in the future OE and are drawn from experimentation against emerging threats but are also rooted in vast historical experience in large scale combat dating back to World War II. Recent experimentation concludes that achieving success against the emerging threats of Russia and China requires Army fires with the following characteristics: echeloned capabilities, enhanced sensor-to-shooter linkages, multi-domain targeting, and ability to leverage JIIM capabilities. These components of the solution have been validated in recent experimentation and are rooted in historical examples of U.S. success in large scale combat operations against peer threats. Volume three, *Lethal and Nonlethal Fires Historical Case Studies of Converging Cross-Domain Fires in Large-Scale Combat Operations*, part of the Large-Scale Combat Operations book set published by Army University Press in 2018 includes multiple historical vignettes that describe the employment of lethal and nonlethal fires in combat, also adding validity to the components discussed in this concept.

a. Echeloned capabilities.

(1) The Army fights in echelons, spanning across each level of war from tactical to strategic, each dependent upon the other for success. According to the EABC, "formations above brigade gain and maintain the initiative by converging multi-domain capabilities, at echelon through the depth of the extended battlefield." Fires formations at all echelons must provide responsive fires in support of strategic, operational and tactical operations to win in MDO. Throughout much of history, professional armies have leveraged the use of echeloned capabilities in warfighting and it remains a valid concept today and in the foreseeable future. Echeloned capabilities gives the Army the ability to fight extended campaigns, cover vast distances of physical terrain, and provides an array of fires capabilities coupled with requisite authorities to employ them. Echeloned capabilities are critical to the employment of effective fires in all domains, helping the Army establish windows of superiority to enable joint force maneuver.

(2) *Army fires structure and capabilities at all echelons.* Countering the threat in any theater of operation requires Army fires organizations and capabilities at each echelon. Army fires provides commanders at echelon with the right set of capabilities, organized and tailored with the expertise and authorities to coordinate and synchronize multi-domain effects. Army fires are enabled by a host of formations at each echelon containing a wide range of capabilities available to the commander. For instance, Army SOF formations operate across the battlefield framework

¹ Synergistic. Relating to the interaction or cooperation of two or more organizations, substances, or other agents to produce a combined effect greater than the sum of their separate effects.

but also as the only ground maneuver force operating in the deep fires area. These forces are critical to the employment of multi-domain fires at the theater, corps and division level.

(3) *Shaping in depth and layered defenses.* Success against future adversaries requires the joint force to project power through strategic and operational long-range attack and high-to-medium, extended-range air and missile defense capabilities. These fires capabilities require complementary C2 platforms that integrate with JIIM partners to create shared understanding and leverage access to a broad range of capabilities to employ and integrate fires for the commander. Shaping and defending in depth with fires in all domains is required to enable echeloned forces to meet commander's objectives with the specific effects needed to overmatch peer adversaries. Although engagement decisions are the commander's responsibility, Army fires control officers are required to synchronize engagements based on mission, mode of control, available munitions, and level of threat. Layered capabilities at echelon provide the commander the ability to preserve combat power by defeating the enemy's ability to bypass integrated air and missile defenses synchronized with an all domain approach to force protection.

(4) *Improved range, lethality, mobility, and survivability.*

(a) Large scale combat operations against peer threats requires U.S. and partner forces to improve multiple aspects of their fires capabilities to overmatch threat systems and counter A2/AD strategies. Enemies and adversaries employ a mix of capabilities to create hybrid threats with significantly higher capabilities and lethality levels that exploit U.S. vulnerabilities and ability to transition to armed conflict. The merger of information and sensor technology overlaid on both old and new weapons systems drives threat lethality. Success requires improved range, lethality, mobility, and survivability. The ability to engage targets at greater ranges and at higher altitude helps commanders achieve stand-off against air and missile threats. Expanded keep-out areas created by improved range is crucial to defending ground forces and allowing freedom of action. Additionally, the fleeting nature of mobile targets coupled with enhanced protection against subsonic or ballistic munitions requires the development of hypersonic weapons that can strike the target faster and survive against sophisticated surface-to-air engagement. Munitions require sophisticated seekers with the capability to course correct in flight to defeat complex target systems. But increased range, velocity, and maneuverability is not enough.

(b) Army fires requires greater lethality, mobility, and survivability to be effective against complex, well-protected targets. Lethality may be achieved in different ways, such as massing fires with multiple volleys on a target, or with the use of a single, precision munition. Both are required for success in MDO. Army fires capabilities must also be mobile, able to emplace and displace rapidly. Static equipment on the battlefield will be at great risk to an enemy strike. Likewise, Army fires capabilities must also be survivable. While much of survivability depends on mobility, other aspects of survivability are important as well, like crew protection, camouflage, use of decoys, point defense capabilities, and conducting counter-recon to deny the enemy the ability to target key fires assets.

(5) *Convergence of effects at echelon.* Mutually supporting echelons require rapid access to capabilities in all domains to enable convergence. Convergence of effects requires authorities, systems, and synchronization. While the maneuver commander is responsible for the integration of fires within the area of operations, the senior field artillery commander doctrinally serves as the

fire support coordinator (FSCOORD), the commander's primary advisor to plan, coordinate, and integrate field artillery and fire support in the execution of assigned tasks. The FSCOORD will continue to play a critical role in coordinating and integrating fires. Conceptually the FSCOORD will continue to lead the commander's targeting process and the integration of all fires, lethal and nonlethal across all domains, in support of the commander's intent. Targeting includes the capability to execute and leverage the Army and joint targeting processes as both will continue to remain valid in future warfare and will be critical to enabling multi-domain convergence.

b. Enhanced sensor to shooter linkages.

(1) *Any sensor, best shooter.* The scale, scope, and rapid decision cycle required to execute MDO in combat operations require near real time targeting and fire control procedures across multiple sensors and delivery systems over extended areas. In the future, automated battle management tools (such as, AI-enabled) will overcome human constraints to responsiveness and minimize human cognitive overload through a 'human in the loop' interface. Sensors and shooters are rapidly converged from multiple networks across domains, monitored through common data terminals and managed by exception with AI assisted fire support coordination measures, creating an 'any sensor, best shooter' paradigm. Sourcing of data from sensors across domains and pairing that data with the best available shooter enables rapid target engagement regardless of domain.

(2) SOF operating in the deep fires area require trained fires personnel and systems necessary to access the integrated fires application to expand the any sensor, best shooter to the deep fires area. Building trust in this kind of system of systems requires rigorous training programs combined with joint and multinational exercises to achieve confidence in the advanced automated tools, which will have the potential to employ fires, with a human decision maker monitoring ("on-the-loop") but not directly in the loop. This method moves the Army beyond the use of simple kill chains and instead creates complex but effective 'joint kill-webs' that offer multiple paths to the target.

(3) *JIIM network integration.* Leveraging JIIM capabilities and capacities to provide layered intelligence, surveillance, and reconnaissance (ISR) data, developed in the competition period, further enables sensor to shooter operations. JIIM sensors and shooters must be fully compatible with an integrated network that is readily accessible to a commander for enhanced situational awareness. Commanders require real time understanding of the capabilities available and seamless network integration to employ them. Employing AI-enabled systems will allow for rapid processing and dissemination of data to match targets and servicing systems, combine lethal systems with nonlethal enablers, but also maintain the algorithms and parameters that prevent fratricide and limit collateral damage. These systems must also provide simulations that will provide commanders with templated scenarios and risk estimates for use of certain fires combinations.

(4) *Redundant and assured communications.* Fires organizations and systems continue to rely heavily on network connectivity. Conducting MDO in a highly contested electromagnetic spectrum (EMS) environment requires highly reliable and assured communications within a low latency network that can provide the capability and capacity necessary to gain efficiencies in multi-domain targeting and air and missile defense engagement operations. Our adversaries are sure to employ methods to break our connections as formations with longer range weapons disperse. For

this reason, creative planning for alternate and contingency communications becomes paramount. Additionally, it is necessary to harden systems and software to prevent disruption and remain vigilant in training fires formations in degraded/denied environments. Enhancing U.S. and partner's ability to establish and maintain linkage between shooters and sensor surveillance on targets is critical to gaining advantages over adversaries.

(5) *AI-enabled targeting and information management.* Human-machine interface enhanced by AI will establish, repair, and prioritize high capacity data networks and transmit targeting and fire control quality information from sensors to shooters operating at multiple echelons, achieving sensor-to-shooter linkages as a state-of-being.

c. Multi-domain targeting.

(1) MDO requires Army fires to support the commander's targeting priorities by leveraging existing and emerging technologies to stimulate, see, understand, and strike targets across domains with input from JIIM partners to create lethal and nonlethal effects. MDO does not drive a departure from the Army Targeting Process (decide, detect, deliver, assess (D3A)) or the joint targeting process, in current doctrine, but it does require a unified approach to targeting at echelon including the integration and synchronization of lethal and nonlethal effects in all domains to enable convergence.

(2) *All domain target development in competition.* To penetrate and dis-integrate A2/AD capabilities effectively, a core requirement in MDO, the Army cannot afford to wait until armed conflict to build accurate intelligence and determine effective targeting solutions against threat A2/AD capabilities. Therefore, the Army (along with joint and multinational partners) must conduct thorough and continuous target development against threat high payoff targets during the competition period. This includes conducting intelligence support to targeting to determine critical components of the target system along with its critical vulnerabilities to determine an effective method for stimulating, seeing, and striking the target. This requires the correct positioning and employment of sensors and shooters in competition as well as the employment of trained and certified targeteers to conduct target development.

(3) *Improved deliberate and dynamic target execution.* Highly complex and mobile threat systems are driving leaders to refine processes and procedures to meet the time-sensitive demands of targeting in MDO. Multi-domain capable systems operating within an integrated fires application with JIIM partners converge to create effects in multiple domains, gaining relative advantage over threat forces through mass and technological overmatch in time and space to open windows of superiority for joint force exploitation.

(4) *Robotics and Autonomous Systems (RAS)/Artificial Intelligence (AI) Application.* Future systems must incorporate robotics and autonomous systems enhanced by AI to execute tasks normally performed by humans or gain efficiencies in tasks that require the intense concentration of human cognition. Common man-machine interface systems with AI, for example, will enhance processing of meta-data and facilitate more timely and accurate targeting and dynamic defense design. The possibilities behind multi-domain targeting are infinite, yet require precise understanding of the effectiveness and efficiency of employing systems that may operate beyond intended parameters.

d. Leverage JIIM capabilities.

(1) In all future operations, Army fires must be enabled by JIIM sensors and shooters to seamlessly integrate and converge fires into operations. Army-only solutions will not be enough to address the problem. Current policy restrictions as well as limited network and platform interoperability hinder the Army's ability to share data, system capabilities, and even network connectivity, which constrains the ability to access and provide capabilities. In MDO, the Army must share information with JIIM partners to integrate JIIM capabilities and converge effects.

(2) *Access to JIIM sensors and shooters.* During competition, sensors, shooters, and command nodes will be developed, tested, deployed, and trained with JIIM partners to develop trust, confidence and shared understanding and seamless interoperability. Strategic and operational defense of critical assets require JIIM interoperable systems, networks, and personnel to coordinate and synchronize air and missile defense capabilities. Likewise, ground-based long-range precision fires will rely on JIIM sensors to provide targetable data to 'see deep to shoot deep' into deep fires areas and provide battle damage assessments. JIIM partners also contribute to the overall fire plan by placing their fires systems (lethal and nonlethal) on the network that allow for their employment at echelon. The fires enterprise will leverage capabilities assured position, navigation and timing (A-PNT) accredited systems, and available to the commander or supported commander.

(3) *Shared understanding.* Sharing data from multiple sensors from different domains enables an increased situational awareness and understanding of the multi-domain battlefield. With AI enabled collection, processing, exploitation, and dissemination, the joint fires community can rapidly distribute fused sensor data to appropriate shooters or effectors for execution.

(4) *System and network interoperability.* At all levels, JIIM partners contribute to Army operations with multi-domain sensors and other fires capabilities. Interoperable systems and implementation of cross-domain solutions, as well as associated tactics, techniques and procedures (TTPs) and standing operating procedures, are required to optimize reporting and internal processes, across all classification levels, in order to facilitate near-real time coordination for fires. The C2 network that enables MDO must provide interoperability with joint and multinational capabilities including the capability for A-PNT. Interoperability will allow JIIM forces, protected by integrated air and missile defense capabilities, to deliver coordinated and precise strategic and operational fires and effects in all domains. Threat nonlethal activities, and their potential effects on offensive maneuver and defensive operations, will be closely monitored and considered in timing lethal and nonlethal effects

(5) *Seamless integration.* The seamless integration and synchronization of Army fires capabilities requires echelons above brigade headquarters with the right capability, expertise, and leadership to provide accurate and responsive fires. Fires provides subject matter experts to integrate and employ fires for the supported commander, including fire support, targeting, air and missile defense, cyberspace operations, EW, SOF, and space. Together, these capabilities are coordinated and synchronized to overwhelm threat systems and open windows of superiority for friendly operations.

Chapter 4

Conclusion

The *Army Futures Command Concept for Fires* provides broad conceptual underpinnings to pursue future technologies, capabilities, and DOTMLPF-P solutions to modernize and equip fires to support MDO. This document describes necessary fires capabilities to execute MDO broken out by the four components of the solution – echeloned capabilities, enhance sensor-to-shooter linkages, multi-domain targeting and leveraging JIIM capabilities. Derived with data captured from experimentation, these components of the solution will drive discussion and frame future assessments for leadership, industry, and capability developers. Fires plays a critical role in how the joint force will conduct operations to counter peer adversaries and for the Army to execute MDO throughout the expanded battlefield.

Appendix A

References

Section I:

Required References

Army regulations, Department of the Army (DA) pamphlets (Pams), Army field manuals (FMs), Army doctrine publications (ADPs), Army doctrinal reference publications and DA forms are available at Army Publishing Directorate Home Page <https://armypubs.army.mil/>. U.S. Army Training and Doctrine Command (TRADOC) publications and forms are available at TRADOC Publications at <http://www.tradoc.army.mil>. All joint publications (JPs) are available at the Joint Electronic Library at <https://www.dtic.mil/doctrine>. Most JPs are unclassified and can be found on the Joint Doctrine, Education and Training Electronic Information System (JDEIS) at <https://jdeis.js.mil/jdeis/index.jsp?>

Capstone Concept for Joint Operations: Joint Force 2020

TP 525-3-1

The U.S. Army in Multi-Domain Operations

TP 525-3-8

Multi-Domain Combined Arms Operations and Echelons Above Brigade 2025-2045

TP 525-92

The Operational Environment and the Changing Character of Warfare

Section II

Related References

AFCP 525-2

Future Operational Environment: Forging the Future in an Uncertain World 2035-2050

ADP 1
The Army

ADP 3-0
Operations

ADP 3-19
Fires

ADP 3-37
Protection

ATP 3-01.15
Multi-Service Tactics, Techniques, and Procedures for Air and Missile Defense

ATP 3-52.1
Multi-Service Tactics Techniques, and Procedures for Airspace Control

ATP 3-60
Targeting

FM 3-01
U.S. Army Air and Missile Defense Operations

FM 3-09
Field Artillery Operations and Fire Support

FM 3-13
Information Operations

FM 3-94
Theater Army, Corps and Division Operations

JP 3-0
Joint Operations

JP 3-01
Countering Air and Missile Threats

JP 3-03
Joint Interdiction

JP 3-27
Homeland Defense

JP 3-28
Defense Support of Civil Authorities

JP 3-31
Joint Land Operations

JP 3-52
Joint Airspace Control

JP 3-60
Joint Targeting

TC 53-03.2
Influenced-Focused Targeting

Appendix B

Required Capabilities

B-1. Introduction

Fires capabilities are generated from the ideas and solutions found in this concept. These capabilities are closely interrelated and, potential DOTMLPF-P solutions may simultaneously fulfill more than one required capability (RC). RCs are based on the broad ideas from the MDO and EABC concepts, proponent analytical work, lessons learned from the last decade of conflict, and this concept. Each RC is followed by a citation that refers to amplifying data within this concept.

B-2. Fires required capabilities (RCs)

a. The following capabilities are required to develop, prepare, and equip Army leaders, Soldiers, Army Civilians, and organizations at all echelons to apply the fundamental principles of fires to help prevent conflict, shape the strategic environment, and win the Nation's wars.

b. Army fires requires a fires-specific mission command application to conduct fire support planning, targeting, and execute fire control in an MDO environment, which perceives the operating environment, mimics cognitive functions for learning and problem solving, and takes actions to achieve goals with minimal error, allowing fires forces to rapidly plan, execute, assess, and integrate with JIIM partners and across warfighting functions at all echelons. (This concept, paragraph 3-5.a.4, 3-5.b.2, 3-5.b.3, 3-5.d.4)

c. Army fires requires the capability to employ ground-based long-range precision fires, integrated with JIIM partners, with increased range, lethality, and efficiency throughout the battlefield and at all echelons in MDO. (This concept, paragraph 3-5.a.4, 3-5.d.5)

d. Army fires requires the capability to employ multi-domain fires in a contested EMS environment, all domains, and the information environment to conduct multi-domain operations. (This concept, paragraph 3-5.b.1, 3-5.c)

- e. Army fires requires the ability to provide support to forces at all echelons by having commensurate mobility, survivability, and protections. (This concept, paragraph 3-5.a.4)
 - f. Army fires requires the capability to conduct short-range air defense integrated with a higher air defense artillery echelon's area air defense plan in multi-domain operations to protect forces and critical assets and retain combat power. (This concept, paragraph 3-5.a.3, 3-5.4.b)
 - g. Army fires requires the capability to conduct multi-domain targeting in support of JIIM operations in all environments. (This concept, paragraph 3-5.c)
 - h. Army fires requires the capability to detect, classify, and track aerial targets at sufficient ranges to effectively identify threats in a timely manner and inform engagement decisions with the precision, lethality, and speed to protect priority assets, prevent fratricide, and minimize collateral damage while conducting cross-domain fires. (This concept, paragraph 3-5.b)
 - i. Army fires requires the capability to acquire targets in all domains and EMS contested environments with accuracy and speed at extended ranges, utilizing both organic and non-organic sensors, which provide fire control quality data to engage moving, displaced, and stationary targets. (this concept, paragraph 3-5.b, 3-5.c, 3-5.d)
 - j. Army fires require deployable, ballistic missile defense system capabilities to address regional and transregional missile threats to the homeland, deployed forces and allies and partners in a JIIM environment. The capabilities must address threats comprehensively (attack operations, active and passive defense) using lethal and nonlethal means in competition, armed conflict, and in a return to competition. (This concept, paragraph 3-5.a.3, 3-5.d)
 - k. Army fires requires the capability to access joint fires assets, including airspace management and control, at the Theater level in order to penetrate and dis-integrate threat A2/AD capabilities when acting as the supported command. This concept, paragraphs (3-5.a.2, 3-5.a.3, 3-5.a.5, 3-5.b.33-5.b.4)
-

Appendix C

Science and Technology

C-1. Introduction

a. The purpose of this appendix is to provide consolidated reference of Fires technology and program investments that will achieve the 2028 MDO-capable force along with outlining conceivable scientific research concentrations providing concept developers research focus areas which will enable the future of Fires. The terms "Science" and "Technology" have often been used interchangeably but in reality, both of these terms are not equivalent. Science is reinforced by discovery drawn by correct conclusions based on validated theories and data that is often aligned with "concept development" in response to "What could be". Technology is associated with design, invention, and production of tangible weapons and systems to link a desired capability with a "requirement" and answering the question "What is possible".

b. The capabilities needed in the future are not static. They will dynamically change in response to an adversary who will intentionally exploit the constant evolution of knowledge. Thus, maintaining overmatch for the Nation will require a deliberate S&T planning and investment strategy that both acknowledges and exploits the distinct, but complementary, roles of scientific discovery and technological innovation. High fidelity inputs into this deliberate S&T planning and investment strategy are the collective S&T options for each capability that capture technical approaches at varying levels of maturity and risk.

c. To distinguish between complementary, use-inspired research efforts, this appendix uses the following descriptors, where the core distinction derives from the maturity of the research idea and its projected impact on future capability.

(1) Breakthrough technological innovations are more mature ideas instantiated in emerging technologies that enable disruptive advancements of existing solutions.

(2) Breakthrough scientific discoveries are nascent but burgeoning ideas that drive discovery science for use-inspired research envisioned to transform the nature of warfighting capabilities.

(3) The detailed breakdown of technological innovations and scientific discoveries can be found in the Science and Technology Annex to accompany this concept.

d. The success of fires in MDO is dependent on the allocation of resources to forge discoveries in science which evolves into maturing technologies that will meet the hyper-dynamic threat environment of the future. This begins with the approach of researcher – concept developer synergetic collaboration which includes the following:

e. Concepts shaping research.

- Refine ongoing research to address critical MDO needs.
- Identify operational metrics to drive research outcomes.
- Shape and inspire innovative research efforts to realize future Army capabilities.

f. Research shaping concepts.

- Ground concepts development in scientific base, art of the possible.
- Devise new capabilities from scientific discoveries and technological advancements.
- Codify research in Army Concept Framework to drive the Future Force Modernization Enterprise.

C-2. Fires Science and Technology Focus Areas

Army fires research focus areas are aligned with Army priority research areas as listed in the *2019 Army Modernization Strategy* and with emerging science and technology trends. These focus areas will assist in addressing the range of threats across mid- and far-terms while helping to refine industry, government, and academia's understanding of Army fires areas of interest. They also allow Army fires to maintain an understanding of technology trends and the realities of maturing and emerging technologies.

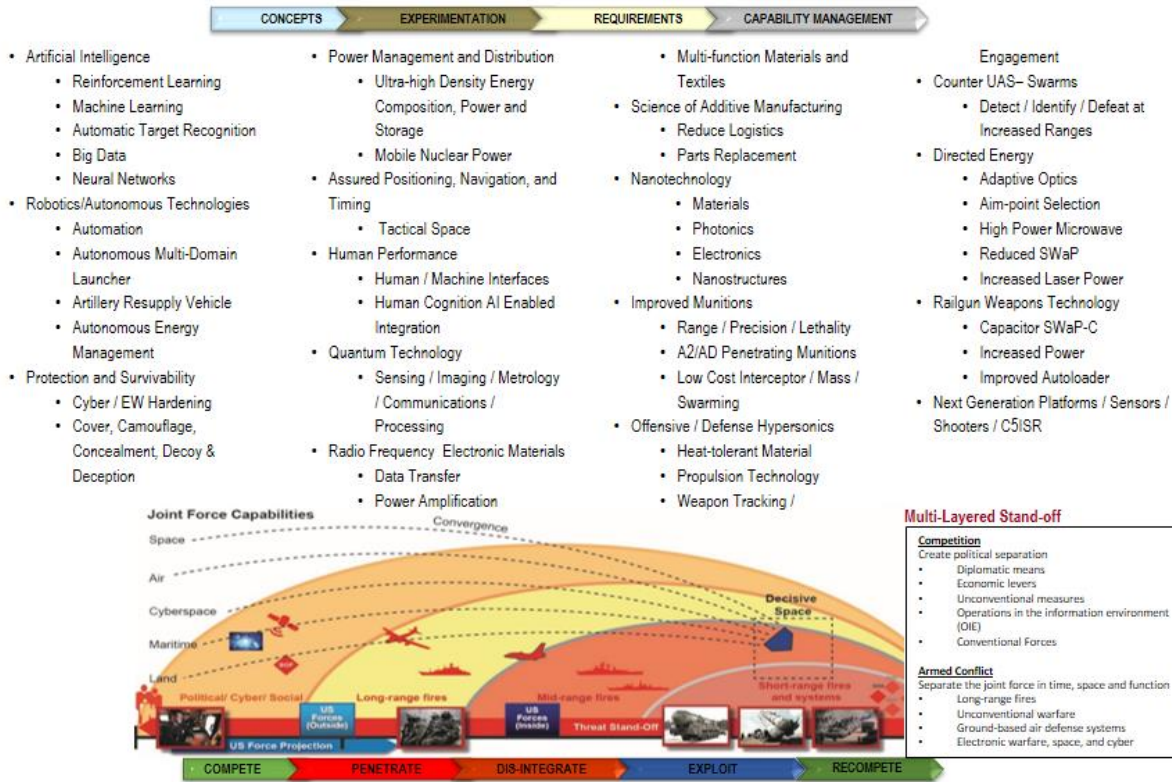


Figure C-1. Fires S&T Focus Areas

C-3. Artificial intelligence (AI)

a. AI refers to the ability of machines to perform tasks that normally require human intelligence – for example recognizing patterns, learning from experience, drawing conclusions, making predictions or taking actions – whether digitally or as the smart software behind autonomous physical systems. The scale and timeframes of MDO in large scale combat operations require faster targeting and fire control across multiple sensors and systems over extended areas. Utilizing automated battle management tools (AI-enabled) overcomes human constraints to responsiveness and minimizes human cognitive overload through a ‘human on the loop’ interface where sensors – shooters – and firing solutions are converged from multiple networks across domains, monitored through common data terminals and managed by exception, creating an ‘any sensor, best shooter’ paradigm. AI can interconnect data across all domains and pairing that data with the best available shooter enables for rapid target engagement whether that target is airborne, on the ground, or any other domain.

b. The integration of AI could result in self-initiate engagement operations driven by the commander's targeting decisions and enabled by AI to detect targets through a sensor agnostic ISR architecture and common language databases, to deliver and assess fires effects at all echelons. Employing AI enabled systems will allow for rapid processing and dissemination of data to match targets and servicing systems, combine lethal systems with nonlethal enablers, and conduct airspace de-confliction while maintaining algorithms and parameters that prevent fratricide and limit collateral damage. Potential technological approaches or research areas include but are not limited to sensor resource management at the network level, combat identification utilizing a large

variety of data sets, EW detection and mitigation, reinforcement learning, robust distributed sensing network, AI-enabled complex activity detection (CAD), and smart munitions. (Aspects of AI could potentially play a role in each of the RCs).

C-4. Robotics and autonomous platforms

a. The potential benefits of autonomous/robotic platforms to the Army may prove to be advantageous to all warfighting functions' mission sets. These technologies may decrease cost, improve effectiveness, allow the Army to operate dispersed over larger areas, and importantly help keep Soldiers out of harm's way. They may prove useful for providing logistical support (such as, fuel delivery, and missile or artillery resupply capabilities) enhanced common man-machine interfaces, improved targeting, and ability to process mega-data. Potential technological approaches or research areas include but are not limited to integrated sensor to shooter linkages, autonomous field vehicle resupply, autonomous active cyber defense, autonomous logistics systems for munitions, robust distributed sensing network, and resilient autonomous networking. (Robotics and Autonomous platforms refer to RC b, c, d, and f)

C-5. Protection and survivability

a. Army Fires requires mobility, survivability, and protection commensurate with the supported force at all echelons to conduct multi-domain operations. Future operating environment will require fires systems to reposition rapidly and while doing so remain undetected and without loss of operating capabilities. By using cover, camouflage, concealment, decoys, and deception and conducting either offensive or defensive CEMA fires forces will possess the necessary capabilities to protect critical capabilities and infrastructure and to support the maneuver force. Offensively, fires requires the capability to provide early warning monitor, regulate, manipulate, and obscure signatures and emissions across all domains and environments, denying the enemy's ability to sense and target friendly forces.

b. Defensively, fires requires the capability of detecting, identifying, locating, mitigating, deceiving, stimulating enemy sensors across all domains and environments, making the enemy susceptible to detection. Potential technological approaches or research areas include but are not limited to improved ability to monitor self-signature (situational awareness of self-emissions/radio frequency (RF) signature, materials (reduce or mask EMS signatures), obscurants (visible and other EM domains), electric magnetic pulse system and structure hardening, multi-spectral obscuration, non-traditional electromagnetic attack, and multi-domain decoys. (Aspects of Protection and Survivability address each of the RCs)

C-6. Power management and distribution

a. Current power and battery efforts are focused on improving existing capabilities, such as improving fuel efficiency, increasing power outputs, or miniaturizing gun-hardened solutions for munitions / fuzzing applications. While such efforts are valuable, the research community must also explore power and battery alternatives that may not rely on fossil fuels and current energy storage technologies. Such discovery and innovation opens new ways to power the battlefield, which may afford tactical advantage. For example, nuclear and alternative fuel options (such as biofuels) could, if viable, significantly change the fuel logistics paradigm by minimizing the need

to move fossil fuels hundreds or even thousands of kilometers across a contested theater of operations. S&T/research and development efforts should also explore future options that might change the power and battery landscape, such as the feasibility of renewable power generating technologies, alternatives to chemical energy storage (batteries), power sources that are multi-fuel capable, power sharing technologies, intelligent power, and energy harvesting at all scales.

b. Potential technological approaches include but are not limited to advanced power generation, energy storage capabilities with greater power and energy density, increased efficiency that enable other capabilities like electric weapons and reduce size, weight, power and components (SWaP-C), electrified armors, energy beaming, software and computer development for optimization of energy generation, conversion, and distribution, ultra-high energy density, wide band gap and ultra-wide band gap materials for both power and energy, adaptive optimal control for power and thermal management, on board vehicle power, intelligent and power sharing technology. (Power Management and Distribution refers to RC b and d.

C-7. Human performance improvement (HPI)

a. HPI is a systematic approach to improving individual and organizational performance. Research conducted in the area of HPI has the potential to provide the necessary tools to help build cohesive teams that are able to thrive in conditions of hyperactivity, ambiguity and chaos. The Army needs technologies that significantly reduce cognitive loading, provide real time situational understanding, improves physical performance, provides ease of human/machine interface, improves crew efficiency and effectiveness along with enhancing and reducing the training burden. Commanders must have a clear operating picture to better synchronize and converge lethal and nonlethal effects. New technologies will push the bounds of human performance and stretch the currently known limits of human-computer interaction.

b. Advanced technology also has a role to play in optimizing human performance with the goal of optimizing unit performance as a competitive advantage now and in the future. Advanced simulation systems, simulated environments, tests, and assessments which improve cultural understanding, communication skills, and creative and critical thinking are an important future capability. Potential technological approaches or research areas include but are not limited to ecosystem for evolving human-AI partnerships and predicting human-AI resilience and robustness, human-guided AI asset coordination capabilities, shared human-AI awareness, and human cognition-informed AI integration. (Human Performance Improvement refer to RC a)

C-8. Quantum technology

a. Quantum technology is an emerging field of physics and engineering, which relies on the principles of quantum physics. It is about creating practical applications—such as quantum computing, quantum sensors, quantum cryptography, quantum simulation, quantum metrology, and quantum imaging. Based on properties of quantum mechanics especially quantum entanglement, quantum superposition, and quantum tunneling. Employment of fires in a hyperactive multi-domain environment in support of large scale combat operations will require advanced target acquisition, weapon systems and the ability to employ secure, resilient, self-healing, and assured C5ISR across multiple sensors and systems over extended areas and ranges. The proliferation of advanced sensors may potentially overwhelm the ability of the commander to

discern what targets to engage. Future fires will require intuitive and adaptive systems that provide network, C2, sensor feed, and targeting system synergy to facilitate rapid target engagement. Potential technological approaches or research areas include but are not limited quantum position, navigation, and timing for situational understanding, quantum networks, distributed quantum sensing, improved compact atomic clocks, quantum networks, and quantum imaging. (Quantum Technology refers to RC a, c, e, f, g, h, and i)

C-9. Radio frequency electronic materials

a. The next generation of military and civilian applications requires the ability to transfer more data, faster, at a high level of quality. As the size of devices continue to decrease and unique form factors enter the technology space, researchers are challenged to find material solutions to evolve wireless communication a reality. Gallium Nitride (GaN)—a material revered for its exceptional ability to power communications systems—laying the groundwork for 5th generation, high speed, agile communication systems of the future. GaN is a type of ‘wide bandgap material’ that can amplify a signal to an antenna. In other words, it can take a signal from a cell phone or other communication device and amplify it for transmission to a tower, ultimately enabling wireless communication. Another area that will benefit is flexible and conformal radar and EW technology.

b. Typical radar systems are big and bulky, but using this technology, we can create systems that can be more easily integrated into dynamic environments. Another benefit is power amplification directly on antenna systems. If you have a flexible power amplifier and can get it as close as possible to your radar antenna, you can improve performance simply by removing the distance a signal has to travel. Flexible GaN gets you the ability to place the amplifier up against the antenna on the same platform and improve performance and transmission. Research is needed to take advantage of optical and thermal properties of diamond materials for DE. Fires science and technology is currently researching potential technological approaches and research areas in the area of RF as it relates to the development of munitions, sensors and platforms. (Radio Frequency Electronic Materials refers to RC a, c, d, e, f, g, h, and i)
etc.

C-10. Science of additive manufacturing

a. Additive manufacturing (AM) technology provides the ability to produce parts and components that cannot be achieved through traditional manufacturing process. Incorporating AM in the initial design, development, and manufacture of new systems or in the redesign in existing systems or components results in systems with fewer components that are lighter, more efficient, and with increased reliability. AM is a critical enabler for maintaining combat power and providing responsive sustainment to widely dispersed units by meeting more demand at the point of need. It also helps reduce Class IX storage requirements; improve supply metrics; increase operational readiness; decreases manufacturing lead times; and reduce system life cycle cost. Fires science and technology is currently researching potential technological approaches and research areas in the area of AM as it relates to the development of munitions, sensors and platforms. (Science of Additive Manufacturing refers to RC a, b, and e)

C-11. Nanotechnology

a. Nanotechnology. The science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers. Nanotechnology is the study and application of extremely small things and can be used across all the other science fields, to include chemistry, biology, physics, materials science, and engineering. One nanometer is a billionth of a meter for perspective. Military application and research can improve medical, casualty care for Soldiers, and to produce lightweight, strong and multi-functional material for use in clothing will include additional protection, and to provide enhanced connectivity. It is possible that these technologies will include medical nanobots and nano-enhanced reconnaissance and communication devices (e.g., micro-radar for miniature vehicles) employed in the 2030 timeframe.

b. Nanotechnology is used to improve body armor. The potential applications of this technology are nearly limitless to include nano-enhanced sensors. Nano-sensors have been developed which take advantage of the unique properties of nanomaterials to become smaller and more sensitive, compared to conventional technology. Portable, efficient sensors will employ capabilities such as the following: highly sensitive infrared thermal sensors; small, lightweight accelerometers and GPS for motion and position sensing, miniature high performance camera systems; biochemical sensors; health-monitoring sensors and drug/nutrition delivery systems; robotic drones; nano-machines to mimic human muscle action in an exoskeleton; stealth coatings; self-healing materials; smart skin materials; adaptive camouflage; adaptive structures; nano-communications networks; enhance military ordnance (munitions propellants and energetics); optical materials; materials for energy storage; thermal management materials.

c. Fires science and technology is currently researching potential technological approaches and research areas in the area of nanotechnology as it relates to the development of munitions, sensors and platforms. (Aspects of Nanotechnology address each of the RCs)

C-12. Improved munitions

a. Fires requires the ability of the land force commander to employ immediately available, surface to surface / maritime, all-weather, long range, precision fires against both precisely and imprecisely located, time sensitive and high value point and area targets. Current and future adversary Integrated Air Defense Systems (IADS) require surface to surface fires to conduct Suppression/Defeat of Enemy Air Defenses (SEAD/DEAD) missions to enable the combatant command to achieve air superiority and to deliver air launched munitions. Army Fires service both stationary and moving targets rapidly creating lethal and nonlethal effects as the situation demands. This requires munitions capable of dynamic targeting and re-targeting while in flight, munitions with intelligent on-board sensor suites, and munitions that loiter for extended periods.

b. Future munitions must be hardened since the Army needs to attack enemy high value targets protected by air defense systems, electronic guidance jamming and manipulation systems, directed energy systems and nonlethal countermeasures. Future munitions must support both precision and mass, able to scale effects from highly localized to across wide areas with a minimum of reconfiguration. Future munitions should be designed in such a way as to reduce the logistical footprint needed to conduct resupply operations. Future munitions must also be affordable and available widely to offset threat advantages in both mass and availability. Potential technological

approaches or research areas include but are not limited to advanced seekers, advanced positioning, navigation and timing extended range and precision, smart and collaborative munitions, multi-function and scalable munitions, counter-measure hardened munitions, non-kinetic effects, and highly directional explosives, projectile KE and range disruptive energetics, propulsion technologies. (Improved Munitions address RC b, e, g, and i)

C-13. Offensive and defensive hypersonics

a. Offensive hypersonic technology. Hypersonic technology has the potential to hold threat strategic forces and infrastructure at risk during all phases of MDO. This technology contributes to the Theater Fires Command and the Army's Strategic Fires portfolio capability by providing and magnifying multi-domain fires lethality, survivability, and affordability along with supporting Army modernization priorities. The capabilities of hypersonic technologies include ranges over 5000 kilometers (increased stand-off distances); hypersonic speed (threat IADS; A2/AD environments are contested); multi-munition launcher (configured to pre-existing platforms); hypersonic guide body and multi-functional warhead (withstand steeper trajectory flight paths, highly maneuverable); internal navigation system (less dependent on GPS in A2/AD environments); target and inflight re-target/updates; hardened target penetrator; AI-enabled guidance and evasion tactical software. Strategic Fires Battalion with hypersonic technologies will provide long-range conventional missile fires for strategic attack to defeat adversary A2/AD capabilities, pre-empt adversary long-range fires (left of launch), and engage other high payoff/time sensitive targets.

b. Defensive hypersonic technology. Hypersonic threat technologies function and maneuver at high-rates of speed, which are challenging to current and legacy AMD capabilities that require rapid detection, reaction, and accuracy to counter the threat. Defensive countermeasures against threat hypersonic missiles will require a layered approach to include detection and tracking during all phases of the launch (sea, land, and space sensor architectures that will enhance sensor to shooter linkages), interceptor (i.e., missile, hypervelocity projectiles, directed energy), and interoperability (open and joint architectures). Defensive measures towards hypersonic missile threats should be a substantial priority for MDO. Fires science and technology is currently researching potential technological approaches and research areas in the area of defensive hypersonic technology to counter maturing threats posed by ballistic missiles, hypersonic cruise missiles, and hypersonic glide vehicles. (Offensive and Defensive Hypersonics address RC b, c, d, g, h, and i)

C-14. Counter – Unmanned Aerial Systems (C-UAS)

a. Army continues to invest in S&T to detect, track, identify, and negate air and missile threats, including class 1-3 UASs. Protecting critical assets and supporting the maneuvering force is essential in conducting MDO. Peer and peer competitors will seek to overmatch U.S. and partner air defense capabilities. Large scale ballistic missiles (and likely hypersonic munitions), and cruise missile attacks are already tactics in use limited only by the enemy's munitions inventory. UAS and massed indirect fires coupled with missiles in complex, structured attacks bring in a new need for additional improvement, other than improved ability to detect, identify, defeat integrated command and control, detection and engagement while on the move. Swarm attacks, must also be countered by DEW, jamming and thermal attack, rapid firing and cheaper ammunition and an

AI aided C3 system able to handle large maneuvering target loads. Potential technological approaches include but are not limited to laser sources and associated systems (thermal, power, beam control, adaptive optics) suitable for employment on vehicles, analytical vulnerability models to evaluate performance of lasers against an array of threats, missiles to provide affordable negation of small and saturating raids of UASs, sensor technologies with increased capabilities to detect, track, and identify air and missile threats. (Counter – Unmanned Aerial Systems address RC d, e, g, and h)

C-15. Directed energy (DE)

a. Directed energy (DE). DE is defined as technologies that relate to the production of a beam of concentrated electromagnetic energy or atomic or subatomic particles (such as, lasers, microwave, particle beams, and other radio frequency weapons) that uses DE to incapacitate, damage, or destroy enemy equipment, facilities, and/or personnel. Directed energy weapons (DEW) have the potential to provide game changing capability. The destructive power of DEW derives from the amount of energy transferred to the target over time.

(1) High energy laser (HEL) can cut through steel, concrete and many other materials in a matter of seconds. It can destroy, degrade, or blind sensors, electronic systems or ISR systems. For high energy lasers, lethality depends on the power output of the laser, the purity and concentration of the light (beam quality), the target range, the ability to keep the laser on the target aim-point (jitter control and tracking), and the atmospheric environment the laser traverses to the target. In this last factor, the frequency of the laser and the engagement altitude will have a significant impact on how much the atmosphere effects the laser's lethality.

(2) Another DEW option is the high power microwave (HPM). With HPMs, the microwave energy effects or lethality depends on the power and range to target, but the energy beams tend to be larger than and not as sensitive to jitter as is the case for the high energy lasers. HPM lethality can be affected by atmospheric conditions as well, but to a much lesser degree than high-energy laser (HEL) weapons. HPM weapons lethality is typically described in terms of their ability to deny, degrade, damage, or destroy a target's capabilities.

(3) A DEW system consists of the engagement system and a command and control system with all the necessary components required to defeat designated target sets. The system must also function as part of a networked environment that includes all battlefield sensors, shooters, and command and control systems. The long-cited advantages of directed energy weapons include speed of light response, precision effects, limiting collateral damage, deep magazines, reduced Class V logistical demand, and low cost per kill. Potential technological approaches or research areas include but are not limited to improved beam quality and control, thermal management, high power microwave, non-mechanical beam steering, increased power with reduced SWaP-C, next generation high power lasers, microwaves, solid state lasers, high energy laser beam control, plasma particle beam, reduction of recharge time. (Directed Energy address RC b, c, e, g, and h)

C-16. Railgun Weapons Technology (RGWT)

a. Railgun Weapons Technology (RGWT). Electromagnetic EMS railgun systems feature electromagnetic launchers that use electricity/electromagnetic energy instead of chemical

propellants to fire projectiles at high speeds. The high muzzle velocity can be twice that of conventional guns leading to short engagement times, buys back stand-off range, and reaches out longer range distances to engagement. The RGWT is intended to integrate with existing Army systems and complement Fires capabilities to defeat air breathing threats (ABT) both fixed and RW, cruise missile (CM), unmanned aircraft systems (UAS), ballistic missiles and hypersonic threats. RGWT mission operations can be employed on fixed or semi-fixed sites as part of layered defense design system to provide increased defensive capability against air and missile threats as part of a layered, integrated air and missile defense system. RGWT provides the ability to engage threats at greater distances and decreased engagement times than current comparable systems. Use of hypervelocity projectile, decreases projectile flight time to target, and lowers cost per engagement compared to other conventional interceptors.

b. Potential technological approaches or research areas include but are not limited to transportability/mobility, power, SWaP-C for capacitors, sustainment, lethality, range, interoperability, autoloader, IFPC follow-on solution, greater range, lethality, increased power output, smaller logistical/sustainment footprint, increased velocity of projectile and payloads, AI/ML enabled solutions. (Railgun Weapons Technology address RC b, c, and i)

C-17. Next Generation Radars and Sensors

a. Radar systems are a critical component of the Army's ability to conduct Air and Missile Defense (AMD) and Counter Target Acquisition (CTA) missions. The Army must have robust AMD and CTA sensors to provide surveillance, fire control, target identification, point of origin, point of impact, and kill assess to compete, fight, and in in future conflicts. Rapid advances being made in sensing technology will increase the range and effectiveness of air defense and Long Range Precision Fires (LRPF) weapons. The Army recognizes the disruptive technology shift from tube based radar systems to Active Electronically Scanned Antenna (AESA) based radars and is investing in LTAMDS, Sentinel A4, M-SHORAD, and upgrades to the TPQ-53 systems. These systems in development and procurement will provide the basis for Army AMD and CTA in support of Multi-Domain Operations (MDO).

(1) The advanced technologies forming the basis for this next generation of sensors also facilitates the threats response requiring the Army to continue to invest in science and technology (S&T) efforts to provide overmatch through 2035 and beyond. The threat is evolving with reduced signatures, swarming techniques, and hypersonics which drives the Army's sensing requirements. The new generation of radars under development will provide the basis for the Army's overmatch in AMD/CTA with continued science and technology investments and capability insertions. To ensure long-term Fires superiority, the Army must invest in new technology and system architectures for transformative overmatch. New, disruptive, non-conventional technologies will be needed to meet the goals laid out in the Army Modernization Strategy. Far-term uncertainties with the operational, geopolitical, technical, adversarial, and financial spaces present complications for radar system developers. To minimize the risks associated with these uncertainties, use of present and mid-term state-of-the-art is needed to project the far-term art-of-the-possible.

(2) Potential technology approaches or research areas for the mid-term include but are not limited to technology to support integrated and dynamic multi-function capability (radar,

electromagnetic warfare, and communications) across the AMD and LRPF mission space; flexible processing concepts, advanced digital beamforming, and target identification that exploits the flexibility of new digital-at-every-element radar and sensor technology; technologies, algorithms, distributed architectures, and machine-assisted sensing to enable phase-synchronous and mobile distributed RF and radar; and advanced thermal and power management concepts for mobile AMD capabilities. While the far-term investment strategy will be enabled by progress made in RF electronic materials and (electronic, photonic, quantum) devices, the direction taken will be informed by the emerging challenges to the AMD and LRPF mission space.

(3) If successful, service-wide multi-function RF systems of the future could operate freely and autonomously without GPS-reliance and with minimal SWaP-C requirements in a distributed, seamless fashion with allied forces in any spectrum environment across all-domains. The main challenges the AMD and LRPF communities foresee are: Power requirements, spectrum occupancy, GPS, secure communications for beyond-line-of-sight MDO, processing, exploitation and dissemination (PED), survivability, and legacy compatibility. Potential Investments aimed at circumventing the main challenges to acquiring the next generation of capabilities include but are not limited to additive electronics materials, radio frequency photonics, and neuromorphic components. (Aspects of Next Gen Radars and Sensors address all the RCs)

C-18. Soldier and platform based precision sensors

a. Precision target location and mensuration are critical elements of employing accurate fires systems, as fires systems are only as precise as the targeting data. Future fires Soldiers will utilize a wide-range of sensors: mounted, dismounted, tethered unmanned systems, autonomous unmanned systems, manned-unmanned teams employing over the horizon, detection, location, and interdiction capabilities. The Army's vision is to achieve real time integration and optimization of targeting data for a range of fires applications.

(1) Current systems provide the dismounted forward observers the capability of color imaging, instant-on infrared imaging, redundant precision azimuth technology, increased detection, recognition and identification ranges, a modular configuration, and several other technological advances to the dismounted forward observer by increasing lethality and survivability. The company Fire Support Teams (FISTs) will have the capability of color imaging, improved infrared imaging, and redundant precision azimuth technologies that will enable precision targeting at extended ranges associated with a dismounted static OP. The Fire Support Sensor System (FS3) is receiving software updates and undergoing testing to enable precision targeting capability. The FS3 will be able to produce a target location error (TLE) that can be passed to the Fire Direction Center (FDC) that will enable the employment of Army and Joint Precision Guided Munitions (PGMs). The Joint Light Tactical Vehicle (JLTV) will be made to ensure the fire support vehicle has the same signature as the rest of the maneuver formation.

(2) Potential technology approaches include but are not limited to precision azimuth technologies; precision vertical angle measurement; advanced optics; and position, navigation, time, non-GPS technologies, and gun launched seeker technologies. The mid-term will consist of further development of currently emerging capabilities and converging these technologies into current systems in order to develop a common operating interface and technology base, reducing

the training burden and cost. The need for lighter and more capable sensors for the dismounted forward observer requires a dramatic reduction in SWaP-C.

(3) The Army will leverage existing partnerships with government research labs and advances in technology in order to increase the role of the current system as a scalable, mission-tailorable, dual-role sensor for the infantry BCT in dismounted configurations, and a mounted configuration for the JLTV. For the ABCT and SBCT formations, the 3rd Generation FS3 will incorporate technology developed under the current programs, improving capability and reducing cost. While the Bradley Fire Support Vehicle (BFIST) currently has the Targeting Under Armor (TUA) capability, the Stryker Fire Support Vehicle (FSV) will pursue TUA efforts.

(4) The far-term strategy is two-fold. The first is to reduce the observer's dependence on binocular-type observation by converging and reducing future Fires targeting technologies and Soldier-worn technologies, into a fully integrated, helmet, body and weapons mounted suite of precision targeting sensors, powered by and communicating via wireless or quantum technologies. This will also include robotic sensors that will operate independently supporting Soldiers. The second is to converge and collapse the Lightweight Laser Designator Rangefinder (LLDR) and Fire Support Sensor System (FS3) into one interoperable, scalable, mission-tailorable, multi-purpose sensor capable of providing long range precision targeting for both dismounted OP missions and vehicle mounted operations on the JLTV, STRYKER, and Next Generation Combat Vehicle (NGCV). (Soldier and Platform Based Precision Sensors address RC a, b, c, d, and g)

C-19. Next Generation Shooters and Platforms

a. On future battlefields, mobility will be essential to survivability, as the threat will place friendly artillery units and air defense assets high on the target list. Fires directly supports maneuver and its BCTs and will need to provide direct support artillery with mobile platforms with beyond line-of-sight capable systems to defeat threat UAS, fixed and RW aircraft, and RAM to protect fixed, semi-fixed, and maneuver assets, integrating multiple capabilities, such as directed energy and kinetic energy interceptors with on-board sensors on highly mobile systems enables survivability and the ability to conduct engagements outside of a network.

(1) The objective for future platforms and shooters are those with open and adaptable architectures able to accept both current and future technologies and software at a greatly reduced cost. The incorporation and integration of advanced technologies support the evolution of future system architectures. Integrated leap-ahead protection technologies that focus on defeat mechanisms can provide increased vehicle survivability and crew protection. Advanced power generation and energy storage capabilities with greater power and energy density, and increased efficiency can enable other capabilities like electric weapons, electrified armors, high power sensors and communications, and energy beaming. Lighter weight, higher strength materiel and optimized structures that reduce combat vehicle weights while increasing future growth capabilities. Mid-term investment strategy leans towards consolidating platforms to support MDO.

(2) In the far-term, the Army sees developments in multifunctional platforms and achieving some commonality in missiles and rockets across fire support and AMD applications. Care must be taken to ensure that weapons platforms exist in sufficient quantities within a unit to conduct

different but simultaneous missions and or functions. The Army will leverage and support emerging advanced technologies such as DE, electro-dynamic kinetic energy weapons, and hypervelocity projectiles to achieve scalable effects. The Army will leverage robotics to support manned and unmanned platforms making available manpower to conduct other tasks, improving expeditionary capability. Potential technology approaches include advanced fire control, signature reduction, modular, common and multi-use components and vehicles with both leader follower and remote operated capability. (Aspects of Next Generation Shooters and Platforms address all RCs)

C-20. Next Generation Fires Command Control

a. The Army envisions one information system that enables forces to plan, prepare, and execute fires in real time and in all domain to include the EMS and information environment. The future Army information network must provide decentralized network structure, automated battle management aids, fused sensor data, targeting assistance, airspace de-confliction, and fire control quality of service.

(1) Mid-term strategy is to collapse all Field Artillery and Air Defense digital systems into a single, role based, user-defined software system. The intent is to have a universal system with the ability to provide the application services necessary to fulfill all individual and unit responsibilities within the Fires Warfighting Function. This would expand into the future variants of C2 digital fire support systems, forward observer and targeting fire support systems, as well as air defense C2. Integral to the success of this strategy will be the effective incorporation of AI technologies, which implement semi- or fully-autonomous targeting processes, conducting automated clearance procedures and airspace adjustments that provide timely synthesis of all firing and control measure data in support of maneuver operations.

(2) Additionally, embedding an AI on a multitude of sensors provides the capability to manage the low-level execution of implied tasks (routing of assets, munition selection, and timing) to increase the speed of action in operations. Some AI entities will need to be proliferated throughout the tactical level by creating a veritable network that can still effectively operate with degraded or disrupted nodes. To ensure success, mastering MDO and intelligence assessments of adversary weapon and digital systems should guide the requirements and capabilities to gain the strategical, operational, and tactical edge worldwide.

(3) In the far-term, fires organizations expect coverage and capability through data sharing and network integration to leverage information available on the network from the full complement of joint, Army, and national and multinational assets, to provide significant improvements for situational awareness, combat identification, and targeting in all conditions. Ultimately, the goal in the far-term is a single fires mission command system consisting of an integrated system of hardware, software, and infrastructure that is sufficiently mobile, reliable, resilient, user-friendly, discreet, protected, expeditionary, adaptive, and enables Commanders to execute command and control in MDO against a peer adversary where the EMS is denied or degraded. Potential technology approaches include but are not limited to sensor fusion technologies, automated decision aides, airspace management tools, architecture integration, ensured networked communications, multi-modal communications, communications under extreme RF conditions,

and cyber situational understanding. (Aspects of Next Generation Fires Command Control address all RCs)

C-21. Diverse, Disruptive Effects for Artillery (DDEA)

a. DDEA provides A2/AD effects and countering-effects. Penetrating the threats by A2/AD defense is essential in MDO in opening windows of vulnerability. The proliferation of threat capabilities to counter friendly rocket, artillery, and mortar systems will limit friendly forces ability to effectively engage targets with fire support. Swarming munitions and the development of munitions with low observability, robustness, homing, and non-predictable maneuver in the electromagnetic and acoustic spectrums – to include delivery and effect – will help friendly forces to maintain overmatch in indirect fires capabilities against peer and near-peer threats. DDEA is a Science Enabler that merges five research vectors: swarming munitions, increased engagement speed, enhanced maneuverability, on-board electromagnetic attack and modular lethality, to create a hypothesized future capability to attack high payoff targets (HPTs) in the operational deep fires area that are denying access to the joint force. This capability is most beneficial when targets are targeted imprecisely due to poor sensor access or targets are highly mobile.

C-22. Alignment with modernization priorities

The U.S. Army Modernization Strategy is the catalyst for focusing Fires CDID investments on near- and mid-term prioritized capability areas which are Long Range Precision Fires (LRPF) Cross Functional Team (CFT) and Air and Missile Defense (AMD) CFT. The CFT's are chartered to serve as the enablers of the Army Modernization Priorities, focusing investment on our most pressing operational needs.

C-23. Long-Range Precision Fires

a. The Long Range Precision Fires Cross Functional Team (LRPF CFT) leads a comprehensive modernization effort to deliver field artillery systems beginning in 2023 in order to ensure combined arms overmatch against peer competition. It is empowered to rapidly integrate and synchronize resources that enable the delivery of leader-approved, Soldier-informed requirements to the operating force. The LRPF CFT also aligns government science and technology efforts and looks for innovative approaches by engaging with traditional and non-traditional industry partners in order to deliver capabilities that ensure overmatch in range and lethality against our adversaries.

C-24. Air and Missile Defense

a. S&T efforts supporting AMD will help to ensure fielding of advanced air and missile defense capabilities to provide improved protection for Joint Forces, maneuver formations, friendly populations and critical infrastructure, preventing adversaries from achieving their strategic A2/AD end state. To provide air defense artillery forces with the most technologically advanced material solutions and command and control networks capable of enabling total force protection, Fires CDID and Air and Missile Defense Army Capability Managers support the AMD CFT modernization objectives of Army Integrated Air and Missile Defense, Maneuver Short Range Air Defense, Indirect Fire Protection Capability and Lower-tier Air and Missile Defense.

C-25. Conclusion

The Army's ability to compete, deter, and win in MDO relies heavily on providing the joint force the fires capabilities to project power through strategic and operational long-range attack capabilities and multi-capable air defenses integrated with JIIM partners. This appendix focused on three things: Near and mid-term efforts undertaken by both LRPF and AMD CFT assisting in achieving the 2028 MDO capable force; Science and technology investments that allow these systems to stay ahead of the threat; and proposed advanced research investments for the next generation of disruptive combat capability. To ensure long-term fires superiority, the Army must invest in new technology and system architectures for transformative overmatch. Looking beyond the major investments made in the near-term and driving towards transformation as a multi-domain force; new, disruptive, non-conventional technologies will be needed to meet the goals laid out in the Army Modernization Strategy. Far-term uncertainties with the operational, geopolitical, technical, adversarial and financial spaces present complications for capability developers. To minimize the risks associated with these uncertainties, use of present and mid-term state-of-the-art is needed to project the far-term art-of-the-possible.

Appendix D Dependencies

D-1. Introduction

This appendix identifies the dependencies on other functions required to perform the capabilities identified in this concept.

D-2. Dependencies on Army Warfighting Functions

a. The future OE requires a multi-domain capable force that is composed of combined arms elements and JIIM partners. Army contributions are provided by the Army warfighting functional proponents. Fires units and systems have unique dependencies upon the other Army warfighting functions, organizations and weapons systems.

b. Army elements. Unique Army warfighting function dependencies are discussed below.

(1) Movement and maneuver.

(a) Fires organizations depend upon maneuver formations to conduct persistent, all-weather, multi-domain reconnaissance and security operations to develop situational understanding, assist in target development, and protect the force.

(b) Army fires depends upon maneuver formations to create temporarily protected corridors and positions of advantage in order to allow fires formations to defeat or destroy long- and mid-range threat systems operating from the operational and strategic fires areas.

(2) C2.

(a) An integrated network and information system that is reliable over vast distance, has an intuitive interface, and is interoperable with all applicable Army and JIIM systems at each echelon is paramount to the successful synchronization and execution of multi-domain fires convergence. Planning for the integration of fires flows from higher to lower echelon. All echelons develop target materials and aid in target development and asset employment in both deliberate and dynamic situations. The intent behind an integrated network is to enable the concept of “any sensor, best shooter”, through any C2 node, and aid informed engagement decisions with proper delegated authorities. Fires are dependent upon timely indications and warnings to enable AMD and fires support/targeting decisions and for fires deployment across the expanded battlefield. This provides the convergence of fires in the MDO network and mandates the expectation and goal for the fires warfighting function to achieve.

(b) Army fires is dependent upon consistent, continuous, and redundant access to a robust and reliable C2 system for a fires-specific mission command application to conduct fire support planning, targeting, and execute fire control in an MDO environment.

(3) Intelligence.

(a) Army fires depends on the intelligence enterprise to ensure the information collection plan supports the finalized targeting and area air defense plans. Providing intelligence support to targeting includes intelligence support to target discovery, target maintenance, target development, and combat assessment. Target development includes vetting, validation, and all-source intelligence analysis, all critical to determining accurate target location success. In addition, weaponeering, target database maintenance (MIDB/MARS), collateral damage estimations in accordance with CJCSI 3370.01B and JP 3-60, and input to target lists (e.g., No Fire, Restricted, HVTL/HPTL) are critical to complete the target development process.

(b) Combat assessment includes battle damage assessment, collateral damage assessment, munitions effectiveness assessment, and re-attack recommendations IAW CJCSI 3162.02. Intelligence support to air and missile defense units includes threat air and missile signature development, characterization, and disposition analysis. Intelligence sensors and fires systems must be interoperable and exchange targetable data seamlessly and instantaneously (sensor-to-shooter). Emphasis will be placed on balancing requirements-based Collection Management with a more sensor awareness-based Mission Management process, which provides NRT streaming data to Fires systems. Force design modification may be necessary to provide optimum manning for technical support to target development through multi-discipline intelligence analysis.

(c) Development of IPB products is required for all domains, the EMS, and the information environment in joint operations based on all-source reporting to support the commander and staff's ability to layer both lethal and nonlethal effects on targets of interest. Additionally, intelligence organizations support development of accurate threat models across all domains. These models enable advanced understanding of our ability to defend against threats and make informed decisions in both competition and war. These products must encompass both traditional means including enemy A2/AD operations and non-traditional means such as the enemy's use of information warfare and cyberspace attacks. National Technical Means (NTM) and organic high-altitude/space-based sensors will be essential to persistently monitor the disposition of threat forces and to meet long-range precision fires targeting requirements. Where possible, the Army must

share relevant intelligence data rapidly with JIIM partners, using all available tactical ground stations, to maximize effectiveness of their fires systems.

(4) Sustainment.

(a) Fires dependencies on sustainment include transportation, supply, maintenance, medical, personnel, legal, and chaplain. Fires forces depend heavily on sustainment resources to supply large amounts of Class V in a high intensity scenario in an austere environment. Fires Class V for both Field Artillery and Air Defense Artillery weapons is unique - it is large in both weight and volume, highly specialized, expensive and fragile - all of which places additional requirements on sustainment assets. In addition, low-density fires munitions are centrally managed in theater or CONUS depots and require strategic lift to support fires operations. The large, and specialized, ammunition requirement necessitates hardened ammunition supply points (ASP). These ASPs require security, physical space, potential hardened facilities and explosive stand-off distances for the storage of large quantities of Class V items, especially those with a high net explosive weight value.

(b) Additionally, Class III (fuel) and other sources of fuels need to be considered to address the energy related demands of current and future Fires systems. This holds for both short term and persistent presence of fielded offensive and defensive capabilities, including radars stationed in forward areas. Directed energy weapons are also likely to shift the demand of Class V to Class III or other electrical power generation from tactical through the strategic level. Furthermore, an oft neglected planning consideration is the material handling equipment needed for loading and reloading at all levels Sustainment planners need to analyze resupply rates and conduct predictive analysis of the operational tempo and consumption rates to ensure that there is enough Class V on hand to support the commander's Field Artillery Tasks for a given operation.

(5) Protection.

(a) Fires requires chemical, biological, radiological, and nuclear (CBRN) staffs to provide advice to planning fires so as not to cause collateral damage that increases the hazard. The integration of CBRN and fires provides valuable information to understanding the enemy's weapons of mass destruction (WMD) capabilities and employment. Information from radar analysis can aid in identifying missiles potentially armed with CBRN warheads. Additionally, fires has the ability to emplace novel CBRN sensors in named areas of interest (NAIs) that would support the overall ISR collection plan and facilitate commanders' risk based decision making. CBRN staff subject matter experts advises on the impacts of WMD employment, on targeted storage, or production sites, toxic industrial materials (TIM) and must aid in the development of targeting packets during the targeting process.

(b) Fires requires security, protection, and survivability of targeting, fires control, and firing system, CBRN hazard contamination mitigation, concealment, and situational understanding of the prioritized protection requirements at echelon for mission support. The integration of engineer and fires provides valuable survivability assets to protect fires from enemy targeted attacks. Fires delivers lethal and nonlethal effects across the battlefield framework to preserve critical capabilities, assets, and activities. They support denying enemy freedom of action through countering enemy fires, air and missile defense, cyberspace, space, information warfare, and

unmanned aircraft systems. Fires provides covering air and missile defense to support critical items on the prioritized protection list.

(c) Fires formations depend on the protection function to plan, coordinate, synchronize, and provide security and force protection of critical fires capabilities, assets, and activities. They provide support to critical C2, and firing elements securing and improving survivability along the patterns of life at the position area of artillery that are most vulnerable to enemy attack. At the operational and strategic levels, staffs must understand the criticality, vulnerability and recoverability of assets within the respective support areas. Additionally, staff's must understand the threats they are realistically facing across all domains. This understanding along with its expression in data and analysis (preventative modelling and reactive AI enabled operations support) will inform decision makers where best to apply defensive and offensive fires.

D-3. Other Critical Dependencies

a. Special operations.

(1) In conflict, Army Special Operations Forces (ARSOF) penetrate into the operational and strategic deep fires areas to enable the destruction of enemy A2/AD systems. ARSOF and Army Fires convergence of multi-domain fires and intelligence capabilities will enhance lethality, expand maneuver, enable joint force targeting, as well as refine intelligence and weather information.

(2) Army fires requires ARSOF Soldiers to identify and track targets in the Operational and Strategic Deep Fires Areas through the use of a multi-domain tagging, tracking, and locating (TTL) sensor that can be emplaced on high value targets (HVT) and remain undetected for long periods of time. The TTL device leverages capabilities across the land, maritime, air, space, and cyberspace domains. The TTL device must be easily emplaced by US or indigenous forces on HVTs. The TTL device significantly improves ARSOFs survivability by allowing the TTL to be planted and ARSOF forces to depart the target area. The TTL device also significantly increases Soldier lethality by allowing multi-domain fires to access or destroy mobile systems.

b. Space. Army fires is dependent upon Space formations to support the targeting process by planning, integrating, synchronizing, and executing space control planning/operations, high altitude planning/operations, and navigation warfare planning/operations. Integral to targeting is the integration of space surveillance, collection, and processing, environmental monitoring, understanding of U.S. and multinational space readiness, and analysis of the space domain.

c. Cyberspace and electromagnetic warfare.

(1) Army fires depends on EW to provide the capability to synchronize and assess OCO to attack enemy and adversary facilities, platforms, sensors, systems, networks, critical infrastructure, and key resources to ensure friendly mission command while denying the same to enemies and adversaries during MDO.

(2) Fires formations are dependent upon EW to provide defensive cyberspace operations, response actions and internal defensive measures, to secure, detect, mitigate, and remediate cyber incidents to support MDO.

d. Information advantage.

(1) Fires formations are dependent upon information advantage to provide the capability to manage the tasks and systems that provide lethal and nonlethal capabilities, to assess, shape, deter, deceive, inform, and influence people, governments, militaries and the operational environment to effect behavioral change in the IE in support of MDO.

(2) Army fires requires information advantage to provide the capability to conduct civil reconnaissance of the operational environment to provide situational understanding to assist in target development, identify critical threats, and leverage multinational capabilities to enhance operations that enable the future force to preserve critical capabilities, assets, and activities in MDO.

Glossary

Section I

Abbreviations

A-PNT	assured position, navigation, and timing
A2	antiaccess
AAMDC	Army Air and Missile Defense Command
AD	area Denial
ADA	air defense artillery
ADP	Army doctrine publication
AI	artificial intelligence
AMD	air and missile defense
APOD	air port of debarkation
APOE	air port of embarkation
ARSOF	Army special operations forces
ASCC	Army Service Component Command
BCT	brigade combat team
BMDS	Ballistic Missile Defense System
C5ISR	command, control, communications, computers, cyber, intelligence, surveillance, and reconnaissance
CA	civil affairs
C2	command and control
CAS	close air support
CBRN	chemical, biological, radiological, and nuclear
CBRNE	chemical, biological, radiological, nuclear, and explosives
CDID	Capabilities Development and Integration Directorate
CEMA	cyberspace electromagnetic activities
CJADC2	Combined Joint All Domain Command and Control

CONUS	continental United States
C-UAS	counter unmanned aircraft systems
D3A	decide, detect, deliver, and asses
DA	Department of the Army
DE	directed energy
DEAD	defeat of enemy air defense
DOTMLPF-P	doctrine, organizations, training, materiel, leadership and education, personnel, facilities, and policy
EA	electromagnetic attack
EAB	echelons above brigade
EABC	echelons above brigade concept
EW	electromagnetic warfare
FA	Field Artillery
FCC	Futures and Concepts Center
FID	foreign internal defense
FSCOORD	fire support coordinator
FSE	fire support element
GEOINT	geospatial intelligence
GMD	Ground-Based Midcourse Defense
HUMINT	human intelligence
FM	field manual
IADS	Integrated Air Defense System
IAMD	Integrated Air and Missile Defense
IJSTO	Integrated Joint Special Technical Operations
IPB	intelligence preparation of the battlefield
ISR	intelligence, surveillance, and reconnaissance
JIIM	joint, interagency, intergovernmental, and multinational
JP	Joint Publication
MASINT	measurement and signature intelligence
MILDEC	military deception
OE	operational environment
OFC	Operational Fires Command
OPSEC	operations security
OSINT	open-source intelligence
Pam	pamphlet
PNT	positioning, navigation, and timing
PSYOP	psychological operations
RAM	rocket, artillery, and mortar
RAS	robotics and autonomous systems
RSOI	reception, staging, onward movement, integration
S&T	science and technology
SEAD	suppression of enemy air defense
SIGINT	signal intelligence
SOF	special operations forces
SPOD	Sea Port of Debarkation
SPOE	Sea Port of Embarkation
SWaP	size, weight, and power

SWaP-C	size, weight, and power-cost
TITAN	Tactical Intelligence Targeting Access Node
TFC	Theater Fires Command
TRADOC	Training and Doctrine Command
TTP	tactics, techniques, and procedures
U.S.	United States
UAS	unmanned aircraft system
USA	United States Army
WMD	weapons of mass destruction

Section II

Terms

accuracy*

The degree to which the result of a measurement, calculation, or specification conforms to the correct value or a standard.

adversary

A party acknowledged as potentially hostile to a friendly party and against which the use of force may be envisaged. (JP 3-0)

command and control system

The arrangement of people, processes, networks, and command posts that enable commanders to conduct operations. (ADP 6-0)

cross-domain fires

Fires executed in one domain to create effects in a different domain. (ADP 3-19)

cyberspace electromagnetic activities

The process of planning, integrating, and synchronizing cyberspace and electromagnetic warfare (ADP 3-0)

cyberspace operations

The employment of cyberspace capabilities where the primary purpose is to achieve objectives in or through cyberspace. Also called CO. (JP 3-12)

electromagnetic attack

Division of electromagnetic warfare involving the use of electromagnetic energy, directed energy, or antiradiation weapons to attack personnel, facilities, or equipment with the intent of degrading, neutralizing, or destroying adversary combat capability and is considered a form of fires. Also called EA. (JP 3-13.1)

enemy

A party identified as hostile against which the use of force is authorized. (ADP 3-0)

field artillery

Equipment, supplies, ammunition, and personnel involved in the use of cannon, rocket, or surface to surface missile launchers. Also called FA. (JP 3-09).

fire support

Fires that directly support land, maritime, amphibious, space, cyberspace, and special operations forces to engage enemy forces, combat formations, and facilities in pursuit of tactical and operational objectives. (JP 3-09)

fire support coordinator

The senior field artillery commander for the theater, corps, division, brigade combat team who is the maneuver commander's primary advisor to plan, coordinate, and integrate field artillery and fire support in the execution of assigned tasks. (FM 3-09)

fire support planning

The continuous process of analyzing, allocating, integrating, synchronizing, and scheduling fires to describe how the effects of fires facilitate maneuver force actions. (FM 3-09)

fires

The use of weapon systems to create specific lethal or nonlethal effects on a target. (JP 3-09)

fires warfighting function

The related tasks and systems that create and converge effects in all domains against the threat to enable actions across the range of military operations. (ADP 3-19)

joint fires

Fires delivered during the employment of forces from two or more components in coordinated action to produce desired effects in support of a common objective (JP 3-09)

multi-domain fires

Fires that converge effects from two or more domains against a target. (ADP 3-19)

multinational

Between two or more forces or agencies of two or more nations or coalition partners. (JP 5-0)

precision*

Marked by exactness and accuracy of expression or detail.

space control

Operations to ensure freedom of action in space for the U.S. and its allies and deny an adversary freedom of action in space. (FM 3-14)

space enabled operations

Combined, derived, or second order tasks and actions enabled by space capabilities that include joint friendly force tracking network transport of DOD information network, commercial imagery, National Reconnaissance Office overhead systems, Army tactical exploitation of national capabilities program, National-to-Theater program interfaces, geospatial intelligence, integrated broadcast service, and common interactive broadcast. Space-related activities Army space

operations, duties, and responsibilities centered on eight codified joint space capabilities: space situational awareness (SSA), PNT, space control, SATCOM, satellite operations, missile warning, environmental monitoring, and space-based intelligence, surveillance, and reconnaissance. (FM 3-14)

space operations

Operations impacting or directly utilizing space-based assets to enhance the potential of the U.S. and unified action partners. (FM 3-14)

space force enhancement

Combat support operations to improve the effectiveness of military forces as well as support other intelligence, civil, and commercial users. The space force enhancement mission area includes intelligence, surveillance, and reconnaissance; integrated tactical warning and attack assessment; command, control, and communications; position, velocity, time; and environmental monitoring. (JP 3-14)

special operations

Operations requiring unique modes of employment, tactical techniques, equipment and training often conducted in hostile, denied, or politically sensitive environments and characterized by one or more of the following: time sensitive, clandestine, low visibility, conducted with and/or through indigenous forces, requiring regional expertise, and/or a high degree of risk. (JP 3-05)

standoff weapon*

Missiles or bombs which may be launched at a distance sufficient to allow attacking personnel to evade defensive fire from the target area.

target

An entity or object that performs a function for the threat considered for possible engagement or other action. (JP 3-60)

targeting

Process of selecting and prioritizing targets and matching the appropriate response to them, considering operational requirements and capabilities. (JP 3-0)

threat

Any combination of actors, entities, or forces that have the capability and intent to harm United States forces, United States national interests, or the homeland. (ADP 3-0)

unified action partner

Those military forces, governmental and nongovernmental organizations, and elements of the private sector with whom Army forces plan, coordinate, synchronize, and integrate during the conduct of operations (ADP 3-0).

weaponizing

The process of determining the specific means required to create a desired effect on a given target. (JP 3-60)

Section III
Special terms

fires weapon(s) system*

A combination of one or more weapons with all related equipment, materials, services, personnel, and means of delivery and deployment required for self-sufficiency to deliver fires and perform fires missions.

interorganizational

Elements of U.S. government agencies; state, territorial, local, and tribal agencies; foreign government agencies, intergovernmental, nongovernmental, and commercial organizations (does not include forces). (AFC Pam 71-20-1)

nonlethal*

Neutralizing or incapacitating a target without causing injury, death, or gross physical destruction.

*proposed in this concept