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MOSUL STUDY GROUP

What the Battle for Mosul Teaches the Force

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Chapter 1

Initial Impressions and Observations on Operation EAGLE STRIKE

> *"You will succeed if you remember to deal with our stories with the understanding of what we knew at the time, what we had to do with, and what we attempted to do in a limited time."*
>
> — GEN George C. Marshall to his biographer.

Introduction

After a brutal nine-month campaign to liberate Mosul from the Islamic State, Iraqi security forces (ISF) retook Iraq's second largest city. This battle was the largest conventional land battle since the capture of Baghdad by coalition forces in 2003 and the first sustained urban operation involving U.S. forces since the 1968 Battle of Hue. The battle was principally conducted by ISF (the Iraqi Army, air force, special operations forces, counterterrorism forces, and police) that planned and led the fighting. These Iraqi forces were greatly aided by an integrated advise-and-assist network provided by the U.S. and coalition forces that accompanied ISF into the fight, down to the tactical level. Coalition elements also aided ISF in the defeat of the Islamic State and the recapture of Mosul through the provision of critical enablers such as combined, joint, and supporting fires; intelligence, surveillance, and reconnaissance capabilities; and logistical networks. These efforts were supported by a force generation effort to prepare, train, and equip ISF for combat. All of this was necessary as the Islamic State proved to be a capable and adaptable hybrid force capable of establishing a robust, layered urban defense with coordinated capabilities across multiple domains. However, Iraqi ground forces — operating with their advise, assist, accompany, and enable formations, enabled by coalition capabilities in all domains — were able to conduct successful combined arms operations while simultaneously consolidating gains in order to defeat the Islamic State on this multi-domain battlefield. This report seeks to provide the U.S. Army with initial insights into what Operation EAGLE STRIKE teaches it about operations in dense urban terrain, security force assistance, joint fires, and fighting on a multi-domain battlefield against hybrid adversaries.

Purpose

The purpose of this report is to provide immediate impressions of Operation EAGLE STRIKE that may or should directly impact the Army and how it approaches future conflicts. It also recommends areas that require further study in order to better prepare the Army for future combat operations. This report will inform Army force design, force structure, future force development decisions, concepts, doctrine, and readiness through the timely feedback of relevant observations and impressions from Operation EAGLE STRIKE. It does not attempt to form conclusions about what these observations mean for the future character of war.

This report is the result of an intense 45-day effort to study Operation EAGLE STRIKE in order to provide the Army with relevant observations that can be immediately injected back into the force. Members of the Mosul Study Group consulted with the units that participated in Operation EAGLE STRIKE and accompanied them on the Mosul battlefield. The study group consulted with numerous after action reports from key advise-and-assist elements and reviewed documents, interviews, and lessons learned captured by the Asymmetric Warfare Group; Center for Army Lessons Learned; 141st Military History Detachment (Washington Army National Guard); Combined Joint Task Force-Operation INHERENT RESOLVE (CJTF-OIR); Combined Joint Forces Land Component Command-OIR (CJFLCC-OIR); U.S. Special Operations Command (USSOCOM); Special Operations Joint Task Force-Iraq (SOJTF-I); Combined Joint Special Operations Task Force-Iraq (CJSOTF-I); U.S. Air Force Central Command Combined Air Operations Center (CAOC); U.S. Agency for International Development (USAID); U.S. Embassy in Iraq; 2nd Brigade, 82nd Airborne Division; and Special Operations Task Force-North (SOTF-N). The U.S. Army Center of Military History also contributed to the study. The Mosul Study Group included representation from the Joint Staff, U.S. Marine Corps, British Army, and the Royal Air Force.

Historical Context

Mosul has a long history that is dynamic and multi-ethnic. As a vital crossroad city at the crux of three major modern Middle Eastern civilizations (Arab, Persian, and Turkic), Mosul has maintained a distinct political and economic independence throughout its history while enjoying the benefits and suffering the perils of its strategic location. Settlements in Mosul have ancient origins to the Assyrian settlements of Mesopotamia. Over time, Assyrians proved remarkably resilient and survived multiple Greek, Roman, and Persian conquests through the mid-17th century. After the Muslim Arab invasions in the seventh and eighth centuries, the city of Mosul gained new importance for Arab settlers and became a vital link in expanding a regional trade network. Alongside the Arab influx, Kurds,

Persians, and Turkic peoples began to settle in and around Mosul. Mosul then passed between a succession of Arab, Persian, and Turkic empires until the 16th century.

Under Ottoman rule from 1519 until 1918, Mosul flourished again and became a center of military operations against the Safavid Persians. During the 18th and early 19th centuries, Mosul was increasingly ruled by local elites that pulled the city away from Ottoman administrative and martial control. Eventually, Mosul's significance in overland trade was severely impacted by the opening of the Suez Canal in 1869. While Mosul's place in the international trade system diminished, Mosul remained vitally important to its regional trade. In particular, Mosul supplied much of the wheat, road material, and water for central and southern Iraq.

At the end of World War I, British forces occupied Mosul as part of Iraq under British administration. An emergent Turkey, however, sought to renegotiate the terms of peace and reclaim Mosul in the early 1920s. At the Conference of Lausanne in 1922 and 1923, Mosul proved to be the greatest obstacle for an enduring peace until the Frontier Treaty of 1926. In the end, the League of Nations deliberated and determined that Mosul had greater strategic and economic importance for Iraq. The burgeoning Iraqi oil industry around Mosul increased the city's fortunes and Mosul again became a crossroads to Turkey and Syria for the delivery of oil. Later, Mosul largely escaped the Iran-Iraq war in the 1980s and was not involved in the Kurdish popular rebellion in the north against Saddam Hussein in 1991.

In April 2003, as part of the opening stages of Operation IRAQI FREEDOM, Joint Special Operations Task Force-North (JSOTF-North) cleared the way with the Kurdish Peshmerga to secure Mosul. Combined Joint Special Operations Task Force-North (CJSOTF-North) focused on supporting the Peshmerga attack to fix the Iraqi Army units at Mosul and Kirkuk, and preventing their movement south to engage the main U.S. and coalition land offensive. The Peshmerga, working with the U.S. Army's 173rd Airborne Brigade and U.S. and coalition air power, defeated Iraqi resistance in the first weeks of April and opened a path to these two crucial northern cities. The 101st Airborne Division established itself in Mosul with a particular focus on local self-government. Notably, the 101st Airborne Division, along with a special forces task force, located and killed Saddam's sons, Uday and Qusay, in Mosul.

While the global network of al Qaeda associated with Osama bin Laden was under major assault in Afghanistan, Pakistan, Saudi Arabia, and Yemen, a new movement had emerged in Iraq in 2004 under the leadership of Abu Musab al-Zarqawi and his al Qaeda in Iraq. As the insurgency in Iraq grew, its supply routes relied heavily on routes through Anbar Province as well

as Mosul. Jihadist violence in Iraq peaked in 2006. Then war-weary Iraqis rallied with U.S. and coalition forces, alongside Sunni, Shi'a, and Kurdish militias to root out jihadists labelled as foreigners. The subsequent surge of U.S. forces into Iraq also combined with the antiterrorist fusion cells (using intelligence and special forces assets) to eliminate al-Zarqawi's followers. By 2010, al Qaeda in Iraq was defeated as an organization, but U.S. plans to battle insurgents in Mosul never materialized and the insurgency reemerged as the Islamic State of Iraq.

The deepening civil war in Syria would soon prove devastating for Mosul. After the wave of Arab Spring uprisings arrived in Syria to topple the government of Bashar al-Assad, the Syrian government lost control and quickly turned to violence to suppress the public protests. Assad sought to undermine and redefine the broad-based opposition by declaring a general amnesty that included radical Islamists in late 2011.

Abu Bakr al-Baghdadi inherited leadership of the Islamic State of Iraq in 2010 when the organization was close to collapse and based in Mosul. Al-Baghdadi then spent the next few years increasingly entrenched in the Syrian civil war as a covert supporter of the al-Nusra Front. However, the allegiance between al-Nusra and the Islamic State of Iraq would soon come to an end. In April 2013, Baghdadi publicly stated, "Al-Nusra Front was only an expansion of the Islamic State of Iraq, and part of it. So we declare, keeping our trust in Allah, the abolishing of the name of the Islamic State of Iraq and the abolishing of the name of al-Nusra Front, and joining them under one name, the Islamic State in Iraq and al-Sham (ISIS), and also uniting the banner, which is the banner of the Islamic State." Baghdadi then amplified violence in Syria and Iraq that culminated in the occupation of Raqqa. By 2014, ISIS controlled 100,000 square kilometers of territory and many analysts began to view ISIS as an enduring threat.

Having set the conditions for Mosul, a small contingent of ISIS forces made a feint to Samarra on 05 June 2014, home to Baghdadi's al-Badri clan, while the main ISIS effort moved to Mosul. As Iraqi forces quickly faced multiple fronts, the Iraqi Army in Mosul proved ill-prepared and ill-equipped for an organized defense. ISIS forces secured Mosul by 10 June and seized significant weapons and materiel left behind by the Iraqi Army. On 04 July, Baghdadi appeared at the Great Mosque of al-Nuri to declare the restoration of the caliphate. Mosul became the political and economic hub for ISIS, securing significant funds through sales of oil and taxes on the local population. ISIS also briefly held the Mosul Dam to the north of the city in July and August 2014, but Iraqi and Peshmerga forces combined to secure the dam, a key resource in the region that requires additional care due to its need for critical repairs.

Liberation of Mosul

Over the next year, Iraqi forces would reorganize, train, equip, and prepare to retake the city. Iraqis learned valuable tactics, techniques, and procedures in the successful campaigns in Tikrit (April 2015), Ramadi (March 2016), and Fallujah (June 2016). Mosul was the last significant ISIS urban area in Iraq. At the start of the battle to liberate Mosul in October 2016, ISIS maintained a light infantry force of approximately 3,000 to 5,000 in the city with significant numbers of heavy machine guns, rocket-propelled grenade launchers, recoilless rifles, mortars, and rockets. ISIS forces constructed an elaborate series of defensive works inside the city, fortifying buildings, blocking avenues of approach, creating obstacles, and constructing underground shelters and tunnels.

Figure 1-1. Mosul, Iraq, 06 April 2008
(Photo by SGT John Crosby)

ISIS augmented its fire support assets with vehicle-borne improvised explosive devices (VBIEDs). ISIS also developed primitive chemical weapons, lending an added dimension of terror to its indirect fire. The enemy demonstrated its ability to adapt and improvise by converting its small commercial unmanned aerial vehicles into reconnaissance and strike platforms. ISIS deepened its defenses by using the civilian population as shields.

Figure 1-2. ISIS VBIED
(Photo by Mosul Study Group, 2017)

In early 2016, ISF began the planning and preparation for the liberation of Mosul, which involved complex negotiations with U.S. forces, coalition partners, the Kurdish Regional Government, provincial governors, multiple Iraqi government ministries, and Iraqi government-supported militias. Learning from the liberations of Ramadi, Tikrit, and Fallujah, U.S. and Iraqi military planners agreed that Shi'a militias and Kurdish Peshmerga would assist in the isolation of ISIS forces but remain outside Mosul. Iraqi forces took the lead in operational planning and execution of operations while U.S. and coalition forces advised, assisted, accompanied, and enabled ISF throughout the battle.

ISF ultimately deployed a force of 94,000 to tactical assembly areas south of Mosul in August 2016. The Iraqi Army, Federal Police, Counter Terrorism Service, and militia groups loyal to the government of Iraq would all participate in the Battle of Mosul, each with its own separate avenue of advance into or flank of the city. The Iraqi Army, Counter Terrorism Service, and Federal Police attacked north into the city, while additional Iraqi Army units, Kurdish Peshmerga, and loyal tribal militias advanced east and north of Mosul.

Iraqi Prime Minister Haider al-Abadi declared the start of the campaign to liberate Mosul on 16 October 2016. Iraqi forces spent the first few weeks of the campaign advancing on the city along both banks of the Tigris, completing the isolation of the ISIS defenders and cutting its lines of communication into east Mosul. U.S. and coalition fires played a key role in destroying and isolating ISIS in East Mosul.

Figure 1-3. Defensive berm, East Mosul
(Photo by Mosul Study Group, 2017)

On 01 November, Iraqi forces entered the city and began clearing the Karama and Gogjali districts, pushing west toward the University of Mosul. The fighting was bitter and Iraqi operations were impaired by poor weather, which slowed the Iraqi advance and diminished the effectiveness of U.S. and coalition air support and reconnaissance. By the end of November, the 15th Iraqi Infantry Division advanced north along the west bank of the Tigris and closed within several kilometers of West Mosul. By mid-December, Iraqi forces, led by the Counter Terrorism Service and its partner coalition special operations forces, began to focus on the University of Mosul complex and took control of the area on 13 January. To the south, additional elements of the Counter Terrorism Force and the Federal Police (Emergency Response Division) advanced to the Tigris, seized crossing sites, and cut ISIS lines of retreat. On 24 January 2017, Prime Minister Abadi announced that Iraqi forces had liberated East Mosul. While Iraqi forces eliminated the last pockets of resistance, the reconstituted local police and vetted militia formations established local security and governance to support reconstruction efforts.

In preparation for the assault on West Mosul, the Iraqi forces pulled back units for reconstitution and retraining. Iraqis and their advisors alike studied lessons learned in urban terrain and developed new tactics, techniques, and procedures to overcome new ISIS challenges. The coalition continued to attack ISIS command and control and supply locations in West Mosul with air and artillery strikes. The concept was to isolate the ISIS garrison from the west and north while ISF — again led by the Counter Terrorism Service

and the Federal Police (Emergency Response Division) — and vetted militia units advanced on separate but mutually supporting axes into the city from the south and southwest.

The assault on West Mosul began on 19 February as Iraqi units advanced north, taking Mosul Airport, and then pressed into the southern neighborhoods. Iraqi forces made considerable progress in the early campaign. On 11 March, Federal Police units reached the outskirts of Mosul's Old City after heavy fighting. On 19 March, elements of the 9th Iraqi Armored Division captured the town of Badush to the north and completed the encirclement of West Mosul. After each reverse, ISIS defenders withdrew into tunnels and alleys inside the Old City as well as in the Al Jamouri Hospital along the Tigris, reconstituted its forces, and continued to resist. Through the end of March, ISF continued to press ISIS back onto its main defensive lines. On 07 March, the Federal Police liberated the Nineveh provincial government compound and raised the Iraqi flag on the roof of the capitol building.

At the end of March, poor weather, stiffening enemy resistance, and the challenges posed by the urban terrain of the Old City again slowed the Iraqi momentum. On 24 March, Iraqi forces temporarily halted their advance and began to plan a new front in the north. As operations began anew in the densely populated areas of West Mosul, ISIS took full advantage of coalition sensitivity to civilian casualties and used the civilian population as shields. In an act of desperation on 14 April, ISIS attacked Iraqi forces with chemical weapons. This attack was not effective and Iraqi troops and their coalition advisors continued their advance.

On 04 May, ISF launched a new offensive from the south. The 9th Iraqi Armored Division, reinforced by units of the Federal Police, attacked 100 kilometers north from Bayji to seize Qayarrah West Airfield. Qayarrah West would serve as the ISF base of operations against West Mosul, enabling coalition logistics and fire support far from the ISF's bases near Baghdad. At the same time, the 15th Iraqi Army Division attacked west from a U.S.-built base near Makhmur in Kurdish-held terrain east of the Tigris River. U.S. forces actively assisted ISF in an opposed river crossing operation near Qayarrah to seal off the Hawijah pocket and encircle Mosul. This attack required careful synchronization among the disparate branches of ISF, sometimes resulting in flanking fire at the Al Jamouri Hospital complex. By the end of June, Iraqi forces had secured most of West Mosul and the fighting centered on the Great Mosque of al-Nuri. ISIS fighters offered stiff resistance at the Great Mosque and much of the Old City was destroyed after weeks of savage fighting and intense, dense urban terrain combat involving house-to-house combat. On 10 July, Prime Minister Abadi announced that Iraqi forces had liberated West Mosul.

Figure 1-4. Destruction of the Great Mosque of al-Nuri in western Mosul by ISIS, 21 June 2017 (Photo by CJTF-OIR)

Throughout the nine-month Mosul campaign, U.S. Army advise-and-assist teams, alongside joint and coalition special forces advisors, joint forward observers, and joint terminal attack controllers, played critical roles in the planning, coordination, and execution of operations with their Iraqi Army and security forces partners. Given the unique challenges of Mosul's dense urban environment and confronting a capable and adaptive adversary in ISIS, advisors enabled and deconflicted a complex array of air and ground joint fires as well as intelligence, surveillance, and reconnaissance assets that made victory expedient and possible. Experiences in Mosul reaffirmed that urban terrain strengthens the defense and therefore required a combined arms approach to warfare. Both ISIS and Iraqi forces demonstrated a willingness and proficiency to adapt in a complex environment by using commercial off-the-shelf technology as an asymmetric advantage. Mosul revealed that a determined and adaptive partner, empowered with the unique capabilities provided by capable advise, assist, accompany, and enable teams, can defeat a determined and adaptive adversary.

Overarching Impressions

Operation EAGLE STRIKE provides the U.S. Army with the opportunity to examine the complex nature of combined arms warfare in dense urban terrain. In this environment, the superiority of the defense was further enhanced by Mosul's complex terrain, ISIS' technical and tactical adaptability, and the militarization of commercial off-the-shelf technology. This clash of wills reinforced the centrality of the human element in war. U.S. Soldiers and ISF Soldiers did not merely endure close urban combat but also adapted not only their tactics, techniques, and procedures, but also technology. This allowed the U.S.-enabled ISF to defeat ISIS by presenting it with dilemmas across multiple domains.

Below are this study's overarching observations. The relevant appendices contain more tailored observations that provide the U.S. Army with initial insights from Operation EAGLE STRIKE regarding operations in dense urban terrain, security force assistance, joint fires, and fighting on a multi-domain battlefield against hybrid adversaries.

Decisive Action in Dense Urban Terrain

1. Urban Situational Understanding. Operation EAGLE STRIKE reinforced the idea that dense urban terrain makes intelligence preparation of the environment much more difficult. Even by the hour of the day, operations physically changed the landscape, the populace migrated, and the electromagnetic spectrum adjusted. Forces engaged in dense urban terrain must understand the construction and layout of buildings, subterranean features, interactions and relationships between various populations, impact of internally displaced persons, communications and transportation networks, and infrastructure within the city. In dense urban terrain, buildings are not just buildings, they are fighting positions — defensible locations. The adversary is using these structures because they provide cover and concealment. *An urban environment is alive, it changes and adapts. To operate effectively in this environment requires a more robust focus on dense urban terrain in professional military education and training. Extensive and unceasing operational preparation of the environment, intelligence preparation of the battlefield, and running estimates are essential to understand this ever-changing complex terrain*.

2. Common Operating Picture. A common operational and intelligence picture is critical to creating and maintaining a shared understanding of the environment. In urban terrain, fires and their effects cause changes in the operational environment on a near continuous basis. Operations in Mosul were imagery-centric, but this imagery was not consistent due to the variety of systems and data disparities (resolution, angle, time of day, refresh rate).

- Subordinate units in the field used different common operating pictures (Google Earth, Android Tactical Advise Kit) to visualize the battlespace and may or may not feed the larger common operating picture (Command Post of the Future, Agile Client).
- The combined joint special operations task force (CJSOTF) used a highly effective common operating picture on its own system.
- Advise-and-assist teams used work-around solutions, including screen shots of imagery, to collaborate with higher headquarters and coalition partners.
- The use of partner position location information systems was sporadic based on distribution and partner ability to operate and maintain the systems.
- Air operations required a real-time image of the "forward line of troops." As a result, the air component developed a live map that dynamically depicted friendly force locations from a variety of available data sources to increase situational awareness.

This topic needs to be examined from a mission command perspective at all echelons. *Different imagery databases resulted in inefficiencies and suboptimal combat effectiveness. The U.S. Army needs a shared and accessible common operating picture to enable dynamic targeting and visualization with joint, coalition, and multinational partners*.

Figure 1-5. Combined command post (Mosul Study Group, 2017)

3. Full-Motion Video Platform Employment. Full-motion video collection in dense urban terrain is degraded by the vertical and horizontal terrain characteristics. Unit tactical systems augmented operational intelligence, surveillance, and reconnaissance and were fed to the combined joint operation centers and advise-and-assist tactical operation centers. The following are anecdotal observations on common full-motion, video-capable platforms:

- MQ-1 (Predator) and MQ-9 (Reaper) were generally favored based on loiter time and tailorable on-board packages.
- MQ-1 (Grey Eagle) was employed for joint intelligence, surveillance, and reconnaissance and also facilitated AH-64 (Apache) attack by fire.
- RQ-11 (Raven) and RQ-20 (Puma) tactical unmanned aircraft systems were sometimes limited by launch and recover points in dense urban terrain but were important to thickening the full-motion video coverage across the city.
- RQ-7 (Shadow) flew primarily at night due to temperature considerations and its engine noise may have hindered overall effectiveness.
- Tethered assets, such as aerostats, provide persistent full-motion video only at static locations and were not used in Mosul.

What was missing in the inventory was used by the Iraqi partner. ISF employed quad-copters (e.g., DJI Phantom series) due to their maneuverability and ease of use. This capability gave the ground force commander exceptional organic intelligence, surveillance, reconnaissance, and targeting capabilities. *In dense urban terrain, ground force commanders, and even small-unit leaders, must have real-time airborne capabilities that provide vertical and horizontal aspects of the target with high-definition, electro-optical cameras*.

Figure 1-6. An MQ-1B Predator taxies in after completing a combat mission 01 July 2017 (Photo by SrA Damon Kasberg, U.S. Air Force)

4. Preparing for Decisive Action. Mosul presented U.S., coalition, and partner forces with the particularly challenging problem of conducting combined arms operations in a dense urban environment that restricted maneuver, command and control, effectiveness of fires, and the effective range of weapons. The city's narrow streets and corridors, rubble, power lines, and unforeseen environmental hazards all negatively impacted mobility and the ability to maneuver. Dense urban terrain aids the conduct of the defense against a superior force and affects the tempo of the attacker. Tempo and timing may be just as important as mass in future urban assaults. U.S. forces must learn faster than their adversaries in order to create opportunities. The U.S. Army must integrate intelligence, surveillance, reconnaissance, maneuver, and precision fires at echelon to overwhelm the defender and create gaps to exploit. Making these adaptations accessible to coalition partners increases the probability of a breakthrough. *Operation EAGLE STRIKE demonstrated that the U.S Army must continue to train at echelon in dense urban conditions to understand the complexities of decisive action in unified land operations. In Mosul, the coalition had to contend with simultaneous execution of offensive, defensive, shaping, and stability tasks*.

5. Maximizing Talent in a Coalition. In the extended fight for Mosul, each element of the coalition brought varying capabilities and strengths to the combined joint task force (CJTF). While national caveats are often considered a constraint, understanding the potential of troop-contributing nations can maximize coalition outputs. This may entail investing in organizations to capitalize on their unique, and often, best-suited capabilities. Because staff and units turn over often, this effort must be continuous as conditions and authorities adjust. Operations that preserve the cohesion of the coalition are potentially as important as operations that advance the forward line of troops. *The CJTF understood and optimized assets given U.S force management-level constraints. This should always be considered while working in a coalition in order to maximize contributions and talent*.

6. Targeting. The U.S. Army must conduct targeting at the speed of modern warfare and then synchronize targeting with the partner's internal processes as effectively as possible. In this mid-high intensity, complex urban fight, dynamic targeting was the norm rather than deliberate targeting. For deliberate targeting, whether in support of deep shaping operations or a planned strike in support of the close fight, processing and approval times took as long as six to eight weeks. Capability to produce target folders and advanced weaponeering solutions for the urban environment is inherent to the air component. Accelerating the deliberate targeting cycle to keep up with the speed of dynamic ground operations would ensure more efficient target-weapon pairing and better support to ground operations, leading to a reduction in munition expenditures. Additionally, it is important to consider the following:

- Determining what separates the close and deep fights for intelligence, surveillance, reconnaissance, and strike.
- In urban fights, deep may equate to only a few city blocks from the front lines.
- Rethink the application of battlefield geometries, such as the fire support coordination line, to optimize the integration and synchronization of air assets with maneuver.
- Battle-tracking friendly and partner forces remains paramount.

Figure 1-7. Combined command post
(Photo by Mosul Study Group, 2017)

7. Munitions. The Battle of Mosul provides a unique data set to examine the availability, utilization, rate of expenditure, subsequent effects, and limitations with regards to the full spectrum of munitions used (air- and surface-delivered). In Mosul, supply chain availability, utility of munition type, tactical accessibility, and battlefield dynamics affected tactical decisions to select and deliver munitions. There are open questions whether current air- and surface-delivered munitions and advanced weaponeering procedures were fully optimized for targets in dense urban terrain. *Further study is needed to determine whether the families of munitions (ground and air) meet the unique characteristics that dense urban terrain presents (multi-floor structures consisting of high-strength concrete, dirt, reinforced steel, attack angle, attenuation and amplification characteristics, etc.).*

Figure 1-8. Soldiers slide a Hellfire missile into place on an AH-64 Apache attack helicopter in Iraq. (Photo by SFC R.W. Lemmons IV, U.S. Army)

8. Surface-to-Surface Fires. Artillery, rockets, and mortars were effectively and continuously employed by advise-and-assist teams to protect coalition and partner formations (counterfire) from ISIS indirect fires and to deliver timely, accurate, and precision effects in support of maneuver. The close fight required detailed planning to integrate and deconflict surface fires with aerial platforms. Counterfire in the dense urban environment required meticulous planning, with an emphasis on intelligence preparation of the battlefield (understanding the physical environment) and predictive and pattern analysis. In dense urban terrain, counterfire radar systems were cued with other intelligence, surveillance, and reconnaissance systems, such as MQ-1 and MQ-9, to be effective. *Guided Multiple Launched Rockets, mortars, and cannon artillery were highly effective in the dense urban environment when positioned with the correct gun-target line and range. As the only organic, accurate, and all-weather capability, surface-to-surface fires employment in Mosul involved a degree of evolving art that requires further study.*

Figure 1-9. Army mortarmen, assigned to the 2nd Brigade Combat Team, 82nd Airborne Division, prepare for a fire mission in support of the 9th Iraqi Army Division near Al Tarab, 18 March 2017. (Photo by SSG Jason Hull, U.S. Army)

9. Precision Fires. Excalibur and Guided Multiple Launched Rocket System precision-guided munitions were used routinely in this low collateral damage estimate environment. Precision effects and time to target appeared to be the same for both, given common conditions.

- Although the Guided Multiple Launched Rocket System provided much greater range, the cannons afforded the ground force commander greater positioning and firing flexibility given the number of systems and its organic assignment.
- Both munitions posed battlefield geometry challenges, given maximum ordnance and the density of the restrictive operating zone over Mosul.
- Although of lesser range than Excalibur, the Precision Guidance Kit on the 155mm served as a low-cost alternative, allowed greater flexibility with battlefield geometry (low-angle fires), and was in greater supply in Mosul to provide near precision capability.
- The use of Precision Guidance Kits allowed units to preserve Excalibur for precision targeting and collateral damage estimate requirements.

All variants of U.S. Army mortars were employed in Mosul. With the continued development of mortar precision-guided munitions, there will be essential organic fires that must be incorporated within the greater fire support plan during dense urban terrain operations. *Surface-delivered, precision-guided munitions, combined with a complement of joint fires capabilities, afforded the commander maximum flexibility in dense urban terrain.*

Figure 1-10. Soldiers assigned to the 1st Cavalry Division's 2nd Battalion, 82nd Field Artillery Regiment, 3rd Armored Brigade Combat Team, fire an M109A6 Paladin from a tactical assembly area at Hamam al-Alil to support the start of ISF's offensive in West Mosul, Iraq, 19 February 2017. (Photo by SSG Jason Hull, U.S. Army)

10. Joint Terminal Attack Controllers. The Mosul fight was characterized by the saturation of targets, density of air assets, and the close proximity of targets to the forward line of troops. The dense urban fight required an increase in the number of joint terminal attack controllers. In order to provide timely delivery of aerial munitions, joint terminal attack controllers were:

- Distributed at both the combined joint operations centers as well as forward-positioned at tactical command posts.
- Situationally aware with immediate contextual understanding.
- Attuned to the ground force commander's intent and priorities.
- Enabled by the requisite communications systems and visual observation through Iraqi and coalition manned and unmanned aircraft systems.

The dense urban environment limits the adversary and friendly force's line of sight. In Mosul, joint terminal attack controllers maximized the ground force commanders' situational awareness at the tactical edge through the employment of multiple visual systems, along with direct communications to aerial assets. Joint terminal attack controllers were highly effective on the ground and, when positioned at echelon, ensured a successful blended approach. The presence of seasoned, highly-trained joint terminal attack controllers operating with the complement of U.S. Army fire support personnel (forward observers and joint fires observers) optimized the employment of joint fires.

11. Army Attack Aviation. As an aerial maneuver element, attack weapons teams were folded into the broader joint fires employment in Mosul. Some viewed AH-64s as an additional close air support platform, and, in practice, the AH-64s were also key to engagement area development, reconnaissance, and security, and helped shape the deep fight. However, in the complex urban canyons of Mosul, AH-64s possessed a special capability with aerial maneuver (movement and fire) due to aspect angles onto the objective area and the ability to quickly maneuver to a position of advantage. This enabled the attack weapons team to rapidly employ fires, destroying enemy fighting positions and strong points with minimal collateral damage.

- Coalition units, partnered with ISF, employed attack weapons teams to develop the battlefield situation and to deliver close supporting fires within ISIS' disruption zone.
- Specific targeting of vehicle-borne improvised explosives enabled Iraqi units as they penetrated deeper into the defense in depth.
- Effects were often obtained through the doctrinal employment of manned and unmanned teaming with the U.S. Army MQ-1 (Gray Eagle) and RQ-7 (Shadow).
- The density of fixed-wing platforms and the surface fires (artillery, rocket, mortar) supporting the coalition and partner created a complex air environment.

Rotary-wing attack aviation provided essential fires from unique angles that were focused on high-payoff targets. This effort and those that shaped conditions external to Mosul is a capability that the U.S. Army must continue to emphasize when conducting operations in the dense urban environment.

Figure 1-12. An AH-64E Apache helicopter from the 4th Squadron, 6th Cavalry Regiment, Task Force Saber, hovers prior to taking off to conduct a mission, Erbil, 11 July 2017.
(Photo by CPT Stephen James, U.S. Army)

12. Bulldozers. Armored bulldozers led the advance of Iraqi maneuver forces as an essential element of a combined arms formation and provided a protective capability in hasty defense. Armored bulldozers provided Iraqi forces breaching, mobility support, and clearance capabilities and became an ISIS high-value target. *In Mosul, heavy engineer platforms were vital and created a significant conundrum for the adversary.*

Figure 1-12. A bulldozer and armored personnel carriers from the 37th Brigade, 9th Iraqi Army Division, advance from one objective to the next north of Al Asthana Ridge, 27 February 2017. (Photo by Capt. Timothy Irish, U.S. Marine Corps)

13. Internally Displaced Persons. Units must be prepared to contend with internally displaced persons during tactical operations. The government of Iraq executed a plan to accommodate internally displaced persons in conjunction with the United Nations and nongovernmental organizations. Mosul operations are a case study for how handling internally displaced persons must be planned early and comprehensively. USAID's Disaster Assistance Response Team was a key partner in working with the government of Iraq. Even with robust USAID and Iraqi planning, coalition forces still had to prepare for dense flows of internally displaced persons congesting key lines of communication, screening, and checkpoints adjacent to key terrain and nongovernmental organizations operating within the area of operations. Staff and leaders will have to plan for internally displaced persons at some level and should also familiarize themselves with USAID capabilities and how the United Nations humanitarian organizations operate. *While the planning and execution rested with the host nation for operations in Mosul, the U.S. Army, as a unified action partner, must be prepared to execute this resource-intensive task in dense urban environments.*

Figure 1-13. Mosul internally displaced persons (Photo by Mosul Study Group, 2017)

14. Assured Power. Assured power was a critical pacing item in Mosul. Commanders and staffs must understand their power generation requirements based on the variety of equipment found within their unit. For expeditionary operations, the Army needs flexible and scalable assured power options that are more deployable, mobile, quiet, and easy to repair. The Army needs to re-examine tactical assured power, starting with the family of tactical generators. *The Army also needs to better understand what expeditionary units require when conducting distributed operations in an austere and nonpermissive environment beyond forward operating bases*.

15. Electromagnetic Spectrum Maneuver. In Mosul, the saturated and contested electromagnetic spectrum impacted maneuver. This environment indicated additional expertise, training, and equipment that would enhance units at every echelon in their ability to better deconflict the electromagnetic spectrum. *The electromagnetic spectrum will continue to have major impacts on maneuver forces during all phases of combat operations. The retention, degradation, and/or denial of the spectrum in the modern and future operating environment will afford a marked advantage to either combatant, thus making it key terrain. Spectrum management and planning needs to be part of a holistic operational plan and not relegated to communications personnel.*

Security Force Assistance

16. Security Force Assistance Unit Design. The 2/82nd Airborne Brigade Combat Team constructed combat advisor teams from out of its organic units and leaders. These cross-functional teams consisted of a battalion or company-level commander, a fire support element, joint terminal attack controllers, an intelligence analyst, and a communications specialist. These teams were secured by a security force with requisite firepower, vehicles, and a medic. The 2/82nd Brigade assets tactically sustained the advisor teams to distributed locations in Mosul. Select advise-and-assist team members possessed operational funding authority (contracting officer representative, field ordering officer, and paying agent) to augment their own sustainment and to support partner forces, as required. Notably, the 2/82nd Brigade adjusted its force mixture to meet changing mission requirements. This was possible because of the organic composition within a brigade combat team. The special operations forces advise, assist, accompany, and enable teams had similar functional capabilities (intelligence and fires) as the 2/82nd Brigade, but also brought special technical capabilities that accelerated precision dynamic targeting of ISIS. Special operations forces advisors also moved advanced medical capabilities close to the forward line of troops, which directly supported their Iraqi special forces partners. *Depending on the scope and scale of the advisory mission, the U.S. Army's developing security force assistance brigades can operate up to a higher end of the conflict continuum with tailored task organization, enabling capabilities, and similar authorities.*

Figure 1-14. Combat advising
(Photo by Mosul Study Group, 2017)

17. Security Force Assistance Condition Setting. Security force assistance is more than (institutional) force generation and meeting partners for planning and execution. Setting conditions for partner operations is equally important in security force assistance as is combat advising and building partner capacity. Operation EAGLE STRIKE security force assistance lead-up activities included critical actions such as establishing temporary assembly areas, opening lines of communication, and establishing mission command architecture. In many ways, this is akin to the U.S. doctrine of setting the theater. In Mosul, advisory teams were also partnered with elements (Iraqi Federal Police) that had not gone through the Iraqi Army training pipeline, but were a key component of the partner's campaign. *Security force assistance units must have a holistic view of partner support. Setting conditions is vital to ensure success from force generation, institutional development, fielding units, and, ultimately, operations with partners.*

Figure 1-15. Combat skills enhancement between fighting (Photo by Mosul Study Group, 2017)

18. Special Operations and Conventional Forces in Security Force Assistance. Advise, assist, accompany, and enable efforts cannot be stovepiped; partners are the focus. Mission planning must take into account all forces operating within the area of operations. Conventional and special operations forces units may have to augment, support, or enable other units engaged in mutually supporting missions (conventional forces,

special operations forces, and coalition partners). The interdependence of conventional forces and special operations forces requires some level of integration and interoperability. In Mosul, the quality of the advisor made the difference in enabling the partner. Coalition partners writ large understood that a special approach and necessitating maturity, empathy, competence, and utmost professionalism was essential. *When conventional force and special operations forces' security force assistance efforts are synchronized and mutually supportive, both elements and, most importantly, partners benefit*.

Fundamental Change: Gaining and Maintaining the Advantage

19. Battlefield Adaptation. U.S., coalition, partner, as well as ISIS forces exhibited adaptation on the battlefield. Both ISIS and ISF conducted improvements and modifications to commercially available off-the-shelf technology in support of their forces. U.S. Soldiers demonstrated their ingenuity by improvising a mobile ground-based electronic warfare system. *The U.S. Army must be prepared to fight in this fluid environment and empower Soldier ingenuity and experimentation. Moreover, the Army needs an agile and coordinated approach from the military industrial base to understand the opportunities of and technological innovations on the modern battlefield (this would include battlefield circulation). To win, the Army must develop the mechanisms and organizations to innovate faster than its adversaries.*

Figure 1-16. Battlefield innovation: ISIS platform fixed-wing unmanned aircraft system (Photo by Mosul Study Group, 2017)

20. Delivering, Training, Operating, and Maintaining New Technology. U.S. and coalition forces faced challenges in effectively delivering counter-unmanned aircraft systems to the units fighting ISIS. Specifically, during the Mosul campaign, early deployment of systems was deliberately requested to protect Soldiers from rapidly evolving small unmanned aircraft system threats that the current inventory could not mitigate. Although there has been some success against ISIS's commercial systems, it is clear that the U.S. Army must make significant improvements on how it delivers technology to the warfighter. This is not a simple problem. The U.S. Army needs a formalized, integrated, and responsive way to deliver needed technology to the fighting front. *Like the joint problem of the counter-improvised explosive device in the mid-2000s, the U.S. Army lacks a comprehensive approach to urgent emerging battlefield challenges. Effectively operating and integrating new equipment was not optimal during Mosul operations, particularly with the integration and execution of new unmanned aircraft and counter-unmanned aircraft systems*.

21. Field Service Representatives. Mosul's mid-to-high intensity combat reinforced the challenge of moving field service representatives forward to provide critical services to units. In short, the U.S. Army may be reaching the limits of its approach to contractor support and utilization. The U.S. Army must re-examine the employment of contractors in a high-intensity conflict. *An expeditionary U.S. Army needs an expeditionary approach to managing and sustaining capabilities. Field service representatives — contractors writ large — have constituted a vital aspect of logistics capability, but present a challenge for battlefield deployment in the advise-and-assist environment. The U.S. Army needs to reconsider the risks associated with continued use of contractors in expeditionary warfare*.

22. Realistic Urban Training. Mosul presented U.S., coalition, and partner forces with the particularly challenging problem of conducting decisive action in a dense urban environment that restricted maneuver, command and control, and the effectiveness of fires and range of weapons. The city's narrow streets and corridors, rubble, power lines, and unforeseen environmental hazards negatively impacted mobility and the ability to maneuver. Dense urban terrain aids in the conduct of the defense against a superior force. *Urban training scenarios are too limited and sterile to replicate conditions such as those experienced in Mosul. The U.S. Army needs to change the scope of its urban training scenarios in terms of both intensity and time.*

Recommendations for Further Study

This study provides initial impressions of the Battle of Mosul that draw from numerous sources, interviews, and eyewitness accounts. It is a preliminary study that highlights some of the challenges the U.S. Army faces today as well as future opportunities.

Within a few weeks, a new study will begin at the Army Capabilities Integration Center that will expand on this study. The new study examines the broader lessons from Operation EAGLE STRIKE relevant to conducting future operations in dense urban terrain. As the U.S. Army and U.S. Marine Corps work together to develop *Multi-Domain Battle: The Evolution of Combined Arms for the 21st Century*, the urban environment will continue to present numerous challenges for the ability of U.S. and partner forces to operate cohesively, resupply, communicate, conduct reconnaissance, and achieve surprise. A better understanding of the lessons of Mosul will prepare the U.S. Army for the future of dense urban combat by informing the development of concepts and doctrine for operations in dense urban terrain. In addition to the efforts of the Army Capabilities Integration Center and U.S. Army Training and Doctrine Command, studies by the joint, special operations, and Air Force communities will no doubt find many additional lessons to improve understanding of the implications of Mosul and the changing character of warfare in the 21st century. Some future studies will be technical in nature, such as studying counter-unmanned aircraft systems and munitions employment. Others will focus on the organization and training of security force assistance brigades, joint forward observers, forward observers, and joint terminal attack controllers.

Similar to this study, the U.S. Army should continue to invest in studies of recent conflicts as they unfold in order to rapidly inform and guide adaptation within the force. In addition to the Army Capabilities Integration Center's planned efforts, the U.S. Army should look for opportunities to rapidly assimilate capabilities into the current force that are supported by this study, such as generators and personal protective equipment, using research, development, test, and evaluation funds. The U.S. Army Center of Military History should detail this seminal case of "by, with, and through" operations in the dense urban environment much like the important "green books" of World War II. This will require assistance from the CJTF-OIR to produce documents that may be shared with a wider multinational audience.

Conclusion

Operation EAGLE STRIKE once again demonstrated the continued indispensable quality of land power. Despite years of air operations against ISIS in Mosul, it still took a nine-month land campaign, enabled by capabilities from the other domains, to retake the city. Operation EAGLE STRIKE also reinforced that operations in dense urban terrain are exceedingly difficult. Urban operations must be approached with a campaign mentality in terms of the duration of the operations and amount of resources required for their conduct. Successful combat operations in dense urban terrain requires skilled leaders who operate according to the principles of mission command.

Throughout the nine-month campaign, ISIS was able to hold Mosul against the superior numbers of ISF. The natural superiority of the defense, which is undoubtedly greater in urban terrain, was also amplified by ISIS's ability to increase its combat effectiveness through the militarization of commercial off-the-shelf technology. ISIS' use of commercial off-the-shelf technology and tactical and technical adaptation in the face of superior resources were significant factors in its ability to sustain the fight. Today, the military potential of commercial off-the-shelf technology has significantly reduced the technological edge of the U.S. Army.

Over the course of this campaign, commanders, staffs, and units adapted to the multi-domain battlefield by integrating capabilities across domains and developing tactical and technological countermeasures to ISIS cross-domain threats. However, the convergence of capabilities must become an integral part of the commander's visualization. Commanders must learn to see intuitively the interconnectedness of domains as part of the operations process so they can effectively visualize, describe, and direct operations on the multi-domain battlefield. Current U.S. Army doctrine and tactics, techniques, and procedures must continue to evolve in order to meet the challenges of the multi-domain battlefields of today and the future.

This study provides a snapshot of Operation EAGLE STRIKE to the broader U.S. Army. The observations are designed to provide immediate feedback to the U.S. Army in order to inform how it approaches current and future conflicts. It also suggests areas that require further study in order to better prepare the U.S. Army for combat. The overarching observations discussed above and the specific observations contained in the appendices will help U.S. Army leaders establish priorities to field the force needed to meet the demands of today's multi-domain battlefields.

Appendix A

Operations in Dense Urban Terrain

Operation EAGLE STRIKE reinforced the multiple challenges of operations in dense urban terrain. Extensive coordination, resource planning, and continuous monitoring and preparation of the environment are all required for success. Urban complex terrain must be approached with a campaign mentality in terms of the duration of operations and the amount of resources required. This examination of Operation EAGLE STRIKE validates the characteristics of the urban environment found in Joint Publication 3-06, *Joint Urban Operations*, 20 November 2013, and provides the U.S. Army with observations relevant to fighting in dense urban terrain. The Iraqi security forces (ISF) and coalition experience in Mosul reinforces both the continuity of current urban operations with larger historical experience and the increasingly multi-domain nature of today's battlefield.

Because of the constricted size of the operational area in dense urban terrain, there can be confusion regarding the application of the traditional deep, close, and rear operational framework. During the Battle for Mosul when the ISF and coalition offensive was focused on East Mosul, West Mosul was considered the "deep fight." Perhaps more readily than other types of combat, urban operations may also entail advances on multiple axes and even a 360-degree fight. This obfuscates the U.S. Army's traditional understanding of the "deep and rear" areas. A detailed, ever-changing operational framework is essential to maintain the tempo of operations. In dense urban terrain, the Army needs to better understand the implications of shaping and deep actions in the physical realm. While a kinetic event could occur within two blocks of a maneuver element, the ultimate effects may not influence the force until days later into the operation. For instance, a propaganda distribution node, providing real-time videos uploaded to social media of partner nations engaged by effective enemy direct fire, could be destroyed with kinetic fires. At the same time, only a block away, the effects of this strike might not be realized or available for ground force exploitation, for some time. The establishment of a coherent operational framework is a critical component to the creation of a shared visualization. This is central to the creation of a common operational picture that is necessary for the effective employment of capabilities within and across domains.[1]

Mosul reinforced that dense urban terrain favors the defense because of the ready availability of cover and concealment. Mosul's dense urban areas provided a seemingly unlimited number of opportunities for ISIS to create a near unassailable defense-in-depth. Thoroughfares into the city, manipulated by heavy equipment, offered obstacles for tracked vehicle movement and provided a lull in momentum that allowed ISIS to concentrate its fires. Additionally, dense urban terrain takes traditional linear defense methodology and applies it to nearly every angle that forcible entry would attempt to exploit. In an urban environment, the architecture and manner of construction of the city are significant factors in determining the character of the fight. Combat can take different forms depending on where it is located within the city. The physical characteristics found within East and West Mosul were different. East Mosul is newer and most of the construction dates from the 1970s or later with a large number of the buildings constructed of concrete and rebar. The western part of Mosul, the Old City, is tightly congested and traversed by narrow streets. In an urban environment, understanding regional construction practices must be part of intelligence preparation of the battlefield. Specific to urban construction is the intangible, in-depth understanding of area utilization, critical to operational planning and adjusted through the fight. The historic areas of a city, typically built using "old world" stonework, provide durability that has endured through the centuries. Modern high-rise structures, designed to withstand natural disasters, inherently sway and move. This was an important consideration when Mosul fires missions identified a gap between building coordinates (bomb on coordinate [BOC]) and the actual location of buildings (bomb on target [BOT]). Finally, commanders and staffs need to understand the utilization of urban areas. When targeting industrial areas, the consequences range from secondary explosions, toxic chemical disbursing, loss of revenue, and resource capacity. Any singular event can have an unplanned impact on coalition and partner operations, the civilian populace, and potentially regional economic stability.

The use of the interior of buildings and subterranean structures limit both the ability to maintain observation and the effects of indirect fire and direct fire systems. Through the use of elements of the existing structure and holes created in connecting walls, defenders can mask their movement from one structure to another. In Mosul, ISIS turned blocks of buildings into continuous, interconnected fighting positions occupied by squad-sized elements.

With multi-story buildings, it can be assumed there are also multiple stories below ground and the building probably connects to others. This subterranean element increases the complexity of operations and requires a methodical approach to clear. This was not evident in Mosul. The result was that units had to clear behind them in this 360-degree fight. Commanders need to distance themselves from techniques for securing complex urban terrain that are a legacy of the past 15 years of conflict and are not suited for urban areas of this scale. The amount of personnel dedicated to clearing and retaining terrain in Mosul was insufficient to clear and secure every room and corner. Due to the "terrain inside of terrain" challenge that dense urban terrain presents, advancing the forward line of own troops (FLOT) may be more akin to trench fighting on the Western Front in World War I or the Battle of Stalingrad during World War II, securing feet of terrain daily, as opposed to combat operations in the past decade where units could be responsible for entire villages.

ISIS fighters proved to be proficient in their ability to use the dense urban terrain environment for camouflage. Given the widespread availability of doctrine readily available in digital format, it should come as no surprise to the coalition that ISIS applied doctrinal approaches to combat operations in Mosul. In addition to using buildings as fighting positions, ISIS fighters used the smoke from burning tires to obscure their positions. In order to conceal their indirect fire assets, ISIS fighters used the loophole method of indirect fire through holes in buildings to conceal their firing positions. They also placed mortars near rooftop water bastions in order to rapidly cool their mortar tubes to negate coalition thermal imagery capabilities. Because ISIS understood that ISF and the coalition would not target overpasses out of a desire to use them in the future, ISIS used these structures for concealment.

The dense urban environment, as was the case in Mosul's Old City with its narrow streets and corridors, will often restrict mobility. This problem becomes especially acute once the fighting starts and rubble, craters, broken-down vehicles, and other effects of battle begin to impact the landscape, disrupting mobility and changing the way vehicles and infantry can be used. The detritus of combat will hinder the ability to travel formerly passable streets and this is without adding the resistance of a determined enemy that is able to employ the terrain to its advantage. In Mosul, side streets and alleys were sometimes inaccessible due to obstructions such as rubble, vehicles, and power lines. The cumulative effect of this is that the mobility of U.S. Army formations will be greatly reduced as will their ability to advance in unison.

Beginning with the first strike, fighting within dense urban terrain causes changes in the environment. Fires constantly change the physical environment, both hindering the mobility of friendly forces and affording the adversary with new opportunities for cover and concealment. The terrain in cities naturally canalizes attacking forces. In the case of Mosul, ISIS further canalized the attacking ISF formations through the preparation of the battlefield with obstacles such as ditches, berms, booby traps, improvised explosive devices, and vehicles. It will not be possible to include the effects of urban warfare — whether rubble, unexploded munitions, or enemy obstacles — as part of the initial intelligence preparation of the battlefield. Dense urban terrain requires a continually updated estimate of the physical terrain.[2]

In addition to the canalizing effect dense urban terrain can have on military forces, the adversary can leverage urban terrain to negate friendly forces' equipment and technological advantages. This allows the adversary to engage friendly forces with multiple weapon systems such as improvised explosive devices, antitank guided missiles, and snipers from various concealed positions. Commanders need to understand how the characteristics of the urban environment impact their ability to employ capabilities, especially their direct and indirect fire weapons systems and mission command systems.

In addition to being time consuming, seizing and retaining terrain in Mosul was manpower and resource intensive. Throughout operations in Mosul, coalition and ISF formations occupied a series of urban patrol bases that could be moved at any time. These patrol bases consisted of sandbagged fighting positions. Weapon systems overwatched key avenues of approach. Accompanying sector sketches were initially hand drawn and later digitally uploaded. It was necessary to tie these positions in with mortars, anti-armor weapons, and claymores because the flanks and rear are always vulnerable in dense urban terrain's 360-degree battlefield.

Figure A-1. Tactical assembly area
(Photo by Mosul Study Group, 2017)

Command posts were mobile and contained the minimal essential upper tactical internet necessary for urban operations. Communications systems and tactical power generation were critical enablers. These command posts fit on organic transport and were situated to be accessible to trafficable routes.

Dense urban terrain makes intelligence preparation of the environment much more difficult as operations physically change the landscape, the populace migrates, and the electromagnetic spectrum adjusts by the hour or day. Forces in dense urban terrain must understand the construction and layout of buildings and of any subterranean features, interactions and relationships between various populations, impact of internally displaced persons, and the communications networks and infrastructure within the city. In dense urban terrain, buildings are not buildings. They must be viewed as fighting positions — defensible locations. The adversary is using these structures because they provide cover and another degree of concealment that allows for "fighter by night, civilian by day" activities. In Mosul, despite the fact that certain mosques rarely saw use as a religious site, the coalition was restricted in its actions against these targets unless receiving fire from them. ISIS knew how to exploit this aspect of the coalition's operational constraints. Additionally, both friendly and enemy actions will continually change the environment. An urban environment is alive, it changes and adapts. To operate effectively in this environment requires a more robust focus on dense urban terrain in professional military education and training. Extensive and unceasing operational preparation of the environment, intelligence preparation of the battlefield, and running estimates are essential to understand this ever-changing complex terrain.

Combat engineers are an especially valuable asset in urban operations. Their ability to conduct breaching operations and route clearance, clear rubble, and reduce obstacles can help restore mobility to urban battlefields.[3] Heavy engineer assets, such as armored bulldozers, have an important role in dense urban terrain because of their ability to clear avenues of advance or conduct a breach while under fire.

Tactical vehicles provided utility beyond mobility such as mounted firing positions, mobile operations systems with soldier network extension and limited assured power, casualty evacuation, and sustainment. These utilities were indispensable platforms that enabled advisor teams to operate effectively from tactical assembly areas and patrol bases in Mosul. Advisor teams often lived out of their vehicles during the dynamic and expeditionary operations. The current family of tactical vehicles (mine-resistant ambush protected [MRAP], MRAP all-terrain vehicle [M-ATV], etc.) have limited space for cargo or casualty care. Mortar vehicles require trailers. Standard military vehicles often will not be able to fulfill needed mobility requirements in this environment. It may be worth examining whether units require a range of vehicle sizes and types to operate in dense urban terrain. Special operations forces and the 2nd Brigade Combat Team, 82nd Airborne Division, used micro-vehicles, in this case MRZRs™, to provide short-range transport through Mosul's constricted terrain.

Figure A-2. Restrictive terrain: patrol base entrance (Photo by Mosul Study Group, 2017)

During Operation EAGLE STRIKE, the coalition and ISF were able to identify ISIS command posts through the use of a variety of intelligence collection means. The congested nature of the electromagnetic spectrum (EMS) environment in dense urban terrain can provide a level of concealment to all parties. However, all friendly, enemy, and noncombatant electronic and human activity create some form of observable signature. This creates the opportunity for exposure and collection. One can safely assume that U.S. command posts, with their large digital signatures, are at least as susceptible to detection and collection.

Unmanned Aircraft Systems

ISIS and ISF constantly innovated during the course of the campaign. Both sides employed unmanned aircraft systems to enable their operations through the use of these platforms for target acquisition and real-time situational awareness. Vertical take-off and landing unmanned aircraft systems such as the commercial, off-the-shelf quadcopter possess the ability to effectively see around corners and into buildings by adding a horizontal aspect while in hover mode. However, even with better equipment, several challenges remain, such as the volume of unmanned aircraft systems operating in a small battlespace and the need to determine friend versus foe in order to avoid counter-unmanned aircraft system fratricide.[4]

Figure A-3. U.S. Army Soldier launches a Puma unmanned aerial vehicle near Al Tarab during an ISF offensive on an ISIS position near the western edge of Mosul. (Photo by SSG Jason Hull, U.S. Army)

VBIED

The VBIED was ISIS's "precision" weapon system. Later iterations of the VBIED were directed by motorcyclists and unmanned aircraft systems. Anecdotally, the majority of VBIEDs were destroyed by ISF with AT-4s. The Carl Gustaf and light antitank weapon (LAW) (high explosive antitank [HEAT] rounds) were also effective for achieving mobility kills. Terrain denial through the creation of ditches and other obstacles such as craters along high-speed avenues of approach were the most efficient means to protect the force from the VBIED threat. These obstacles forced VBIED drivers to slow down to find alternate routes. Gunners watching these obstacles from their firing positions had the time needed to engage and destroy VBIEDs with organic weapon systems.

Figure A-4. ISIS VBIED (Photo by Mosul Study Group, 2017)

Figure A-5. ISIS VBIED (Photo by Mosul Study Group, 2017)

Sustainment

Mosul was an extended expeditionary operation. The nine-month battle to liberate the city was the duration of a campaign. The intensity and potential length of operations in dense urban terrain have implications for sustainment. Operational-level sustainment planning must provide critical support to the force. The sustainment plan needs to be flexible, and account for the sustainment of coalition and partner forces. In dense urban terrain, the consumption rates across classes of supply will change. Assured power is critical, and generators are a pacing item. Combat debris, such as rubble and rebar, is hard on tires. Vehicles will operate for longer amounts of time, to include significant time idling, while accumulating low mileages. This will impact vehicle maintenance requirements. In Mosul, units without mechanics were dependent on field support representatives for maintenance support.

Medical Evacuation

In dense urban terrain, rotary-wing casualty evacuation is hindered by the operational risk posed by the tactical situation and limited helicopter landing zones. As a result, the field surgical team needs to be closer to the front so that it can receive ground medical evacuation within the "golden hour."[5] Ground medical evacuation is often restricted due to the tactical situation or obstructions along the route. These considerations may impact the time required to move a casualty from point of injury to the appropriate level of medical treatment within the "golden hour" and influence the medical equipment available at forward positioned facilities. Role 2 facilities may need to be located closer to the FLOT to ensure the appropriate level of care can be achieved in time. During Operation EAGLE STRIKE, forward positioned field surgical teams, damage-control surgical teams, and special operations forces casualty collection points provided life-saving capability close to lead units. Because of the increased likelihood of coming into contact with injured noncombatants, it is imperative that the medical rules of engagement are clearly understood at all levels. Prior to operations, medical support for the civilian population and internally displaced persons should be coordinated with nongovernmental organizations.

Civil Affairs

In Mosul, the civil affairs effort helped link the Iraqi government with U.S. Agency for International Development's (USAID's) leaders to develop a plan for internally displaced persons. Civil affairs personnel developed a level of understanding of the Mosul populace down to the tribal-leader level. This facilitated information dissemination through informal networks. These were often more effective than direct means such as radio and television broadcasts, leaflets, and loudspeaker operations. Civil affairs teams must possess the appropriate level of education and experience to enable effective joint task force-level collaboration with the country team.

Internally Displaced Persons

The high population density of urban environments naturally increases the likelihood that in the course of operations units will be confronted with internally displaced persons. An adversary like ISIS can easily blend into the population and flee using internally displaced persons as cover. ISIS sought to blend into the human terrain in order to escape detection. In the case of Operation EAGLE STRIKE, the government of Iraq took the lead in the handling of internally displaced persons. The Iraqi government screened internally displaced persons to check for ISIS fighters using a system of familial verification. Biometric screening systems such as the Secure Electronic Enrollment Kit (SEEK) can also be used to compare internally displaced persons to an existing database of previously scanned people and flag ISIS supporters.[6]

Information Operations

Information operations must be able to keep up with the changing environment and battlefield in order to address unfolding events and the adversary narrative. There is a need for the synchronization of the information environment in order to mass effects across domains to realize desired effects. In Mosul, ISIS operated as much in the cognitive space as the maneuver space. The U.S. Army is not doing the same at the tactical level.

Operation EAGLE STRIKE provides a good case study in operations in dense urban terrain. This battle, the largest conventional land battle since the capture of Baghdad by coalition forces in 2003 and the first sustained urban operation involving U.S. forces since the 1968 Battle of Hue, offers the U.S. Army modern and relevant observations for conducting operations in dense urban terrain. It reinforces both the continuity of current urban operations with the broader historical experience and the increasingly multi-domain nature of today's battlefield.

Endnotes

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5. The “golden hour” refers to the first hour following a traumatic injury when emergency treatment is most likely to be successful.

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Appendix B
Security Force Assistance

Background

During Operation EAGLE STRIKE, a nine-month campaign to liberate the ISIS-held city of Mosul, U.S. and coalition forces conducted an aggressive, unrelenting campaign with Iraqi security forces (ISF) in the lead as the maneuver force. In Mosul, ISF, led by a senior Iraqi Army general, consisted of elements from the Ministry of Interior, Ministry of Defense, Counter-Terrorism Services, and Popular Mobilization Force. The later part of December 2016 was an inflection point in Operation INHERENT RESOLVE. A decision by the Combined Joint Task Force-Operation Inherent Resolve (CJTF-OIR) commanding general to increase the combat effectiveness of ISF required a change in approach to security force assistance. This new approach facilitated the partnering of U.S. forces with ISF down to the tactical level to engage in combat advising. By sharing the hardships of our partners, we assured them of our commitment to the fight and improved shared awareness of the tactical situation. This expanded role required a mission command approach that enabled our combat advisors through a distributed and forward-postured tactical organization, but with the acceptance of a greater degree of risk. By accepting this risk, we shifted to a direct relationship with our Iraqi partners that fully integrated enabling capabilities.

The shift to combat advising also entailed participation in extended operations. This stretched our sustainment capabilities. The requirements of extended operations placed a particular focus on the critical requirements of combat advising such as assured electric power and tactical communications bandwidth. However, this approach also resulted in the creation of a shared vision that unlocked the employment of the full range of coalition capabilities including combined, joint, and supporting fires and intelligence; surveillance and reconnaissance capabilities; and logistical networks (to a much greater degree of effectiveness). Ultimately, ISF reclaimed ISIS-held territory, backed by coalition advise, assist, accompany, and enable teams who leveraged an expansive network of intelligence, surveillance, reconnaissance, joint fires, sustainment, and medical capabilities.

Purpose

This appendix serves as a primer, highlighting observations gained from the security force assistance mission aspect of Operation EAGLE STRIKE. These observations are specifically focused to inform the newly forming security force assistance brigades with recent and relevant battlefield experiences.

Scope

The 10 observations below focus primarily at the tactical level, including special operations and conventional forces. This appendix is limited specifically to operations in Mosul.

Terms of reference, as used during Operation EAGLE STRIKE:

- **Partner** — The unit or leader who is the object of military support. *The person you are working with daily.*
- **Advisor** — The individual assigned as the principal coach, teacher, or mentor for a partner. *The person working with the partner.*
- **Advise** — The use of influence and knowledge to teach, coach, and mentor while working by, with, and through a partner. *I am providing you with a recommended and proven (rooted in doctrine and experience) way to do it.*
- **Assist** — Directly or indirectly support partners to enhance their ability to deliver desired effects. *I am helping you do something better that you can already do.*
- **Accompany** — Move with and be present with the partner. *I will go forward with you.*
- **Enable** — Use of coalition capability to enhance the partners' desired effects where their organic means may be insufficient. *I am helping you do something that you cannot effectively do — I can help you with our assets.*
- **Assure** — The demonstration of commitment. An approach used by security force assistance units that describes the commitment that drives confidence with your partner. *We are with you in this fight; we can do it together.*

1. Understanding Partner Military Culture. Security force assistance requires a thorough understanding of the partners' doctrine, how they fight, and why they fight. Advisors in Mosul had to be cognizant of their partners' internal and external influences, how mission command is implemented, and how the partner leaders' decision-making process works. Strategic and historical culture, military tradition, unit sub-culture, strategic and historical culture, tactical leadership (particularly the strength of the noncommissioned officer corps and the role of junior officers), familial relationships, education levels, individual partners' aspirations and motivations, and religion are examples of key considerations for the advisor. Successful advisory missions require continuity; deep cultural knowledge is developed over time and must be passed deliberately during unit transitions. Successful advisory missions also require persistent attention to the relationship. This was particularly important on the "bad" days, where assurance kept the relationship sound. Assurance was a part of a daily battle rhythm for coalition forces supporting the advise, assist, accompany, and enable mission. Operating and continuously living with partners (shared hardship) demonstrated commitment and is seen as a best practice for assurance.

Figure B-1. U.S. Army advisor (right) speaks to a 9th Iraqi Army Division brigade commander before a review of the division's concept of operations for the upcoming battle to liberate West Mosul, 17 February 2017. (U.S. Department of Defense photo by Capt. Timothy Irish, U.S. Marine Corps)

2. Approach. Seek an approach empathetic to the partner's perspective with simplicity and clarity, while reinforcing the basics. The key is to be aware of how the partner most effectively understands the advisor inputs. During Operation EAGLE STRIKE, advisors often provided feasible courses of action, grounded in the principles of war. This allowed partners to make the plan their own. This was more effectively accomplished by close connections among the advisors at every level (similar to an observer controller/trainer network). As Iraqi leadership leaned towards a specific decision, the network of advisors communicating across coalition echelons served as sensors that created unity of understanding, leading to unity of effort. As a result, each advise-and-assist unit maintained better situational understanding that increased coalition agility. Like successful observer controller/trainers, effective advisors needed to demonstrate a complement of sound tactical and technical competence with great empathy, humility, and patience with the correct mindset. In some cases, emotional IQ had greater value than battlefield IQ. In essence, *think* like your partner, *adapt* your processes to meet partner objectives, and *anticipate* your partner's next move.

3. Influence. Influence is paramount and without it you will not accomplish the mission. Therefore, the primary focus must be your partner and understanding how your partner's operational and decision-making processes work. This is tied to the importance of recognizing the partner's culture, experience, doctrine, and education. A clearer understanding of the Iraqi partner and his views enabled the coalition advisors to better understand their partner's behavior. During Operation EAGLE STRIKE, ISF operational planning vastly differed from anything that advisors had seen before. It involved consensus, negotiation, and politics conducted up to the Iraqi national level. As Iraqi forces iterated their planning, advisors adjusted their enabling plans. This required tremendous flexibility and adaptability. During planning and operations, coalition advisors found great benefit toward focusing effort on multi-influencer engagements at every echelon. It helped smooth the partners' divergent thinking at the tactical and operational levels. In most cases, advisors helped enable common understanding and perspective. This varied depending on the echelon and how effectively advisors were able to operate within the Iraqi system and within the guidelines set by the coalition. Advisors must use caution when partners cede too much responsibility and request advisors to lead planning. In many cases, ISF leaders developed deep trust in their coalition advisors. This was because of the strength of their relationship, commitment, and competence. New advisors need time to cultivate their own relationship after the reset.

4. Capacity and Capability Training. In Operation EAGLE STRIKE, building partner capacity for Iraqi operations was as important as combat advising. The focus on building partner capacity, to include issuing equipment, set conditions for Iraqi-led combat operations in Mosul. Security force assistance activities also included critical actions such as establishing temporary assembly areas, opening lines of communication, and establishing the mission command architecture. In many ways, this was akin to the U.S. doctrine of setting the theater.

The following observations from ISF leaders in after action reviews of the Battle of Mosul yield reinforcing insight to the value of institutional advising:

- Training is an important component of advising.
- Training leaders (separately might be best) should be emphasized and will assist with training the formation.
- Different learning styles (visual, oral, and individual, group) require different training methods and potentially different instructor methodologies.
- Investing in the development of a partner instructor cadre pays dividends.
- Resourcing for training is paramount. Specifically, advisors will need to consider partner appropriate training areas, facilities, equipment, and training material.
- Advisors must account for varying languages and dialects, the levels of reading and writing skills, prior experiences and training, etc.
- Culture and character always matter.

Partner capability and capacity range broadly. The Combined Joint Special Operations Task Force-Iraq (CJSOTF-I) security force assistance approach to the Iraqi Counter-Terrorism Service is an example of a comprehensive and long-term approach to building partner capacity. Training, equipment readiness, and leadership are very high. On the other hand, in Mosul, coalition advisory teams were also partnered with elements (Iraqi Federal Police) that had not gone through the Iraqi Army training pipeline, but were a key component of the partner's plan. Security force assistance units must have a holistic view of partner advisement. Shaping the conditions with your partner will ensure success from force generation, institutional development, fielding units, setting conditions for combat, and operations.

5. Enabling the Partner as an Art. There were two key advisor operating principles in the Mosul fight: help partners fight but do not fight for them, and do not make yourself the main effort. In short, it is about how to make the partner more effective. The enabling process was subtle. Our partners in Mosul relied on the coalition's persistent intelligence, surveillance, reconnaissance, and precision-fire capabilities. Yet, it was demonstrated that enabling comes in many forms beyond intelligence and joint fires. In some cases, advise and assist teams directly supported partner snipers, mortars, and other direct-fire capabilities.

Ultimately, the art is in how to convey assurance to overcome partner commanders' hesitation. In Mosul, advisors had to consider the following:

- Competence creates partner confidence. Advisor proficiency and leadership often inspired Iraqi partners and assured coalition credibility in warfighting.
- Selection of the best battlefield placement to optimize operating with their partner while integrating coalition capabilities (e.g., proximity to the forward line of troops).
- Increasing advisor team effectiveness through informing, empowering, and enhancing with appropriate capabilities (joint terminal attack controllers, upper tactical internet, etc.).

6. Tactical Fusion is Critical to Successful Enabling of Partner Forces. Shared understanding of the environment is essential between advisors and their partners. Combined joint operations centers, located at Baghdad, Erbil, and Makhmur, achieved tactical fusion through the integration of intelligence, targeting, and command functions between coalition advisors and their Iraqi counterparts. Combined tactical assembly areas and forward patrol bases were also operated to achieve tactical fusion. Although the coalition brought key strengths, advisors recognized that the partner's capacity to provide intelligence (particularly human intelligence) was often essential to effective operations. Therefore, advisors strived to simplify processes within operation centers and command posts, and to communicate objectives with a clear intent. This was particularly important in achieving a clear common operating picture of the locations of partner forces to minimize clearance issues with supporting fires.

Figure B-2. U.S. Army and ISF leaders discuss operations at a shared headquarters in Mosul, Iraq, 08 June 2017. (Photo by SSG Jason Hull, U.S. Army)

7. Unity of Security Force Assistance Efforts. Combat advisors require an understanding of their partners' intent and awareness of other interests with other entities (including organizations, political parties, and national interests). This brings a greater level of complexity to advising and, therefore, mission planning must take into account all the forces operating within the battlespace. The primary ISF were partnered with a variety of coalition partners. These partners aligned with the CJFLCC-I and SOJTF-I organizations that shared battlespace and enabling assets, and occasionally were co-located together. When special operations and conventional forces' security force assistance efforts were synched and mutually supportive, all parties benefited from the interaction. Mission planning must take into account all forces operating within the battlespace. This leads to effective interdependence, integration, and interoperability when advisors become familiar with the unified action efforts in the area of operations. Consideration must be given to the importance of sharing information, intelligence, atmospherics, and lessons across security force assistance efforts.

8. Enabling the Advisor. Advisors are pacing items that constitute the critical nodes of the advisor network (observer controller/trainer). Each advisor team requires essential support elements that have to be planned and accounted for (security, mobility, communications, sustainment, interpreters, etc.) for the duration of the mission. As well as familiarity with their own and the partner's capabilities, combat advisors must be equipped with skill sets outside their military occupational specialty (e.g., familiarization with small engine repair, tactical satellite, construction, and electrical) to maximize the combat power of each Soldier.

It is imperative to know where the partner stands in logistical means and capability. Operational contracting is a key enabler for security force assistance operations and requires forethought due to the training and certification requirements (contracting officer's representative/field ordering officer/paying agent). Assured power requirements are an essential part of the security force assistance arsenal. In the Mosul fight, combat advisors' ability to effectively enable partners hinged on the upper tactical internet. Over-the-horizon communication and redundant power generation were pacing items for the campaign.

The Android Tactical Assault Kit was a huge success in Mosul and is seen as a best practice. It is currently employed effectively in the U.S. Central Command (USCENTCOM) area of responsibility for common operating picture and joint operational area interoperability. Capabilities of the system include topographic, satellite, and hybrid moving maps; instant messaging; overlay tools for maneuver forces; and personal locator information beacon information.

Interpreters are critical to mission success and are a vital extension of the advisor's capability. It is essential to select articulate, trustworthy, and culturally astute individuals with an ability to speak both English and local languages, including the understanding of military terms and concepts. They need to convey not just thoughts, but the underlying emotions associated in language. Multiple interpreters may be required during a key leader engagement while the rest of the advisor team is conducting operations in the combined tactical operations center.

9. Understanding 1236/Leahy Vetting. There is a high likelihood that security force assistance units will experience some requirement related to the vetting of partner forces that is a precondition for them to receive U.S. support. Individuals likely will undergo 1236 and Leahy (human rights vetting) in order to receive training and equipment. An understanding of both the process and the time required to complete the vetting process is important for mission planning of all parties.

10. Protection. Protecting security force assistance units and their partnered elements is the highest priority. When the conditions are appropriate, embedding in partner defense can afford greater protection, engender deeper trust, and enhance responsive combined capability. Planning and developing the defensive posture is by, with, and through the partner unit. This does not obviate specific security force requirements. Independent security measures must be developed, tested, and improved to guard against external and insider attacks. Advisors should consider the following:

- Defensive planning considerations in urban terrain should make use of all available structures and incorporate this into the overall defensive scheme of maneuver/occupation.
- Be mindful of signature profiles and minimize exposure as a command and control element.
- From a defense perspective, have the right aspects of protective and defensive posture (e.g., antenna placement, camouflage).
- Build a personnel recovery plan, possibly coordinated with the partner force.
- All information sources are useful for developing situational awareness, including local media.

Appendix C
Joint Fires Initial Impressions

Background

The urban environment is among the most complex multi-dimensional terrains in the world. During Operation EAGLE STRIKE, a nine-month campaign in the ISIS-held city of Mosul, U.S. and coalition partners conducted an aggressive, unrelenting campaign with Iraqi security forces (ISF) as the lead maneuver force. Ultimately, ISF reclaimed ISIS-held territory, backed by coalition advise-and-assist teams who leveraged an expansive network of intelligence, surveillance, reconnaissance, joint fires, sustainment, and medical capabilities.

Figure C-1. Soldiers from Battery C, 1st Battalion, 320th Field Artillery Regiment, Task Force Strike, load a round into an M777 artillery piece to support ISF during the Mosul counter offensive in northern Iraq, 24 December 2016. (Photo by 1LT Daniel Johnson, U.S. Army)

Purpose

This appendix serves as a primer, highlighting initial impressions gained from the joint fires aspect of Operation EAGLE STRIKE, as well as possible implications that could affect the newly formed security force assistance brigades.

Scope

The observations and information gathered here focused primarily at the tactical level, below the division (combined joint force land component command [CJFLCC]).[1] Observations and conclusions gained at the division and above are best suited for a more deliberate study. Insights from the combined joint task force (CJTF)[2] and U.S. Central Command Combined Air Operations Center (CAOC) helped in the development of this appendix. This appendix is solely directed at the operations in Mosul and may not necessarily be applicable in current operations.

Figure C-2. M109A6 Paladin conducts a fire mission at Qayyarah West, Iraq, in support of ISF's push toward Mosul, 17 October 2016. (Photo by SPC Christopher Brecht, U.S. Army)

1. Integrating Joint Fires with ISF. In early 2017, new policies directed coalition forces to accompany Iraqi forces to the forward line of troops. By doing so, coalition advise-and-assist teams, with their fire supporters and joint terminal attack controllers, were better positioned to support Iraqi operations with intelligence and fire. Combined command posts and joint operating cells increased collaboration during the planning and execution of Mosul operations. It also fused Iraqi and coalition intelligence, surveillance, and reconnaissance capabilities for target acquisition, as well as joint fires planning and execution through unit command post and fire support elements, sometimes referred to as "strike cells."

2. Strike Cells Operations. The "strike cell" was a command post with a fire support element, with each higher echelon having greater communications capability and authorities. The strike cells used in Operation INHERENT RESOLVE were specific to Iraq and Syria and described a non-doctrinal, task-organized team that integrated and synchronized coalition joint fires and intelligence, surveillance, and reconnaissance at all levels, from company to division. Strike cells were manned with a combination of coalition maneuver, fires, air, and host-nation personnel, and were designed to be agile and responsive to the dynamic nature of the current fight. At the company and battalion levels (including special operations task forces), they were highly mobile and leveraged a secure communications suite. They also incorporated displays of unsecure commercial drone feeds that were being used by both coalition and partner forces, enhancing overall situational awareness.

The division-level fires team was similar to the joint air ground integration center, which was modified to embed into a combined joint operations center. This team, consisting of U.S., coalition, and host-nation personnel, had a primary role to provide synchronized kinetic and non-kinetic support to troops in contact. The team also provided intelligence, surveillance, and reconnaissance and was used to deconflict airspace. While strike cells provided both deliberate and dynamic support, the greater focus was on dynamic targeting, which generally occurred in the following manner:

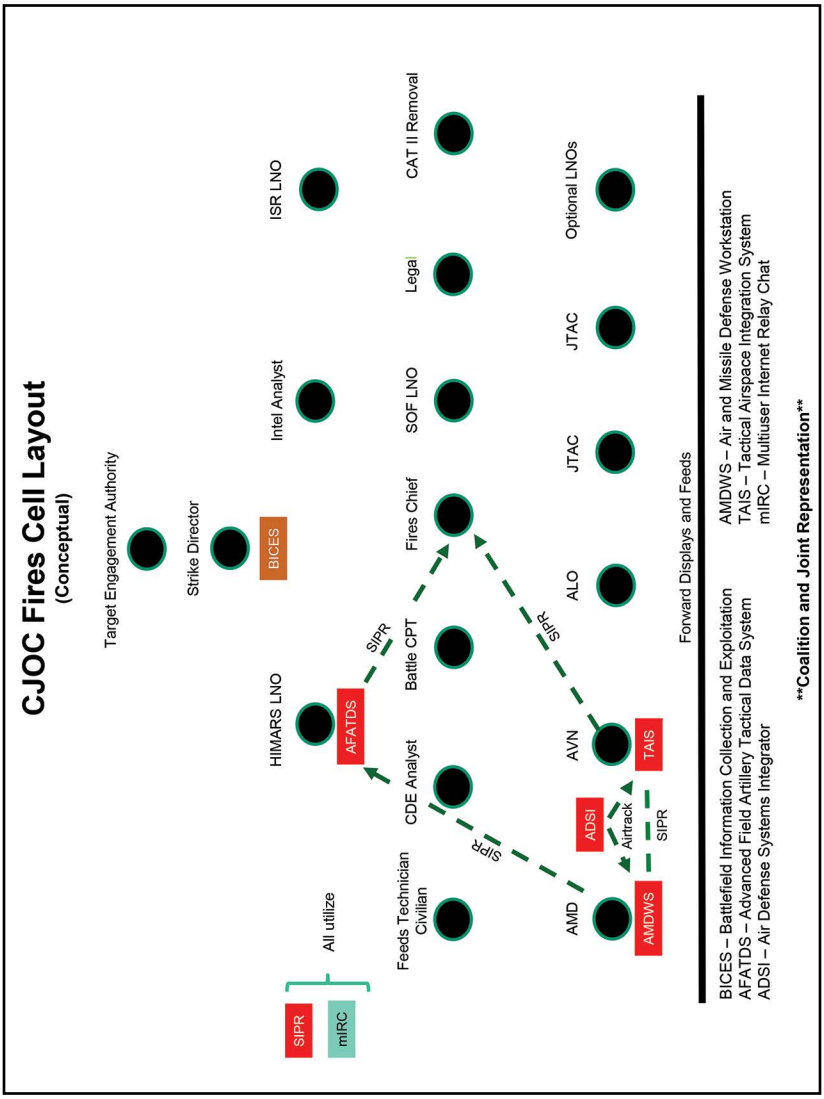

Figure C-3. Combined Joint Operations Center (CJOC) Fires Cell Layout

Dynamic support requests began with embedded advisors at the host-nation tactical headquarters. Advisors received targeting requests from host-nation counterparts. They vetted, prioritized, and then called the special operations liaison officer or the joint terminal attack controller (in the strike cell) to arrange station time with unmanned aircraft systems, and fixed-wing and rotary-wing aircraft, while deconflicting artillery. Once a potential target was identified, the team executed its battle drill by first determining if the target was legitimate. If it was, it was given a collateral damage estimate rating, and the legal advisor checked for rules of engagement compliance. Once cleared, it was then passed to the fires desk; they determined which system was most appropriate. Once the weapon system had been selected, the director cleared the battle captain to build the strike request, which was then sent to the CJOC. Once in the CJOC, the strike request was sent to the target engagement authority (TEA),[3] who examined the strike request and assessed the collateral damage estimate and target structural protection removal recommendations. If the request was approved, it was then sent to the Iraqi side of the CJOC where Iraqi officers reviewed the strike package with the assistance of an interpreter. If they concurred with the strike, they signed off on its approval and then the strike proceeded for prosecution. All strike requests were archived as evidence of kinetic activity in the event that the coalition was accused of unnecessarily destroying buildings.

Deliberate targets were approved through regular targeting meetings, which, over the course of the campaign, proved to be ineffective due to their lack of responsiveness to the shifting environment and vetting timelines. A hybrid method shortened the targeting cycle and proved to be more responsive, allowing utilization of advanced weaponeering. This hybrid method allowed for maximization of effects in support of the scheme of maneuver.

3. Lack of Deliberate Targeting. During Operation EAGLE STRIKE, it became apparent that targeting had to meet the pace of battle and be synchronized with Iraqi partners' processes as quickly and effectively as possible. For deliberate targeting, whether in support of deep shaping operations or a planned strike in support of the close fight, processing and approval took time. This was due to stringent requirements of target development, understanding patterns of life, and positive identification, balanced with considerations of collateral damage and civilian causalities. This resulted in significant rules of engagement implications for operating in a sovereign nation. The CAOC recognized the problem and developed solutions to reduce planning timelines.

In the future, determining what separates the close and deep fights is essential to optimizing coalition targeting teams. In the urban fight, understanding that deep and shaping operations may equate to just a few city blocks from the front lines will improve how battlefield geometries, such as the fire support coordination line, are utilized. Otherwise, sub-optimal integration and synchronization of air assets with maneuver will continue to be much higher, air will continue to be constrained and ground effects will continue to be limited.

In dense urban terrain, the environment changes quickly. Disputes over the common operating picture and location of Iraqi forces within Mosul demonstrated the need for a consolidated, multi-system compatible, digital common operating picture. Frequently, valuable intelligence, surveillance, and reconnaissance assets were diverted to confirm partner force positions instead of supporting ongoing lethal operations. The dense urban conditions made Mosul an imagery-centric fight and was often fought off noncommon imagery (with various sources and refresh rates). During the Mosul fight, the target engagement authorities sometimes questioned the validity of a target observed by an in-contact ground element based on outdated imagery. On the ground, the difference between a building and a pile of rubble was measured in hours as opposed to the speed at which the imagery was updated (at best several days). Additionally, the environment changed with the impacts and devastation caused by larger munitions. Target grids could differ substantially from imagery after a series of fires effects changed the landscape within Mosul.

A common operational and intelligence picture is critical to creating and maintaining a shared understanding of the environment and communicating that common picture within the U.S. Army, throughout the joint force, and to both the coalition and partner forces. The common operating picture in Operation EAGLE STRIKE resided at the CJOC-level (the CJFLCC at Baghdad and Erbil, the brigade at Mahkmur). However, subordinate units in the field used a variety of systems to aid in their situational awareness. Different common operating pictures (e.g., Distributed Common Ground System-Army, Command Post of the Future, Google Earth) provided different levels of and approaches to visualization, which may or may not have fed the larger common operating picture. The coalition force's common operating picture systems have not been federated. Therefore, different imagery databases resulted in inefficiencies and sub-optimal combat effectiveness.

4. Dense Urban Terrain Requires Thorough Intelligence Preparation. The battle in Mosul offered an opportunity to observe the effects of air- and ground-delivered munitions in dense urban terrain. The current family of air-delivered munitions, available to ground forces, has been engineered for specific purposes, namely the destruction of buildings and hardened targets. In Mosul, the destruction of physical terrain did not necessarily equate to comparable effects against personnel or communication nodes. Munition choices in Mosul, amplified by the structural density of the city, were not always proportional to the intended effects on the enemy and, when combined with rules of engagement considerations, on collateral damage. Even when considering overpressure and blast waves from these rounds, ISIS fighters were forced from their defensive positions by shrapnel or direct-fire weapon systems, rather than blast effects. Throughout the Mosul campaign, delivering ordnance under danger-close parameters was common. The frequency of these decisions was unprecedented and required strict clearances and coordination to achieve.

5. Dense Urban Terrain will Influence Munition Performance. The Battle of Mosul provided a unique data set to examine the availability, utilization, rate of expenditure, subsequent effects, and limitations concerning our families of munitions (air and surface) in an urban environment.

For air-delivered munitions, advise-and-assist teams noted that general-purpose bombs and missiles might create more than just the desired effects. The nature of the targeting, whether dynamic or deliberate, and the time allowed to conduct advanced weaponeering played a crucial and often misunderstood role in achieving effects. The focus on dynamic targeting may have resulted in sub-optimal effects and increased expenditures.

In Mosul, building construction (old and new) within the city center presented challenging munitions survivability issues, mainly due to use of high-pressure concrete, steel reinforcement, and multiple stories; munitions survivability in terms of fuzing and body construction in some instances did not meet the desired effect. In addition, this created a follow-on force hazard of unexploded ordnance, which the enemy could exploit.

Artillery special munitions, such as phosphorus and illumination, were used to effect in Mosul but required additional planning in order to optimize their performance. For phosphorus, both white and red, use was limited to the outskirts of the city, or to defoliation missions along the river.

6. Indirect Fire in Dense Urban Terrain. From the point of view of a battalion fire support officer who supported ISF throughout the recapturing of Mosul, indirect fire played a crucial role in support of the Iraqi scheme of maneuver. Surface-to-surface fires were not "irrelevant" in the Mosul fight. Radars and sensors (both ground and air) and position area artillery placement considerations must address battlefield geometry and environmental constraints (science). The M31 GMLRS, mortars, and cannon artillery are highly effective in dense urban terrain, and when positioned with correct gun-target line and range, accurately and quickly delivered effects in all weather conditions.

The M982 Excalibur and M31 GMLRS precision-guided munitions were routinely used in this low collateral damage-estimate environment. Precision and responsiveness appeared to be the same for both, given common conditions. Both M982 Excalibur and M31 GMLRS provided valuable 24/7 all-weather, precision-guided capability and the doctrinal layering of the systems. These, combined with the full joint fires capabilities, afforded the commander maximum flexibility in dense urban terrain.

7. Angles Matter in Dense Urban Terrain. Mosul demonstrated that angles matter in dense urban terrain when attempting to leverage all forms of joint fires capabilities. Urban design, understanding the directions of roads, the heights of buildings, and elevation of terrain should be taken into account when planning artillery, mortar, and radar positioning to best support the scheme of maneuver.

When indirect fire systems were incapable of striking a target, attack helicopter and armed remote-piloted aircraft were often utilized, leveraging the AGM-114 (Hellfire). The Hellfire missile offered a flat trajectory that, when fired from an aerial platform, could target individual floors with great accuracy. When incorporating aerial support-by-fire positions into planning, it provided manned aircraft an effective standoff capability. When aircraft did not have eyes on the target, joint terminal attack controllers were able to laze the target and provide additional talk-on directions to achieve effects. Lining up on the target from any direction, from above instead of below, offered even greater flexibility compared to surface fires. When attack helicopters and remote-piloted aircraft were paired, the conduct of manned-unmanned teaming provided an even greater effect in Mosul. In some cases, hunter aircraft spotted and tracked targets, lining them up for the killer aircraft to engage the threat. This was reminiscent of Vietnam hunter-killer "Pink Team"[4] operations, but with the 21st century twist of a remotely piloted aircraft.

Figure C-4. Bravo Troop, 4th Squadron, 6th Calvary Regiment, Task Force Saber, conduct preflight on an AH 64E Apache helicopter at Camp Erbil, Iraq, 10 January 2017.
(Photo by SPC Craig Jensen, U.S. Army)

Both the terrain and ingenuity of the enemy taking complete advantage of the environment — leveraging angles to their advantage and masking their fires — tested counterfire operations in dense urban terrain. Thus, radar operators had to develop a solid understanding of enemy tactics, techniques, and procedures to conduct better predictive analysis during counterfire operations. The enemy use of "mouse holes," where fighters would knock holes in rooftops and sides of buildings, while also knocking down interior walls between structures (think row houses), allowed them to move freely in newly created hollow and interior building spaces. This created new challenges as target location error would rise when trying to determine an accurate point of origin. This had immediate impact on collateral damage estimates when generating counterfire and strike requests.

8. Airspace Design and Management Over Mosul. During operations in Mosul, the importance of time and space deconfliction of fires became an important focal point. Ground-based systems such as artillery were typically stopped in order for aerial-based delivery platforms to execute their mission. In fact, the capabilities could have been integrated, offering protection and more effective target prosecution. Army ground supporting fires assumed a supporting role as joint terminal attack, controller-qualified personnel took the lead on deconfliction, synchronization, and execution of targets. This caused Army organic fires to be underutilized in Mosul. Complicating things further was the volume of air assets aligned against a saturation of targets in condensed, physical terrain. The Battle of Mosul turned joint terminal attack controllers into what at times seemed like air traffic controllers managing up to 40 aerial platforms.[5] In the past, fire support personnel would arrange platforms by time, space, and desired effects, call them to the target area, and quickly take them out of the "stack." A Special Operations Task Force-North senior joint terminal attack controller described this by saying that he had never seen anything like the dense old Mosul; it was like a micro-airspace with extraordinary challenges when talking on close air support. A consideration for future operations is to incorporate a dedicated command and control element that works directly for the CJOC. This could help reduce task saturation as seen by the joint terminal attack controllers in Mosul.

U.S. Army attack aviation was effectively employed in Mosul, and managed as a close air support platform. This added to the airspace and asset management demands placed on joint terminal attack controllers. Aside from the aircraft that carried munitions, the amount of intelligence, surveillance, and reconnaissance platforms occupying airspace throughout the duration of Operation EAGLE STRIKE, while also monitoring other areas of interest, were a constant consideration. This had implications for the synchronized employment of assets within the restricted operating zone in support of the close and deep fights.

Figure C-5. Soldiers assigned to the 4th Squadron, 6th Cavalry Regiment, 16th Combat Aviation Brigade, prepare to launch a RQ-7B Shadow Tactical Unmanned Aircraft System, 22 May 2017. (Photo by SSG Heidi McClintock, U.S. Army)

9. The Dense Urban Environment Provides Concealment Opportunities to the Adversary That Reduce Current Technological and Firepower Advantages. In Mosul's complex terrain, the ground force commander interpreted the deep fight as starting just blocks away from the current position. This led to an increased concentration on the close fight vice the traditional deep fight and revealed difficulties with the dynamic nature of targeting and network development. This brings into question what defines the close and deep fight in dense urban terrain. In Mosul, this was highlighted in the challenge to the disciplined and effective employment of armed intelligence, surveillance, and reconnaissance platforms (multi-role assets) between the roles of "strike" and "collect." At times, this created friction due to end-user preferences for a specific asset. Dynamic targeting requirements reprioritized platforms, thereby retasking armed remotely piloted aircraft to conduct immediate strikes. This trade-off with the intelligence collection capabilities inevitably reduced network and deep-fight development. Yet, in dense urban terrain and in mid-high intensity combat, dynamic targeting will always be essential.

10. Understanding National Caveats. It is imperative that commanders and their staffs understand broad operational constraints placed on coalition assets by their governments. This will improve asset-target pairing during targeting. In order for certain countries to engage targets, specific criteria must be met (i.e., some coalition members can only fire ground artillery if in a defensive situation). To improve this understanding, coalition representatives were physically located within the CJOC headquarters and CAOC.

Figure C-6. French soldiers conduct a fire mission in support of ISF's advance toward Mosul, 17 October 2016. The support was provided by the Caesar truck-mounted artillery. (Photo by SPC Christopher Brecht, U.S. Army)

Further Investigation

Beyond the observations above, the following points were identified as areas for further investigation:

- Apportionment of strike assets in the congested airspace will need to balance density and capability. Were the correct number of aircraft assigned to fulfill the tasks? For Mosul operations, was the airspace appropriately sized for coordinated, deliberate, and dynamic targeting?
- Effective battle damage assessment and dissemination will need to shape follow-on operations. Was there adequate battle damage assessment undertaken, reported, and disseminated to support follow-on operations?

- Comparative analysis of operations in East Mosul and West Mosul needs to be considered with regard to strike and intelligence, surveillance, and reconnaissance. What were the approaches to addressing the systematic targeting of East Mosul and West Mosul?

Endnotes

1. For Operation INHERENT RESOLVE, a division headquarters fulfilled the CJFLCC.

2. For Operation INHERENT RESOLVE, a corps headquarters fulfilled the CJTF.

3. TEA is an O-6 (colonel) or higher officer who has been delegated the authority to authorize lethal and nonlethal strikes on behalf of ground force commander. SOJTF elements are authorized to delegate down to O-5 (lieutenant colonel) in support of their mission set.

4. “Pink Team” refers to teaming of scout and attack helicopters, such as OH-6 “Loach” or OH-58 Kiowa scout helicopters and the AH-1 Cobra attack helicopter during the Vietnam War.

5. Interview with the CAOC on 18 August 2017.

Appendix D
Multi-Domain Battle Against Hybrid Adversaries

Operation EAGLE STRIKE provides the U.S. Army with observations relevant to fighting on a multi-domain battlefield against hybrid adversaries. The current draft U.S. Army and U.S. Marine Corps multi-domain battle operational concept describes how the Joint Force must converge capabilities from across domains and functions over time and physical space in order to create windows of advantage. These windows provide opportunities to gain freedom of maneuver or achieve a position of advantage to enable the Joint Force to defeat adversaries through the conduct of campaigns across an expanded battlefield. As demonstrated during the Battle of Mosul, fighting through multiple domains creates additional dilemmas for the adversary and opportunities for friendly forces. If done incorrectly, it could create dilemmas for friendly forces. During the course of Operation EAGLE STRIKE, ISIS, Iraqi security forces (ISF) and the anti-ISIS coalition demonstrated that adaptability is required to conduct successful cross-domain operations. Aspects of a multi-domain battle were evident in the actions of ISIS, ISF, and the coalition. This appendix will specifically focus on the role that operations in the electromagnetic spectrum environment, air domain (specifically unmanned aircraft systems and counter-unmanned aircraft systems operations), and information operations played in this campaign.

Electromagnetic Spectrum Environment

The ability to navigate the electromagnetic spectrum environment is critical to combat effectiveness. The electromagnetic spectrum is constantly changing and requires coordination and synchronization to operate successfully within it. All phases of operations can be impacted by the retention, degradation, and/or denial of the electromagnetic spectrum. On an increasingly digitized battlefield, the electromagnetic spectrum is key terrain. However, it is difficult to achieve electromagnetic spectrum dominance. There are no easy solutions; completely blocking the spectrum restricts U.S. and anti-ISIS coalition capabilities. Conversely, leaving unblocked gaps in the spectrum comes with the risk that the spectrum may be utilized by the adversary. The U.S. Army must be able to operate within a congested and contested electromagnetic spectrum environment for both offensive and defensive purposes.

> *"Spectrum management operations are the interrelated functions of spectrum management, frequency assignment, host-nation coordination, and policy that together enable the planning, management, and execution of operations within the electromagnetic operational environment during all phases of military operations"*
>
> — Field Manual 6-02, *Signal Support to Operations*, 22 January 2014

Electromagnetic spectrum management is a critical combat enabler. The increasingly joint nature of operations point to the need for a joint electromagnetic spectrum common operating picture. The future of multi-domain battle rests on the premise that the Services will converge capabilities across domains. To be effective, spectrum management considerations must be incorporated from the onset of planning and form an integral part of a holistic operational plan. This means that responsibility for spectrum management cannot be relegated to communications personnel and commanders must remain aware of what is occurring in their digital and cognitive battlespace.

In a robust electromagnetic spectrum environment, there is an increased necessity for incorporating all aspects of electronic warfare that enables friendly operations and denies adversaries the full use of their capabilities. However, electronic warfare should not be a solitary, isolated capability — it touches all of the warfighting functions. Indeed, effective electromagnetic spectrum management and integration of an organization's electronic planners with the primary staff proponents throughout the mission is essential for the U.S. Army to successfully bring the capabilities from multiple domains to bear on the adversary.

Air Domain (UAS/C-UAS)

As demonstrated during Operation EAGLE STRIKE, unmanned aircraft systems are another capability of increasing concern. The effective use of unmanned aircraft systems can enable ground forces and create additional tactical dilemmas for the adversary. ISIS made considerable use of commercial off-the-shelf unmanned aircraft systems. Over the course of Operation EAGLE STRIKE, ISIS increased its proficiency with commercial off-the-shelf unmanned aircraft systems in a variety of roles. These included ISF position identification and development; harassing fires with 40mm high-explosive dual purpose (HEDP) rounds; unmanned forward observer duties in support of indirect fire; and in a form of manned-unmanned teaming, assisting vehicle-borne improvised explosive device (VBIED) drivers to negotiate the city to reach their target. These operations were recorded with additional unmanned aircraft systems and then exploited on ISIS propaganda social media platforms, further bolstering the psychological impact unmanned aircraft systems had on ISF.

ISIS's success in unmanned aircraft systems employment, sometimes referred to as the ISIS air force, demanded an effective counter-unmanned aircraft systems strategy from the U.S. and coalition to enable the success of ISF. This was challenging because ISIS demonstrated the ability to rapidly adapt its technology and tactics. To defeat adaptive adversaries such as ISIS, the U.S. Army requires creative and innovative Soldiers at the tactical edge. Soldiers do not have the luxury of waiting for formal processes, such as doctrine development or procurement, to provide the immediate solutions they need. The Soldiers of 2-325 Airborne Infantry Regiment demonstrated the advantages of this approach when they made a stationary AUDS platform mobile, therefore increasing the level of protection for their partner forces and combat advisors from ISIS unmanned aircraft systems.

This successful development of an effective counter-unmanned aircraft system capability emphasizes the situational understanding of multi-domain battle at the tactical level, the critical gap between commercial technological advances, and the inability of the Department of Defense to provide a timely solution to the warfighter at the front. The institutional Army must prepare Soldiers for contested environments, and to confidently conduct operations in multiple domains in a way that is as quick and agile as the threat capabilities that are used against them. Counter-unmanned aircraft systems typically conflict with a majority of the organic systems in the electronic inventory of the U.S. Army and partner forces. The AUDS referenced above affected both friendly and adversary systems. As both unmanned aircraft systems and counter-unmanned aircraft systems technology advances, there will be an increase in the number of systems on the battlefield capable of disrupting, delaying, spoofing, and blocking signals moving through the electromagnetic spectrum. Commanders' understanding of the capabilities and employment of these systems is vital to both effective application of desired effects and to preventing electromagnetic spectrum or unmanned aircraft systems fratricide. Commanders must understand that adaptation is an ongoing process that will inevitably result in an enemy reaction and a start of the process again.

Information Operations

For U.S. forces to compete on the battlefield of perceptions, commanders and staffs need to go beyond traditional intelligence preparation of the operational environment and develop human matrixes that explore demographics, cultural differences, and values of the inhabitants. Information operations must be nested in the populaces' needs and desires in the area of operations. In Mosul, leaflet drops were not effective due to a lack of specific knowledge on tribal and community differences, environmental understanding, and a lack of instruction on leaflet disbursement techniques with ISF. When leaflet drops were successfully deployed into an area, the risk to people was high. If an attempt was made

by a civilian in Mosul to pick up a leaflet in the street, it could be answered with a bullet from an ISIS sniper. The necessity for certain leaflet operations also became an issue. Specifically, leaflet drops announcing "Mosul was liberated" were answered by inhabitants wondering why the coalition could drop common sense leaflets but not badly needed supplies. Within the context of multi-domain battle and specifically Mosul, information operations planners need to appreciate that sentiment is no longer village-by-village. It could differ greatly among communities, floors of a building, or elicit sympathetic responses from IP addresses across the world.

In today's world, the population is connected through social media, banking systems, or person-to-person interaction. In areas where a commander chooses not to participate, adversaries will exploit those opportunities and dominate the space. Messaging can be accomplished through various electronic means in multi-domain battle, but this does not diminish traditional human intelligence (HUMINT) capabilities to develop and advance a narrative. Additionally, not compiling and synchronizing efforts in multi-domain battle gives adversaries an opportunity to counter with their own messaging, backed by the faults of the coalition's efforts. Ultimately, this leads to a messaging opportunity lost and opportunities for ISIS social media managers to highlight the incompetence of the government of Iraq and the coalition.

Units working in the multi-domain battlefield must understand that connectivity can have an immediate ripple effect. With the increased interaction between the Department of Defense and academia, problem sets from the military can be accessed by the adversary. Specific to Mosul, counter-unmanned aircraft system issues appeared for discussion on the internet far quicker than a solution could be developed. There are also implications in cyber monitoring by adversaries and hacktivists who monitor traffic and provide it to peer and near-peer threats.

During Operation EAGLE STRIKE, aspects of multi-domain battle were evident in the actions of ISIS, ISF, and the anti-ISIS coalition. In this campaign, operations in the electromagnetic spectrum environment, air domain (unmanned aircraft systems and counter-unmanned aircraft system operations), and information operations played a significant role in the conduct of operations and offer the U.S. Army observations relevant to fighting on a multi-domain battlefield against hybrid adversaries. Fighting in multiple domains created dilemmas for the adversary in Mosul. Additionally, counter-unmanned aircraft system operations in particular, demonstrated the imperative of adaptability to adjust to the proliferation of easily militarized commercial off-the-shelf technology and to conduct successful cross-domain operations.

MOSUL STUDY GROUP

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