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Intelligent robotics and autonomous systems (IRAS) are proliferating within armed conflict at increasing rates finding appplicability across all warfighting functions and in all domains. To realize the outsized effects IRAS present while pacing with adversary threats, the forces within the Department of Defense can achiever greater interoperability and enhanced effects from each service through the integration of IRAS. By exploring how nascent capability integration has been observed through historicial use cases in limited scale conflict prior to the onset of global war, current leaders can accelerate change and avoid being mired by bureaucratic inefficiencies through a capability-centric approach. By enacting joing force design, acquisition strategies, talent management, and capabilities integration for IRAS across the armed services will ensure the United States is prepared to fight and win future conflict.

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Getting Out of Our Own Way: Understanding History and Emergent Capabilities to Inform Joint Force Design for Intelligent Robotics and Autonomous Systems

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Getting Out of Our Own Way:
Understanding History and Emergent Capabilities to Inform Joint Force Design for Intelligent Robotics and Autonomous Systems

by Travis L. Hord

Lieutenant Colonel, USMC

A paper submitted to the Faculty of the Joint Advanced Warfighting School in partial satisfaction of the requirements of a Master of Science Degree in Joint Campaign Planning Strategy. The contents of this paper reflect my own personal views and are not necessarily endorsed by the Joint Forces Staff College or the Department of Defense.

This paper is entirely my own work except as documented in footnotes (or appropriate statement per the Academic Integrity Policy).

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Abstract

Intelligent robotics and autonomous systems (IRAS) are proliferating within armed conflict at increasing rates finding applicability across all warfighting functions and in all domains. To realize the outsized effects IRAS present while pacing with adversary threats, the forces within the Department of Defense can achieve greater interoperability and realize outsized effects from each service through the integration of IRAS. By exploring how nascent capability integration have been observed through historical use cases in limited scale conflict prior to the onset of global war, current leaders can accelerate change and avoid being mired by bureaucratic inefficiencies through a capability-centric approach. By enacting a joint force design, acquisition strategies, talent management, and capabilities integration for IRAS across the armed services will ensure the United States is prepared to fight and win future conflict.

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Dedication

My best hope is some elements of this work are used or made more complete to contribute to designing fighting forces with methods and capabilities that outmatch any potential adversary. This research is dedicated to all those who choose to serve their Nation with the ever-present danger of going in harm's way. Further, dedication goes to the many civilians and government employees tirelessly working to ensure each and every warfighter is resourced and equipped with the very best to fight our Nation's battles.

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Emergent Capabilities in the Modern Era of Conflict

The return of Great Power Competition coupled with the ongoing changes in the character of warfare places the joint force at an inflection point for how it will contend with emergent threats in the global security environment. Shifts within the operating environment signal the need for the joint force to re-examine service force structures and warfighting methods. Assumptive military dominance in all domains has long ceased as a planning factor calling for the force to exercise operational innovation. A growing aspect of these shifts is the manifestation of various capabilities from a growing family of intelligent robotic and autonomous systems (IRAS) in military application.[1] As seen in current conflict abroad and from observations of near-peer threats, IRAS in myriad forms permeates the battlespace finding applicability across all warfighting functions and in all domains. The opportunity to remain on the leading edge of innovation through the benefits of IRAS requires an equally innovative approach to align the execution of acquisition and integration activities.

In the face of global competition demands, the joint force must keep pace with the changing character of warfare. Initiatives such as "Replicator," an Office of the Secretary of Defense (OSD) led program aims to set the conditions for such change. During the unveiling of the initiative in September 2023, Deputy Secretary of Defense Hicks described the effort as a method to, "field attritable, autonomous systems at a scale of multiple thousands [and] in multiple domains within the next 18-to-24 months."[2] However, integrating emergent capabilities and operationalizing concepts in this rapidly evolving field presents challenges beyond fielding systems alone. Currently, each service is taking its own approach in terms of acquisition strategy, capability integration, personnel, and training. While each service innovation approach has merit

at some level, there is growing risk that future joint force commanders will be offered IRAS enabled formations that are not interoperable. In an operational environment marked by increasing use of IRAS, how does the joint force posture itself to integrate emergent technologies while operationalizing developing service warfighting concepts to field interoperable combat ready capabilities for use throughout the competition continuum? Where this risk resides, there is also opportunity. While pacing with adversary threats, the joint force can achieve greater interoperability and realize outsized effects from each service through a joint force design of IRAS acquisition strategies, talent management, and capabilities integration.

Research Methodology

The findings and recommended actions within this paper are based upon both primary and secondary research. The author has consulted with defense analysts, acquisition program managers, military practitioners, and robotics industry leaders with the intent to inform the current state of systems and their future integration across the Department of Defense. Further, he has professional experience in the development and integration of IRAS at the Service planning level within the United States Marine Corps. The author has organized planning conferences and led writing teams for the creation and publication of Service level doctrine while establishing the first Primary Military Occupational Specialty (PMOS) course for Small Unmanned Aerial Systems – 7316.[3]

The research is also cognizant of ongoing active conflicts and other current events in which myriad examples of robotic systems are in martial use. Open-source research on various social media platforms reveals the scale of potential application and the pace at which systems are being developed and implemented is at a level no one person can properly track and reconcile. However, it is the intent of this work to be reflective of the most up to date examples

and implications for future use at scale within the Department of Defense. While current global events offer no lack of valuable study opportunities it is carefully understood the live use of such systems is but a part of the human interactive process that is warfare. The findings and recommendations are to be viewed by the reader from a capabilities-based standpoint. The highlight of utility or success in use does not constitute a endorsement the employing belligerent.

In order to structure the research within the subject areas to form a baseline of understanding and provide recommendations, this paper will consist of four major sections:

1. Presentation of a short informed fictional story, known commonly as "FICINT," to offer the reader a possible future in which IRAS was not properly procured and integrated with a joint force approach that leads to detrimental effect in a competition leading to crisis scenario. This section is also inclusive of the challenges regarding organizational change when presented a crosscutting capability that forces bureaucracies to challenge standing assumptions.
2. Historically scoped case study of the Russo-Japanese War giving focus to impact of novel capabilities used and how those capabilities were viewed by outside observers. The case study will demonstrate how each nation's observations led to further innovation and the eventual scaling, or lack thereof, of select capabilities in the period prior to World War I.
3. An overview of Human Machine Teaming (HMT) and synthesis of real time examples with emphasis on the evolving Russo-Ukraine War as well as best practices from industry. This section intends to reveal a prospective view of HMT while highlighting opportunities adapt and integrate IRAS at scale.

4. The recommendations section will offer a joint force design approach for the integration of IRAS across each of the services while presenting opportunities through the lens of the doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy (DOTMLPF-P) framework.

Attempts to present solutions within a future state is naturally difficult. However, the historically bound framework and considerations put forth in this paper are grounded on practical knowledge of both IRAS and military organizational processes and joint structure.

FICINT: Storytelling for Purpose

Envisioning future environments and the scenarios in which security challenges may manifest requires blending technical knowledge of emergent capabilities with plausible situations to demonstrate their utility. In short, it is storytelling for purpose. However, storytelling is a skill and requires deep understanding of both the audience and intended effect. A story worth remembering, or even acting upon, highlights tension, conflict, and resolution with precise language linking the audience in such a way that they can identify with the characters. However, for efforts to usher new means and updated methodologies into entrenched bureaucracies a stirring fiction alone is not sufficient. Militaries tend best to tell themselves the success stories of their last major conflict, thus reinforcing biases and leaving them exposed when the next war does not play out in a similar manner. As novel technologies and ways to use them in warfare emerge, new stories offer challenges to current norms of military processes and methodologies.

As described by August Cole, fictional intelligence or FICINT, is the "combination of fiction writing with intelligence to imagine future scenarios in ways grounded in reality."[4] The method assists in raising awareness of a problem set as well as challenging current assumptions

while expressing complex concepts. Through proper application of FICINT along known planning cycles, senior military leaders and decision makers alike can be given glimpses of nascent systems and their concepts of employment to inform levels of investment as well as identify potential gaps along the way. Further, awareness of the total force can be enhanced to anticipate downstream training and integration requirements as technologies and methods mature. Identifying the future of warfare perfectly is an unattainable goal. However, storytelling with purpose through FICINT offers a way to grapple with issues and better understand the problem.

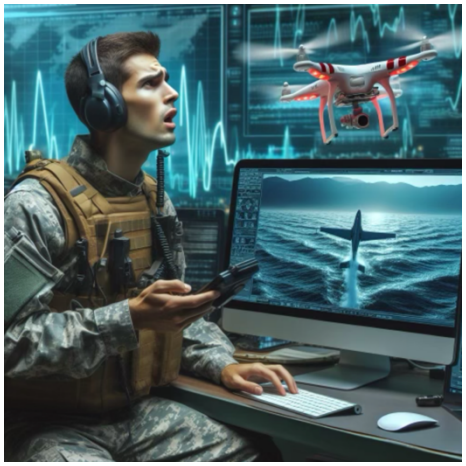
"We Skipped Too Many Steps"

The admiral stood on the bridge wing to watch the final sortie launch from the catapult, under his breath he muttered, "*I just sent them to die, hopefully they will buy us the time we need*." As he turned to avoid the jet blast his eye caught the flight deck crew pushing the armed drones off the fan tail to make room for the incoming CASEVAC flights to land. The petty officer beside him yelled over the engine noise, "*a lot of good those did us Sir – they didn't even work*!" The admiral didn't respond and made his way back into the bridge.

It was the flash point that had been written about and wargammed for years. Though no one prepared for how violent and fast it would happen when it occurred at scale. The admiral recalled the Russo-Ukraine War, how seemingly simple it would be to integrate various robotic platforms across our own forces based off innovations witnessed there. But that did not happen - even with the seemingly promising OSD programs aimed to surge thousands of systems across the services in

the years before. "*We skipped too many steps*," the admiral said over and, in his head, as he scrolled through damage and casualty reports.

As a joint task force commander, the admiral had composited a command comprised of all the service component offerings to counter the invasion. It was a massive afloat and shore-based force not seen in motion since the later years of World War II. The capability briefs he had received from each of the subordinate commanders were promising but largely untested. Each brief was also reflective of how their respective force offering was the answer to solve the problem. But there was bigger problem, one that existed for years during testing and evaluation within the individual service efforts to integrate robotics across their formations. All of service efforts, individually impressive at varying levels, did not work together once fielded.



"*Admiral, another data node relay was struck, and the screening force no longer has access to forward sensors - we lost communications with them*," the watch officer called from his station. Still over and over in the admiral's head, "*we skipped too many steps-we skipped too many steps*." Another watch stander called from her station, "*with that node down the data patches aren't going to automate within the task force, we'll be completely blind in two hours*." The same refrain circled in the admiral's head, "*we skipped too many steps*." The joint task force did not have two hours.

Five hours before, when Marine Littoral Regiments went to active sensing force to que their unmanned surface shooters the spectrum fratricide took out the adjacent Army Multi-Domain Task Force's local ISR platforms. Enemy elements that had infiltrated the ashore

sensing task unit's location was prepared to jam but discovered they didn't need to – they had been monitoring the spectrum analysis closely, they had been trained to. From that point on the negative consequences cascaded. Locations with critical capabilities whose lightly manned defenses reliant on robotic platforms and sensor sharing were systematically isolated and destroyed. Even the battalion level capabilities proved ineffective during the close in fighting. The smaller systems worked due to their operation on local ad hoc mesh networks. However, not enough personnel had been trained to operate them use them.

The surviving ships made best speed back toward Hawaii – the remaining ground formations did not have time to backload, they were on their own. The joint task force formed around disjointed service specific robotic platforms had nearly been defeated in-detail because of them. It was an entirely preventable catastrophe - paid for in human lives.

During the transit back the thought still echoed, "*we skipped too many steps*."

Managing the "Douhet Dilemma" for Joint Force IRAS Development

Change is hard. First and foremost, in the understanding of large military institutions is that they are bureaucracies, and the nature of bureaucracies is to resist change.[5] This is not to say bureaucracies are bad. Conversely, bureaucracies are useful for long term survival as they "are equipped to solve technical problems where authority, experience, and existing solutions can provide a pretext to decisions."[6] When an artifact or process works well within the system, the system by design forms antibodies to protect it. However, when the system is presented a problem devoid a clear solution the opposite occurs. The same is true when the system is presented with an opportunity that challenges its current ability to effectively assimilate it. Such opportunities may come in the form of uniquely exquisite or crosscutting capabilities, either of which having the potential to upend current methods. Other forms of opportunity to resist are methodologies that seemingly run counter to existing doctrine and accepted practices. When the opportunity is a combination of both forms, the systems with a bureaucracy tend to acutely attack it through discrediting the potential value while reinforcing the efficacy of status quo ways and means.

A poignant historical example of a crosscutting capability that would forever alter the character of military operations is the introduction of aviation. First through lighter than air designs and then by way of powered flight, the addition of an aerial capabilities vector gave relative advantage to the side that employed it. Where modern practitioners take for granted what has become military aviation, especially within those nation's with highly mature air forces, the origins of air power's potential were not so obvious. Early air power theorists, such as Giulio Douhet, is among the first people to think and write in earnest about airpower and its future role in warfare. In 1910, only seven years after the Wright brother's first flight, he predicted:

"The skies are about to become a battlefield as important as the land or sea…only by gaining command of the air shall we be able to derive the fullest benefit from the advantage which can only be fully exploited when the enemy is compelled to be earth bound." [7]

Today the quote would be recognizable as an expression of "air superiority,"[8] but to the contemporaries of Douhet the notion would have sounded like the rantings of a technophile. Further, his conceptions of neutralizing vital centers while maintaining defense on the ground to maintain a coalition underpin many of operational preconditions used today before landward maneuver forces are committed to the offense. While more can be said on the foresight of Douhet, the issues he faced in his time are not unlike the dilemma faced by future looking military planners today. Aircraft in the early 1900s, much like robotic systems that represent the future of IRAS, did not yet exist, or at best were nascent examples not yet capable of achieving the purported tasks. In that, the "Douhet Dilemma" is born.


Giulio Douhet

Douhet was a describing the use of aircraft and their effects in warfare before the aircraft were physically capable of conducting the tasks. The hyperbole in his writing and outright exaggerations about the effects airpower would, in fairness, did not help his plight. However, many of his offerings have come to fruition in the century of military aviation after he penned them, even if they were largely wrong at the time.[9] For the modern planner, the question arises in avoiding the Douhet Dilemma, "what is the best method to communicate and demonstrate the

opportunities of a total force level capability while it is still in an emerging state?" The answer to that question about the future can be found through the correct use of history.

Where Douhet did not have the benefit of a historical record to back his claims, the modern planner can avoid the trap through examination and comparison of like systems and effects. In the search for historical baselines to make novel systems comparison, a planner can make use of case studies to compare effects rather than individual platforms. For IRAS, no one example of robotics it starkly different from the crewed variant that has achieved similar tasks in combat. In many cases, the limitations of an aircraft, tank, or submarine, for example, can be obviated due to the absence of a human operator. Understanding that making a direct comparison with a Group 1 First Person View (FPV) striking system to an attack helicopter would be, on the outset, ridiculous. The better way to make the comparison is to describe the effect of the system while drawing out the differences of cost comparison, maintenance requirements, and long-term training pipelines. In this manner, the capability of the attack helicopter is the baseline while the explanation of the FPV striking system describes how to achieve similar, and in many cases, enhanced effects differently. The challenge in overcoming the Douhet Dilemma, however, does not rest in convincing utility alone. Rather, the aim is to demonstrate how to scale the capability in time and space while taking in to account the irregularities it presents to existing systems while mitigating the perceived effect on the current system. Failing to achieve the level of clarity required to avoid bureaucratic backlash, or worse,

Ukrainian soldier with FPV striking system trainer.

exaggerating a capability in such a way that decision makers lose faith is what planners working in the IRAS field must avoid at all costs.

Understanding and overcoming the Douhet Dilemma is a challenge for anyone within a military bureaucracy. However, this is not a new challenge. Rather, it is way to use history as a vehicle to understand the evolving characteristics and effects of modern combat systems. An apt case study from the same timeframe of Douhet comes in the form of the Russo-Japanese War. The case study will demonstrate how observations of modern weapon systems use on a limited scale led to further innovation and the eventual widespread adoption, or lack thereof, of select capabilities in the period prior to World War I.

The Value of Historical Case Studies

A supreme challenge in military leadership is imbuing organizational cultures to be learning institutions. Remaining anticipatory of the demands future of conflict also demands being informed correctly by historical lessons. While developing future scenarios begins with an analysis of the present, a choice is required about what historical lessons will gird decisions on current battlefields or future force development. It is a choice of the utmost importance, as it will inform the character of conflict militaries prepare for. However, as stated by Sir Michael Howard, "No matter how clearly one thinks, it is impossible to precisely anticipate the character of future conflict. The key is to not be so far off the mark that is becomes impossible to adjust once that character is revealed."[10] In this, the proper use of history must be understood to avoid the pitfalls of applying incorrect lessons to the problem at hand. The potential for incorrect use, Hans Delbruck points out the lesson applies to academic as well as military professionals. For the academic, the risk comes in the form of "labor[ing] under the danger of subscribing to an incorrect tradition because he cannot discern its technical impossibility."[11] Similar peril may be

met by the military professional in "transferring phenomena from contemporary practice to the past, without taking adequate account of the difference in circumstances."[12] Understanding each perspective in this manner assists either practitioner in avoiding the hazards of poor framing. In this, historical case studies can be applied to current operational requirements with power and precision through careful study of the width, depth, and context of the event.

The Russo-Japanese War: A Missed Learning Opportunity Before the Great War

British Soldiers with Maxim-Nordenfeldt Machinegun, 1902

In 1904, as military planners witnessed the end of the Second Boer War, the emerging Russo-Japanese provided revealing insights to the future of war. The forces of the United Kingdom in South Africa had been faced with guerilla tactics of the Boer commandos which challenged standing doctrine. In turn, the methods of the British expeditionary forces adapted to address a counterinsurgency not reflective of large-scale battle. The Boer War experience itself gave British military leaders reason for pause and was the first signal the character combat in the era was changing. As the British were the preeminent military at the time, the challenging of assumptions, in terms of armament, organization, and doctrinal methods, resonated within militaries across the world. From a broad historical standpoint, the Russo-Japanese War provided a prelude to innovative weapon technologies before they adopted at scale in World War I. However, for contemporary armies the lessons learned, and the

Boer Commandos, 1902

lessons adopted had between them a great divide leading up to 1914. The Russo-Japanese War stands as an example to appreciate the process of ow to analyze and make change from observations of ongoing and recent conflict.

The conflict is parallel to the current U.S. experience in the era post two decades of counterinsurgency operations in Iraq and Afghanistan as the Russo-Ukrainian War drives on. Current planners must consider, now, the lessons that can be learned during the ongoing conflict. Moreover, military leaders must be comfortable in challenging current assumptions when considering demonstrated use of the novel capabilities and methods in use across eastern Ukraine. What will be most prescient are the decisions to adopt and integrate at scale the observed capabilities throughout the Department of Defense. It is in this a historical example of a limited scale conflict marked with emergent capability use is useful to draw from and apply lessons to inform current approaches in capabilities development and integration.

The Russo-Japanese War, from 8 February 1904 to 5 September 1905, serves a useful example in terms of the relatively limited scale, the nascent combat capabilities used, and its placement in time prior to worldwide conflict. The latter being of great importance as the war gave a glimpse of new weaponry and of the day and their uses in combat. Many of the weapons and methods would be implemented at scale in orders of magnitude eight years later during World War I. It is worth

Russo-Japanese War Map with Major Battle Sites, Defining Conflicts, A Core Topic of Modern Japan (https://fanningtheflames.hoover.org/shorthand-story/6)

consideration, however, how these early observations were received at the time. Both the United States and England were highly interested in the conflict as the last instance of major ground combat had been twenty-five years earlier during the Russo-Turkish War. For large scale naval combat, the most recent example had been nearly forty-five years earlier.[13] It was only two days after the Japanese navy surprise attack on the Russian fleet at anchor in Port Arthur that President Theodore Roosevelt wrote, "I am greatly interested in the Russian and Japanese War."[14] The driving force behind the interest was not merely to be aware of two states in conflict. Interested in two states in conflict, Roosevelt also focused on the developing military technological innovations that demonstrated critical divergences on proper integration, organization, and doctrinal improvement.[15] The observations of the Russo-Japanese War were to provide a live use demonstration of developing weapons systems, their organization, and use on the battlefield to validate proposed changes still at the academic level of debate. Notably, it was the conclusions of the foreign military observers during the Russo-Japanese War that informed force design decisions of their respective nation's leading up to the Great War.

Timeline of Major Events

08–09 February 1904
Battle of Port Arthur—Japan's surprise attack on Russia
Declaration of war by Japan (three hours after the attack commenced)
09 February 1904
Battle of Chemulpo Bay (modern Incheon, Korea)
30 April – 01 May 1904
Battle of Yalu River (modern Uiju, Korea)
25–26 May 1904
Battle of Nanshan (Liaodong peninsula, just north of Port Arthur)
14–15 June 1904
Battle of Te-Li-ssu (aka Battle of Wafangou)
01 August 1904
Siege of Port Arthur begins
10 August 1904
Battle of Yellow Sea
24 August – 04 September 1904
Battle of Liaoyang
10 October 1904
Russia's Baltic Fleet departs European waters to reinforce the Pacific Fleet
05–17 October 1904
Battle of Shaho
02 January 1905
Surrender of Port Arthur to the Japanese
25–29 January 1905
Battle of Sandepu
20 February – 10 March 1905
Battle of Mukden
27–28 May 1905
Battle of Tsushima Strait (arrival of the Russian Baltic Fleet)
01–31 July 1905
Japanese invasion of Sakhalin
05 September 1905
Treaty of Portsmouth officially ends the war

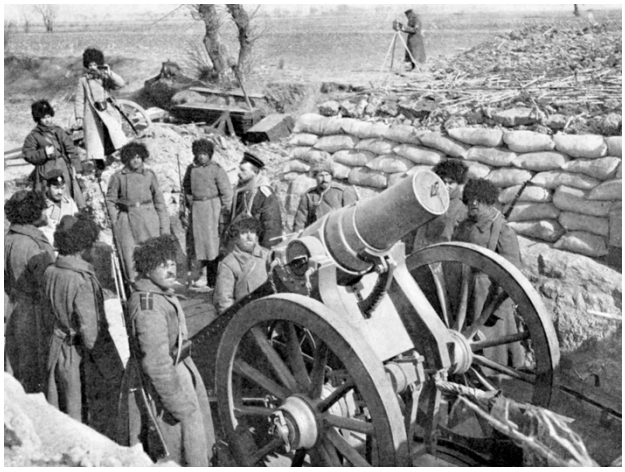
Defining Conflicts, A Core Topic of Modern Japan (https://fanningtheflames.hoover.org/shorthand-story/6)

Through the Eyes of the Observers: The Beginnings of Combined Arms

The American observers of the Russo-Japanese War were a group of specially selected officers chosen by the War Department based off previous experience and ongoing work in weapons development. The officers, to gather information in a holistic manner, investigated the conflict from the perspective of the two opposing forces. Each of the eight observers, to include a young Second Lieutenant Douglas MacArthur, were given instructions to focus on assigned functional areas and the use of various weapon employment impacted organizational effectiveness and design.[16] The specific takeaways from observer reports regarding period weapon characteristics have little utility to make direct comparison to the modern battlefield. However, the methodologies and effects of the new systems during the conflict are of great value from a capabilities centric standpoint. By grouping the observations along use case and functional themes, the lessons of this conflict, as precursors to what would arise on a global level, are useful parallels for modern leaders.

"Last Charge and Capture of Port Arthur", https://www.historycentral.com/asia/Russo-JapWar.html

The prevailing thought from European military thinkers, based on Boer War experiences, was "infantry could not attack and take a defended position in the face of modern small arms and artillery fire."[17] In part, an extension of this thought manifested on the battlefields of Manchuria



Russian six-inch howitzer battery during the defense of Port Arthur, https://www.britannica.com/event/Battle-of-Port-Arthur

as both the Russians and Japanese extensively used trenchworks and fortifications due to machinegun and artillery fire. With regards to entrenchments an observer said, "it may be said truthfully of both sides that the soldiers dug when they did not march or fight."[18] Though this was more of an early indication of the effectiveness of modern artillery and less a signal of the waning utility of infantry formations. What the observers were witnessing was the initial growth of combined arms as a concept and the reaction to forces exposed the effects. The observers noted early on, "the Japanese artillery and infantry work together splendidly…the artillery keeps up its fire during the infantry advance, sometimes even until the infantry walks into the burst of shrapnel."[19] Whether its use in offensive or defensive roles, the conclusions of American observers universally emphasized the need for greater fire support emphasizing, "the increasing use of indirect fire as the war progressed is worthy of careful study; the advantages of its effective use are obvious."[20] The use of the machinegun was another important aspect of the early ideas leading to combined arms.

In the latter stages of the siege of Port Arthur in 1904 machineguns were reported to be "murderously effective." Both Russian and Japanese officers stressed the machinegun's use increasing numbers leading to report assessments such as, "it seems certain that is weapon will play an important part in the future, and the equipment and tactics of machineguns should receive serious and prompt consideration for our Army."[21] Much as with indirect fire, the

conflicting conclusions centered on the primary use of the weapon for the attack or defense. Used in the defense from the reserve, a compelling observation stated the machinegun's,

> "…greatest physical and moral effect is produced when it is employed suddenly against massed troops…or in enfilading lines of any kinds. It is, in general, impossible to foresee when and where such opportunities will arise. Hence, the best organization is that which distributes the machineguns among the fighting units as to take instant advantage of an opportunity without making a good target for the enemy."[22]

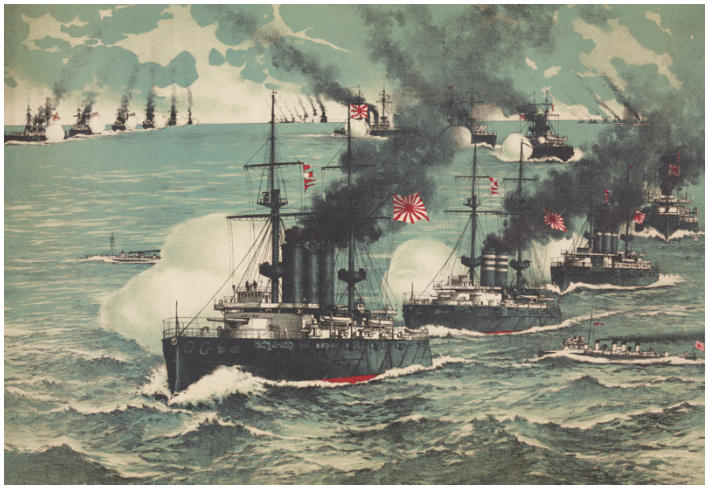
Russian Trench at Bulla, https://militaryhistorynow.com/2015/06/14/world-war-zero-more-incredible-facts-about-the-russo-japanese-war/

However, considering the obvious benefit of providing massed and rapid fires against an attacker it was noted the machinegun, "is equally valuable on the offensive or defensive to an active moving force for which knows how to use it."[23] Although the observers could not ascertain detailed operational requirements to logistically support machinegun formations it was recognized that organizationally they belonged within the infantry.

Another important aspect of creating a combined arms effect with machineguns and artillery for the infantry was the necessity of telephonic communications. Because of the effects artillery and machineguns delivered on massed formations the employment of elements across the battlefield became increasingly dispersed. To communicate orders and conduct close coordination in contact, wired telephones became prevalent within both the Japanese and Russian forces.[24] The observers were keen to note the links between division, brigade, and

battalion level headquarters as well as the interval of telephones along the front-line fortifications. It was observed the Russians, "had four or five telephones to the mile, along the fortified belt, in addition many behind it, and in addition to telephones for fire direction of artillery."[25] The ability to conduct extended communications was not reserved for the land domain alone.

The Russo-Japanese War was the first conflict in which wireless telegraphy, or radio, was used during the Battle of Tsushima (Battle of the Sea of Japan). Prior to the engagement at sea, a Japanese auxiliary cruiser on a scouting mission used radio to relay the position, course, and speed to fleet leadership.[26] Admiral Togo Heihachiro, commander of the Japanese Combined Fleet, correctly maneuvered his force in anticipation of the Russian course and won a decisive victory. Although other factors such as updated fire direction control and superior training played a part in the victory, the ability to communicate over the horizon enabled the Japanese to close with the opposing force in battle formation. As a result of the heavy losses in the Baltic Fleet the Russians sued for peace thus ending the war in 1905. Of the engagement itself one of the observers reported of the future use of radios was, "every ship employed for military purposes in time of war should have a wireless (radio) outfit."[27] The growth of both wired and wireless communications would continue to grow as an integral component to link units and their developing systems, in all domains, to create combined arms effect.



Battle of Tsushima, https://www.historynet.com/battle-of-tsushima/

It is important to note each of the observers agreed in that the Russo-Japanese War "signaled no fundamental departure in the nature of combat."[28] Even with the introduction of technologically advanced weaponry and tactics Major Joseph Kuhn, an engineering officer, noted, "so far as I am able to judge, the recognized rules and principles for conducting warfare underwent no serious modification in their application."[29] This is an important point to consider for modern observations of conflict and the impact of novel capabilities on the battlefield. While the increase in destructive capability potential of indirect fire and the machinegun was an evident takeaway, the platform centric approach of the observations clouded efforts for future combined arms integration.

Through the Eyes of the Observers: Seeing is Not Believing

Observations of the Russo-Japanese War were a missed opportunity to drive organizational change in the face of demonstrated technological innovation. During World War I leaders, searched for methods to resolve the carnage within the trenches across Europe. Many of the lessons learned during the Russo-Japanese War were re-learned on a much greater scale in the form of human and national cost between 1914 and 1918.[30] Instead of driving change, the lessons of the in Manchuria generated a decade of inconclusive debate of how to incorporate what had been seen. Due to pre-existing notions and beliefs on how to best prepare for and conduct warfare, the reports of each observer were divergent and at times provided conflicting recommendations. Both the U.S. War Department and European armies took the experience as either a confirmation of their existing doctrines or irrelevant to the future of warfare. The bureaucracy within the armies considered the risk in making doctrinal and organizational change based on "slim and ambiguous" evidence too great to contradict their own institutional beliefs and practices.[31]

The specific lessons of the Russo-Japanese War in terms of weapons and tactics, while historically interesting, are not the point of this case study. The most valuable lesson is how leaders at the time did or did not perceive and implement near term changes from observed conflicts. The tactical lessons of the Russo-Japanese War became apparent more so after 1918 than before 1914 due to their failure to penetrate rigid institutional minds at headquarters, staff colleges, and the doctrine writer level.[32] A leading historian of the Russo-Japanese War aptly said, "learning the correct lessons of recent wars and then implementing appropriate changes are no less critical challenges to today's military leaders than they were for their predecessors after 1905."[33] While observing the ongoing conflict in Ukraine, the ability to distinguish important trends while being aware of biases that inhibit learning at the institutional level to make change is crucial. Failing to understand the consequences of not seizing on the opportunities the Russo-Japanese War provided prior to the onset of World War I should ring clear as a reason to be receptive to change.

Learning From Conflict in the Modern Era

Today, leaders within the Department of Defense are at a strategic inflection point having concluded two decades of counterinsurgency now facing the challenges of great power competition. While focus is increasingly shifting toward the People's Republic of China (PRC) as the pacing threat, the ongoing Russo-Ukrainian conflict cannot be ignored. Beginning first in 2015 with major escalation in February of 2022 the conflict, while currently limited in terms of geographic scale, is

Assessed Control of Terrain in Ukraine and Maine Russian Maneuver Axes as of January 11, 2024, https://twitter.com/TheStudyofWar/status/1745622690759606541/photo/1

continually expanding as international support to Ukraine grows. To date, nearly $350 billion in military aid, mostly from Western nations, has been given to Ukraine to support their defense.[34] For U.S. military planners this conflict, while tragic in human loss of life, is of key importance as reflections of the character of warfare in the modern era are emerging. The use of currently fielded conventional weapon systems and other supporting materiel in combat is confirming and denying the relevance of various platforms. Further, the ongoing conflict is spiked with emergent capabilities and novel battlefield innovation, particularly from various robotic platforms, allowing the Ukrainian defenders to hold at bay the mass of their invaders. As a result, some observers are offering the current examples of emergent capabilities in the conflict as a "genuine military revolution."[35] Though, is this the correct conclusion of what is occurring? Often when the phrase "revolution in military affairs" is injected into professional dialogue it spurs major debate and can become contentious when linked to specific capabilities or operating concepts. The connotation of the phrase itself begins to serve its own purpose, leading thought and action to prove the basis of the assertion devoid of utility on the battlefield. Only by understanding the effect of new systems through a capabilities centric view can a proper reconciliation of integration opportunities be achieved.

Human Machine Teaming: A Capabilities Centric Understanding

Arguably the most difficult step toward the integration of technologically advanced systems is how to best communicate the value of their potential. Understanding the value of emergent warfighting technologies requires leaders and the bureaucracies of institutions to appreciate novel systems in terms of their capabilities and not the platform alone. Where a platform centric approach leads to siloed efforts to produce unique infrastructure in support of an exquisite system, a capability centric approach does the opposite. Appreciating robotics as a

multidisciplinary field with cross-cutting use cases calls for a capabilities centric approach. This approach allows capabilities to be delivered and updated through a modular and open system environment.[36] By valuing the opportunity in terms of use case scenarios within understood warfighting functions will assist in accelerating perceptions across large organizations such as the Department of Defense.[37] Also required is a baselining of terminology that is in-line with and understandable with current practitioners. Through a capabilities centric approach with a commonly understood lexicon, leaders across the Department of Defense can accelerate the realization of force enhancement potential.

Refining Definitions

The term "Intelligent Robotics and Autonomous Systems" (IRAS) describes the perceptive (intelligent), physical (robotic), and cognitive (autonomous) aspects of these capabilities, enabling IRAS to augment all domain effects beyond the physical bounds of human perception. The concept of IRAS goes beyond traditional definitions of "unmanned systems" to account for the inherent aspect of human involvement. IRAS can greatly multiply a military force's capabilities across the competition continuum by reducing risk to human operators, accelerating task execution, and providing outsized effects from the employing organization.[38]

Militaries employ IRAS for three reasons, IRAS:

1. Reduces risk to human operators completing the same function.
2. Can complete tasks at a commensurate or increased level compared to human operators and at a reduced cost (financial or manpower).
3. Produces nonlinear results and decisive effects across all seven Warfighting Functions.

The use of various capabilities from a growing family of IRAS has manifested in significant ways throughout the global operating environment in both civil and military application. However, the key linkage to these systems is the interface with human decision-

makers, analysts, and operators. The relationship is best understood as Human Machine Teaming (HMT). Failing to place at the core of integration efforts the relationship between humans and any type of IRAS risks a narrow platform centric approach.[39] HMT consists of four elements:

1. Humans: An operator (or operators) that provides inputs for and tests machine, as well as leverages their outputs.
2. Machines: Ranging from an AI and machine learning (ML) algorithm to a drone swarm, the machine holds a degree of agency to make determinations and supports a specified mission.
3. Interactions: The way in which the human (s) and machine(s) interface to meet a shared mission.
4. Interfaces: The mechanisms and displays through which humans interact with machines.[40]

As systems and sensors rapidly mature, it is growing increasingly difficult to distinguish between pure civilian use and martial application. In either use case, HMT provides additive capability and capacity to augment traditional tasks while giving commanders the option to take on greater risk and maintain tactical advantage. The military benefits to integrating IRAS across every warfighting function is widely recognized, as demonstrated by multiple near-peer competitors and other threat actors globally. IRAS are being used in novel ways to re-conceptualize the use of conventional weapons through precision means to locate, target, and strike. Simultaneously, various militaries, and peer threats are developing a wide range of new systems to enable operating concepts predicated on the use of IRAS in all domains to achieve military effect at scale.

HMT Across the Joint Warfighting Functions

IRAS possess current and future equities within every warfighting function that, when realized, can greatly multiply the joint force's capabilities across the competition continuum. Understanding the effects IRAS can achieve across commonly understood warfighting functions provides a solid framing to produce a capability centric approach.

Command and Control: Joint force units will utilize IRAS that covertly enter and persist in advance or in conjunctions with operations to collect information; long-range, high endurance IRAS will provide digitally interoperable, reliable, and secure communication networks to maintain situational awareness, while extending the kill web of joint assets. Joint elements will share a common operating picture fed by a constellation of networked IRAS with multi-spectral sensing in all domains and on-board processors to provide actionable information in real time.

Ghoul Aerial Signal, Forbes.com https://www.forbes.com/sites/davidhambling/2024/01/12/inside-the-secret-weapon-that-extends-the-reach-of-russias-fpv-drones/?sh=5b5b2ddc101d

Information: The importance and reliance on Information Operations has changed the way militaries operate. Adversaries have developed, acquired, and fielded modern, state-of-the-art information technologies of their own to disrupt and exploit the U.S. military's information dependence. Additionally, the information environment continues to drastically change due to the large proliferation of unmanned systems. IRAS allows participants in conflicts to effectively use information as a target and as a weapon to destabilize systems, networks, and partnerships. Unmanned systems provide almost instantaneous data for exploitation. This allows a lesser military power to compete with a greater military power and match them on the strategic level.

Figure 1British soldiers experiment with VR network training https://twitter.com/britisharmy/status/1450461900312088586?s=46&t=vteyG3H8PnAvnMgKIeWTdg

Intelligence: One unique and progressive aspect of IRAS involves the application of future Artificial Intelligence (AI). Five distinct capabilities nested under AI are: Machine Learning (ML), Neural Network, Deep Learning, computer vision, and natural language processing. Criminal justice entities across the country currently leverage ML by predicting if criminals are likely to commit crimes again and their risk of committing a crime in the future. Similarly, this capability can augment a commander's intelligence section with machines coded to ingest data with labels. AI would subsequently use statistical models to find relationships within the large amounts of data humans would find difficulty conceptualizing. Machines possess more potential than humans when it comes to sorting through large amounts of data, identifying key information, predicting future events, and providing commanders with an operational advantage. Other IRAS contributions involve the use of multi-intelligence payloads and sensors across multiple domains. The capabilities of IRAS, augmented with AI and connected within a network, can perform each step of the intelligence cycle at a faster rate than a human counterpart.

https://twitter.com/magtravf/status/1280169578925109248?s=46&t=vteyG3H8PnAvnMgKIeWTdg

Logistics: IRAS will contribute to near-term logistics operations through small and medium UAS capable of carrying tens to hundreds of pounds. Unmanned aviation assets will also improve to carry more weight. Inevitably, logistics requirements will also be

https://twitter.com/sambendett/status/1745819785726746678?s=46&t=vteyG3H8PnAvnMgKIeWTdg

filled by unmanned ground and surface vehicles. Generally, unmanned logistics will provide a high fulfillment capability with low risk to humans during the transit phase, enabling provision of supplies, at scale, to distributed forces via air, land and surface, or a combination of the three. This envisions a system of systems approach to long range autonomous distribution where the individual platforms form an interconnected, redundant, and decentralized distribution system. Another key component for this logistics functional concept includes a logistics common operating picture (LOGCOP) that enables logisticians to track platforms and materiel in all domains.

Fires: Current world conflicts demonstrate the ability of sUAS, for example, to turn area fire weapons (e.g., artillery) into precision fire weapons to achieve first round effects. The small, inexpensive aerial systems easily find targets which are concealed from a ground observer.

https://twitter.com/igorsushko/status/1744483964386234743?s=46&t=vteyG3H8PnAvnMgKIeWTdg

For the future force, IRAS will enable the integration of long-range, persistent, penetrating, responsive fires using conventional and future systems. This networked approach to destroy, disrupt, or limit enemy systems with lethal and non-lethal effects throughout the battlespace will set conditions for deep, close, and rear operations. Further incorporation of information related capabilities within modular payloads allows multi-domain IRAS to detect, locate, degrade, neutralize, or destroy the enemy's system.

Maneuver: Warfare by maneuver stems from a desire to circumvent a problem and attack it from a position of advantage rather than meet it straight on. IRAS enables this concept from maneuver warfare through the utilization of air, land, and sea-based platforms with offensive, defensive, fires, and transport capabilities. These systems can augment or, at times, obviate manned formations, as well as deceive the enemy without risk to force or mission.

WSJ.com, https://www.wsj.com/world/europe/short-on-shells-ukraine-relies-on-explosive-drones-to-hold-russia-back-a18053b3

Force Protection: As elements of the joint force transition to more distributed operations, IRAS will play a pivotal role in protecting every formation type in all domains. Force protection will require commanders to integrate IRAS into the elements of combat power: protection, movement, maneuver, intelligence, fires, sustainment, and C2. Unmanned systems will have the capability to integrate various payloads to enhance base defense plans (forward arming and refueling points, airfields, logistic hubs, etc.); detect and operate in chemical, biological, radiological, nuclear, and explosives (CBRNE) environments; and counter-adversary ISR. IRAS will also detect and counter adversary intrusion into tactical networks across the electromagnetic

CBRNE Detection Drone,https://dronelife.com/2024/01/10/remote-cbrn-detection-with-autonomous-teaming-drones-draper-wins-pentagon-contract/

spectrum. A balance between system utilization and the possible increase of friendly electromagnetic signature will be required. This will ensure the capability being employed is not detrimental to the protection of the force.

IRAS Spatial and Temporal Dimensions

The Department of Defense must apply IRAS in all domains to meet the demands of current security challenges. The ability to utilize IRAS more effectively than an enemy could be the deciding factor in future conflicts. For example, a long-range unmanned surface vessel can utilize naval surface fire support and/or loitering munitions to set conditions for a landing force. In another example, a robotic dog equipped with radar, an electro-optical sensor, an infrared camera, and a rifle, can detect and neutralize an enemy sUAS at greater ranges than its human counterpart. In this example air, land, and the electromagnetic spectrum (EMS) domains are all affected or utilized.

Air: The largest opportunity for utilizing IRAS exists in the air domain due to the current applications of sUAS. IRAS fielded at the tactical level provides commanders across the joint force the opportunity to conduct surveillance, reconnaissance, and target acquisition without relying on external support. These assets fulfill information requirements almost the moment they are generated. It also saves manned aviation sorties, allowing those aircraft to conduct other missions. IRAS provides the ability to execute aviation missions without risk to aircrew, and many systems carry materials as

Army Test of Interactive Drone Swarm
https://twitter.com/fxwoessner/status/1518116336601387010?s=46&t=vteyG3H8PnAvnMgKIeWTdg

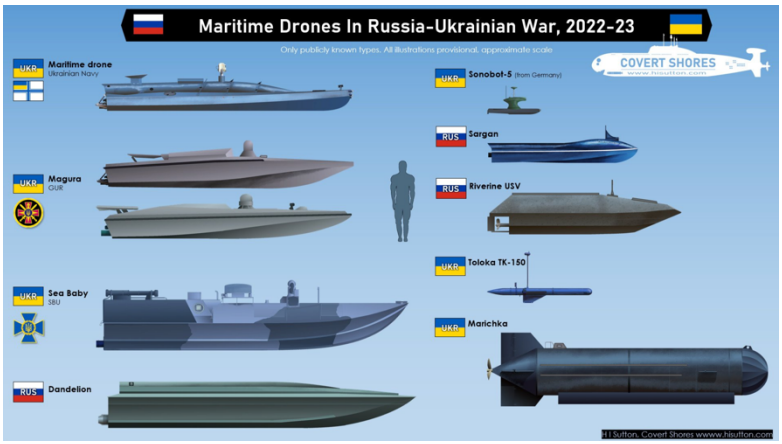
opposed to one large asset. These benefits change the risk-benefit calculations associated with aviation operations, and they open the door to actions which previously would have incurred unacceptable levels of risk for comparatively inconsequential payoff. Advances in technology will bring even more potential for utilization in many of these small-scale actions to generate strategically important effects.

The applications of sUAS, loitering munitions, unmanned fighters, and other assets are virtually limitless. The proper sequencing, timing, and planning for these assets can lead to devastating results on single enemy positions or its entire network, thus extending a unit's capabilities while reducing risk to missions and force.

Ground: While aerial unmanned systems currently dominate the IRAS landscape ground systems continue to develop and present varied applications. Aerial systems have been the logical starting point where Unmanned Ground Vehicles are more difficult to operationalize. Historically there is precedent here as blimps and airplanes were first useful for observation and later attack with the integration of tanks coming much later. However, once the tank was mature it became a fixture of land combat, becoming an integral part of combined arms warfare as we now know it. The future of land robotics, once realized, portends a similar future. Ground robotics are inclusive of more than weaponized tracked vehicles as commonly envisioned. Uses include explosive ordnance disposal (EOD), equipment carrying, reconnaissance, CASEVAC, and communications relay platforms.

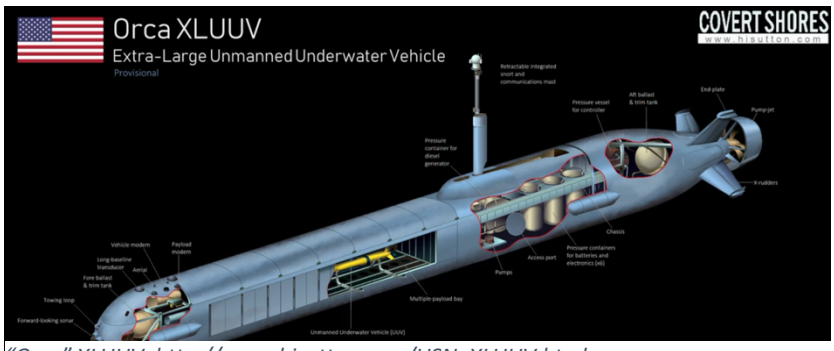
"Ironclad" Ground Robotic, https://en.defence-ua.com/weapon_and_tech/ukrainian_ironclad_ugv_helps_in_assault_operations_and_provides_fire_support_on_the_frontline-8033.html

Sea: Current service operating concepts, such a Distributed Maritime Operations, Multi-Domain Operations, and Expeditionary Advanced Based Operations Marine Corps call for the ability to operate within contested maritime and littoral environments. The air, land, and sea domains are all elements of the littoral environment. Unmanned surface vehicles/vessels (USV), unmanned underwater vehicles (UUV), and UAS all affect the sea domain. UAS while operating from the air, are a key robotic system type that influences the sea domain. These systems find, fix, track, target, engage, and assess (F2T2EA) as well as provide airborne early warning and control (AEW&C) and data relay to name a few capabilities advantageous to a navy. UUVs operate under the water's surface and have current application in mine, counter-mine (MCM) operations, hydrographic survey, and munitions.



Various Sea Robotics in Use by Ukrainian Forces

The future application for these systems are extensive as they require enemy sub-surface detection systems to find them while operating. However, the sub-surface medium presents physical drawbacks. The primary physical challenge is the range limitation on high frequency wave propagation under water, significantly reducing the amount of data able to be wirelessly transmitted. USVs operate on the water's surface and are a key robotic system type to project power within the sea domain. These missions vary from resupply underway, to maritime domain awareness, and kinetic effects or



"Orca" XLUUV, http://www.hisutton.com/USN_XLUUV.html

non-kinetics. USVs permit nearly limitless future applications.

Cyber: Robotics require protection from and capability to conduct cyber-attacks. Cyber has presented itself as a low-cost option to counter adversaries with a larger defense budget. The most effective means to protect integrated IRAS is through a comprehensive architecture to include secure and encrypted communications. Additionally, the appropriate development and application of payloads enabled by cyber tools, given the appropriate authorities, can allow a force to conduct its own cyber operations. This can be accomplished during operational planning as pre-coordinated capabilities.

Cyberspace and the Electromagnetic Spectrum: Cyberspace and the electromagnetic spectrum (EMS) are different from each other. However, the two domains are interwoven with each other. Cyberspace is one of the five domains of warfare and uses a portion of the EMS for operations. Both cyberspace and electronic warfare require frequency assignment, management, and coordination. RAS require a specific EMS allocation for operation.

"Nota, EW and Poroshenko" [НОТА, РЭБ и Порошенко], Rybar, Nov. 16, 2023, https://rybar.ru/nota- reb-i-poroshenko/

Cyberspace and the EMS are heavily congested due to the high volume of friendly, neutral, and adversary use, and contested due to adversary actions. Spectrum is a limited resource the joint force relies on throughout the operating environment that must be mitigated to ensure the safe use, deconfliction, and employment of all assets.

Emphasis at component and major subordinate must account for the use of robotic systems throughout a joint task force when making broad spectrum allocation and removal decisions. Spectrum capabilities and resources must be identified to ensure appropriate needs are generated and support mission success. All coordination and deconfliction includes inherent risk. Risk mitigation in the EMS involves proper coordination between Spectrum Managers, the Airspace Control Authority (ACA), Robotics Operator, and joint force commanders. For full integration within a given joint task force, all elements involved with robotics must understand the EMS limitations as well as the capabilities and limitations of individual robotics systems involved in the battlespace.

Anti-Drone Systems from Ruselectronics Will Be Trained to Determine the Control Frequencies of Enemy UAVs" [Антидроновые системы "Росэлектроники" обучат определять частоты управления вражескими БЛА], Tass, Nov. 16, 2023, https://tass.ru/armiya-i-opk/19295067

The proliferation of systems leads to a contested EMS within a given area. This has negative connotations for friendly forces because of varied platforms utilizing similar or the same frequency. While this risk can be balanced using selectable or software defined radios, it will always be a planning consideration regarding system employment. However, this also means friendly assets can be utilized to generate a larger EMS footprint within a given area, effectively acting as a decoy or denying a pre-determined bandwidth to disable or limit enemy system use.

Capabilities Perspective of IRAS Use in Current Conflict: The Russo-Ukrainian War

Since the 22 February 2022 Russian invasion of Ukraine, both militaries have adopted the use of IRAS and are applying them in modern combat. What began as a Russian combination air assault and ground attack to capture the Ukrainian capital of Kyiv has, to date, turned in to a positional fight within the Donbas anchored around Kharkiv.[41] Within this region along the Ukrainian easter border both sides have established defensive belts in depth inclusive of trenches

Ukrainian-R18	Russian "Kvazimachta"	"Orlan-10"	Russian Orion
			
Designed for bomblet drops. The drone only uses bare essential components to maximize payload capacity. The R18 can operate in the dark for total visual stealth, while using thermal-imaging cameras to spot enemy troops and vehicles.	*Tethered "hardware-raising system" designed to hover in place above a base station for periods of up to three days. This system integrates an optical sensor and telecommunications equipment to serve as a hovering "mast" that can be rapidly relocated.*	*A catapulted, airplane-shaped Russian drone. (16) hour flight time with a noisy, fuel-powered engine. Uses cameras and sensors to correct artillery barrages and prowl for enemy movement, Can carry various payloads including bomblets and electronic attack.*	*Similar silhouette to the American-made Reaper combat drone. A distinctive V-shaped tail reduces the aircraft's radar signature. (24) hour flight time. The aircraft has been filmed firing guided air-to-air missiles.*

and mine fields making penetration and sustained break through attempts exceedingly difficult. Further, neither side has established conditions of air superiority for crewed platforms such as fixed winged aircraft or attack helicopters to support ground maneuver. As a result, both the Russians and the Ukrainians are innovating through necessity within the battlespace to generate effects in all domains through novel means. Various platforms and enabling systems are being integrated to obviate the need for crewed platforms to attrit enemy forces in the opposing defensive positions. This unique circumstance is making the Russo-Ukrainian War, while tragic in terms of human cost, a large-scale live experimentation of emergent capabilities much like the Russo-Japanese War previously discussed. By examining current system use cases from a capabilities perspective, the lessons currently being used by forces in conflict can inform, and in some instances accelerate, the understanding of the potential for integration in other militaries.

Aerial sensing robotics, commonly termed small unmanned aerial systems (sUAS), and loitering munitions are being used together in place of crewed aviation to conduct:

- Ground and maritime strike
- Augment battle damage assessment (BDA)
- Provide local intelligence, surveillance, reconnaissance, and targeting (ISR-T)
- Coordinate sector air defense activities
- Disrupt adversary air defense assets

The presence of sUAS in the battlespace produces cascading effects on forms of maneuver, the ability to mass, and sustainment activities. Belligerents are forced to adapt to continual observation from constellations of systems providing federated sensor feeds to multiple surface indirect fire and strike assets. At a local level, the effects of these systems are requiring commanders to diverge from standing doctrinal approaches as rear areas and attack positions where forces could traditionally mass in relative safety are now at near constant risk. When armored and mechanized formations are in movement or massed in assault formations, they become targets for increasing use of first-person view (FPV) quadcopters fitted with munitions. When employed by a skilled operator, these FPV striking systems, costing only hundreds of dollars, can destroy or heavily damage armored platforms costing millions of dollars. The benefits in the cost offset alone are driving both sides to move from a low-level integration effort

DJI "Mavic Series"

Cheap and easy to operate system made by a Chinese company. Used for reconnaissance, artillery correction, and for dropping small antipersonnel grenades.

Switchblade

American-made "suicide drones" weigh 2.5 kilograms, and the entire system can be carried in a backpack. Deployed from a mortar-like tube for initial launch. Switchblades use a live video feed for target acquisition. Range of 10km with speed up to 160kph. Small grenade sized warhead designed for personnel and light skinned vehicles.

Geran-2 (Shahed 136)

The Iranian-made, Russian-branded suicide drones are launched in small "swarms" of five or more. Recently employed against infrastructure in Ukraine.

Bayraktar

Turkish-made drone seen as an initial "game-changer" for Ukraine. Videos showed the Bayraktars destroying valuable Russian hardware with baseball-bat-sized "micromunitions" during the chaotic first days of the Russian invasion.

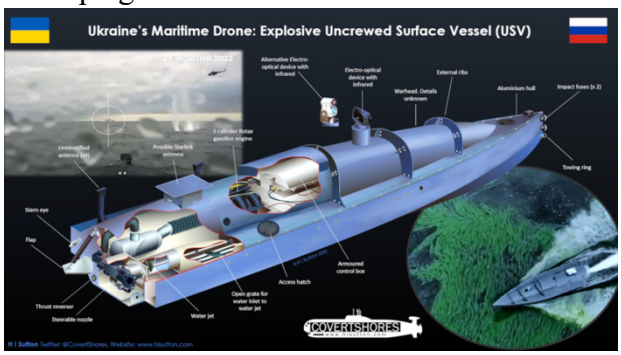
to a scaled state driven approach. HMT within this conflict is not limited to aerial forms of IRAS alone. The Ukrainians have also expanded their efforts in the maritime domain to achieve outsized effects from emergent systems.

What may be termed "The Battle of the Black Sea" has been a key aspect in the ongoing conflict but is manifesting outside of traditional naval engagement for one main reason, Ukraine does not have a fleet. The use of IRAS, aerial and surface variants, mixed with cruise missiles has given the Ukrainians the effect of sea denial generated solely from landward forces. Ukraine is not the first country to use surface drones in conflict but as a nation without a naval force they have, "used drones and other missile strikes to largely stave off attacks from the Black Sea Fleet while slowly dismantling Russia's dominance over the Black Sea."[42] Taking note of the effects generated by landward forces in the seaward space through IRAS use should be of particular interest for the U.S. as developing concepts are centered on that very ability.

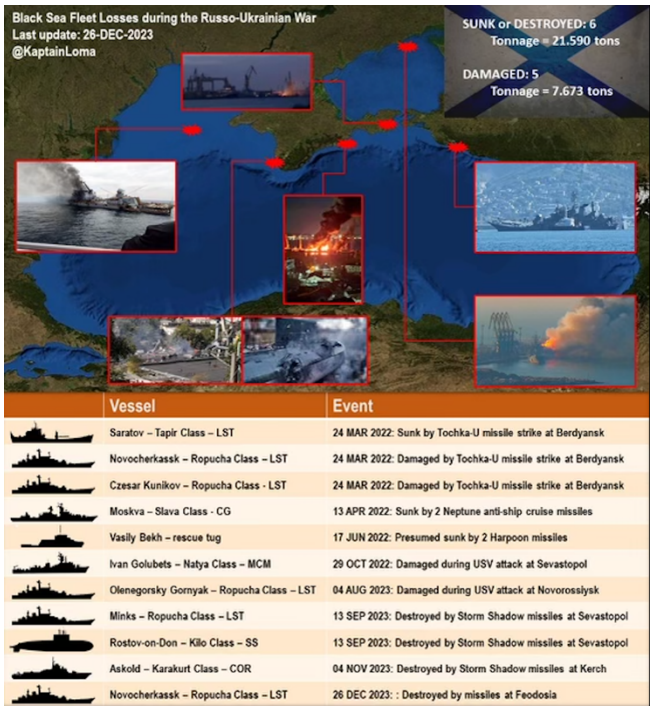
RTS Moskva (121) following an April 13, 2022 strike from Ukrainian missiles. Russian MoD

Memorably, during the assault on Snake Island in February 2022 a Ukrainian border guard radioed to the former RTS Moskva, a Russian landing ship, to "go f*ck yourself."[43] The banter stirred Ukrainian resolve and generated international support, but the island was seized by the attacking Russian force. However, in mid-April Ukrainian forces used aerial robotics to track the Moskva and subsequently sink the vessel with two land-based Neptune missiles. Another poignant example occurred within October 2022 with the attacks on the Black Sea Fleet Headquarters at Sevastopol with unmanned surface vessels (USV) in combination with aerial

striking systems. These attacks caused limited damage to port infrastructure and to the flagship Admiral Makarov, however the larger result was the Russian relocation of the fleet to Novorossiysk to avoid further attacks. Soon after these attacks Ukraine began a crowdsourcing campaign to fund 100 more maritime drones which are reportedly $250,000 a copy.[44]



The emergent lessons from Russo-Ukrainian conflict alone are worth careful consideration for the Department of Defense and should inform the action of each service as they look to incorporate robotics. Non-standard form factors continually generate effects once thought reserved for technically mature crewed platforms. The democratization[45] of airpower is procedurally upending current methods of aerial surveillance and strike as well as the ability to defend against smaller dispersed systems. The difficulties to detect, track, and target maritime robotics are presenting similar risks to large multi-mission ships while having the ability to sink



or achieve mission kills at the fraction of production costs. Further, both the Ukrainians and Russians are undergoing a period of deconstruction and reconstruction of their institutional approaches to account for the integration of IRAS and the downstream training requirements necessary for operators and maintainers. In line with the lessons learned by failing to incorporate the lessons of the Russo-Japanese War, current planners

must quickly pivot off a capability centric approach to the lesson being offered from the conflict in Ukraine.

Recommended Actions for IRAS Joint Force Design

Current State

The state of robotics within the Department of Defense (DoD) is service specific and is devoid of a unifying direction to realize the opportunities of IRAS integration. Further, there is a lack of a joint force design and coordinating authorities to align service resourcing across the lines of DOTMLPF-P to include acquisition strategies, governing joint doctrine, organizational influence and advocacy, formalized and progressive training, alignment of military occupational specialty (MOS)/ratings, structure and initial inventory, and organized policy. The lack of integration and alignment prevents the scale necessary to provide resilience within multiple mission threads or to support extended operations.

Central Idea

The desired future state is to integrate professionally trained personnel and IRAS in multiple configurations, employment methods, and scale to enhance respective service capabilities and enhance the options of joint force commanders (JFC). Through a holistic approach, each service within the Department of Defense form will capitalize on technological advances to embed a family of interconnected IRAS within every formation at all echelons. Over time, IRAS will grow from platform centric tools used for basic tasks to a capability-centric approach where IRAS systems are employed by professionally trained specialists to contribute to operations in all domains. While each service has made significant investment in current

systems, future IRAS will have a central role in performing and supporting an extensive array of mission sets across the range of military operations.

Military Problem

Adversaries are presenting new operational and tactical problems to disrupt current military efforts. In the near term, a *reverse offset* is manifesting for adversaries through lethal, low-cost, and highly proliferated technology that generates an outsized warfighting advantage. Persistent surveillance capabilities complicate operational security and local concealment methods, while adversary long range precision fires raise costs and risks of our operations throughout the operating environment. Adversary information operations, cyber, and electronic warfare capacities can disrupt existing command and control networks, and cue adversary targeting systems. As a result, the joint force must find ways of operating in a cost-effective and risk-worthy manner, while placing adversary capabilities at risk, across the competition continuum, from peacetime exercising and cooperation to deterrence activities, coercion, and combat.

Desired Future State

Services within the DoD are guided by a joint force design focused on interoperability to integrate IRAS to enhance service component capabilities and expand the options of joint force commanders. Formations across the DoD total force under a joint coordinating authority postured to capitalize on technological advances to shift from platform centric to a capability-centric approach where J-IRAS are employed by trained specialists that contribute to operations in all domains.

J-IRAS Defined

Where the concept of IRAS provides a holistic understanding of the capabilities, there is risk should the individual services reflect the term only in their own cultures and Title 10 responsibilities. While seemingly insignificant, the inclusion of "joint" to the term signals an acknowledgement of the capability as an accepted additive element to warfighting. In addition, Joint-Intelligent Robotics and Autonomous Systems (JIRAS) would serve as the first forcing function to ensure individual service experimentation and integration efforts are aligned and interoperable for eventual employment within the joint forces.

The Principles of JIRAS:

- The human element of warfare remains central in the use of JIRAS.
- JIRAS augment or obviate human processes.
- The joint forces prepared to operate machine speed.

Tenets to Inform JIRAS Strategies:

- Develop a lethal, agile, mobile, and resilient joint force.
- Deliver performance to the joint force at the speed of relevance.
- Increase interoperability and all domain awareness across the joint force.
- Recognize and treat data as a strategic resource.
- Increase transparency and cooperation with international, government, industry, and academic partners.

Operational Approach

The DoD must enact joint force design to maximize the potential of JIRAS and realize the efforts of individual services while ensuring interoperability through an integrated framework. Establishing the authority to coordinate acquisition strategies and processes to integrate robotic systems that enhance or obviate existing platforms and methods, the DoD can avoid the development of IRAS that only replace existing platforms performing existing multi-

mission roles. As noted in a parallel study, "the DoD will need to flip its traditional acquisition approach and adapt US military tactics or mission threads so they can integrate uncrewed systems (JIRAS) that are available today."[46] The operational approach consists of five main lines of effort that address service equities while creating a common framework to enable the interoperability of JIRAS.

Systems Meshing

Embracing a bottom-up system meshing approach and avoiding a top-down systems engineering process, the DoD can leverage best practices within established industry to efficiently integrate IRAS across all formation types. Focusing where JIRAS serves the greatest utility across a DOTMLPF-P framework will allow each service under authority of the Office of the Secretary of Defense to efficiently absorb systems. This approach does represent a significant departure in the current service's authorities to man, train, and equip. It does not, however, suggest divergence from existing systems practices for long-term program requirements of crewed platforms.[47]

Coordinating Authority for System Meshing

Establish a coordinating authority within the J-7, Joint Staff to develop policy, align service strategy, and to resource systems meshing for JIRAS within each of the services. Aligning the authorities of existing acquisition entities for the purposes of JIRAS links with fast paced nature of the field of robotics and enables an agile model for research and development. This office would serve to validate the interoperability of a service identified requirements while ensuring the needs of Combatant Commanders to fulfill assigned missions with aggregated component offerings.

OSD Approving Authority for Service JIRAS Program Executive Offices (PEOs)

Each service creates a JIRAS focused PEO to support system meshing of various robotic form factors and proper integration within intended use cases. In this arrangement the approving authority resides within the Office of the Deputy Secretary for Defense allowing for the proper management of service system meshing activities. The service JIRAS PEOs will interface with operating forces, industry, and academia to connect research and development activities directly with experimentation efforts conducted by appropriate formations within the respective service.

Accelerated Experimentation

Create within geographic combatant commands dedicated staff structure for experimentation that couples with service led experimental task forces to form a method by which OSD in coordination with the J-7 guides needs informed experimentation activities. Through iterative and recursive use case scenarios alongside traditional formations and capabilities, JIRAS enabled elements will gain trust and greater awareness throughout the joint force. The lead agent within the combatant command experimentation structure reports to OSD and coordinates with service JIRAS PEOs and component service level experimentation task forces within the respective area of operations.

J-IRAS Talent Management -the first Joint Occupational Field

The multi-disciplinary of nature of robotics requires trained specialists across several functional fields to ensure proper employment, maintenance, and network updates for various JIRAS. Aligned by the J-7 coordinating authority, each service develops of a robotics occupational field for officers and enlisted personnel to facilitate the development of JIRAS expertise in the joint force tailored to operational requirements and existing service manning. The occupational field will consist of MOS's or ratings that span the roles of operator, hardware

maintainer, communications and network specialists, and data collection, and policy adherence. Over time, the JIRAS occupational fields within the individual services may natural align giving opportunity for the creation of the first “Joint MOS.”

Conclusion

At this moment in global affairs the long-standing rules based international order and those institutions charged to uphold stability and peace are being increasingly challenged. Marked by ongoing conflict in Ukraine, Israel, and most recently in the Red Sea state actors and state backed violent extremist organizations are using novel robotic enabled capabilities to seek battlefield advantage and to disrupt global commerce. Viewed in singularity, systems such as a small armed aerial vehicle may not present a compelling reason to update assumptions about the modern battlefield. However, when taken in at scale it becomes clear the integration of robotic capabilities in martial use is changing the character of warfare. In recognition of such change, it is incumbent for leaders at every level to understand the implications to current operational methods and the risks of remaining status quo.

Within the operational dilemma, however, there is a greater opportunity to enhance the warfighting effectiveness of the joint force. In order to do so, both policy makers and commanders must remember the lessons the nation learned in the past from recent conflicts prior to the onset of large-scale war. Instances such as the Russo-Japanese War showcased emergent capabilities and tactical methods that were soon after scaled on a global level during The Great War. Such circumstances exist today as the Nation observes ongoing conflict in the Russo-Ukrainian War. By understanding the long view of historical innovations and tactical adaptation, current leaders can take the lessons on ongoing conflict and apply them to inform acquisition strategies and experimentation efforts. As demonstrated, the history of past and current battles

alone is insufficient as a driver for change. History can be misunderstood and misapplied if wielded incorrectly.

The opportunity to enhance and make the joint force more interoperable through JIRAS first requires a methodical understanding of the capability areas and then structured approach to integrate systems across the force. Through viewing various systems in the lens of the war fighting functions, a capability-centric approach can be adopted without becoming fixated on a platform-centric approach. The capabilities-centric approach allows the commander as well as the program manager to observe current use cases and quickly apply those lessons to inform force design and tactical methodology updates. With a departure from current practices and the adoption of joint force design grounded in the realities of JIRAS, the DoD can posture itself with a force wide approach to adopt HMT and integrate IRAS. Now is the time to accelerate the changes required to meet the demands of current conflict. Demonstrated use in conflict and the advances of our Nation's pacing threat signal remaining status quo is no longer acceptable. The Department of Defense can realize outsized effects within its warfighting formations to accomplish assigned missions and deter adversaries. However, if not pursued in a prudent and well-informed manner the joint force could find itself ceding the advantage to its adversaries. Now is the time to get out of our own way.

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commanded the Advanced Infantry Training Battalion, Training and Education Command where the sUAS Operators Course was created.

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