No. 24
March 2019

The Mitchell Forum

Building a Fifth Generation Coalition:
Advancing Allied F-35 Interoperability

By Maj Luke J. Harris and Col Max M. Marosko III, USAF

About the Forum

The Mitchell Forum exists to give an open venue to authors with ideas and thoughts on national defense and aerospace power. The series features topics and issues of broad interest and significant impact on current and emerging policy debates.

The views expressed in this series are those of the authors themselves alone, and do not necessarily represent the views of the Mitchell Institute for Aerospace Studies.

Abstract

Allied F-35s operating around the world stand as the most recognized symbols of the United States' effort to strengthen modern coalition airpower. In a world where modern, capable threats are proliferating, these fifth generation fighters are a key tool for U.S. and allied leaders as they work to ensure shared interests are defended. Due to its revolutionary capabilities, the potential for the F-35 is far more expansive than any other combat aircraft built to date. However, to fully harness the attributes of both U.S. and allied F-35s, it is crucial to ensure aircraft interoperability.

This paper outlines the challenges, from both a technical and policy vantage, to F-35 integration and provides a path forward based on the following areas: improving technical communications and data sharing, improving allied tactics through smart disclosure and training, and building better coalition maintenance and sortie generation practices. The paper concludes with a vignette describing a future conflict demonstrating how an integrated allied F-35 force might fight—with interoperability standing as a vital attribute.

As allied political and military leaders make decisions regarding the future of the F-35, they must understand the long-term importance of promoting interoperability. As far as the U.S. is concerned, this includes ensuring that security and policy barriers do not strands as impediments towards this goal.

Introduction

"We [the United States] depend on an integrated coalition fighter force operating the F-35 in order to counter near peer adversaries with advanced surface and air defenses."[1]

– Air Force Lt Gen Jeffrey Harrigian, former director, F-35 integration office

"[Interoperability is] the ability to operate in synergy in the execution of assignments, or the ability to act together coherently, effectively, and efficiently to achieve tactical, operational, and strategic objectives".[2]

– Joint Publication 3-0, Joint Operations

This paper addresses opportunities to improve F-35 interoperability between the United States and its allies who are acquiring the F-35 fifth generation fighter aircraft. After an extended development and fielding period, the F-35A, the F-35B, and the F-35C have achieved initial operational capability (IOC) as part of the U.S. military's combat aircraft inventory, but delayed improvements have prevented integration opportunities with partners and allies. In recognizing this current shortcoming, U.S. Air Force leadership has declared that interoperability improvement is now a main priority for the F-35 going forward.

…the F-35 is a cornerstone of modern allied interoperability efforts that promise the high likelihood that any future coalition military operation will defeat adversary air defenses.

Despite Air Force Chief of Staff Gen David Goldfein championing this issue, and discussions continuing among U.S. military leaders and civilian Department of Defense (DOD) officials about how to improve interoperability, progress toward this objective has proved slow. Delays are in part due to a lack of understanding of the purposefully designed interoperable capabilities within the F-35, and to a degree, this is because the F-35 is a relatively new aircraft and combat system. Many of the technical documents of this program remain classified, but the potential for the F-35 is far more expansive than any other combat aircraft built to date.

In order to improve understanding in both military and civilian circles of what exactly "interoperability" is and why it is necessary for the success of the F-35 in the years ahead, this paper will investigate three specific aspects of interoperability and recommend a path forward. Specifically, these lines of effort are: improving technical communications and data sharing, improving allied tactics through smart disclosure and training, and building better coalition maintenance and sortie generation practices. This paper highlights these areas of focus not only for the F-35's future success, but to improve U.S. and coalition combat airpower capability. Following an investigation of interoperability, this paper will lay out a hypothetical vignette that describes a future conflict where an integrated F-35 force fights in a manner that optimizes interoperability, and demonstrates how properly integrated coalition squadrons may prove vital to success in combat.

To begin, the F-35 is a cornerstone of modern allied interoperability efforts that promise the high likelihood that any future coalition military operation will defeat adversary air defenses. Today however, this aircraft is limited in its potential by shortfalls in integration with other nations who are acquiring it. As Goldfein recently stated, the Air Force and the U.S. military have "bet the farm on the F-35 and the jury is still out."[3] Part of the rationale behind Goldfein's statement is that he and other senior leaders recognize the F-35 is not optimally integrated among partner nations.

While some F-35 partner nations are still in the early stages of acquiring the aircraft and incorporating it into their respective air forces,

a framework needs to be built so that the F-35 can fulfill its potential to strengthen the U.S. and allied military capabilities. The F-35 has already achieved IOC with the U.S. Air Force (USAF), U.S. Marine Corps (USMC), the U.S. Navy (USN), and several partner nations are standing up their first squadrons. The time is right to build the foundation to optimize future interoperability, before the F-35 becomes more prolific in our allies' military inventories. The strengthening of alliances and partnerships depends on the ability of the F-35 to work seamlessly among partner nation air forces. To accomplish this goal, the F-35 must be able to share information among formations of F-35s from various nations, with pilots employing congruent and validated tactics, and maintainers sharing common sortie generation practices.

Given the current poor state of F-35 interoperability among partners, it is incumbent on U.S. military leadership, leaders in the intelligence and national security communities, and leaders in Congress as well as partner and allied officials to remove barriers to F-35 operational integration…

Currently, F-35-equipped allies fall short in each of these areas. First, allied and partner militaries do not share information across the multifunction advanced data link (MADL) from one country's F-35 to another as well as they could. Second, outdated and restrictive security policies prevent integrated training among allies with F-35s. Finally, well-intentioned security and safety concerns can prevent progress in joint and allied maintenance practices. Given the current poor state of F-35 interoperability among partners, it is incumbent on U.S. military leadership, leaders in the intelligence and national security communities, and leaders in Congress as well as partner and allied officials to remove barriers to F-35 operational integration so that F-35 force projection and battle space awareness can be maximized. Additionally, decision makers must understand the importance of allied interoperability in future combat operations. The international F-35 program is a coalition, but it is one with no central directing authority. Decisions made by individual F-35 partner countries affect the interoperability for all the partners. The need for immediate improvement in allied F-35 interoperability is particularly vital in light of the threats and challenges outlined in the December 2017 *National Security Strategy of the United States of America,* and with the fiscal constraints that may reduce the planned U.S. procurement of 2,443 F-35s bearing down.[4]

The F-35 program has progressed rapidly in recent years as it has steadily entered the force structure, demonstrating great potential as a capable aircraft and joint operations force multiplier. As the first operator of the F-35, the U.S. Marine Corps declared IOC in 2015, and the U.S. Air Force followed in 2016. It was not long after the IOC declarations that operators and leaders alike saw the F-35's potential in action. At Red Flag 17-1, which took place from January to February 2017, Air Force F-35s from Hill AFB, Utah's 34th Fighter Squadron (FS) demonstrated a high level of lethality with an initially reported 15:1 kill ratio in engagements, as well as the ability to improve fourth generation fighter survivability by their mere presence. Since the exercise, Air Force and Marine Corps leaders testified to Congress that the F-35's kill ratio was in fact higher than the 15:1 ratio reported at the time, with the F-35A achieving a 20:1 ratio at the event.[5] Shortly after Red Flag 17-1, the 34th FS completed a European deployment, the F-35A's first to the continent, demonstrating force projection capability and the ability to operate with international partners. Since this initial overseas deployment, both the Marine Corps and the Air Force have rotated

through the U.S. Indo-Pacific Command (INDOPACOM) area of operations as part of routine deployments, and have built confidence in the aircraft to carry out operations.

As international involvement in the F-35 program has expanded, expectations have grown that it will fulfill the security needs of American taxpayers as well as meet the investment expectations of the program's international partners. The DOD for its part has not wavered in its commitment to the program, and current F-35 production and procurement goals make it the largest DOD acquisition program in the department's history.[6] Current plans call for the USAF to purchase 1,763 F-35As; the Marine Corps to purchase 353 F-35B short take-off and vertical landing (STOVL) variants along with 67 F-35C carrier variants; and the Navy will buy 260 F-35Cs.[7] Additionally, nine partner countries and three foreign military sales (FMS) countries currently plan to purchase the F-35. These include: Australia, Canada, Denmark, Italy, the Netherlands, Norway, Turkey, the United Kingdom and the United States, as well as the FMS customers Israel, Japan, and the Republic of Korea (South Korea).[8] For several of these countries, the F-35 is one of the cornerstones of their respective defense plans in terms of monetary investment and prioritization, and if interoperability does not improve, the lost opportunity may cripple future combat capability. Many defense budget watchers have assessed that the U.S. F-35 objective inventory may decrease in the future too, based on fiscal constraints. But, if this was to occur, the United States would be forced to increase its reliance on international partner F-35 squadrons for necessary fifth generation aircraft capability in future coalition operations.

Growing peer and near-peer threats around the globe show the need to capitalize on capability accrued by the F-35 program through interoperability. As described in the latest national security strategy, the U.S. and its allies are increasingly challenged by great powers who aim to expand their influence, and make smaller states pay the cost.

Growing peer and near-peer threats around the globe show the need to capitalize on capability accrued by the F-35 program through interoperability. As described in the latest national security strategy, the U.S. and its allies are increasingly challenged by great powers who aim to expand their influence, and make smaller states pay the cost.[9] The White House believes that great power competition has returned to the forefront of national security planning, with a resurgent Russia asserting itself on its periphery, and a Chinese military whose capacity and capability is rapidly advancing. To counterbalance this threat, the new national security strategy states the U.S. will strengthen its "long-standing military relationships and encourage the development of a strong defense network with our allies and partners."[10] The DOD's *2018 National Defense Strategy of the United States of America* (NDS) similarly emphasizes the strengthening of existing relationships by reinvigorating and focusing America's approach to alliances and partnerships in the Indo-Pacific and European theaters.

In light of the global threat environment, and in order to strengthen military relationships, America must ensure that it remains actively involved as a reliable training and security partner, as well as help allies modernize in order to deter and if necessary defeat aggression.[11] According to former Secretary of Defense James Mattis, a primary means for achieving this is through bettering interoperability by training for high-end combat via multinational exercises.[12] The F-35 is well-suited for this task, as it has been designed and "optimized for stealth, [which] will allow it to operate in threat

environments where the F-16 [for example] could not survive," according to Air Force Lt Gen Jeffrey Harrigian, the former director of the F-35 integration office on the Air Staff, and currently the deputy commander of U.S. Air Forces in Europe-Air Forces Africa (USAFE-AFAFRICA).[13]

As long as the U.S. continues to improve interoperability with allies flying the F-35, it will act as more than just a combat aircraft—but an instrument to bring together militaries and coalitions. However, this will not happen if the U.S. and its allies do not maintain a hard focus on integrating F-35 systems, tactics, and capabilities in the years ahead.

Technical Communication and Data Sharing

"Does it connect? Good. Does it share? Better. Does it learn? Perfect."

–Air Force Chief of Staff Gen David Goldfein

One of the F-35's core strengths is the aircraft's enormous potential to collect, process, and share data and information. By advancing airborne and multi-domain integration between the U.S. and its F-35 allies, the platform's incredible battlespace awareness and data sharing capability via its MADL can be better exploited. MADL is a radio waveform that serves as an information broker by formatting messages via "keys," and uses a fusion control node for passing data. Despite a clear foundational need, MADL communication among allies remains relatively unproven and is in continuing development.

By advancing airborne and multi-domain integration between the U.S. and its F-35 allies, the platform's incredible battlespace awareness and data sharing capability via its MADL can be better exploited.

In order to better understand the challenges of MADL interoperability, a few technical details should be highlighted. To begin with, there are multiple prerequisites for the aircraft to communicate over MADL. First, the aircraft's software programming, known as its operational flight program (OFP), must be compatible for aircraft to communicate. Differences in OFPs will not limit interoperability since all F-35 countries will initially operate the "3F" OFP configuration, which is the combat capable software baseline (all 3F OFPs are backwards compatible). This software is critical to the jet's full potential, as it enables flight control, radar, communications, navigation, electronic attack, sensor fusion, and other capabilities. Second, mission planners and pilots must configure onboard settings to enable compatibility, which is not a major challenge.

While OFP compatibility and configurable settings fulfill two of the requirements, there are other limitations that must be addressed. The first major limitation comes from so-called "crypto keys" that are required to encrypt and transmit data securely between aircraft equipped with MADL. These keys are built in the United States, but there are currently no bilateral networks capable of sharing these keys. The network architecture to allow F-35 information sharing with allies is only now in its design phase, and fielding must be accelerated so that MADL keys (and other forms of classified information) can be easily be shared with American allies.

More foundational than the need for crypto keys though is the requirement for compatible mission data files (MDFs), which remains the biggest obstacle to increasing interoperability. MDFs provide a database for onboard sensors and inform how the F-35 will search for and classify threats and share information. While the MDFs are technically compatible (since their baseline is in the "3F plus" software block), each

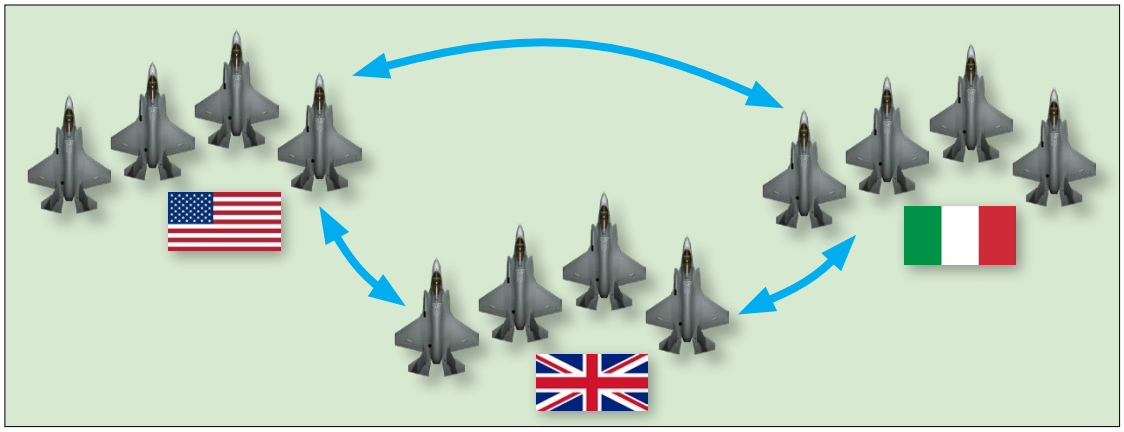

Figure 1: Three allied F-35 flight groups, connected via MADL. The U.S. four-ship is the "flight group," the UK F-35s are an "adjacent group," and the Italian F-35s are an "other group."

F-35 partner country has a specialized MDF built by their programming labs. The time and resource burden to test the basic MDF function is enormous though. As a result, the interoperability test effort has lagged, and F-35-equipped allies must aggressively advocate for and implement a test plan for realizing connectivity across MADL in order to ensure that shared air and surface track data is of high-fidelity quality and accuracy.

Due to the necessity of each country maintaining its overall acquisition priorities and national sovereignty, the current dynamic with regard to data sharing is effectively little more than a coalition of the willing among F-35 program participants.

While the multiple re-programming labs struggle to meet the MDF development and test deadlines, there are planned changes being urged along to improve data communication. One change that can be made with proper support is for all F-35 partners to agree on a common platform list (CPL) of possible surface and air tracks. MDFs contain a platform list of each emitter with a unique numerical "fusion entity number," but the numerical identifiers do not match between MDFs built by different countries. The lack of a common reference creates a hazardous situation where an aircraft may wrongly interpret a fused identification, sent by a partner aircraft, misidentify a hostile aircraft, or worse—even commit fratricide.

Common platforms lists must match, because while there is no expectation that U.S. or allied and coalition F-35s will operate in a mixed four-ship formation at the flight group level, there is every expectation that F-35s will be tied together as adjacent groups, operating as distinct formations with the need to share data via MADL in order to locate and jam threats, and carry out other tasks. In Figure 1, F-35 formations from the U.S., UK, and Italy, are shown operating together, using compatible MDFs so that threats passed across MADL between aircraft are correctly displayed by the receiving aircraft.

While it is clearly in the best interest of all program participants to develop a CPL, progress is slow due to the many partners involved in the F-35 program, and the inherent slow speed of bureaucratic program administration in all governments. This is a case where, while the U.S. and its allies may fix the CPL issue, the systemic root cause is that there is no governing body to implement agreed upon and mutually beneficial standards for the F-35. This lack of a common standard, adhered to by all program partners, hurts the entire F-35 effort and degrades interoperability, undercutting its stated goal of being an international and interoperable combat aircraft program. Under a governing body to set these standards, each country would still retain the ability to run its program independently, but this approach could forward important design and operational decisions that could benefit all F-35 allies and partners. Due to

the necessity of each country maintaining its overall acquisition priorities and national sovereignty, the current dynamic with regard to data sharing is effectively little more than a coalition of the willing among F-35 program participants.

Again, the difficulty in getting agreement on a CPL is just an example of the lack of concurrence among the F-35 partners, and the difficulty inherent in doing what is best for the program because of the large number of interested parties. The F-35 program will likely find a solution to the lack of commonality among CPLs, but the issue highlights the difficulties in making progress on simple problems facing multi-national coalitions.

Seamless MADL connectivity is absolutely essential for the success of the F-35 in the long run, and allied warfighting writ large. A coalition F-35 offensive counter air (OCA) or suppression of enemy air defenses (SEAD) package will fall short of its capability without MADL connectivity, which allows accurate data passage of surface and air threat data and identifications…

Seamless MADL connectivity is absolutely essential for the success of the F-35 in the long run, and allied warfighting writ large. A coalition F-35 offensive counter air (OCA) or suppression of enemy air defenses (SEAD) package will fall short of its capability without MADL connectivity, which allows accurate data passage of surface and air threat data and identifications (IDs) as well as surface threat geolocation. Additionally, connected adjacent flight groups would leverage the wide tactical formations of F-35s to greatly increase battlespace awareness.

In conjunction with wide coverage of a conflict zone, MADL sharing, sensors, and fusion on the F-35 provides the capability to aid the introduction of a new warfare paradigm, by actualizing the concept of the "combat cloud."[14] Capitalizing on modern sensors, resilient data links, and other means to assure connectivity, this concept builds on the well-known observe, orient, decide, and act (OODA) loop to enable a flight of F-35s to complete the kill chain in such a timeframe that an adversary will not be able to build sufficient awareness of what is happening. This allows application of force inside an enemy's decision cycle before they can react, maneuver, or protect defenses. In a dynamic targeting situation, a package of allied F-35s can rapidly find, fix, track, target, engage, and assess enemy targets (also known as the F2T2EA process) far quicker than a package of fourth generation fighter aircraft. Furthermore, an allied F-35 package can prosecute targets in a highly contested environment due to the survivability afforded the aircraft by stealth, electronic countermeasures (ECMs) and its multi-role offensive capabilities. Post attack, the F-35 can provide real time battle assessments, and other tasks such as verifying a lack of electro-magnetic emissions in a given area.

Despite the tactical advantages of rapid kill chain prosecution inherent in the F-35, this aircraft is not a singular solution, but will serve as a vital element in next-generation aerial warfare. Mission success could be greatly enhanced by the F-35's ability to participate as a critical node in the future combat cloud as an element of kill chain execution. Goldfein has described this rapid, cross-domain, sensor agnostic kill chain execution as a sort of second-generation OODA loop.[15] As a node in a future combat cloud construct, the F-35 could also share air and ground threat positional data, and targeting information with coalition F-35s, fourth generation fighters, and other connected platforms across all domains.

Eventual actualization of the combat cloud concept is vital to achieving decision advantage over other potential adversary nations, and their focus on informationized warfare. For example, the Chinese People's Liberation Army (PLA) now characterizes and understands modern warfare as a

confrontation between "opposing operational systems" rather than merely opposing armies, according to a recent RAND Corporation report. Warfare to the PLA is no longer centered on the annihilation of enemy forces on the battlefield, but is won by the belligerent that can disrupt, paralyze, or destroy the operational capability of the enemy's operational system. This can be achieved through kinetic and non-kinetic strikes against key points and nodes.[16] Through the secure, jam, and detection-resistant MADL network, the F-35 can counter an adversary's attacks on its operational network and combat systems. When U.S. and allied command and control networks are disrupted, the F-35 can provide redundancy in a distributed command and control network, with the data sharing suite of the F-35 acting as a force multiplier to overcome network attacks.

Current rules governing tactics sharing do not align with the expected level of allied capability in combat, where U.S. and allied lives depend on military forces having the sharpest tactical advantage possible.

Tactics and Training

"…Equally important is our ability to break down the barriers to aggressively sharing this picture and the information with our allies and partners. There is no greater confidence-building measure than sharing the critical and timely information with our allies and partners needed for success on the battlefield."[17]

– Gen Goldfein

Given the increasing U.S. and allied focus on great power competition with advanced military capabilities, it is clearly not enough to achieve advanced MADL interoperability with the F-35 alone. The U.S. and its allies and partners must also step up tactical execution by sharing valuable lessons learned, and exercising proven tactics against robust threats to build a shared model for victory.

As Goldfein stated in February 2018, there is no better confidence building measure "than sharing critical information with our allies and partners needed for success on the battlefield."[18] However, current tactics disclosure policy does a disservice to U.S. allies and partner military forces who are often training against outdated threats. Furthermore, the guidelines for tactics disclosure do not align with the technology the U.S. has shared with its allies. Current rules governing tactics sharing do not align with the expected level of allied capability in combat, where U.S. and allied lives depend on military forces having the sharpest tactical advantage possible.

The United States has already forged relationships that have increased interoperability of fourth generation fighters through tactics disclosure and coalition exercises. The U.S. and its allies can build on those practices. But the F-35 breaks new ground with its unprecedented level of technology sharing and the need to train at a higher classification level against more advanced threats. The U.S. is providing allies with the F-35 aircraft, and needs to follow through by sharing the technical knowledge and tactics, techniques, and procedures (TTPs) to use it as effectively as possible. With rapidly evolving military technology proliferating worldwide, the level of releasable tactics for U.S. allies and partners has lagged and must be re-baselined.

The current DOD disclosure policy is outdated, especially with regard to the F-35 program. The result is the continued use in teaching curriculums of un-survivable and unrealistic tactics, reinforcing negative lessons. This problem is systemic, because it starts at initial qualification training for F-35 pilots, where U.S. allies learn slightly watered-down mission tactics. This situation

is also very unfortunate because the United States now has over a decade of experience flying fifth generation stealth fighters, experience and lessons that the U.S. can and should share with trusted allies. Current "stove piped" DOD security policies, though, prevent optimized training among F-35 allies.

At the same time, complicated, outdated F-35 special access program (SAP) restrictions are long overdue for overhaul, considering the damage they are causing to allied F-35 interoperability efforts. With an appropriate reduction in SAP restrictions, F-35 partners would be able to access a common, relevant, advanced employment manual (AEM) to enable productive training. Beyond initial qualification training, the U.S. should provide our allies with continued support to answer basic questions regarding topics such as best practices for mission planning software and avionics optimization.

If the U.S. continues to withhold effective TTPs, American allies will not be fully capable of providing mutual defense against common adversaries when needed most. Ultimately, the U.S. will have to share information with allies—regardless of outmoded DOD policy—in order to survive first contact with the enemy.

With limited numbers of fifth generation aircraft in operation until the advent of F-35 sales to allied partners, this "over-classification" issue had been effectively side-stepped. But with mass production ramped up and F-35s now arriving in the inventories of allies and partners, the release guidelines for tactics must be revisited to optimize integration. Current DOD security disclosure mitigation measures are ineffective, and come at a huge cost to training, allied relationships, and warfighting potential.

If the U.S. continues to withhold effective TTPs, American allies will not be fully capable of providing mutual defense against common adversaries when needed most. Ultimately, the U.S. will have to share information with allies—regardless of outmoded DOD policy—in order to survive first contact with the enemy. It is wiser to take these steps in peacetime, to disclose information as needed on a limited basis, rather than hastily disclose tactics and intelligence on the eve of a conflict. This increased disclosure should be done soberly, with the understanding that we trust and depend on certain allies more than others. For example, the level of training at a top (so-called "tier one") combat exercise will feature training in higher level tactics than ones which would be featured at a more inclusive, broader based exercise (such as a Red Flag-Alaska event, which frequently features participation from a range of U.S. allies and partners). With increased sharing, America and its allies can develop fourth and fifth generation fighter integration tactics and standards proactively.

Coalition Maintenance and Sortie Generation

While it is notable to strive for advanced MADL interoperability and shared TTPs, we should not overlook gains that could be easily reached through improving coalition maintenance and sortie generation capability.

There are currently limited numbers of U.S. fighter aircraft and support personnel available for major combat operations. Across the fighter fleet since 1990, the U.S. has cut the number of air superiority and multi-role fighters from 3,444 to 1,570.[19] The number of fighter squadrons has also been reduced from 134 to 55.[20] This reduction in fighter aircraft has occurred with a corresponding reduction in maintainers and equipment. In any "fight tonight" scenario with minimal time to gather and prepare forces, the need to maximize sortie generation is magnified. In the Asia-Pacific theater, F-35-equipped treaty allies (Australia, Japan, and South Korea) will operate a preponderance of the combined F-35 force. Likewise, in the European theater, Denmark, Italy, the Netherlands, Norway,

Turkey, and the United Kingdom will operate the majority of European based F-35s.

With limited U.S. fifth generation aircraft in the Pacific and Europe, and with plans to carry out distributed operations in a major conflict, the U.S. will by necessity have to rely on allies to perform basic maintenance, refueling, and weapons reloading. There are not enough U.S. personnel, spare parts, or maintenance equipment to service the expected dispersed flights of F-35s spread out to several bases across either Europe or the Asia-Pacific theaters. In order to promote basic integration, Air Force and DOD officials need to remove limitations that would prohibit a non-U.S. F-35 maintainer from performing basic maintenance, refueling, and weapons loading on U.S. F-35s. If this maintenance integration is not practiced in peacetime, wartime implementation will be carried out hastily. There is an urgent need for basic integration as the F-35 program expands, and opportunities should be capitalized on in the context of current exercises and deployments. Ultimately, the value added through integrated maintenance operations may contribute more to mission success than advanced technical and tactical integration.

With limited U.S. fifth generation aircraft in the Pacific and Europe, and with plans to carry out distributed operations in a major conflict, the U.S. will by necessity have to rely on allies to perform basic maintenance, refueling, and weapons reloading.

Envisioning a Potential Future Coalition Air Operation

"…Prioritize ground, air, sea, and space forces that can deploy, survive, operate, maneuver, and regenerate in all domains while under attack. Transitioning from large, centralized, unhardened infrastructure to smaller, dispersed, resilient, adaptive basing that include active and passive defenses will also be prioritized."[21]

– The 2018 National Defense Strategy of the United States of America

"In the near term, the stealth technology on our fifth generation platforms, the F-22 and F-35, is the price of admission into the fight. The lethal envelope of advanced air-defense systems continues to grow against our 4th Generation aircraft."[22]

—Air Force Gen Mark Welsh, Former Chief of Staff

With a return to emphasizing great power competition in national security planning, the U.S. is preparing for rising tensions and a potential crisis abroad. It is not difficult to imagine a scenario where interoperability and closer allied integration could make a clear difference in the future.

In one possible hypothetical scenario, a near peer revisionist power launches a cyberattack followed by an offensive campaign to forcefully annex an independent nation state allied with the U.S. In order to provide a shield for maneuvers and deter a response, the adversary employs an anti-access area-denial (A2/AD) strategy which includes use of modern long-range surface-to-air missiles (SAMs) as part of an integrated air defense system (IADS). The threat of, and then initial use, of precision ballistic missile attacks forces U.S. and coalition partners into a standoff basing scenario, where aircraft and assets must be stationed outside the threat range of these weapons.

The U.S.-led coalition then readies itself to counter this A2/AD barrier with a strategy that depends heavily on the fifth generation fighter force assembled in the region using dispersed basing operations. Fortunately, thanks to policies guided by the new national defense strategy, the United States has moved to update disclosure policies for its partners and allies, and has built transparent security relationships to share intelligence data on potential threat systems. The coalition countries involved in this crisis have also exercised together against simulated high-end threats, using tactics that optimize lethality and sur-

vivability. At the technical level, the U.S. Air Force led the effort to help validate and improve MADL connectivity among F-35 partners before the crisis broke out, and moved to establish smart data sharing contracts that maximized passage of date within reasonable disclosure limits.

During the opening hours of this hypothetical conflict, coalition F-35s disperse to various multi-national bases where they are maintained and resupplied by coalition troops. These partner nations work hard to generate sorties with minimal required personnel, regardless of the country affiliation of the F-35 on the ramp. Many of the maintainers, crew chiefs, and weapons loaders are cross-trained to aid essential, routine functions for all U.S. fighter aircraft so they can support other variants that drop in to the base as well. For safety and security reasons, there is also at least one American maintainer at each location to oversee the maintenance on their own aircraft and perform sensitive "U.S.-only" functions.

During the opening hours of this hypothetical conflict, coalition F-35s disperse to various multi-national bases where they are maintained and resupplied by coalition troops. These partner nations work hard to generate sorties with minimal required personnel, regardless of the country affiliation of the F-35 on the ramp.

Launching from dispersed bases, a coalition force of USAF F-35As, USMC F-35Bs, USN F-35Cs, and coalition partner F-35s form the core of the initial counter-IADS strike sorties. While fourth generation aircraft operate from stand-off orbits due to the long reach of SAM systems, they support F-35 missions that are able to penetrate these long-range defenses and strike key IADS nodes. These strikes enable follow-on co-alition missions. The allied F-35 formations also use MADL to execute SEAD tasks across a wide offensive front. F-35s help geolocate and then map key IADS locations with their synthetic aperture radar (SAR) systems to generate targetable coordinates. Coalition F-35s seamlessly transmit locations and IDs of air and surface threats through MADL to complete the kill chain. These allied F-35 flights are able to successfully execute their missions with lower tactical risk, but still operate within acceptable levels of danger in order to sustain fewer losses. They are able to do so because of common understanding of fifth generation fighter TTPs, built over years of participation in high-end training exercises. Over the next several days of combat operations, the F-35s, integrated with other aircraft and weapon systems, degrade enemy IADS and begin to strike strategic targets for maximum effect on the enemy.

After sortie completion, these F-35 formations return to nearby coalition bases for refueling and reloading by allied maintenance teams, and F-35 pilots swap out with another pilot (from their respective country) for maximum sortie generation. Pilots are also able to complete minor updates to their aircraft mission file, such as inputs on new target locations and route points using a compact, deployable stand-alone version of the offboard mission planning system (OMS).

Over the subsequent days of the air war, with critical elements of the enemy IADS negated, fourth generation aircraft are then able to move forward over enemy territory. Through stealth's survivability advantages, the F-35s target the most lethal air and ground threats while passing off others to fourth generation aircraft. Because of the fused air and ground picture available to the F-35 pilots, they are able to advise and direct the flow of forces for maximum package lethality and survivability as the operation unfolds—dramatically enhancing the situational awareness of the entire combined force.

As the above scenario demonstrates, beyond traditional fighter capabilities, the F-35 can provide redundancy in distributed

command and control networks to help mitigate network attacks. The data sharing suite of the F-35 (which will eventually prove a key element of the combat cloud) achieves a degree of force multiplication that is able to at least partially compensate for the dramatic reduction in operational combat aircraft forces and readiness that has saddled the Air Force, and the U.S. military services, since the passage of the 2011 Budget Control Act.

The United States has accepted a higher level of risk by selling advanced U.S. stealth and sensor technology to other nations, and trusting our allies not to disclose these capabilities. That trust is built on the mutual understanding that it is in our allies' national interest to protect these capabilities.

The ability to execute at a high level in combat with very little warning from dispersed bases is a powerful advantage, but it cannot be generated overnight. Accordingly, the U.S. and its partners and allies affiliated with the F-35 must embark on the reforms identified in this paper as rapidly as possible—or risk having to learn these lessons in combat at a far higher price.

Conclusion

The F-35's journey from concept to development and deployment has proved long and resource intensive. The worth and value of this aircraft will be proven, however, in its ability to make other systems even better by sharing and exploiting vital information in combat as never before. The F-35 has the capability to share high volumes of critical data, which makes it an important element of what will become the combat cloud, but the tactics, techniques, procedures, and practices of this approach need to be realistically tested and implemented.

There are few DOD programs better postured than the F-35 to improve allied warfighting capability and overall relationships. However, an F-35 pilot will only be an effective force multiplier if F-35 aircraft systems can communicate seamlessly with other F-35s, and other aircraft. Future F-35-equipped coalition forces must operate with common TTPs and a shared mental model achieved through high-end training and tactics disclosure.

The United States has accepted a higher level of risk by selling advanced U.S. stealth and sensor technology to other nations, and trusting our allies not to disclose these capabilities. That trust is built on the mutual understanding that it is in our allies' national interest to protect these capabilities.

The United States, likewise, needs to trust our allies with the intelligence, information, and proven best tactics and practices that were previously not releasable, so they can optimally employ the F-35 and provide value-added combat capability. With American F-35s dispersed worldwide, the U.S. is absolutely dependent on regional allied capacity and capability to succeed in future combat operations. To optimize allied F-35 interoperability, the U.S. must remove the security and policy barriers that inhibit this objective and smartly share intelligence, technical information, tactics, techniques, and operating procedures with our allies. Only by doing this will America see the true potential of the F-35 as a revolutionary combat capability. ✪

Endnotes

1 Lt Gen Jeffrey L. Harrigian, USAF, author interview, 2016.

2 Joint Chiefs of Staff, *Joint Publication 3-0: Joint Operations,* JP 3-0 (JCS, January 17, 2017), http://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp3_0_20170117.pdf (all links accessed January 2019).

3 Gen David Goldfein, USAF, remarks to the U.S. Air Force fellows conference, September 8, 2017, Arlington, Virginia.

4 "Global Participation: The Centerpiece of 21st Century Global Security," Lockheed Martin: F-35 Lightning II website, https://www.f35.com/global.

5 Authors' note: Perspectives on the changed kill ratio during the exercise were noted from an outbrief for members of the 34th Fighter Squadron, after participating in Red Flag 17-1, held at Nellis AFB, NV from January to February, 2017, as well as comments from senior USAF officials. Also see, Valerie Insinna, "Red Flag Gives F-35A Its Toughest Test Yet," *Defense News*, February 3, 2017, https://www.defensenews.com/training-sim/2017/02/03/red-flag-gives-f-35a-its-toughest-test-yet/; Tom Demerly, "Red Flag Confirmed F-35 Dominance With a 20:1 Kill Ratio, U.S. Air Force Says," *The Aviationist*, February 28, 2017, https://theaviationist.com/2017/02/28/red-flag-confirmed-f-35-dominance-with-a-201-kill-ratio-u-s-air-force-says/.

6 Tony Capaccio, "F-35 Program Costs Jump to $406.5 Billion in Latest Estimate." July 10, 2017, *Bloomberg*, https://www.bloomberg.com/news/articles/2017-07-10/f-35-program-costs-jump-to-406-billion-in-new-pentagon-estimate.

7 "Global Participation: The Centerpiece of 21st Century Global Security," Lockheed Martin.

8 Ibid., 2.

9 Donald J. Trump, *National Security Strategy of the United States of America* (Washington, DC: The White House, December 2017), https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905-2.pdf, 27.

10 Ibid.

11 Evan S. Medeiros, et al., *Pacific Currents: The Responses of U.S. Allies and Security Partners in East Asia to China's Rise*, MG-736-AF2008 (Santa Monica, CA: RAND Corporation, 2008), https://www.rand.org/pubs/monographs/MG736.html, 17.

12 James Mattis, *Summary of the 2018 National Defense Strategy of the United States of America* (Washington, DC: Department of Defense, January 2018), https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf, 5.

13 Colin Clark, "F-16 Vs. F-35 in a Dogfight: JPO, Air Force Weigh in on Who's Best," *Breaking Defense,* July 2, 2015, https://breakingdefense.com/2015/07/f-16-vs-f-35-in-a-dogfight-jpo-air-force-weigh-in-on-whos-best/.

14 David Deptula, "Evolving Technologies and Warfare in the 21st Century: Introducing the 'Combat Cloud,'" *Mitchell Institute Policy Papers*, Vol. 4 (Arlington, VA: Mitchell Institute for Aerospace Studies, September 2016), http://docs.wixstatic.com/ugd/a2dd91_73faf7274e9c4e4ca605004dc6628a88.pdf.

15 Goldfein, "Air Force Association Air Warfare Symposium – Keynote Speaker General David Goldfein, Chief of Staff, U.S. Air Force," (symposium remarks, Orlando, Florida, February 23, 2018), http://www.af.mil/Portals/1/documents/csaf/CSAF_AFA_Orlando-23Feb18.PDF, 5.

16 Jeffrey Engstrom, *Systems Confrontation and Systems Destruction Warfare: How the Chinese People's Liberation Army Seeks to Wage Modern Warfare*, RR-1708-OSD (Santa Monica, CA: RAND Corporation, 2018), https://www.rand.org/content/dam/rand/pubs/research_reports/RR1700/RR1708/RAND_RR1708.pdf, iii.

17 Goldfein, "Air Force Association Air Warfare Symposium," (remarks, February 23, 2018), 8.

18 Ibid.

19 Eric Heginbotham, et al, *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996-2017*, RR-392-AF (Santa Monica, CA: RAND Corporation, 2015), https://www.rand.org/pubs/research_reports/RR392.html, 37.

20 Stephen Losey, "Air Force Wants to Grow from 55 to 60 Fighter Squadrons," *Air Force Times,* February 1, 2017, https://www.airforcetimes.com/news/your-air-force/2017/02/01/air-force-wants-to-grow-from-55-to-60-fighter-squadrons/.

21 Mattis, *Summary of the 2018 National Defense Strategy of the United States of America.*

22 Joe Pappalardo, "The Air Force chief of Staff on Cyberwar, the Next Generation of Stealth, and the Future of Air Warfare," *Popular Mechanics*, April 15, 2014, https://www.popularmechanics.com/military/a10406/pm-interview-air-force-gen-mark-a-welshiii-16698594/.

About The Mitchell Institute

The Mitchell Institute educates the general public about aerospace power's contribution to America's global interests, informs policy and budget deliberations, and cultivates the next generation of thought leaders to exploit the advantages of operating in air, space, and cyberspace.

About the Forum

The Mitchell Forum series is produced and edited by Marc V. Schanz, Mitchell Institute's director of publications. Copies may be reproduced for personal use. Single copies may be downloaded from the Mitchell Institute's website. For more information, author guidelines, and submission inquiries, contact Mr. Schanz at mschanz@afa.org or at (703) 247-5837.

About the Authors

Maj Luke Harris, USAF, is an F-35 Lightning II pilot currently assigned to Pacific Air Forces (PACAF) headquarters at Joint Base Hickam-Pearl Harbor, HI, where he serves as the Neptune Hawk exercise director, using his fifth generation operational experience to help integrate numerous Department of Defense organizations and U.S. military combat aircraft wings. Prior to his current assignment, he led PACAF's F-35 integration office, where he helped coordinate efforts for F-35 operations across the Asia-Pacific region and worked to improve integration and interoperability between the U.S. military services, allies, and regional partners. Prior to arriving at PACAF, Harris was part of the initial F-35A cadre at Hill AFB, UT, where he contributed to efforts to achieve initial operational capability for the Air Force's first combat-coded F-35 squadron, Hill's 34th Fighter Squadron. Additionally, he served as project officer for the first overseas deployment of the F-35 from Hill to Europe, and was lead planner for European Response Initiative training sorties in Bulgaria and Estonia. Harris is an F-35A evaluator pilot, and has more than 1,700 hours in the F-35A and F-16CJ, including 133 combat hours. He is a 2006 distinguished graduate of the U.S. Air Force Academy.

Col Max M. Marosko III, USAF, is an F-22 Raptor pilot, currently serving as the deputy director for air and cyberspace operations at PACAF. Marosko served multiple combat tours in the F-15C prior to transitioning to the F-22. In addition to serving as an Air Force Weapons School instructor in both the F-15C and the F-22, Marosko has commanded an F-22 squadron, and previously served as the 325th Operations Group commander at Tyndall AFB, FL prior to his current assignment. At the 325th OG, he oversaw both an operational F-22 squadron and the Air Force's only F-22 training squadron. Marosko also served in the initial training cadre for USAF's F-22 formal training unit, and is a graduate of the National War College at Fort McNair, Washington, DC.