Department of Defense

Unmanned Aircraft System Airspace Integration Plan

Version 2.0
March 2011

Prepared by:

UAS Task Force
Airspace Integration Integrated Product Team

This plan supersedes the 2004 "OSD Airspace Integration Plan for Unmanned Aviation"

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REVISION HISTORY

The following table defines all changes incorporated with this document.

Version	Date	Description of Change
Version 1	November 2004	Original Version released by OSD
Version 2.0	March 2011	Complete rewrite from Version 1

FOREWORD

Over the past decade, Unmanned Aircraft Systems (UAS) have become an integral part of the United States (U.S.) Military and Government operations. Currently, there are many different systems and thousands of aircraft fielded and/or deployed within the Department of Defense (DoD) and Other Government Agencies (OGAs). They also support operations for Homeland Security (HLS), Homeland Defense (HD), and Defense Support of Civil Authorities (DSCA). In support of their operational, training, and test and evaluation missions, DoD UAS require safe and routine access to the U.S. National Airspace System (NAS) similar to manned aircraft. Beyond the NAS, DoD's requirement to deploy globally into foreign and international airspace requires a high level of awareness of international law and conditions placed by foreign sovereigns on use of their territorial airspace.

The challenges of UAS Airspace Integreation (AI) are complex and multidimensional. They are influenced by the differences in UAS types, classes and types of airspace, Programs of Record (POR) requirements, available technologies, and specific mission needs. Without a clear regulatory path to integration, DoD intends to leverage new technologies, procedures, and policies to maximize regulatory compliance. This plan outlines a set of critical UAS flight profiles to identify and focus resources to tailor solutions that enable near term routine operations. Near-term efforts can help increase UAS access to the NAS immediately, while a full set of regulations, policy and procedures, standards, and technology must be developed and considered to allow UAS appropriate access to the NAS in a safe and efficient manner.

The Department of Defense recognizes integrating UAS into the NAS is essential to fulfill our airborne mission requirements. This plan supersedes the 2004 *OSD Airspace Integration Plan for Unmanned Aviation* and recognizes the importance of DoD to speak with a unified voice by establishing a new precept encouraging the Military Departments to "Engage as One".

WILLIAM J. LYNN, III

Deputy Secretary of Defense

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1 *OVERVIEW*

Over the past several years, Unmanned Aircraft Systems (UAS) have become a transformational force multiplier for the Department of Defense (DoD). When UAS were introduced into the front-line DoD aircraft force structure over a decade ago, small numbers of aircraft were fulfilling niche capabilities. This is no longer the case. The numbers and roles of UAS have expanded dramatically to meet overseas demands, and in some categories, more unmanned aircraft (UA) are budgeted than manned. Operational commanders have come to rely upon robust and persistent support based on unmanned platforms to execute their core missions against hostile forces.

While reliance on UAS continues to grow, the ability to integrate UAS into the National Airspace System (NAS) to support operations, training, and testing has not kept pace. Routine access to exercise and execute Combatant Command (COCOM)-tasked missions, and to support broader military and civil missions such as Homeland Security (HLS), Homeland Defense (HD), and Defense Support of Civil Authorities (DSCA) is necessary. Current NAS access for UAS is greatly limited under interim FAA policies that govern UAS operations in the NAS. Currently, DoD UAS operations conducted outside of Restricted, Warning and Prohibited areas are authorized under a temporary Certificate of Waiver or Authorization (COA) from the Federal Aviation Administration (FAA) or under limited conditions outlined in the 2007 DoD-FAA Memorandum of Agreement (MoA).[1] Although DoD has been able to facilitate a small number of flights through the COA process, DoD has not been able to obtain the level of airspace access necessary to accomplish the wide range of DoD UAS missions at current and projected operational tempos.

DoD UAS Operations Directly Support National Security

An emphasis on expanding unmanned payloads and military functions is critical for a nation at war during economically-challenging times while taking into account the interests of other airspace users. The DoD employs unmanned aircraft safely and will continue to do so. The DoD is working to incrementally eliminate restrictions and limitations associated with UAS by developing and implementing policies, standards, and technologies that will further justify and enable routine NAS access for all required DoD UAS missions.

In order for any military aircraft – manned or unmanned – to fly routinely in the NAS, three foundational requirements must be met:

(1) Aircraft must be certified as airworthy

(2) Pilots/Operators must be qualified to operate the aircraft in the appropriate class(es) of airspace

(3) Flight operations must be in compliance with applicable regulatory guidance

[1] Memorandum of Agreement for Operation of Department of Defense Unmanned Aircraft Systems in the National Airspace System, 24 Sep 07.

These three requirements form the foundation for UAS airspace integration. Title 10 of the United States Code, the legal underpinning for the roles, missions, and organization of DoD, provides authority for the military departments to organize, train, and equip U.S. forces, fulfilling the core duties for national defense. Consistent with this statutory authority, longstanding practice, and as reinforced by interagency agreements, DoD is responsible for establishing airworthiness and pilot training/qualification requirements for the military, and ensuring rigorous military standards are satisfied.[2] The third and most complex requirement, regulatory compliance, encompasses both internal military department and applicable flight regulations. Regarding flight in the NAS, DoD follows its own flight regulations as well as applicable FAA rules and regulations.

DoD Aircraft and Pilots/Operators Are Certified By DoD

1.1 DoD Equities in UAS NAS Integration

The requirements for conducting NAS operations are specifically tiered to the nature of the flight operations and the specific classes of civil airspace (described in Appendix E) accessed. For example, in order to operate in Class A airspace, a pilot/operator must be instrument-qualified and an aircraft must have specific types of equipage. To achieve routine NAS access for UAS, it is necessary to conduct a thorough UAS Airspace Integration (AI) effort. The DoD has a number of qualifications which make it uniquely positioned to be at the forefront of any UAS AI effort:

- Largest operator of unmanned aircraft in the world
- World-class aviation research and development expertise
- Established partnerships with the FAA, National Aeronautics and Space Administration (NASA), Department of Homeland Security (DHS), and others
- Longstanding systems and processes for safety lifecycle management
- Unparalleled control over DoD aircraft, operators, facilities and airspace
- Largest regulator (outside the FAA) of aircraft and pilots, certificator of aircraft, employer of air traffic controllers, manager of airspace, and operator of airfields
- Long history of U.S. aviation/certification firsts - e.g. jet propulsion, fly-by-wire, Global Positioning System (GPS)

The DoD is Uniquely Positioned to Lead UAS Airspace Integration for Public Aircraft

1.2 Vision, Purpose, and Objectives

Vision. The DoD's vision is to ensure UAS have routine access to the appropriate airspace required to meet mission needs. For military operations, UAS will operate with

[2] Title 10 provisions relating to Service authority to organize, train, and equip includes 10 U.S.C. Sec. 8062 (Air Force), 10 U.S.C. Sec. 3062 (Army), 10 U.S.C. Sec. 5062 (Navy), and , 10 U.S.C. Sec. 5063 (Marine Corps), There are multiple service instructions addressing airworthiness standards, for example, AIR FORCE INSTRUCTION 62-601, of 11 JUNE 2010.

manned aircraft using Concepts of Operations (CONOPS) that make manned or unmanned aircraft distinctions transparent to Air Traffic Service (ATS) authorities and airspace regulators. Having robust UAS AI capabilities for all classes of U.S. airspace will facilitate worldwide UAS deployment.[3]

Purpose. In November 2004, the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD (AT&L)) developed the initial Office of the Secretary of Defense (OSD) Airspace Integration Plan for Unmanned Aviation to establish the strategies for integrating DoD's UAS into the NAS. This 2010 version supersedes previous versions and updates the DoD's approach, which is summarized by four overarching precepts:

(1) ***Apply Our World-leading Aviation Expertise to UAS*** – The U.S. military is the most experienced aircraft developer, operator and regulator in the world. The policies and processes used to build our most advanced aircraft will guide us in developing the safest, most capable UAS fleet possible.
(2) ***Conform Where Possible, Create Where Needed*** – We will strive for maximum compliance with existing regulatory guidance, and inform regulatory processes when changes are needed to enhance effectiveness and/or safety.
(3) ***Leverage DoD Authorities and Equities*** – Fully exercise the Department's statutory authorities to certify its aircraft, pilots/operators, and systems. DoD will design, test, and ultimately certify its UAS and supporting systems as fully compliant with applicable standards, regulations and orders.
(4) ***Engage as One*** – The regulatory and policy challenges we face are broad in scope with far reaching impact -- none uniquely affect a single military department, COCOM, or activity. Military departments, COCOMs, and other Department activities should make every effort to coordinate through the DoD Policy Board on Federal Aviation and the UAS Task Force prior to engagement with the FAA or other external agencies on UAS airspace integration matters.

Objectives. Prior to updating the 2004 version of the OSD UAS Airspace Integration Plan, several objectives were established. These objectives are intended to provide scope and direction to the creation of this updated plan:

- Outline DoD's equities in UAS Airspace Integration
- Present an incremental DoD NAS access strategy
- Define foundational activities for NAS access
- Identify validation activities needed to achieve compliance
- Define capabilities needed for current and future operations
- Inform the UAS Executive Committee's (ExCom) NAS Access Plan development

[3] Office of the Secretary of Defense Unmanned Systems Roadmap (2009-2034), 06 Apr 2009, pg 91.

1.3 Authorities and Responsibilities

DoD Authorities/Responsibilities for UAS NAS Integration. As previously stated, the Military departments and appropriate COCOMs certify their aircraft and pilots/operators. Each military department implements exhaustive airworthiness guidance and tailored UAS pilot/operator training programs to meet safety standards and the warfighting requirements of the COCOMs. The Military Departments ensure their aircraft and pilots/operators comply with appropriate standards and regulations. This is analogous to non-aircraft operations such as military Humvees on public roads. The Military Departments are solely responsible for ensuring the vehicles comply with applicable federal, state, and local laws and that its drivers are qualified to operate them. No outside organization inspects any equipment or scrutinizes a driver's qualifications.

FAA Authorities/Responsibilities for UAS NAS Integration. The FAA authority to regulate aviation activities is granted by statute. Title 49, U.S.C. §40103 specifically grants the FAA Administrator the authority to "develop plans and policy for the use of the navigable airspace and assign by regulation or order the use of the airspace necessary to ensure the safety of aircraft and the efficient use of airspace."

DoD and Non-DoD Stakeholders. The DoD's strategy is to harness and align all DoD AI activities and resources towards a unified solution. These activities will be fully integrated and leveraged with current and prior civil efforts such as RTCA SC-203 (U.S. civil standards development) and EUROCAE WG-73 (European civil standards development). The DoD UAS Task Force was formed to coordinate critical DoD UAS issues and develop and implement a strategic plan to promote UAS integration. Within the task force, the AI Integrated Product Team (IPT) coordinates AI activities with OSD, the military departments, Interagency Groups, and COCOMs. DoD also regularly interfaces with several external stakeholders including the FAA, DHS, NASA, Joint Planning and Development Office (JPDO), Standards Development Organizations (SDO), and academia. Appendix C contains a list of major stakeholders.

1.4 Executive Committee Partnership

The National Defense Authorization Act (NDAA) for Fiscal Year 2009[4] included a recommendation to form a joint Department of Defense–Federal Aviation Administration executive committee (ExCom) on conflict and dispute resolution. The Executive Committee was proposed as a focal point for senior leaders to resolve any policy and procedural disputes, and to identify solutions to any concerns regarding the integration of DoD UAS into the NAS. Subsequent discussions between DoD and FAA executives led to the addition of DHS and NASA in the ExCom to capture other federal agency efforts and equities. Senior executives from all four organizations meet periodically to resolve the challenges preventing UAS from routinely operating within the NAS.

[4] National Defense Authorization Act for Fiscal Year 2009, Public Law 110-417, October 14, 2008, Section 1036 "Sense of Congress on Joint Department of Defense-Federal Aviation Administration Executive Committee on Conflict and Dispute Resolution."

1.5 Way Forward

The DoD is focusing on near-term, mid-term and far-term activities to accomplish UAS integration. This allows immediate improvements in NAS access, while working towards viable far-term solutions.

Near-Term Activities address small UAS (sUAS), DoD-controlled airspace, and operations under COAs**.** Priority is given to initiatives that reduce COA requirements and streamline the FAA approval process. The DoD believes significant near-term improvement in UAS NAS access is achievable through COA, policy, and procedural initiatives. **Specific goals include:**

(1) Update the 2007 DoD-FAA MoA[5] to increase access to specific categories of airspace
(2) Improve the COA application and approval process
(3) Formally ratify safety case methodology and appropriate level of safety

Mid-Term Activities address local airfield and transit operations, such as investing in standards and technology, developing validated airspace integration requirements and associated standards, and establishing a Sense and Avoid (SAA) capability. **Specific goals include:**

(1) Certify and field a Ground Based Sense and Avoid (GBSAA) system
(2) Standardize procedures for separation, avoidance, coordination, and contingencies
(3) Develop GBSAA Fielding Plan that guides implementation at any UAS basing location.

Far-Term Activities address all UAS missions in any operating location and airspace. The end state is routine NAS access comparable to manned aircraft for all DoD UAS. **Specific goals include:**

(1) Develop and approve all other technical standards and performance specifications
(2) Develop, certify, and field Airborne Sense and Avoid (ABSAA) system and GBSAA/ABSAA collaborative solutions
(3) Develop, certify and field other UAS-enabling technologies
(4) Leverage NextGen initiatives for UAS development activities such as the Automatic Dependence Surveillance-Broadcast technology

The remainder of this plan lays out a course of action for achieving DoD's vision.

[5] Memorandum of Agreement for Operation of Department of Defense Unmanned Aircraft Systems in the National Airspace System, 24 Sep 07.

2 DOD UAS NAS ACCESS REQUIREMENTS

DoD UAS have become a critical component of military operations. DoD UAS flew over 450,000 flight hours in 2009 for missions including Operations Enduring Freedom and Iraqi Freedom (exclusive of hand-launched systems, see Figure 1). They are beginning to take an active role in HD, HLS, DSCA, and other domestic operations.

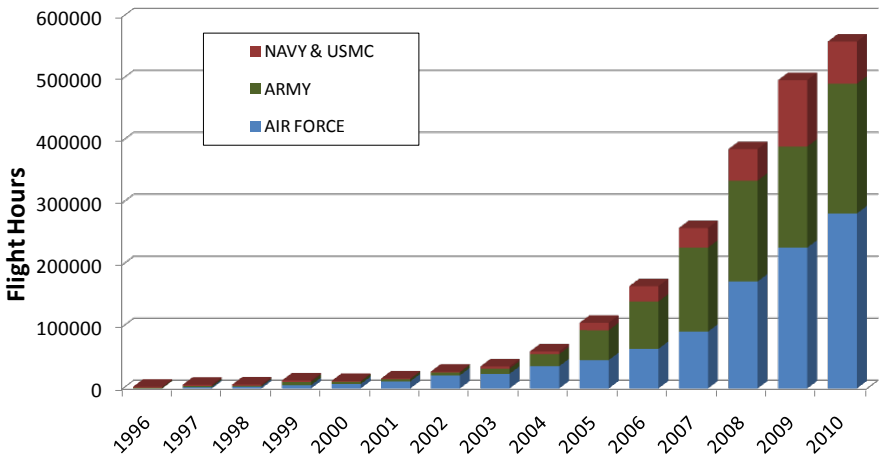


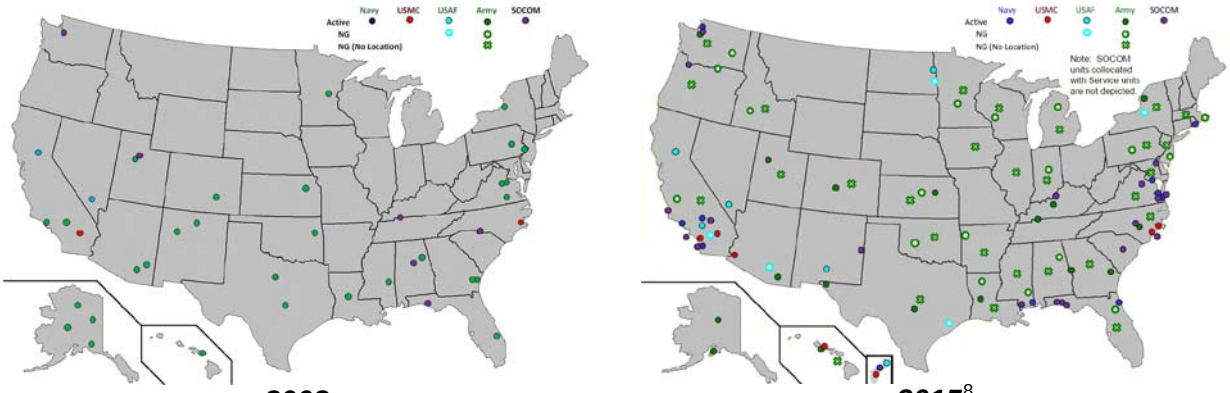
Figure 1: Worldwide DoD UAS Operations and Training

Operational Missions. The DoD needs to operate UAS in the NAS to execute operational tasking, typically from a COCOM such as the United States Northern Command (NORTHCOM). Many of these tasked missions relate to HD, HLS, and DSCA. This includes border and port surveillance, maritime operations, and disaster or special event support. The DoD currently has 146 UAS units based at 63 contiguous United States (CONUS) locations. By 2015, the Joint UAS Center of Excellence (JUAS COE) estimates the DoD will have 197 units at 105 locations - a 35% increase in units and 67% increase in number of locations.[6] Small UAS (Group 1) are expected to comprise the majority of total UAS flight hours. As a result, most of the required airspace will be Class E and G, which contains the majority of non-cooperative traffic and the highest accident potential.[7] Similar UAS operational needs are rapidly evolving for Other Government Agencies (OGAs). Also, due to global deployment requirements, DoD's UAS operational and training needs extend into international and foreign airspace.

Training Missions. To maintain a high degree of combat readiness, the Military Services and appropriate COCOMs need to conduct realistic UAS and integrated training in the NAS prior to operational missions. Service training missions will continue to increase as UAS return from combat zones to the U.S. Collective and continuation training will be required to maintain UAS proficiencies and mission readiness. Individual, unit-level, and multi-Service/Joint

[6] Joint Unmanned Systems Center of Excellence, *National Airspace Integration*, March 2010
[7] Unmanned Aircraft Systems Airspace Integration briefing - Mr. Dyke Weatherington, Deputy Director, Unmanned Warfare, OUSD(AT&L)/PSA, 24 March 2009

exercise collective and continuation training will compete for airspace with Operational Missions and Support Missions, while UAS inventories (military and civilian) grow.



2008 ***2015***[8]

Figure 2: Representative DoD UAS Locations

For each UAS, the military departments and COCOMs establish training and readiness matrices that require training missions to maintain the qualifications and proficiency of pilots/operators, other crewmembers, and maintainers. To meet these requirements, military departments and COCOMs must maintain proficiency in areas such as line-of-sight operations, launch/recovery operations, orbit operations, ground target tracking operations, and night operations. Line-of-sight (LOS) operations may require access to portions of Class G and E airspace with a horizontal radius of approximately 100 nm.[9] Launch/Recovery operations can be conducted in conjunction with LOS operations for UAS Groups 1-3 (see Appendix D for UAS Group descriptions), but Group 3 and larger UAS, such as Predator or Global Hawk, may require access to terminal airspace (e.g., Class C and D). Unlike the above two operations, long-range reconnaissance UAS will need to fly across vast geographical regions (orbit operations) to fulfill their operational objectives, mainly in Class A and E airspace. The military departments and COCOMs need to conduct low- to mid-altitude ground target tracking operations, typically in Class G and E airspace.[10] Integrated training with supported units and civil agency counterparts is also needed to maintain readiness.

<u>Support Missions</u>. Support missions primarily involve UAS development testing, acceptance testing, and post-maintenance check flights. These missions also include the development and integration of payloads into the Unmanned Aircraft (UA), verifying procedures, ferry flights, and other missions that are not dedicated operational or training missions.

UAS have become an integral part of operations for DoD and other government agencies. UAS perform a wide range of DoD operational and training missions and support HD, HLS, DSCA, and other domestic operations. The missions, units, and locations continue to expand at a rapid rate with evolving airspace requirements.

[8] *National Airspace Integration*, Joint Unmanned Aircraft Systems Center of Excellence, March 2010
[9] JUAS COE Briefing for R&E IPT, 07Jul09
[10] OSD UAS AIP Overview for FAA UAS Conference, 23Feb10

3 DOD UAS NAS ACCESS METHODOLOGY

The DoD's UAS NAS access methodology includes the interrelated set of UAS Groups, required airspace, incremental capabilities, and implementation activities/products required to attain routine operations within the NAS. This methodology uses an incremental approach (Figure 3) to provide DoD UAS access to a given operations profile prior to implementing a full dynamic operations solution. This methodology recognizes that the DoD requires access to differing classes and types of airspace (described in Appendix E) as soon as possible, and that routine dynamic operations will likely take several years to implement.

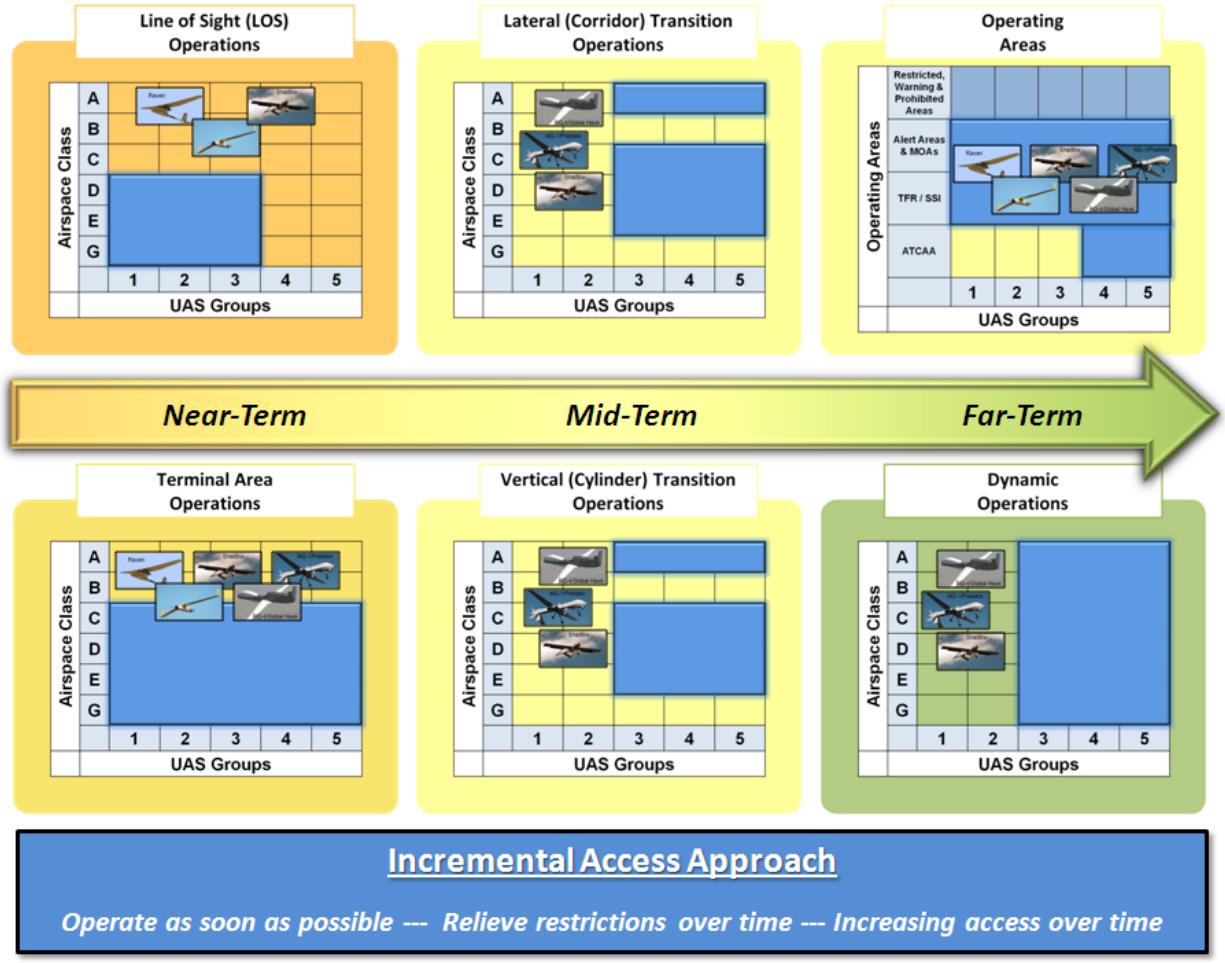


Figure 3: Incremental Access Approach

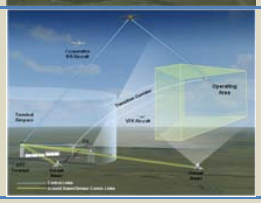
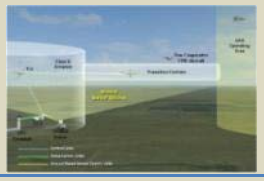
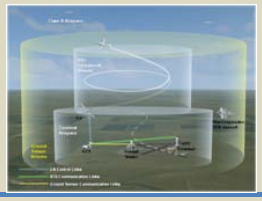
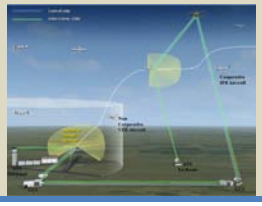
Plans and programs to enable UAS operations within a profile will be evaluated for joint applicability and NAS access utility. OSD will work with stakeholders to coordinate and integrate these programs into a coherent access enterprise by ensuring that foundational access activities meet overall near-, mid-, and far-term objectives. For example, since ~90% of the required near-term airspace for DoD UAS will be in Class D, E and G, the DoD intends to focus much of its near-term resources on addressing this major need.[11]

[11] Joint UAS Center of Excellence Report of Results, Unmanned Aircraft System (UAS), Integration into the U.S. National Airspace System (NAS), 12 Dec 08.

3.1 DoD UAS NAS Access Profiles Summary

The capability development identified by OSD follows a set of access profiles. Serving as a capabilities toolbox, the goal is to establish the necessary policies, procedures, and technology solutions for each access profile that enables UAS operations. The end result is operational, training, and support mission capabilities for the Warfighter. Table 1 summarizes example capabilities provided by each access profile across the missions.

Table 1: Airspace Access Profiles and Example Mission Capabilities

	Access Profiles	Operational Missions	Training Missions	Support Missions
Visual Line of Sight		• Tactical surveillance & reconnaissance • Disaster relief-DSCA	• Pilot/Operator qualification proficiency • Combat readiness	• Development & test • Maintenance & checkout
Terminal Area		• Local security (e.g. event & emergency)	• Take-off / landing proficiency • Orbit proficiency • Check-flights	• Development & test • Maintenance & checkout
Operating Areas		• Local security (e.g. event & emergency)	• Orbit proficiency • IFR Qualification & proficiency • Combat readiness • Check-flights	• Development & test • Maintenance & checkout
Lateral Transit		• Convoy & roadway security • Border patrol • Deployment	• Transit to training airspace • Training for convoy/roadway	• Development & test • Ferry (e.g. contractor to test facility)
Vertical Transit		• Transit to Class A controlled airspace for all operational missions	• IFR Qualification & proficiency • Combat readiness • Orbit operations	• Development & test • Ferry
Dynamic		• All operational missions	• All training missions	• All support missions

3.2 Visual Line-of-Sight (VLOS) Operations

VLOS Operations (Figure 4) call for a visual observer to be in sight of the UAS, surrounding air traffic, ground/weather hazards, and in direct communication with the pilot/operator during the flight. The observer can be located on the ground, in a moving vehicle/boat, or in a chase plane. Air traffic control communications may or may not be required based on operations and location.

Incremental Capability • Establishes a means to conduct UAS operations in Visual Flight Rules (VFR) conditions **Airspace Classes Enabled** • Class D, E & G operations	**UAS Group(s) Supported** • Groups 1, 2 • Some Group 3 **Implementation Needs** • DoD-FAA MoA • sUAS Special Federal Aviation Regulation (SFAR) • Airworthy UAS • Qualified observer, pilot and operator

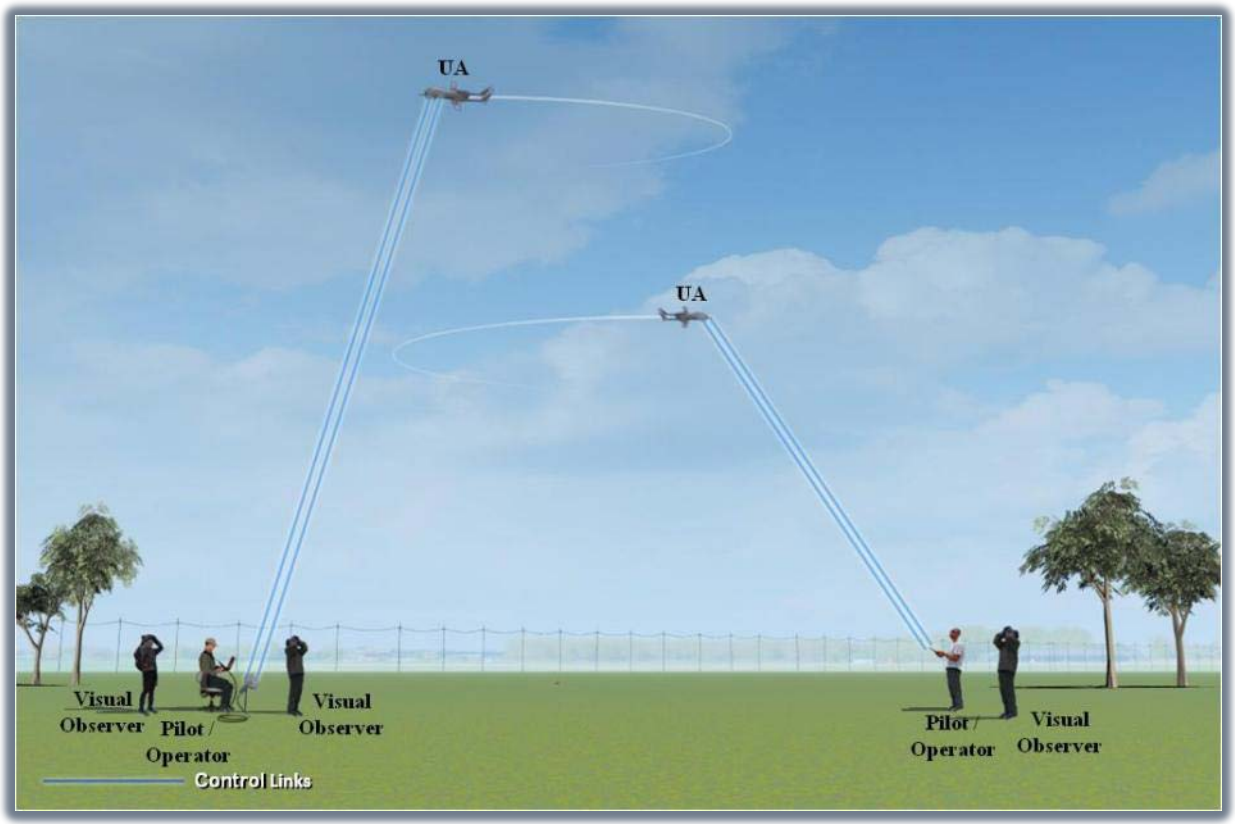


Figure 4: Visual Line-of-Sight Operations

3.3 Terminal Area Operations

Terminal Area Operations (Figure 5) are intended to facilitate UAS operations in a confined volume of airspace near a regional terminal area or near a restricted airspace. To ensure safe UAS operations in the terminal environment, this concept utilizes ground-based observers or sensor technology capable of scanning beyond the edges of the confined operational airspace volume. The observers or sensors alert the UAS pilot/operator of approaching traffic so actions may be taken to avoid potential collisions with other traffic. Alone or in conjunction with participating air traffic controller (ATC), UAS can effectively conduct their training and other missions without impacting the safety of other manned aircraft and the controller's workload.

Incremental Capability • Ability to operate in confined volume of airspace • Facilitates terminal operations and training (e.g. take-off & landing) • Ground sensors for separation **Airspace Classes Enabled** • Class C, D, E, and G operations	**UAS Group(s) Supported** • All Groups **Implementation Needs** • DoD Class D procedures • Enabling technologies (e.g. GBSAA) or observers • Airworthy UAS • Qualified pilots/operators

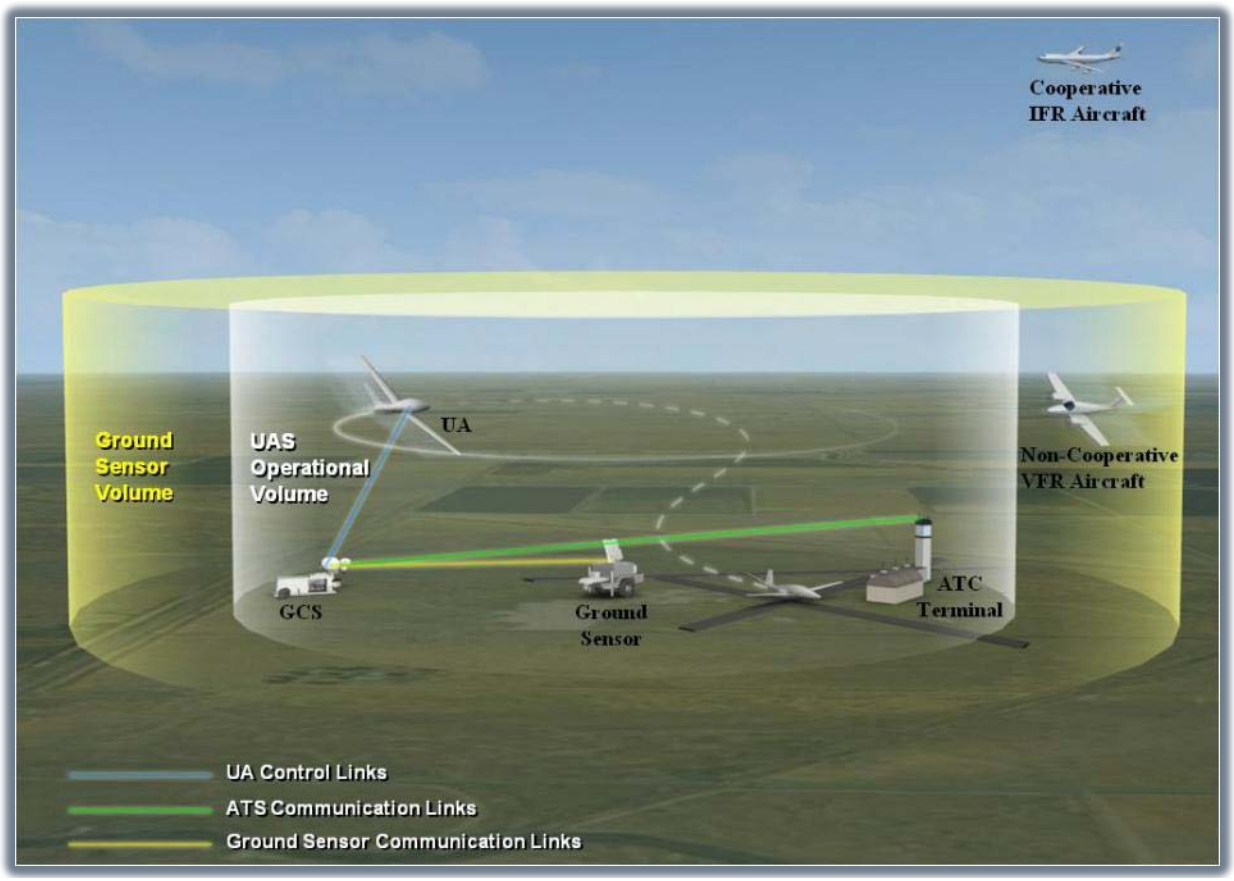


Figure 5: Terminal Area Operations

3.4 Operating Areas

DoD has a longstanding need to operate UAS freely and at their discretion within given volumes of airspace that are designated or created to support military activities, such as Military Operating Areas (MOAs), Restricted Areas, and Warning Areas (Figure 6). In addition, DoD UAS may be called upon to support operations within airspace created or designated to accomplish specific mission requirements, such as disaster relief support or special security activities. Examples of such categorized areas are included in the table at right.

UAS Operating Areas

Special Use Airspace	Other Airspace
• Alert Area • Military Operations Area (MOA) • Prohibited Area • Restricted Area • Warning Area • Danger Area	• Air Traffic Control Assigned Airspace (ATCAA) • Temporary Flight Restriction (TFR) • Special Security Instruction (SSI) Airspace

While the Military Departments already have limited access to Restricted, Warning, and Prohibited Areas[12], much of their core training needs cannot be addressed in these areas due to issues with proximity, volume, access, and scheduling. Developing and validating access methods for certain other military training airspace resolves these issues and ensures availability of a nationwide framework of military UAS training airspace. In particular, MOAs are exceptionally well-suited for DoD UAS operations. By definition, MOAs are "airspace established outside Class A airspace to separate or segregate certain nonhazardous military activities from IFR Traffic and to identify for VFR traffic where these activities are conducted."[13] UAS operations are inherently non-hazardous, however they require a certain level of segregation in order to appropriately exercise their full capabilities. MOAs clearly identify to other NAS users that military specific operations may be conducted, and that associated risks are associated with transit through them.

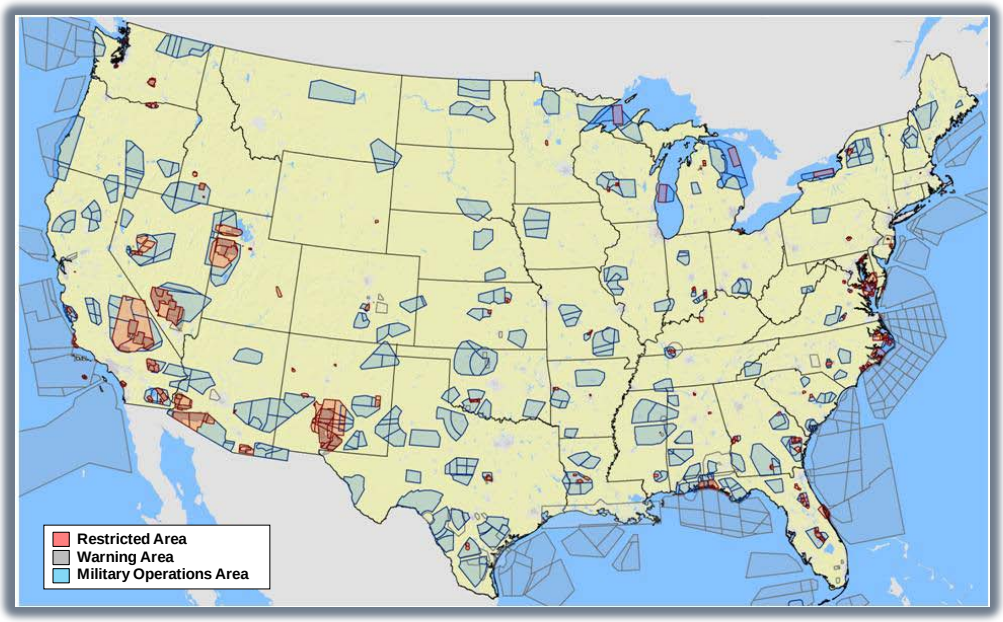


Figure 6: Special Use Airspace

[12] Memorandum of Agreement for Operation of Department of Defense Unmanned Aircraft Systems in the National Airspace System, 24 Sep 07.
[13] 14 CFR §1.1

Nearly 500 existing MOAs can provide DoD UAS the ability to span 43 states and over a half million square miles of operating space. MOAs provide a robust, nationwide UAS training capability to Active and National Guard units without the creation of new airspace categories. Utilizing existing MOAs would allow DoD UAS ready access from a wide variety of locations, and enable military units to "train as they fight" alongside other DoD assets in military-designated airspace specifically designed for military training (Figure 7).

Incremental Capability • Enables safe operations within designated Operating Areas • Alert local traffic of UAS activity • Relies on ground sensors and/or ATC for traffic advisories **Airspace Classes Enabled** • Special Use Airspace • Other Airspace	**UAS Group(s) Supported** • All Groups **Implementation Needs** • Procedures (e.g. lost link, divert, recovery) • Enabling technologies (e.g. GBSAA, ABSAA) • Airworthy UAS • Qualified pilots/operators

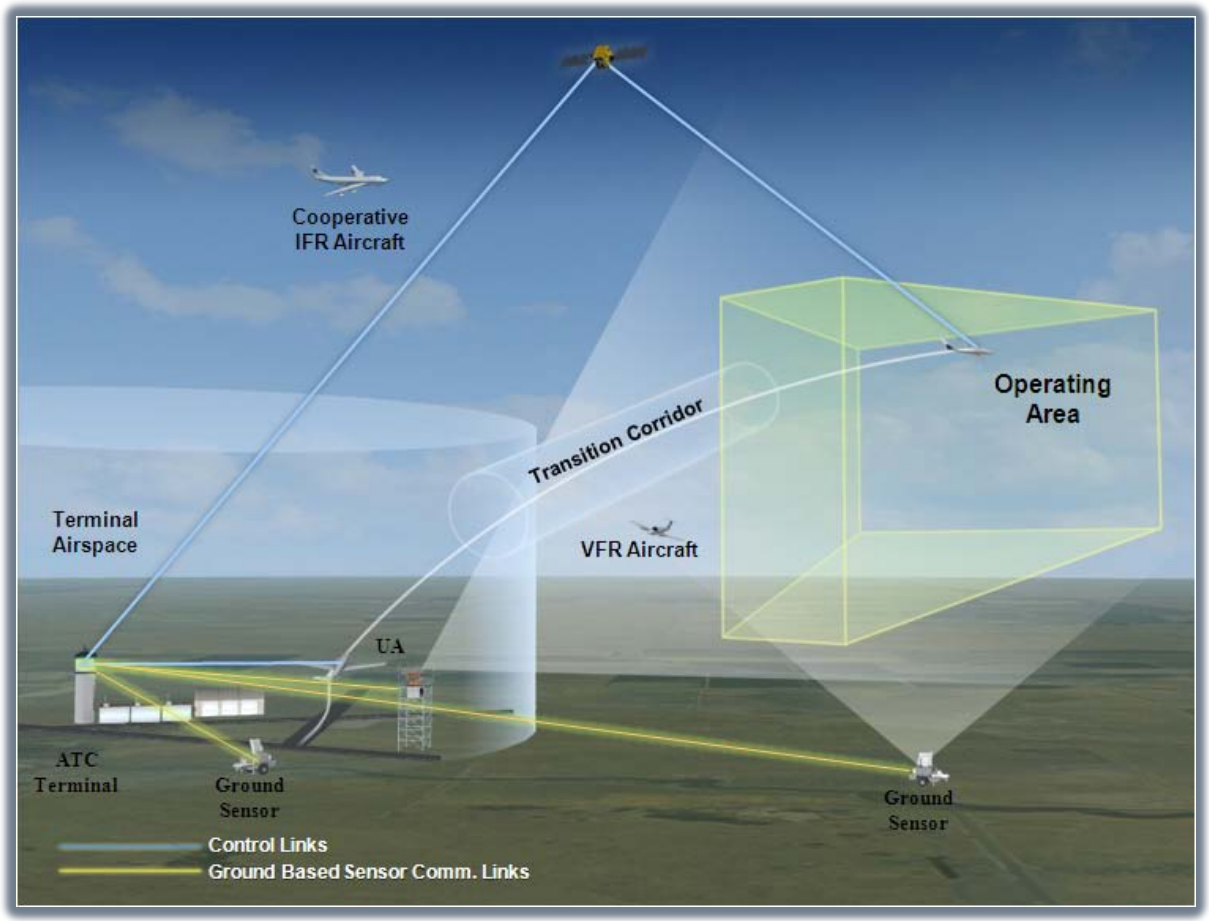


Figure 7: UAS Operating Areas

3.5 Lateral Transit (Corridor) Operations

Lateral Transit (or "Corridor") Operations (Figure 8) consist of flying from one controlled airspace to another through a pre-defined corridor. Corridor operations can be between terminal, restricted, or any other controlled airspaces. The corridors can potentially be implemented at any altitude, but typically reside in Class E airspace (above 1200 ft AGL, but below 18,000 ft MSL).

Incremental Capability	UAS Group(s) Supported
• Enables safe transition through a predefined horizontal corridor bridging two volumes of airspace (e.g. Class D & Restricted Area) • Corridor can be implemented at any altitude • Relies on ground sensors for separation **Airspace Classes Enabled** • Class A, C, D, E, and G operations	• Groups 3, 4, and 5 **Implementation Needs** • Procedures (e.g. lost link, divert, recovery) • Enabling technologies (e.g. GBSAA, ABSAA) • Airworthy UAS • Qualified pilots/operators

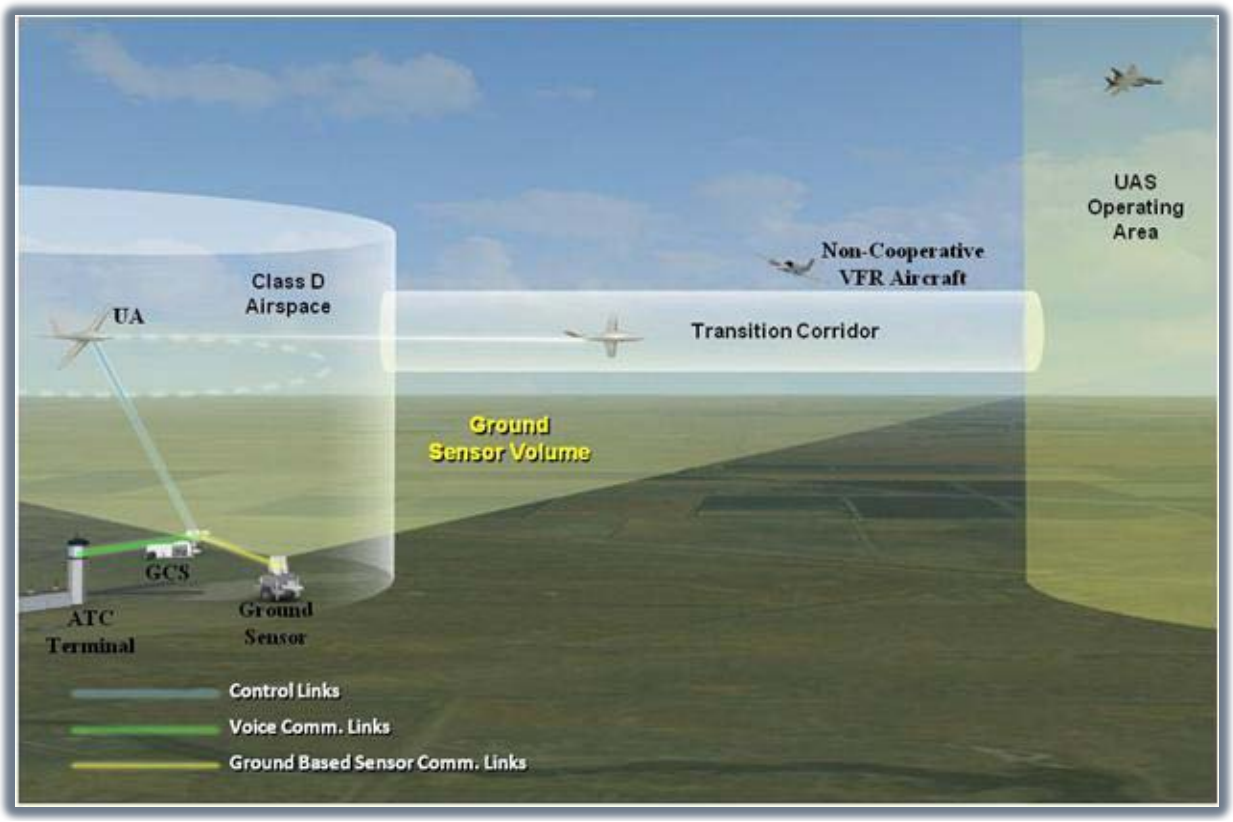


Figure 8: Lateral Transit (Corridor) Operations

3.6 Vertical Transit (Cylinder) Operations

Vertical Transit (or "Cylinder") Operations (Figure 9) consist of a spiral climb or descent within controlled airspace to / from Class A controlled airspace (18k – 60k feet) or a designated corridor altitude. The airspace in which the spiral climb/descent takes place can be a terminal area, military restricted/warning area, or other controlled airspace.

Incremental Capability	UAS Group(s) Supported
• Enables safe transition through a predefined vertical corridor that bridges a lower and a higher body of airspace • Corridor can be implemented at any altitude • Relies on ground sensors for separation **Airspace Classes Enabled** • Class A, C, D, and E operations	• Groups 4 and 5 **Implementation Needs** • Procedures (e.g. lost link, divert, recovery) • Enabling technologies (e.g. GBSAA, ABSAA) • Airworthy UAS • Qualified pilots/operators

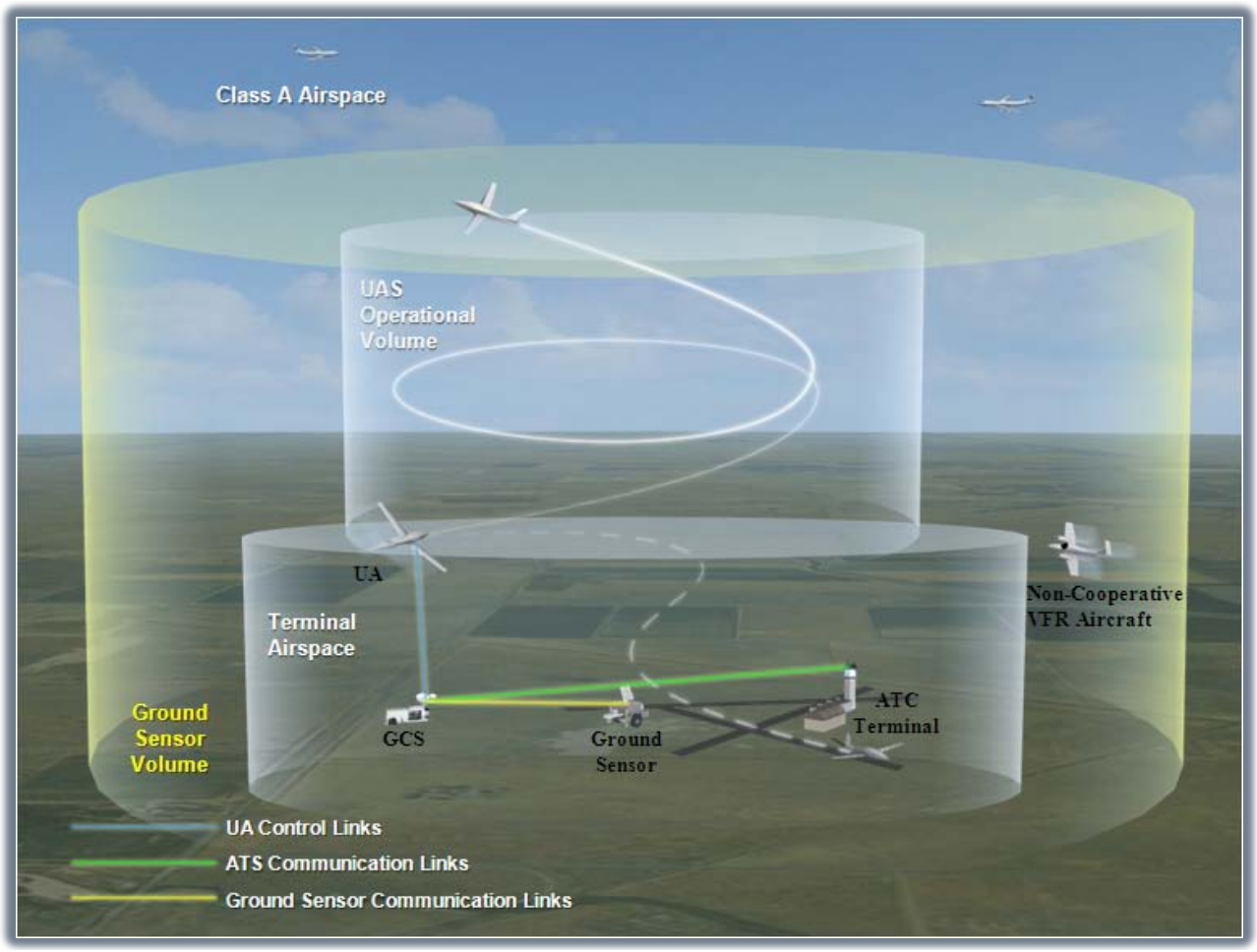


Figure 9: Vertical Transit (Cylinder) Operations

3.7 Dynamic Operations

Dynamic Operations (Figure 10) for routine operations envisions that the UAS will possess the ability to integrate routinely into the NAS comparable to today's manned aircraft. This concept enables the proponent of an appropriately equipped UAS to file a flight plan and then perform the activities listed in that flight plan with unfettered accesses to the airspace.

Incremental Capability • Provides safe conduct of routine operations within the NAS comparable to today's manned aircraft • Relies on airborne sensors to detect other aircraft and autonomously perform self-separation and collision avoidance **Airspace Classes Enabled** • All airspace classes	**UAS Group(s) Supported** • Groups 3, 4, and 5 **Implementation Needs** • Adopted technical standards for UAS • Enabling technologies (e.g. GBSAA, ABSAA) • Airworthy UAS • Qualified pilots/operators

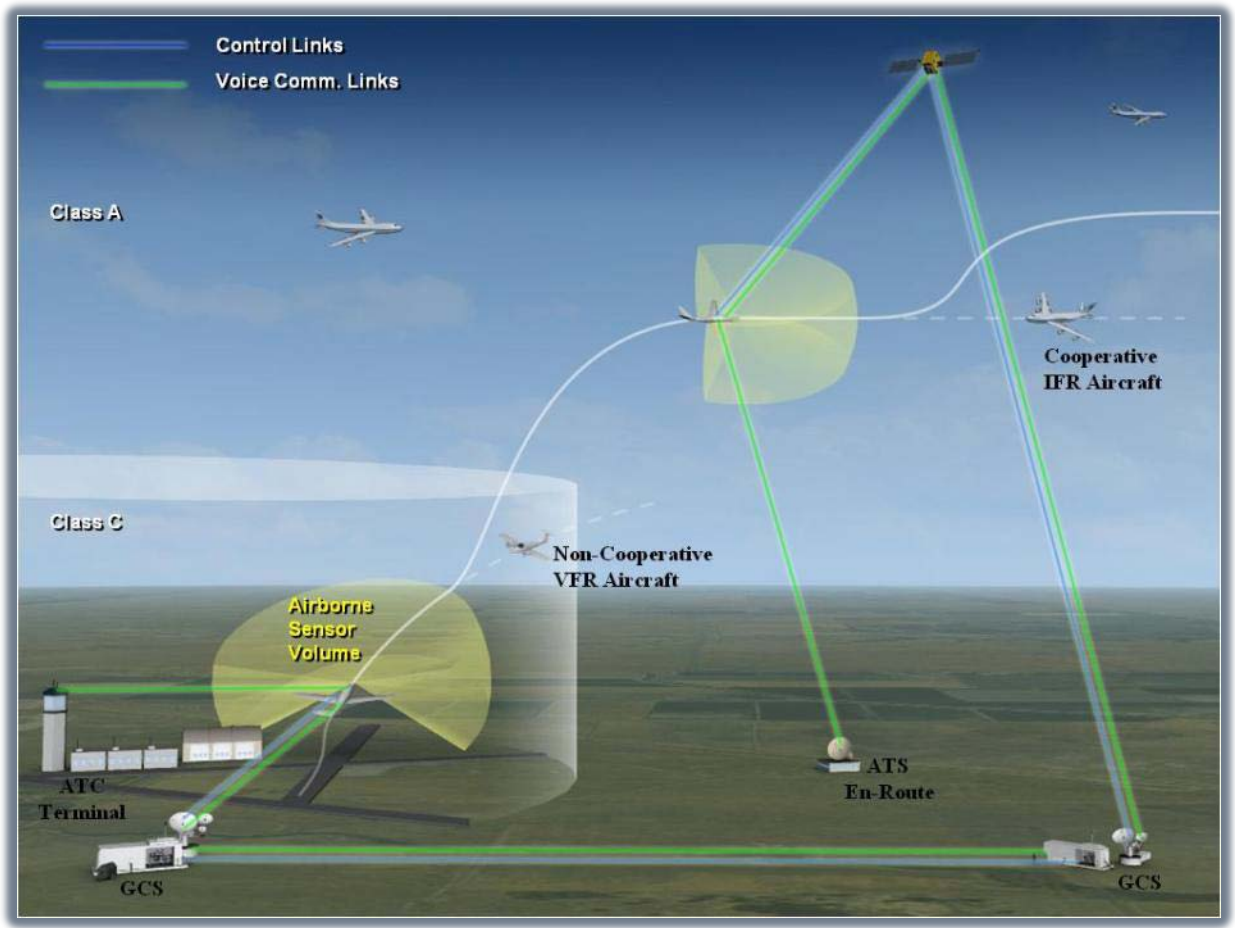
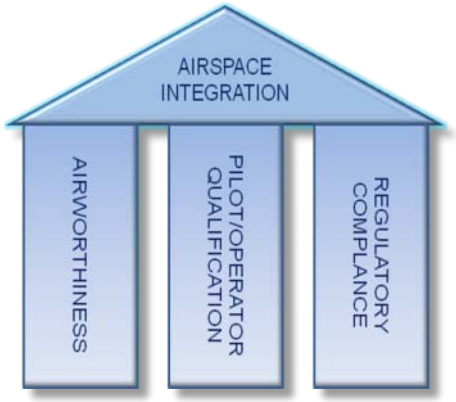


Figure 10: Dynamic Operations

In summary, the DoD's UAS NAS access methodology uses an incremental approach to provide DoD UAS access to one or more of the six operations profiles and recognizes that the DoD requires access to differing classes and types of airspace as soon as possible. The need for DoD UAS access to the NAS will continue to increase over the next few years. This includes training and domestic operations missions, as previously described. The use of airspace access profiles will enable the Warfighter to implement operations incrementally and prior to a full dynamic operation capability. Once Dynamic Operations access is implemented, the other profiles become the exception instead of the standard.

4 FOUNDATIONAL REQUIREMENTS

For routine access to the NAS, it is the goal of DoD and FAA to conduct UAS operations safely and expeditiously, present no threat to the general public, and do no harm to other users of the NAS.[14] In furtherance of this goal, and in keeping with existing DoD practices, DoD will require that UAS aircraft are:



1) ***Airworthy***
2) ***Operated by a Qualified Pilot/Operator***
3) ***Compliant with Operating Rules, Standards, and Procedures***

These three requirements form the foundation for UAS airspace integration. Providing these three requirements are met, the Department's UAS should be able to safely access and integrate into the NAS.

4.1 Airworthiness

Airworthiness is a basic requirement for any aircraft system, manned or unmanned, to enter the airspace. Military handbook MIL-HDBK-516B defines airworthiness as "the ability of an aircraft system/vehicle to safely attain, sustain and terminate flight in accordance with an approved usage and limitation".[15]

Airworthiness Certification is the process that attests to or certifies the compliance of the aircraft system/vehicle to applicable airworthiness standards and results in the airworthiness approval of the as-flown configuration. Determination of the applicable standards are based on the UAS configuration (i.e., hardware, software, command and control elements, etc.) as well as the UAS usage and environment as determined from analysis of program requirements (e.g., a requirement for world-wide UAS deployment). Airworthiness Certification ensures that DoD aircraft systems are designed, manufactured, and maintained to enable safe flight. Certification criteria, standards, and methods of compliance establish a minimum set of design and performance requirements for safely flying a given category and class of aircraft. Certification takes into account system configuration, usage, environment, and the hardware and software of the entire system (e.g. aircraft, control stations, control and communications (C&C) data links). It also considers design characteristics, production processes, reliability, and in-service maintenance procedures that adequately mitigate risk of injury/damage to people, property and and/or the environment. For this reason, safety considerations related to the overflight of populated areas in both segregated and non-segregated airspace are taken into

[14] Memorandum of Agreement Concerning the Operation of Department of Defense Unmanned Aircraft Systems in the National Airspace, dated 24 Sep 07.
[15] MIL-HDBK-516B with change 1, *Airworthiness Certification Criteria*. dated 29 Feb 2008

account by the military department airworthiness authority. Each military department already has a robust, safe, and repeatable airworthiness certification process for manned aircraft. The DoD is developing a full set of UAS-specific airworthiness criteria, standards, and methods of compliance so that DoD UAS can routinely access the NAS with fewer operational restrictions.

Responsibility for Certifications. As previously discussed, DoD is responsible for establishing airworthiness and pilot training/qualification requirements for the military, and ensuring rigorous military standards are satisfied. Title 10 provides the legal basis for the roles, missions, and organization of all DoD military departments and COCOMs. Consistent with this authority, the DoD organizes, equips and trains our armed forces to preserve the peace, security, and provide for the defense of the United States.

MIL-HDBK-516B. The primary guidance for DoD airworthiness certification is found in MIL-HDBK-516B, *Airworthiness Certification Criteria*. This is the foundational document that establishes the criteria and basis for determining the airworthiness of all manned, unmanned, fixed wing, and rotary wing aircraft systems/vehicles. UAS program offices are ensuring their program requirements align with appropriate airworthiness documents. In accordance with the 2009 OUSD (AT&L) Memo for UAS Airworthiness Criteria[16], the top priority for FY 2010 airspace integration funding is to update the MIL-HDBK-516 with UAS-specific criteria.

4.2 Pilot/Operator Qualification

The DoD determines where and how it will operate its aircraft, and each military department creates the training programs necessary to safely accomplish the missions of that aircraft or weapon system. The 24 September 2007 DoD-FAA MoA states each DoD pilot/operator, "*Shall be qualified by the appropriate Military Department activities to fly in the class of airspace in which operations are to be conducted*."[17]

UAS pilot/operator training requires a different skill set than flying a manned aircraft because there are differences in the means of takeoff, cruising, and landing by visual remote, aided visual, or fully autonomous methods. Therefore, the military departments and COCOMs have agreed on minimum standards for the knowledge, skills and abilities required by UAS pilots/operators operating in the NAS and beyond. Those minimum standards can be found in the Joint Chiefs of Staff Instruction (CJCSI) 3255.01, *Joint Unmanned Aircraft Systems Minimum Training Standards.*[18] The document outlines the basic aviation knowledge and required skills for pilot/operator certification for each UAS group and/or unique UAS to fly in certain airspace. Military departments and appropriate COCOMs must also establish and apply Visual Observer qualifications and UAS Medical Standards. Beyond the basic aviation knowledge and required skills for joint pilot/operator certification, each Service establishes basic and advanced levels of qualification and required training standards for maintenance of these skills.

[16] OUSD/AT&L Memorandum for Program Executive Officer, Unmanned Aviation and Strike Weapons Aeronautical Systems Center, Engineering Directorate, Army PEO Aviation, Subject: "Unmanned Aircraft System (UAS) Airworthiness Criteria", October 9, 2009

[17] Memorandum of Agreement for Operation of Department of Defense Unmanned Aircraft Systems in the National Airspace System, 24 Sep 07.

[18] *CJCSI 3255.01, Joint Unmanned Aircraft Systems Minimum Training Standard*, dated 17 Jul 2009.

4.3 Regulatory Compliance

The military departments have a robust process for establishing manned aircraft flight standards and procedures. However, the FAA has not yet released specific and permanent guidance for unmanned aircraft flight standards and procedures. This makes it difficult to know, with consistency or certainty, if UAS can or cannot comply. An example is the FAA Unmanned Aircraft Program Office's Interim Approval Guidance 08-01, which asks COA applicants to provide system safety studies that support any proposed UAS *see and avoid* strategy without visual observers. In the absence of defined compliance standards, UAS proponents would need a comprehensive methodology for generating sufficient analytical evidence. Unfortunately, there is no established FAA methodology or guidance for creation of such system safety studies. In fact, some current UAS may already be operating at appropriate levels of safety, but until UAS-specific standards and acceptable compliance methodologies are defined, it is difficult to generate evidence in support of routine operations. Also, the absence of FAA standards for UAS safety makes assessment of comparable safety levels difficult, and invites inconsistency in approval of COA requests. Currently, UAS operations within the NAS are treated as exceptions or one-time events through the COA process.

COA Process. For DoD UAS operations, FAA Joint Order 7610.4N currently requires the DoD to request COAs for UAS operations outside restricted or warning areas. The COA process imposes significant delays in initiating UAS operations, and even when valid COAs are issued, UAS are typically subject to numerous limitations and conditions for operations. The Policy Board on Federal Aviation (PBFA) is spearheading the DoD effort to maintain and update the DoD-FAA MoA. It is hoped that PBFA discussions with the FAA regarding COA improvements and the potential MoA revision will serve as a mechanism for DoD to gradually reduce restrictions on its UAS operations by modifying or creating new operational procedures.

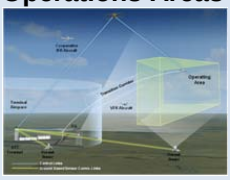
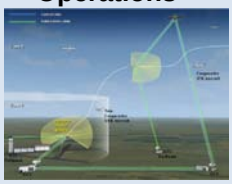
Standards and System/Technology Development. As stated above, UAS-specific standards, regulations, and compliance methodologies are needed to enable routine operations. The DoD is addressing this incrementally through the six access profiles discussed in Section 3. For example, a standard for safety criteria and compliance methodology will enable quantifiable and repeatable safety cases for any access profile. A common, consistent approach and data source allows regulators to focus on the results rather than the methodology or assumptions used.[19] Between December 2008 and March 2009, subject matter experts from government, industry, and academia concluded that a Target Level of Safety (TLS) approach is the most likely to succeed given its traceable, comprehensive end-to-end analysis that quantifies the total risk of the system.[20] Table 2 lists representative incremental activities for each of the six access profiles.

As noted above, there are several activities to enable more routine NAS access. Continuing to improve the COA process as well as developing necessary UAS-specific standards, regulations, and agreed-upon compliance methodologies will allow DoD UAS to conduct critical domestic training, operations, and testing in the NAS while providing the best opportunity for achieving the goal of UAS operations that are conducted safely and expeditiously, present no threat to the general public, and do no harm to other users of the NAS.

[19] FAA-sponsored SAA Workshop Final Report, 9 October 2009

[20] Wolfe, Russell. *Why Demonstrating An "Equivalent Level Of Safety" For See And Avoid Is An Inappropriate Requirement For Unmanned Aircraft System Operations*, 28 May 2009.

Table 2: Incremental Approach to Regulatory Compliance

ACCESS PROFILE	REGULATORY COMPLIANCE ACTIVITIES	
	PROCEDURAL/STANDARDS	*SYSTEMS/TECHNOLOGY*
Visual Line of Sight Operations	• Repeatable & Quantifiable Safety Methodology • Multi-Service Class G Procedures (Small UAS) • Standard Communications Rules of Engagement (ROE) / Terminology • Operating Limitations • Multi-UAS Operations Procedures • Multi-Service Visual Observer Procedures (Day / Night)	• Reliable Control Links • Approved UAS Control Link Spectrum
Terminal Area Operations (DoD Non-Joint Use Airfields)	• Repeatable & Quantifiable Safety Methodology • Class C and D Operations Procedures • ATC System Standards (Phraseology, Terminology) • Separation-Assurance Criteria • Operating Area Rules • Standard Lost-Link Guidelines • Blanket COA • Ingress/Egress from Adjacent Restricted / Warning Areas	GBSAA Development: • Airspace Characterization • Sensor Assessment / Validation / Selection • Optimized Surveillance Radar • Directed/3D Radar • Tool Assessment / Validation / Selection (Display, Comm, etc)
Military Operations Areas 	• Repeatable & Quantifiable Safety Methodology • MOA Operational Procedures • Separation-Assurance Criteria • Standard Lost-Link Guidelines • Standard Recovery Guidelines	GBSAA Development: • Airspace Characterization • Sensor Assessment / Validation / Selection • Optimized Surveillance Radar • Directed/3D Radar • Tool Assessment / Validation / Selection (Display, Comm, etc)
Lateral (Shown) and Vertical Transit Operations	• Repeatable & Quantifiable Safety Methodology • Separation-Assurance Criteria • Collision-Avoidance Criteria • Operating Area Rules • Standard Lost-Link Guidelines • Standard Recovery Guidelines • Standard Divert Guidelines	GBSAA Development: • Airspace Characterization • Sensor Assessment / Validation / Selection • Optimized Surveillance Radar • Directed/3D Radar • Tool Assessment / Validation / Selection (Display, Comm, etc)
Dynamic Operations 	• Repeatable & Quantifiable Safety Methodology • Procedural (Cross-Leverage w/GBSAA) • Operating Area Rules • Standard Lost-Link and Recovery Guidelines • Separation-Assurance Criteria • Collision-Avoidance Criteria	ABSAA Development: • Autonomous Separation Algorithms • Autonomous Collision Avoidance Algorithms • Sensor Evaluation/Selection • GBSAA/ABSAA Collaborative Solutions

5 CAPABILITY VALIDATION & IMPLEMENTATION ACTIVITIES

There are many ongoing foundational airspace integration efforts. Some are validating concepts to streamline airspace access, while others involve planning, programming, budgeting, and execution (PPBE) of future technical solutions to solve a piece of the access problem. The following discussion highlights capability validation and implementation activities for each of the foundational requirements.

5.1 Airworthiness

Airworthiness validation and implementation activities involve updating airworthiness standards. The current version of MIL-HDBK-516B specifically addresses UAS by noting that there may be unique safety-of-flight system requirements and establishing minimum levels of design for safe operation and maintenance. These minimum levels must be determined in part from program requirements and CONOPS and must be substantiated through analysis and appropriate validation. Therefore, activities throughout the Future Years Defense Plan (FYDP) will update MIL-HDBK-516B to not only identify the criteria for UAS Airworthiness, but also the applicable Standard and Method of Compliance used to show the criteria have been met. UAS-unique standards derived from NATO Standardization Agreements (e.g. STANAG 4671, 4702, 4703)[21] and other applicable Aeronautical Design Standards will be reviewed and incorporated, as appropriate. OSD will engage military department UAS program offices to ensure that program requirements and CONOPS align with appropriately tailored airworthiness requirements. This will ensure that the necessary level of certification can be achieved, thus ensuring UAS are built to established certification level criteria and meet their airspace access requirements. Since MIL-HDBK-516B is provided only as guidance to the military departments, each one will be responsible for updating its individual department UAS policies and program of record publications. The final step is for the military departments to identify what level of certification they require based upon the required airspace access, and then ensure the system is built to the established criteria for each level of certification.

5.2 Pilot/Operator Qualifications

To merit NAS access, DoD is careful to ensure Pilot/Operators meet appropriate, exacting military standards for qualification. Implementing UAS-specific pilot/operator qualifications will therefore further support efforts to gain increased NAS access for UAS. The standards to train and qualify pilots/operators of UAS will remain under the Title 10 authority of each military department and appropriate COCOM, and minimum joint qualifications requirements are documented in the previously mentioned *CJCSI 3255.01, Joint Unmanned Aircraft Systems Minimum Training Standards*. This document requires basic aviation knowledge and lays out the

[21] NATO Standardization Agreement (STANAG) 4671 - *Unmanned Aerial Vehicles Systems Airworthiness Requirements*, STANAG 4702 - *Rotorcraft Airworthiness*, STANAG 4703 - *Light UAS Systems Airworthiness Requirements (USAR-LIGHT) For NATO Military UAV Systems*; NATO Standardization Agency.

specifically required operating skills for each UAS group and/or unique UAS for flight in specified airspace. The intent is to leverage basic aviator knowledge/skills and a century of proven DoD flight safety programs that have consistently lowered accident rates and instructed aviation risk management. The military departments and COCOMs shall ensure both current and future UAS programs comply with the knowledge requirements outlined in this CJCSI. Current military department UAS training programs shall be compliant with this instruction no later than 1 October 2011. OSD will ensure that the military departments have sufficient guidance and resources to comply with the instruction. While CJCSI 3255.01 applies to basic, joint qualification training, the military departments maintain additional qualification standards and requirements for collective and continuation training. Collective and continuation training requirements ensure the pilot/operator maintains the skills and proficiency to conduct UAS operations in the unit mission.

5.3 Regulatory Compliance

In addition to airworthiness certification and pilot/operator qualification, there are procedural, equipment, and technical regulatory compliance issues which impact access to the NAS. To address these issues, a range of capability validation and implementation activities are required.

COA Refinement. Refining the COA approval process is an important near-term activity for improving NAS access for UAS. DoD is examining whether COAs can be extended in duration, and allow for the operation of multiple UAS. The Department is also working to establish conditions for streamlined approval with the FAA and developing/validating standard mitigation strategies for COA challenges. Other items include developing procedures for lost link, divert, recovery, and terminal operations, and agreed-upon communications and terminology standards.

Small UAS Rules. The small UAS Aviation Rulemaking Committee (ARC) recently reviewed current policy and recommended the FAA develop a Special Federal Aviation Regulation (SFAR) for sUAS. The FAA accepted the recommendation and is developing the SFAR. One example of a specific recommendation by the ARC is expanding notification procedures for sUAS under 20 lbs outside of military controlled lands up to 700 feet AGL, with various restrictions.[22] The DoD will leverage this work by seeking to incorporate many of the ARC's recommendations into an updated DoD-FAA UAS MoA.

Standardized Lost Link Procedures. The JCOE, in collaboration with the military departments and selected COCOMs, is establishing a standard suite of lost-link procedures for DoD UAS in all phases of flight. Once adopted, these procedures will provide defined methods for lost-link recognition, notification, and the appropriate actions to either regain link or recover/divert. The DoD will coordinate with the FAA, as appropriate, on this "rules of the road" issue.

Frequency Allocation. The FAA and OSD UAS Task Force Frequency and Bandwidth (F&B) IPT are cooperatively evaluating spectrum regulatory and aviation requirements to traverse the NAS. Domestically, aviation and spectrum regulatory groups are conducting evaluations and making recommendations to appropriate federal flight safety and spectrum

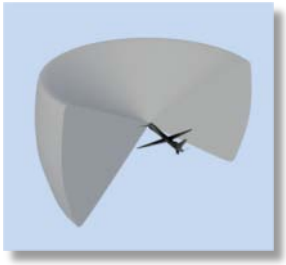
[22] Small Unmanned Aircraft System Aviation Rulemaking Committee "*Comprehensive Set of Recommendations for sUAS Regulatory Development*", 1 April 2009, Page 27, Section 11.2 (4)

authorization authorities. Internationally, the FAA and F&B IPT are supporting technical and regulatory analysis for potential UAS C&C, ATC voice communications, and SAA global operations frequency bands for future non-segregated airspace. Flexibility to use current and/or preferred equipment for C2 and SAA functions is part of the overall spectrum access strategy.

Equipment Compliance. To comply with FAA operating rules and regulations, UAS must have certain equipment to fly within the NAS. DoD subject matter experts will modify existing or develop new DoD equipment standards for technology development, as well as a means for compliance. OSD will evaluate and prioritize standards gaps, and refer them to standards organizations for creation/revision and publication. DoD stakeholders will work closely with the standards organizations, as needed, and adhere to critical standards and regulatory guidance from the FAA.

GBSAA Technology. DoD GBSAA efforts seek to develop methods to satisfy aircraft separation requirements using a ground-based system that includes sensors, displays, communications and software. GBSAA solutions will incrementally relieve restrictions on existing COAs and facilitate UAS training and operations in the NAS. This effort is establishing requirements, gathering data, performing modeling & simulation, testing and verifying collected data, and obtaining airworthiness approvals, as appropriate. The end result will be a defined set of system performance criteria and associated operating procedures that will provide the basis for military department certification of GBSAA capability as compliant with appropriate regulations.

ABSAA Technology. ABSAA efforts are focused on developing onboard capability to perform both self separation and collision avoidance (CA) that ensure an appropriate level of safety. Current programs have phased validation schedules for Due Regard, En Route/Class A, and Divert/Class E/G operations. The Navy and Air Force are leveraging a common functional baseline for their RQ-4B Global Hawk and RQ-4N Broad Area Maritime Surveillance (BAMS) aircraft. In addition, a Traffic Alert and Collision Avoidance System (TCAS) and/or Automatic Dependent Surveillance-Broadcast (ADS-B) may be incorporated into UAS in coordination with FAA guidance to provide additional safe separation and collision assurance precautions.



With the execution of the outlined validation steps and implementation strategies, DoD UAS can incrementally achieve the necessary increased access to the NAS as time proceeds. Ultimately, UAS will achieve routine dynamic flight operations through continuing to diligently observe and constantly improve on high military standards for flight operations, which have been a hallmark of military aviation.

6 *SUMMARY*

DoD UAS have become a critical component of military operations. Many DoD UAS now require rapidly expanded access to the NAS, international and foreign airspace to support operations, training, testing, and broader governmental functions.

For military aircraft to fly routinely in the NAS, the aircraft must be certified as airworthy, operated by a qualified pilot/operator in the appropriate class(es) of airspace, and comply with applicable regulatory guidance. DoD certifies its aircraft and pilots/operators, follows military regulations and applicable FAA rules and regulations.

The DoD's plan to increase UAS NAS access uses an incremental approach to provide DoD UAS critical initial access where necessary prior to achieving a full dynamic operations solution in the longer term. The DoD's immediate focus is gaining near-term mission critical access while simultaneously working toward farther-term routine NAS access. This will be accomplished through policy and procedural changes, as well as technology and standards development. The desired end state is routine NAS access comparable to manned aircraft for all DoD UAS operational, training, and support missions.

Success will depend on a coordinated, full-spectrum effort. As a world-wide leader in aviation, the DoD is uniquely positioned to be the first to integrate, and to spearhead this effort for federal public aircraft. Partnering with internal DoD and external stakeholders will be critical to success. The DoD is committed to identifying and implementing the necessary policy, procedural, and technical solutions to enable routine NAS access for all required DoD UAS missions.

APPENDIX A: DEFINITIONS

Autonomous/Automatic Operations – Operations that do not require direct pilot/operator control.

Beyond Line-of-Sight (BLOS) – The condition where the operator/control station and the UA are beyond visual contact.

Certificate of Waiver or Authorization (COA) – An FAA grant of approval for a specific operation(s).

Civil Aircraft – Aircraft other than public aircraft.

Collision Avoidance – The sense and avoid system function where the UAS takes appropriate action to prevent an intruder from penetrating a volume of airspace centered on the UA within which avoidance of a collision can only be considered a matter of chance.[23]

Concept of Operation – A detailed description of the means for implementing an operational concept that is necessary to integrate UAS into the NAS in order to accommodate a "file and fly" capability.

Cooperative Traffic – Traffic that broadcasts position or other information which assists in detecting and assessing conflict potential.

Due Regard – Flights of military aircraft over the high seas may require flight in otherwise controlled airspace without coordination with civil authorities. Such operations are recognized under Article 3 of the Chicago Convention of 1944. The shorthand designation "due regard" is derived from the text of the convention which states that such operations are accountable for "due regard for the safety of navigation of civil aircraft." See DoDI 4540.01, Section 6.3.2 for specific details.

High Altitude Long Endurance Aircraft – An aircraft capable of performing mission objectives at an altitude above 40,000-feet mean sea level (MSL) for durations of more than 24 hours.

Line-of-Sight (LOS) – The condition where the pilot/operator/control station and the UAS are within visual line-of-sight. Also referred to as Visual Line-of-Sight (VLOS).

Manned Aircraft – Aircraft that are incapable of flying without a pilot on board.

National Airspace System – The network of US airspace; airports; air navigation facilities; ATC facilities; communication, surveillance, and supporting technologies; and operating rules and regulations. Its function is to provide a safe and efficient environment for civil, commercial and military aviation.

Non-cooperative Traffic –Aircraft that do not broadcast position or other information.

[23] FAA Sense and Avoid Workshop, *Sense and Avoid (SAA) for Unmanned Aircraft Systems (UAS),* 10 Aug 09 (DRAFT).

Pilot/Operator – The appropriately DoD-trained and rated individual monitoring and controlling the UAS through issuance of command input. May also include the unmanned aircraft system commander or unmanned aircraft system mission commander.[24]

Public Aircraft – An aircraft used only for United States Government purposes, or is owned and operated, or exclusively leased for at least 90 continuous days, by a governmental entity such as a State, the District of Columbia, a territory or possession of the United States, or political subdivisions of such entities. DoD aircraft are public aircraft.

Routine Operations – The ability to operate a UAS in the necessary class of airspace without any additional restrictions imposed other than what would be required for a manned aircraft of a similar class and/or type.

Sense and Avoid – The capability of a UAS to remain well clear from and avoid collisions with, other airborne traffic. Sense and avoid provides the functions of self separation and collision avoidance to fulfill the regulatory requirement to see and avoid.[25]

Self Separation – The sense and avoid function where the UAS maneuvers within a sufficient timeframe to prevent activation of a collision avoidance maneuver while conforming to accepted air traffic separation standards.[26]

Unmanned Aircraft – An aircraft operated without the possibility of direct human intervention from within or on the aircraft.[27]

Unmanned Aircraft System – A system consisting of an Unmanned Aircraft and its associated elements required for operation.[28]

Visual Line-of-Sight (VLOS) – The condition where the pilot/operator/control station and the UAS are within visual line-of-sight (VLOS). Also referred to as “Line-of-Sight (LOS)”.

[24] OPNAV 3710.7U IC 40, pgs. 14-6 and 14-8
[25] FAA Sense and Avoid Workshop, *Sense and Avoid (SAA) for Unmanned Aircraft Systems (UAS)*, 10 Aug 09 (DRAFT).
[26] Ibid.
[27] JUAS COE CONOPS, *Joint Concept of Operations for Unmanned Aircraft Systems, Chapter 2*, Version 1.5
[28] Ibid.

APPENDIX B: ACRONYMS

14 CFR	Title 14, Code of Federal Regulations
ABSAA	Airborne Based Sense and Avoid
ADIZ	Air Defense Identification Zone
ADS-B	Automatic Dependent Surveillance - Broadcast
AFSOC	Air Force Special Operations Command
AGL	Above Ground Level
AI	Airspace Integration
AIS	Automatic Identification System
AI IPT	Airspace Integration Integrated Product Team
ARC	Aviation Rulemaking Committee
ARTCC	Air Route Traffic Control Center
ATC	Air Traffic Control
ATCAA	Air Traffic Control Assigned Airspace
ATCSCC	Air Traffic Control System Command Center
ATS	Air Traffic Services
BAMS	Broad Area Maritime Surveillance
BLOS	Beyond Line of Sight
CA	Collision Avoidance
C&C	Control & Communications
CBA	Capability Based Assessment
CBRNE	Chemical, Biological, Radiological, Nuclear, and Explosive
CFR	Code of Federal Regulations
CJCSI	Chairman of the Joint Chiefs of Staff Instruction
CNS/ATM	Communication Navigation Surveillance / Air Traffic Management
COA	Certificate of Waiver or Authorization
COCOM	Combatant Commander
CONOPS	Concept of Operations
CONUS	Contiguous United States
CTA	Controlled Airspace
DEPSECDEF	Deputy Secretary of Defense
DHS	Department of Homeland Security
DoD	Department of Defense
DOT	Department of Transportation
DSCA	Defense Support to Civilian Authorities
DSPO	Defense Standardization Program Office
EO/IR	Electro-Optical / Infrared
ExCom	UAS Executive Committee
F&B	Frequency and Bandwidth
FAA	Federal Aviation Administration
FINAS	Flight In Non-Segregated Air Space
FIR	Flight Information Regions

FL	Flight Level
FLIP	Flight Information Publication
FSS	Flight Service Stations
FYDP	Future Years Defense Plan
GATM	Global Air Traffic Management
GBSAA	Ground Based Sense and Avoid
GPS	Global Positioning System
HD	Homeland Defense
HLS	Homeland Security
ICAO	International Civil Aviation Organization
ICD	Initial Capabilities Document
IFR	Instrument Flight Rules
IPT	Integrated Product Team
ISR	Intelligence, Surveillance, and Reconnaissance
JCOE	Joint Unmanned Aircraft Systems Center of Excellence
JFCOM	Joint Forces Command
JIPT	Joint Integrated Product Team
JPDO	Joint Planning and Development Office
JROCM	Joint Requirements Oversight Council Memorandum
JUAS COE	Joint Unmanned Aircraft Systems Center of Excellence
LOS	Line of Sight
LRF/D	Laser Range Finder/Designator
M&S	Modeling & Simulation
MoA	Memorandum of Agreement
MOA	Military Operations Area
MSL	Mean Sea Level
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NDAA	National Defense Authorization Act
NextGen	Next Generation Air Transportation System
NM	Nautical Miles
NORTHCOM	United States Northern Command
NOTAM	Notices to Airmen
NTIA	National Telecommunications and Information Administration
OAA	Offshore Airspace Area
OCC	Oceanic Control Centers
OGA	Other Government Agency
OSD	Office of the Secretary of Defense
OUAI	OSD UAS Airspace Integration
OUSD	Office of the Under Secretary of Defense
OUSD (AT&L)	Office of the Under Secretary of Defense for Acquisition, Technology, & Logistics

PBFA	Policy Board on Federal Aviation
POR	Program of Record
PPBE	Planning, Programming, Budgeting, and Execution
PQ	Pilot Qualifications
RA	Restricted Area
RC	Radio Controlled
RF	Radio Frequency
RNAV	Area Navigation
RNP	Required Navigation Performance
ROE	Rules of Engagement
SAA	Sense and Avoid
SDO	Standards Development Organization
SFAR	Special Federal Aviation Regulation
SIGINT	Signal Intelligence
STANAG	NATO Standardization Agreement
SUA	Special Use Airspace
sUAS	Small Unmanned Aircraft System
SVFR	Special Visual Flight Rules
TCAS	Traffic Alert and Collision Avoidance System
TFR	Temporary Flight Restriction
TLS	Target Level of Safety
TRACON	Terminal Radar Approach Controls
TSO	Technical Standard Order
U.S.	United States
UA	Unmanned Aircraft
UAPO	Unmanned Aircraft Program Office
UAS	Unmanned Aircraft System
USC	United States Code
USSOCOM	United States Special Operations Command
VFR	Visual Flight Rules
VLOS	Visual Line of Sight
VMC	Visual Meteorological Conditions
WA	Warning Area

APPENDIX C: INTERNAL AND EXTERNAL STAKEHOLDERS

DoD Stakeholders

There are many stakeholders within the DoD that are affected in some capacity by UAS airspace integration. In addition to the Services, the following organizations are considered to be key internal DoD stakeholders:

- **OUSD (AT&L)**: On 13 September 2007, DEPSECDEF Memo 14667-07 established the OUSD UAS Task Force dedicated to the acquisition, development, and integration of UAS into the Services under the direction of OUSD (AT&L). The Task Force is responsible for providing overarching strategic guidance and direction to the OSD UAS AI IPT. The IPT will pursue technologies, standards, and policies for DoD UAS programs with the Director of the Task Force. In addition, the IPT will coordinate Service updates to the OSD Unmanned Systems Roadmap and other unmanned aviation-related products that influence DoD-wide UAS acquisition and technology development decisions associated with airspace integration.

- **Policy Board on Federal Aviation (PBFA)**: The DoD PBFA, established by Executive Order 11161, and as defined by DoD 5030.19, is responsible for coordinating DoD and FAA common requirements and serves as the DoD liaison with the Department of Transportation (DOT) and the FAA on federal air traffic control and airspace management. The PBFA provides policy and planning guidance for comprehensive airspace planning to: (1) ensure that the Military Departments have sufficient airspace to fulfill operational, training, and test and evaluation requirements, (2) cooperate with the FAA for the effective and efficient management of the NAS, and (3) ensure operational interoperability between the DoD and the FAA.

- **US Northern Command (NORTHCOM)**: NORTHCOM is responsible for command and control of DoD homeland defense efforts and coordinating DSCA activities. Additionally, they also have the lead role in establishing a joint UAS CONOPS for the NORTHCOM mission. The AI IPT will consider NORTHCOM UAS requirements to ensure NORTHCOM UAS training, exercises, and employment missions are not compromised.

- **US Joint Forces Command (JFCOM)**: JFCOM is responsible for providing mission-ready, joint-capable forces, and supports the development and integration of joint, interagency, and multinational capabilities to meet the present and future operational needs. The AI IPT will consider JFCOM UAS requirements as it recommends AI policy to ensure JFCOM UAS training, exercises and employment missions are not compromised.

- **US Special Operations Command (USSOCOM)**: USSOCOM is responsible for the acquisition and employment of UAS for special operations forces. USSOCOM's lead component command for UAS, to include UAS airspace management, is Air Force Special Operations Command (AFSOC). USSOCOM controls its own acquisition budget independent of the Services, predominately acquiring small UAS and SOF-unique payloads and modifications for larger UAS.

- **US Central Command (CENTCOM):** CENTCOM is heavily dependent on UAS for operations in Iraq and Afghanistan for several reasons including their Intelligence, Surveillance, and Reconnaissance (ISR) and weapons capabilities. For this reason, CENTCOM's needs as a stakeholder impact training requirements within the NAS.

- **US Southern Command (SOUTHCOM) and US Pacific Command (PACOM):** SOUTHCOM and PACOM can be affected by UAS operations in the NAS. US land and territories such as Hawaii and Guam fall under PACOM's area of responsibility where the FAA has regulatory jurisdiction. Also, some countries requiring US military assistance (e.g. Haiti Earthquake relief effort) also depend on the United States for airspace regulation guidance.

- **Service UAS Program Offices**: Each Service's UAS program office is responsible for the development, acquisition and sustainment of Service UAS programs of record that address approved Service requirements.

- **Joint UAS Center of Excellence (JUAS COE)**: JUAS COE is chartered by the Joint Requirements Oversight Council Memorandum (JROCM) 197-05, 12 September 2005, to pursue solutions to optimize UAS capabilities and utilization. The JUAS COE supports the development and integration of common UAS operating standards, capabilities, concepts, technologies, doctrine, tactics, techniques, procedures, and training.

- **The Office of the Deputy Under Secretary of Defense for Readiness ODUSD(R), Readiness and Training Policy and Programs (RTPP):** ODUSD(R) is responsible for advising the Secretary of Defense, through the Under Secretary of Defense Personnel and Readiness (USD(P&R)), on all policies, resources, and issues related to the training of U.S. military forces. As UAS resources return from conflict areas to their bed-down locations, the Services will be faced with UAS training and airspace challenges to meet mission training requirements and readiness imperatives. RTPP is developing UAS readiness and training policy that provides UAS training guidance while complementing other UAS DoD Stakeholder activities.

- **National Guard**: As part of their mission, the National Guard will need to perform UAS-related missions within civil airspace. These missions will include both operational and training activities.

- **Defense Standardization Program Office (DSPO)**: The DSPO is responsible for the development and use of standards across DoD. Where possible, it coordinates the adoption of consensus industry standards for military use.

Inter-Agency Stakeholders

- **UAS Executive Committee (ExCom)**: In Fiscal Year 2009 National Defense Authorization Act[29], dated October 14, 2008, the U.S. Congress recommended that the DoD and FAA form an Executive Committee (ExCom) to act as a focal point for resolution of issues on matters of policy and procedures relating to UAS access to the NAS. The NDAA stated the perception that techniques and procedures could be rapidly developed to temporarily permit the safe operation of federal public UAS in the NAS until more permanent solutions can be developed or identified. The ExCom is led by Senior Executives from the FAA, DoD, NASA, and DHS, with their role to provide executive direction for gaining access for UAS operations within the NAS. The DoD is represented by OUSD (AT&L), Director, Portfolio Systems Acquisition and OSD, Executive Director, Policy Board on Federal Aviation (PBFA). Members of the UAS ExCom will be Senior Executives from the FAA, DoD, NASA, and DHS. Their role will be to provide executive direction for gaining access for UAS operations within the NAS.

Non-DoD Stakeholders

Non-DoD stakeholders are all other organizations potentially impacting OSD AI activities from a programmatic or execution standpoint. There are a number of external stakeholders the IPT will need to interface with on a regular basis. These organizations include the FAA UAS Program Office, Standards Development Organizations and Academia. These are each further described below.

- **Federal Aviation Administration (FAA):** The FAA authority to regulate aviation activities is granted by statute in Title 49, USC Chapter 401 (§40103) specifically grants the FAA Administrator the authority to "develop plans and policy for the use of the navigable airspace and assign by regulation or order the use of the airspace necessary to ensure the safety of aircraft and the efficient use of airspace."

- **Department of Homeland Security (DHS)**: DHS has an immediate need to operate UAS in the NAS for border security, maritime surveillance and other high priority missions. Customs and Border Patrol (CBP) is currently operating several UAS along the U.S. / Mexico border and the U.S. / Canada border and within the Gulf of Mexico. The Coast Guard is evaluating application of UAS for reducing maritime crime, security of maritime borders, and protection of maritime infrastructure. Not only does DHS need to train within the NAS, but their operational missions are also mostly inside the NAS.

- **National Aeronautics and Space Administration (NASA)**: Along with the DoD and DHS, NASA also has needs for UAS to operate in the NAS primarily for science and exploration purposes. However, on occasion, they are called upon in response to natural disasters such as forest fires, hurricanes, flooding, and earthquakes. In addition, NASA provides expertise in NAS integration since they led the first national effort to address UAS AI (i.e. Access 5). Lastly, NASA has continued to research and develop potential solutions for sense and avoid that can be leveraged.

[29] United Stated Public Law 110-417, "Fiscal Year 2009 National Defense Authorization Act", October 14, 2008, Section 1039 "Sense of Congress on Joint Department of Defense-Federal Aviation Administration Executive Committee on Conflict and Dispute Resolution."

- **Joint Planning and Development Office (JPDO)**: As the lead organization for planning and implementing the Next Generation Transportation System (NextGen), JPDO is establishing the capabilities and timelines related to NextGen for all users in the NAS, including UAS. Efforts must be made to ensure 1) UAS will be able to meet required capabilities and 2) their roles, missions, and characteristics are considered for NextGen operations.

- **Civil Standards Development Organizations (SDOs)**: SDOs offer a forum for the UAS community to come together and develop consensus-based standards. The two SDOs leading the initiative to establish civil standards for UAS are the RTCA SC-203 and the ASTM Committee F38. RTCA SC-203 "Unmanned Aircraft Systems" was chartered in November 2004 to develop Minimum Aviation System Performance Standards for two UAS-critical technology areas: Sense & Avoid (SAA) and Control & Communications (C&C). Similarly, ASTM Committee F38, chartered in July 2003, has three subcommittees that are focusing their efforts on developing UAS standards. These subcommittees are: F38.01 - "Airworthiness Standards for UAS," F38.02 - "Operations Standards for UAS," and F38.03 – "UAS Pilot/Operator and Maintainer Qualifications." Two other SDOs are also contributing to unmanned aviation but in lesser roles. SAE established three committees; AS-4 for C&C standards, AC-9C for anti-icing standards, and G10 for human systems integration standards, early in 2004. AIAA established its UAV/ROA (Unmanned Aircraft Vehicle/Remotely Operated Aircraft) Committee on Standards in late 2002.

- **NATO:** The North Atlantic Treaty Organization is working on multiple standardization agreements to enable interoperability of UAS among NATO members. The Flight in Non-segregated airspace (FINAS) working group is dedicated to developing standards to operate UAS in non-segregated airspace. The United States has ratified various NATO UAS STANAGs including those related to operator training requirements, datalink, and UAS airworthiness.

- **Academia:** There are a number of universities having an interest in utilizing UAS for educational and research-related purposes. Some of these universities have recently received funding and grants to explore issues pertaining to integrating UAS into civil airspace.

APPENDIX D: UAS ELEMENTS AND GROUPS

UAS Elements

In order to focus on the UAS AI challenge, a common understanding and definition for UAS and its elements must be understood. An Unmanned Aircraft System is a system comprised of an unmanned aircraft and its associated elements required for operation. This section discusses the elements contained within a UAS, the classification categories, and the types of missions they support.

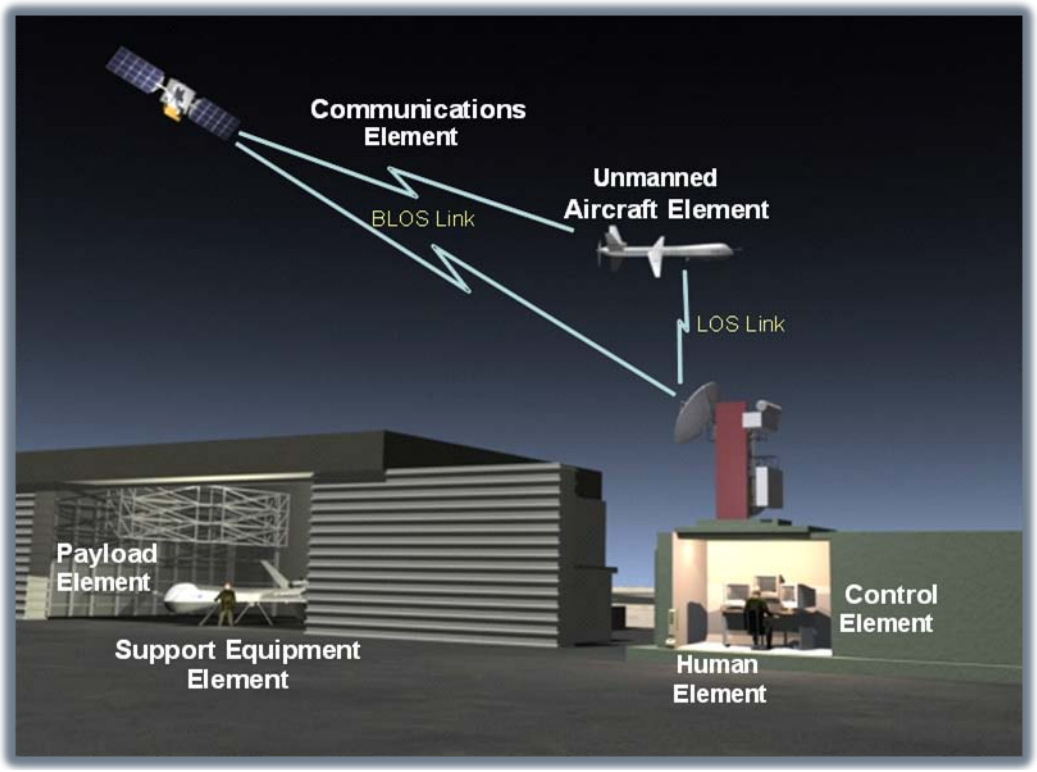


Figure 11: UAS Elements

Because UAS vary widely in size, weight, and performance, various documents and studies have separated UAS into a number of different elements with varying terminology. To be consistent with the UAS operational community, this Plan will use the JUAS COE defined six common UAS elements, with specific focus on those elements relevant to airspace integration. These elements are described below.

- **Unmanned Aircraft:** The UA is a rotary, fixed winged, or lighter than air aircraft that is operated remotely, programmed and/or autonomous, and can be capable of flight beyond visual range.

- **Payload:** The equipment allowing the UAS to accomplish its tactical mission. UAS payloads can generally be categorized into the following four sub-elements: sensors, communication relay, weapons, and cargo. For the purpose of this plan, an assumption has been made that airspace integration equipage is not part of the payload, but rather the UA itself.

- **Communications:** The communications element includes all communications internally and between the UAS and ATS. Communication links may be either Line-of-Sight (LOS) or Beyond Line-Of-Sight (BLOS).

- **Control:** The UA pilot/operator is located within the UAS Control Element. While the Control Element is typically on the ground, it may also be on another aircraft, ground vehicle or maritime vessel. Currently, most Control Elements are unique to that particular UAS, however, a common Control Element is being developed that can control a variety of UAS.

- **Support:** Equipment that is necessary to transport, maintain, launch, and recover the UA.

- **Human:** Personnel including the trained and certified pilot/operator, maintainer, mission commander, and mission analyst, depending on the concept. UAS are operated under direct human oversight or control. While there can be exceptions to this, such as during lost-link events, strong attention to the quality of the human interface must be continued.

UAS Groups

UAS capabilities vary widely depending on the size, performance, and function of the UA. UAs range in size and speed from a wingspan less than one foot hovering at treetop level, to a wingspan of over 130 feet operating above 60,000 feet. These unofficial classification categories vary widely depending on which perspective is used - tactical use, performance, size, airworthiness, levels of autonomy, etc. The individual groups of UAS are identified by attributes of airspeed, weight, and operating altitude and briefly described below.

- **Group 1:** Typically hand-launched, self contained, portable systems employed for a small unit or base security. They are capable of providing “over the hill” or “around the corner” reconnaissance and surveillance. They operate within visual range and are analogous to radio-controlled model airplanes as covered in AC 91-57.30

- **Group 2:** Small to medium in size and usually support brigade and intelligence, surveillance, reconnaissance, and target acquisition requirements. They usually operate from unimproved areas and launched via catapult. Payloads may include a sensor ball with electro-optic / infrared (EO/IR) and laser range finder/designator (LRF/D) capability. They typically perform special purpose operations or routine operations within a specific set of restrictions.

- **Group 3:** Operate at medium altitudes with medium to long range and endurance. Their payloads may include a sensor ball with EO/IR, LRF/D, signal intelligence (SIGINT), communications relay, and chemical biological radiological nuclear explosive (CBRNE) detection. They usually operate from unimproved areas and may not require an improved runway.

- **Group 4:** Relatively large UAS that operate at medium to high altitudes and have extended range and endurance. They normally require improved areas

[30] FAA Advisory Circular (AC) 91-57, *Model Aircraft Operating Standards*, 9 June 1981.

for launch and recovery, beyond line-of-sight (BLOS) communications, and have stringent airspace operations requirements. Payloads may include EO/IR sensors, radars, lasers, communications relay, SIGINT, Automatic Identification System (AIS), and weapons.

- **Group 5:** Include the largest systems, operate at medium to high altitudes, and have the greatest range, endurance, and airspeed capabilities. They require improved areas for launch and recovery, BLOS communications, and the most stringent airspace operations requirements. Group 5 UAS perform specialized missions such as broad area surveillance and penetrating attacks.

Table 3: DoD UAS Group Descriptions[31]

UAS Groups	Maximum Weight (lbs) (MGTOW)	Normal Operating Altitude (ft)	Speed (kts)	Representative UAS	
Group 1	0 – 20	<1200 AGL	100	Raven (RQ-11), WASP	
Group 2	21 – 55	<3500 AGL	< 250	ScanEagle	
Group 3	< 1320	< FL 180		Shadow (RQ-7B), Tier II / STUAS	
Group 4	>1320		Any Airspeed	Fire Scout (MQ-8B, RQ-8B), Predator (MQ-1A/B), Sky Warrior ERMP (MQ-1C)	
Group 5		> FL 180		Reaper (MQ-9A), Global Hawk (RQ-4), BAMS (RQ-4N)	

[31] JUAS COE CONOPS, *Joint Concept of Operations for Unmanned Aircraft Systems*, *Chapter 2*, Version 1.5

APPENDIX E: AIRSPACE DESCRIPTION[32]

National Airspace

The National Airspace System consists of many elements, and is more than "airspace". NAS elements include airports, FAA facilities such as Control Towers, Terminal Radar Approach Controls (TRACON), Air Traffic Organization Service Areas, Air Route Traffic Control Centers (ARTCC), Oceanic Control Centers (OCC), Flight Service Stations (FSS), and the Air Traffic Control System Command Center (ATCSCC). In addition, the NAS also consists of radio navigation aids, radars, radio sites, weather sites, aeronautical charts, and the rules, regulations and procedures that enable safe and routine flight operations in the airspace about sovereign U.S. territory.

As illustrated in Figure 12, there are multiple classes of ATS airspace of defined dimensions within which specific types of flights may operate, and for which air traffic services and rules of operation are specified. Because these classes are referenced throughout this document, a brief description is provided.

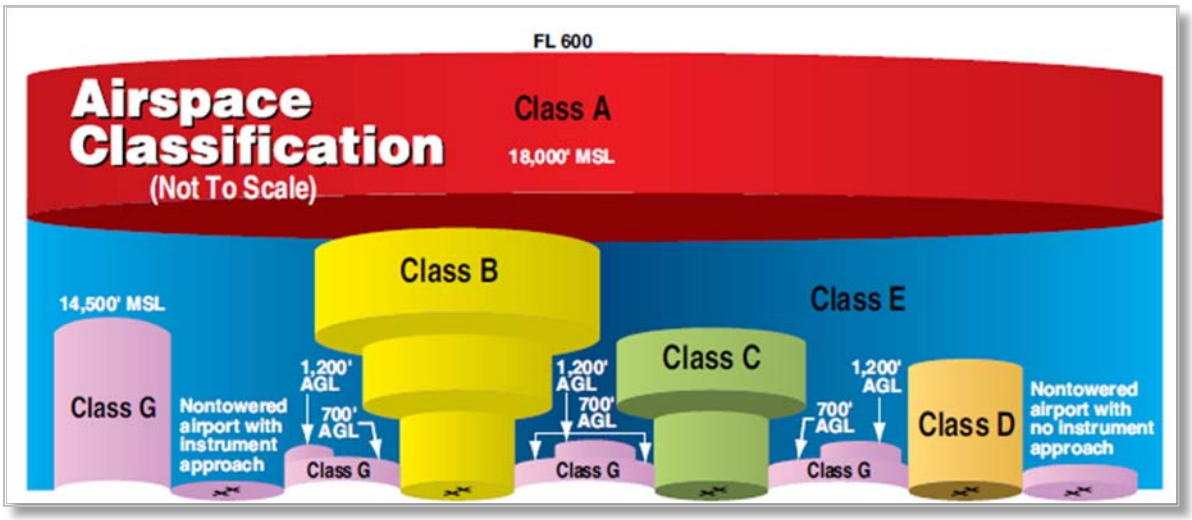
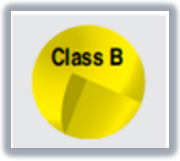


Figure 12: National Airspace System Airspace Classes

- **Class A** airspace exists from Flight Level (FL) 180 (18,000 feet Mean Sea Level (MSL)) to FL600 (60,000 feet MSL). All flight operations must be conducted under Instrument Flight Rules (IFR) or Special Visual Flight Rules (SVFR). All operations are subject to ATC clearance, and all flights are separated from each other by ATC.

- **Class B** airspace surrounds major airports (generally up to 10,000 feet MSL) to reduce mid-air collision potential. Operations may be conducted under IFR, SVFR, or Visual Flight Rules (VFR). All aircraft are subject to ATC clearance, and all flights are separated from each other by ATC.



[32] *JIPT UAS Airspace Integration Concept of Operations*, February 2008.

- **Class C** airspace surrounds busy airports (generally up to 4,000 feet Above Ground Level (AGL)) that do not need Class B airspace protection, and requires flights to establish and maintain two-way communications with ATC. Operations may be conducted under IFR, SVFR, or VFR. IFR aircraft are subject to ATC clearance. VFR aircraft require radio contact prior to entering airspace [not to be confused with ATC clearance]. Aircraft operating under IFR and SVFR are separated from each other and from participating VFR flights. Participating VFR flights are separated from IFR flights, and receive traffic advisories in respect to other participating VFR flights.

- **Class D** airspace surrounds airports (generally up to 2,500 feet AGL) that have an operating control tower. Flights in Class D airspace must establish and maintain communications with ATC. Operations may be conducted under IFR, SVFR, or VFR. IFR aircraft are subject to ATC clearance. VFR aircraft require radio contact prior to entering airspace [not to be confused with ATC clearance]. Aircraft operating under IFR and SVFR are separated from each other, and are given traffic information in respect to VFR flights. Flights operating under VFR are given traffic information in respect of all other flights, but VFR flights do not receive separation service.

- **Class E** airspace is all other controlled airspace in which IFR and VFR flights are allowed. Although Class E airspace can extend to the surface, it generally begins at 700 feet AGL, 1200 feet AGL, 10,000 feet MSL, or 14,500 MSL, and extends upward until it meets a higher class of airspace (A-D). It is also above FL600. Operations may be conducted under IFR, SVFR, or VFR. Aircraft operating under IFR and SVFR are separated from each other, and are subject to ATC clearance. Flights under VFR are not subject to ATC clearance. As far as is practicable, traffic information is given to all flights in respect to VFR flights.

- **Class G** airspace is uncontrolled airspace. Class G airspace can extend to 14,499 feet MSL, but generally exists below 1200 feet AGL, and below Class E airspace. Operations may be conducted under IFR or VFR. ATC separation is not provided. Traffic information may be given as far as is practical in respect of other flights.

The International Civil Aviation Organization (ICAO) defines an additional Class of Airspace:

- **Class F.** Operations may be conducted under IFR or VFR. ATC separation will be provided, so far as practical, to aircraft operating under IFR. Traffic information may be given as far as is practical in respect to other flights. Class F airspace is not used within the CONUS, but does exist in some overseas countries.

In summary, Classes B, C, and D relate to airspace surrounding airports (terminal areas) where increased mid-air collision potential exists; Classes A, E, and G primarily relate to en route flight and are defined in terms of altitude, and the nature of flight operations that commonly occur at those altitudes. ATC provides separation services to all flights in Classes A and B, and participating flights in Class C. They provide it to some flights in Class E, and do not provide service in Class G. Regardless of the class of airspace, or whether ATC provides

separation services, pilots are required by Part 91 to "see and avoid other aircraft" whenever weather permits.[33]

Special Use Airspace

Special Use Airspace (SUA) is airspace of defined dimensions identified by an area on the surface of the earth wherein activities must be confined because of their nature and/or wherein limitations may be imposed upon aircraft operations that are not a part of those activities.[34] The FAA recognizes five types of SUA in the U.S., all of which are currently or potentially applicable to DoD UAS operations:

(1) **Alert Area**: Airspace which may contain a high volume of pilot training activities or an unusual type of aerial activity neither of which is hazardous to aircraft. Alert Areas are depicted on aeronautical charts for the information of nonparticipating pilots. All activities within an Alert Area are conducted in accordance with Federal Air Regulations, and pilots of participating aircraft as well as pilots transiting the area are equally responsible for collision avoidance.

(2) **Military Operations Area (MOA)**: A MOA is airspace established outside of Class A airspace to separate or segregate certain non-hazardous military activities from IFR traffic, and to identify for VFR traffic where these activities are conducted. Although not required, ATC or a military radar unit may provide advisory/monitoring /separation services within a MOA. However, the pilot is responsible for remaining within the area and exercising "see and avoid" during Visual Meteorological Conditions (VMC).

(3) **Prohibited Area**: Airspace designated by 14 CFR, Part 73 within which no person may operate an aircraft without the permission of the using agency.

(4) **Restricted Area**: SUA designated by 14 CFR, Part 73 within which the flight of aircraft, while not wholly prohibited, is subject to restriction. Aircraft may not operate within 3 nautical miles (nm) of a Restricted Area (RA) unless authorized under the provisions of FAR 73.13. Most restricted areas are designated joint use and IFR/VFR operations in the area may be authorized by the controlling ATC facility when it is not being utilized by the scheduling agency.

(5) **Warning Area**: A Warning Area (WA) is airspace of defined dimensions, extending from 3 nm outward from the coast of the US, which contains activity that may be hazardous to nonparticipating aircraft such as: aerial gunnery, bombing, aircraft carrier operations, surface and subsurface operations, naval gunfire, missiles, etc. The purpose of Warning Areas is to segregate this activity, and to warn nonparticipating pilots of these potential dangers. A Warning Area may be located over domestic or international waters, or both. Although Warning Areas may contain hazards similar to those found in a Restricted Area, the US does not have the authority to prohibit flight by nonparticipating aircraft in international airspace. Therefore, Warning Areas are designated to alert nonparticipating aircraft to potential dangers.

ICAO defines an additional type of SUA:

[33] 14 Code of Federal Regulations (CFR). *Part 91 General Operating and Flight Rules, Subpart B Flight Rules, Section 91.113 Right of way rules: Except water operations.*
[34] DoD FLIP General Planning (GP), Chapter 2.

(6) **Danger Area**: Flights are not restricted but avoidance is advised during time of use.

Other Airspace

Other types of controlled or regulated airspace that are potentially applicable to UAS AI are as follows:

- Air Traffic Control Assigned Airspace (ATCAA): Airspace of defined vertical/lateral limits, assigned by ATC, for the purpose of providing air traffic segregation between the specified activities being conducted within the assigned airspace, and other IFR air traffic.

- Temporarily Flight Restriction: A Temporary Flight Restriction (TFR) is a type of Notices to Airmen (NOTAM). A TFR defines an area restricted to air travel due to a hazardous condition, a special event, or a general warning for the entire FAA airspace. The text of the actual TFR contains the details of the restriction.

- Special Security Instruction (SSI) Airspace: By regulation, the FAA may issue specific restrictions in the interest of national security. Prior to September 11, 2001, this section was rarely used. Since then, numerous TFRs have been established under the authority of this section. TFRs have been used around cities, over military facilities, and to protect Space Shuttle launch facilities in Florida. In other cases, section 99.7 TFRs have been issued in response to threat assessments affecting certain major sporting events and over significant national landmarks. Pilots must also be aware of a standing notice, issued under section 99.7, advising them to avoid the airspace above, or in proximity to, sites such as nuclear power plants, power plants, dams, refineries, industrial complexes, military installations, and similar facilities. In addition, section 99.7 is the basis for restrictions around certain sporting facilities (often referred to as the "Sports NOTAM"). Except for limited cases specified in the NOTAM, all aircraft and parachute operations are prohibited at and below 3,000 feet AGL within a three NM radius of any stadium having a seating capacity of 30,000 or more people in which a Major League Baseball™, National Football League™, NCAA™ division-one football, or major motor speed-way event is taking place. Restrictions issued under section 99.7 may vary dramatically in size, and there is no standard configuration.[35]

International Airspace

International airspace is divided into Controlled Airspace/Flight Information Regions (CTA/FIRs). The aircraft of all nations have the right to use the airspace over the high seas. Foreign sovereign airspace extends only to the outer limits of the territorial seas; aircraft of all nations enjoy high seas freedoms of overflight in the airspace above Exclusive Economic Zones of coastal states beyond the territorial seas.[36] By international law, a nation's sovereign airspace corresponds with the maritime definition of territorial waters, which are approximately 12 nm out from a nation's coastline (12 nm from established baselines). State aircraft (such as military aircraft) are not obliged to comply with ICAO rules or the directions of the country responsible for the safety of civil aircraft in FIRs, but must operate with due regard for the safety

[35] "Airspace Obstacles and TFR Trivia: A Pilot's Guide to Understanding Restrictions in Today's National Airspace System," Michael W. Brown
[36] DoDI 4540.01, 28 March 2007

of civil air and surface traffic. It is DoD policy, however, to observe ICAO flight procedures and any reasonable warning procedures with regard to the military aircraft of all nations, when to do so is practical and compatible with the mission.

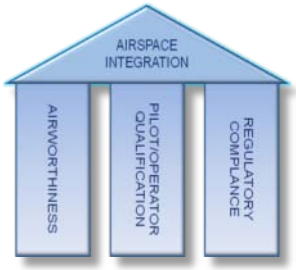
Global Air Traffic Management

Communication, Navigation, and Surveillance for Air Traffic Management (CNS/ATM) is driving requirements for aircraft avionics and operational procedures worldwide. The NAS and the global aviation support architecture are moving toward CNS/ATM to meet user and air traffic management demands in response to increased traffic density, and commensurate safety concerns. This issue is not "new", and has been articulated in many service documents, including the USAF's *Capstone Requirements Document for Global Air Traffic Management (GATM)*.[37] The requirements listed in the GATM CRD have been implemented, in whole or part depending on their mission requirements, by numerous DoD manned aircraft programs. These requirements must now be evaluated for applicability to UAS, because global compliance is a prerequisite for global deployability.

A significant amount of DoD training and operations occur in Warning Areas and International airspace just off the coast of the U.S. landmass. In addition, because DoD has global deployment responsibilities, UAS AI compatibility with worldwide airspace operations must be considered. Therefore, UAS AI CONOPS must include operations to/from the NAS into Warning Areas, and Oceanic airspace.

[37] USAF Document, *Capstone Requirements Document (CRD) USAF 003-97, Global Air Traffic Management (GATM) Phase I*, 15 November 1999.

APPENDIX F: MAPPING OF THE "THREE FOUNDATIONAL REQUIREMENTS" TO THE "FIVE PILLARS"



As discussed in the main section of the document, three foundational requirements must be met in order for any military aircraft to fly routinely in the NAS. All DoD aircraft must be:

1) **Airworthy**
2) **Operated by a Qualified Pilot/Operator**
3) **Compliant with Operating Rules, Standards, and Procedures**

In December 2008, the UAS Task Force Senior Steering Group requested the JUAS COE expound upon the quick-turn Capability Based Analysis (CBA) that they performed a year earlier, by developing a UAS AI ICD. One outcome of the ICD was a list of five challenge areas, or "pillars" which are:

1) **Airworthiness (AW)**
2) **Pilot Qualification (PQ)**
3) **Operating Standards and Procedures (OSP)**
4) **Sense & Avoid (SAA)**
5) **Equipage (EQ)**

The first two requirements map directly to pillars one and two. Requirement three maps to pillars three, four, and five as shown in the figure below.

"Three Tenets"	"Five Pillars"
Airworthy	Airworthiness
Operated by a Qualified Pilot/Operator	Pilot Qualification
Compliant with Operating Rules, Standards, and Procedures	Operating Standards and Procedures Sense & Avoid Equipage

Figure 13: "Three Foundational Requirements" Mapped to "Five Pillars"

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