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Strategic Concept of Employment

for Unmanned Aircraft Systems in NATO

Joint Air Power
Competence Centre

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FROM:
The Executive Director of the Joint Air Power Competence Centre (JAPCC)

SUBJECT:
JAPCC Strategic Concept of Employment for UAS in NATO

DISTRIBUTION:
All NATO Organisations – Releasable to the Public

Unmanned Aerial Systems (UAS) are proliferating across the spectrum of military conflict. NATO has recognized the importance of these systems and is transforming to take advantage of them. Various NATO and non-NATO organisations are working the complex issues associated with UAS operations within the alliance. Principle focus areas include air space management, integration and interoperability, force development, and command and control. Enclosed you will find the JAPCC Strategic Concept of Employment for UAS in NATO.

This document describes a capabilities-based approach to UAS employment, which enhances the joint and coalition operator's ability to execute assigned missions and tasks. Additionally, it recommends NATO guidance, considerations, and concepts for optimum UAS employment.

Our hope is that this JAPCC document will serve as a stepping stone to the development of NATO doctrine and pave the way into the future for UAS in the alliance.

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Lieutenant General, DEU AF
Executive Director

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PREFACE

Aim

This publication provides the fundamental guidance and an overarching concept for NATO operations and employment of unmanned aircraft systems (UAS) through the full spectrum of military operations.

Purpose

It describes a capabilities-based approach to UAS employment, which enhances the joint and coalition operator's ability to execute assigned missions and tasks. This document recommends NATO guidance, considerations, and concepts for optimum UAS employment across the full spectrum of military operations. It is intended for use by NATO nations and coalition forces in preparing their operational and program plans, in support of service, joint, and coalition doctrine, and assist in CONOPS development. This publication does not restrict the authority of the Joint Force Commander (JFC) from organising forces and executing the mission in the most appropriate manner.

Application

The fundamental principles, guidance, and capabilities presented in this publication support the Ministries of Defence, the commanders of combatant commands, joint task forces, and subordinate components of these commands (see Preface Table, page v). While this document is not authoritative in nature, the recommended guidance offered should be followed except when, in the judgment of the commander, circumstances dictate otherwise. If conflicts arise between the contents of this publication and the contents of joint and doctrinal service publications, the joint publications will take precedence for the activities of joint forces.

Acknowledgements

The JAPCC would like to express its appreciation for the outstanding contribution by the United States Joint UAS Centre of Excellence. Their expertise and inputs were essential to the completion of this document. The authors also very much appreciated the exceptional contribution and critiques of the entire Joint UAV Panel community representing all NATO nations and NATO institutions involved in UAS operations.

Preface Table (Applications)

	Target Organisation	Applicability	Context
Primary	Ministries of Defence Combined/Joint Task Force (CJTF)/Service Component/Functional Component Staff	NATO operations and planning NATO doctrine and concepts development Joint operating domain Training	Guidance and overall joint context on UAS employment Integrate LTCR into Joint operator requirements Interoperability Common terminology and architectures Information Assurance
Secondary	Operators (below JTF level) National Service Headquarters Staff	Services operations and planning Services Tactics, Techniques and procedures (TTP), CONOPS	Provides overarching joint context for UAS operations and its influence on Service CONOPS Common Terminology
Tertiary	Nations acquisition, Logistics, Technology Programming and Policy agencies Coalitions and multinational partners Others (including other government agencies)	Defence and Service Business domain	Insight into capability and program gaps

Overview

This publication provides the NATO vision for the operation, integration, and interoperability of UAS until 2025. This document describes a capabilities-based approach to UAS employment, which enhances the joint operator's ability to execute assigned missions and tasks. It emphasizes joint guidance for optimum UAS employment across a range of military operations. The document focuses at the operational (campaign) level of warfare and Civil Support (CS) for use by NATO and its multi-national/coalition partners. Additionally, this document assists with the development of joint/coalition, Service doctrine, CONOPS, and operational plans.

Chapter I - Introduction: Sets the stage for a UAS capability discussion by briefly describing the background and the necessity for tasking which resulted in this document development. This chapter also briefly describes and differentiates UAS from manned aircraft.

Chapter II - UAS Family of Systems: Defines and describes key UAS terms and related employment concepts. It begins with a discussion of UAS components (aircraft, payload, communications, control, support, and the human aspect). Next it defines NATO UAS categories. Finally, it provides an overview of UAS capabilities and limitations by category.

Chapter III - Planning and Employment Considerations: Highlights the most important issues regarding UAS employment in the near term. Optimal UAS employment presents complex and unique challenges requiring joint planners to be educated with the information needed to mitigate those challenges.

Chapter IV - UAS Support to Joint or Coalition Force Operations: Provides a top-level discussion for the optimised employment of UAS based on current doctrine and near- to mid-term concepts. This chapter also highlights the range of potential operational missions in which UAS can be employed in support of the joint force or its component commanders.

Chapter V - Doctrine, Organisation, Training, Materiel, Leadership and Education, Personnel, Facilities, and Interoperability (DOTMLPFI) Considerations: Highlights UAS issues that may require DOTMLPFI changes or new materiel solutions. The chapter provides issues, discussions, recommendations, and ongoing efforts that are addressing the issues.

Appendix A - Operational Vignettes: Puts the discussion of Chapter IV into context by including vignettes to illustrate how UAS are employed in support of joint/coalition operations. The vignettes include a major operation and campaign, a non-combatant evacuation operation (NEO), urban, Homeland Defence (HD), and Civil Support operations.

CHAPTER 1

Introduction

1.1 Background

UAS are considered to be the system, whose components comprise the necessary equipment, network, and personnel to control an unmanned aircraft (UA).

1.1.1 UAS are recognized as critical assets across all levels of joint/coalition command. Demand for the capabilities UAS can provide are likely to grow in conflicts. Due to this increased demand, resolving employment and system integration challenges is more important than ever.

1.1.2 UAS are just one part of a complex blending of manned and unmanned aerial systems across Services and across Nations. This concept of employment will focus on several scenarios where UAS can reduce risk, increase confidence and enable mission success. The growing number of UAS potential mission sets and scenarios demand their comprehensive integration into present and future combined and joint operations. It is essential to seamlessly integrate UAS with manned operations in a joint environment. There is a pressing need to integrate and fuse the C4ISR data from UAS with that gathered from existing and future C4ISR architectures to bring about proper integration with the Intelligence cycle.

1.2 Aim

This document provides a common approach to the development of the capabilities of current and future UAS for operational planning and execution under a wide range of conditions. It will allow joint operators and planners to select from the UAS capabilities set to achieve the desired operational effects and will:

1.2.1 Provide a NATO vision and joint/coalition context for the operation, integration, and interoperability of UAS in campaigns through the year 2025.

1.2.2 Describe a capabilities based approach to UAS employment, which enhances the joint operator's ability to execute assigned missions and tasks across the entire range of military operations.

1.2.3 Establish NATO joint guidance for UAS planning and execution at the operational (campaign) level of military operations.

1.3 Scope

The scope of this document deals specifically with UAS and their contribution to joint operational scenarios. NATO's strategic context and future environment is mainly taken from the work of the Multiple Future Project (MFP) and the Defence Requirements Review (DRR) process. It uses the MFP implications for future military engagement within a comprehensive approach to address complex, dynamic problems. The DRR process defines several operational scenarios. The timeframe considers employment principles for current and future operations as defined by NATO's long term capabilities requirements. This document reflects these operational considerations and employment scenarios.

1.4 Implications

The implications of UAS employment principles span several areas for future work. UAS employment must be integrated into operational design across the full range of military operations. UAS must be considered in the development or modification of operating concepts, doctrine, STANAGs, and tactics, techniques and procedures. It may also assist the integration of UAS into NATO education, training, exercises, and evaluation. These UAS employment principles also support technology development and procurement and are linked to capability developmental elements known as DOTMLPFI . As a baseline for the UAS contribution to the Joint operation (along with future doctrine development) and new Standard Operating Procedures (SOPs), these principles support commanders by enabling the integrated and efficient use of UAS capabilities.

1.5 What Makes UAS Different

UAS operations resemble those of manned aircraft in many ways. The similarities include: aerial platforms; disciplined, professional operators/crews; use of airspace; requirement for aviation maintenance/logistical support; and training. However, the major difference of UAS over manned aircraft is the ability to operate in dangerous environments without the risk to human life, together with increased loiter time over the operating area. Conversely, there are challenges associated with removing the human from the airframe, most notably the necessity for data links for flight control and aircraft monitoring. This document highlights the specific capabilities and limitations the joint operator must be aware of when planning, allocating, integrating, and controlling UAS.

1.5.1 Reduced Risk. The proliferation of UAS across NATO provides an enabling capability to the commander to minimize risk across the spectrum of conflict within an established Joint Operational Area (JOA). Some specified and implied joint tasks which may be too "dull, dirty or dangerous" for direct human involvement may require unmanned systems to enable the successful accomplishment of the task while lowering the risk to personnel and equipment. The commander's willingness to risk an asset will usually be greater when no risk to human life is involved. UAS can lower the risk and raise the political acceptance and confidence that high risk missions will be successful. Even in missions that have traditionally been performed by manned aircraft, UAS can improve joint effectiveness and reduce uncertainties by closing the seams between the elements of the Find, Fix, Track, Target, Engage, Assess (F2T2EA) cycle. The commander now has an expanded risk envelope in which combat operations can be conducted. The following are two examples of high risk operations where UAS is used to reduce mission risk:

1.5.1.1 UA can carry a chemical, biological, radiological, and nuclear (CBRN) sensor into areas unsafe for manned aircraft, allowing detection of such threats without risking human operators.

1.5.1.2 In recent combat operations, during high priority missions, commanders have assumed the risk for potential loss of UA in circumstances that would not normally be permissible for manned aircraft (e.g., adverse weather conditions, maintenance anomalies, or low fuel states).

1.5.2 Design. Without the requirements associated with manned flight, UA can be designed to any required size appropriate to the mission from tactical to strategic.

1.5.3 Mission Flexibility. Although possible with manned aircraft, UAS are routinely employed in multi-tasked roles in a single sortie. Certain missions may not be planned before the aircraft launches, but the flexibility inherent to UAS allows the commander to re-task the aircraft multiple times on a single sortie. This gives the JFC operational capabilities where and when needed and enhances the operational art of time-space-force considerations.

1.5.4 Endurance and Persistence. Two related terms where endurance refers to the ability for increased time on station and persistence refers to the tenacity of purpose and efficacy of UAS capabilities. For example, a UA can be designed to maximize endurance, which may translate into increased effective mission time. Depending on payload configurations, some UAS routinely exceed 20 hours of effective mission time and future capabilities may exceed months of operational endurance. Other types of UA can be launched within minutes, remain aloft for a few minutes to produce an effect (ISR, Decoy, etc.), land and be re-tasked for another launch as needed as needed to provide persistence over the battlefield.

1.5.4.1 Separating the human from the UA introduces challenges with airspace integration both in a military role, as well as air traffic control procedures in non-segregated airspace:

1.5.5 Airspace Deconfliction/Integration. The UA operator has limited visual and situational awareness cues. To avoid mid-air collisions, the current methodology employed by manned aviation includes procedural deconfliction, visual acquisition, and terminal control avoidance systems. While UAS may communicate with air traffic control and/or use onboard avoidance systems, UA operators typically do not have the same visual field of view and response times as manned aircraft. To overcome these limitations, UA operators must build and maintain their situational awareness through utilization of other resources (e.g., observers, ground radar, electro-optical/infrared (EO/IR) cameras, chat, etc.). Today's environment uses segregated air space as the means of ensuring safe operation between manned and unmanned aviation. The ultimate goal is for full integration of UAS with manned aviation in all areas of operation.

1.5.6 Standards and Training. UAS operations require standardized rules, regulations and procedures. NATO currently lacks many of these standards which may reduce overall interoperability and integration. STANAG 4670 defines minimum UAS operator training standards.

1.5.7 Data Links. UAS are constrained by data links, whether conducting line-of-sight (LOS) or beyond line-of-sight (BLOS) operations. Interruption or loss of the controlling data link could result in degraded mission effectiveness, mission failure, and in extreme cases, loss of the UA. LOS operating distances are affected by UAS equipment, terrain, and atmospheric conditions. BLOS operations are sensitive to any anomalies in a complex communications relay structure. The number of UAS that can be employed in a common operating area may be constrained by the available satellite bandwidth. Potential UAS data link vulnerabilities may be mitigated by encryption, the creation of redundant critical nodes, and further advances in autonomy/automation.

CHAPTER II

UAS Family of Systems

2.1 UAS Components

From an operational perspective, UAS consist of several common components. Various documents and studies have separated UAS into different components. The UAS components are: the unmanned aircraft, payloads, human element, control elements, data links and support element. The following sections describe these components. Since these components must be integrated into a whole UAS, it could be argued that what is included in one element could be of more value included in another (e.g., communication and payloads). Direction, collection, processing, and dissemination, while not technically part of the UAS, are critical to integrate and optimize the capabilities of UAS with the operation.

2.1.1 Unmanned Aircraft (UA). An aircraft that does not carry a human operator and is capable of flight under remote control or autonomous programming. A UA is designed to be recoverable, but can be expendable and can carry a lethal or non-lethal payload. UA are rotary or fixed-wing aircraft or lighter-than-air vehicles, capable of flight without an onboard crew. For the purposes of this document, all UA are intended to be recovered (i.e., landed),

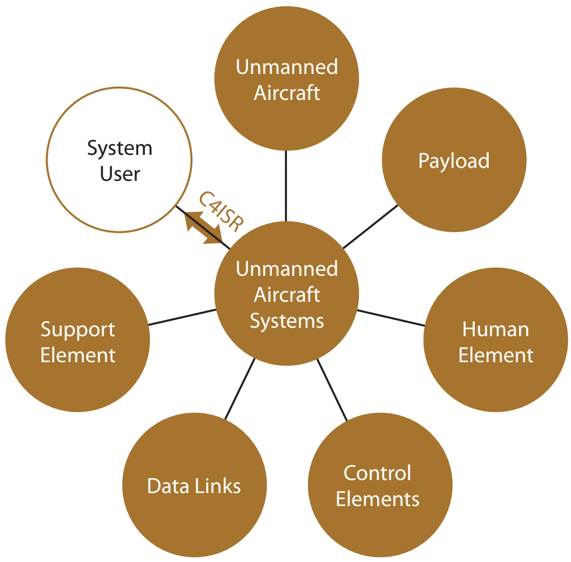

Figure 1: Unmanned Aircraft System Components

even though they may be expended. UA may be operated remotely or autonomously. The UA includes the aircraft and integrated equipment (propulsion, avionics, fuel, navigation, and communication systems).

2.1.2 Payload. UA payloads include sensors, communications relay, weapons, and cargo. Payloads may be internally or externally carried. Modular sensor interfaces should conform to NATO interface standards (STANAG 4586).

2.1.2.1 Sensors. The majority of today's payloads are imaging sensors, such as electro-optical (EO), infrared (IR), and radar (synthetic aperture radar [SAR], inverse synthetic aperture radar [ISAR], and maritime search radar). In addition, there are ground, surface and maritime moving target indicators, light detection and ranging (LIDAR), chemical, biological, radiological, nuclear, or high yield explosive (CBRNE) detection, automated identification system (AIS), measurement and signature intelligence, and signals intelligence (SIGINT) sensors. Sensor packages may also include a laser range finder and/or laser designator (LRF/D) capability. These pulse laser systems enable accurate and instantaneous distance and speed measurement for target location and the ability to provide target designation for laser guided weapons. Future technological advancements may include sensor types, such as environmental, multispectral, and hyper spectral.

2.1.2.1.1 Sensors downlinks include full motion video (FMV) and still frame imagery. FMV transmissions typically consume large amounts of bandwidth, while still frame imagery transmissions may consume less bandwidth. Some current narrow field of view sensors may be replaced by wide area sensors with the ability to cross cue to multiple points of interest for multiple users. Some UAS have sensors capable of topographical mapping and measure the geometric quantities of an object.

2.1.2.2 Communications Relay. Communications relay payloads provide the capability to extend voice and data transmissions via the UA. For example, these payloads presently provide relay capabilities for Single Channel Ground and Airborne Radio System, Enhanced Position Location Reporting System radios, remote sensors, and data networks. For operations involving allied/coalition forces, interoperability will be the primary factor for successful communications and information sharing. Future communications gateway payloads may include bridging, range extension, and translation capabilities that will allow users to communicate between disparate types of radios, data links, and networks.

2.1.2.3 Weapons. UA may employ both lethal and non-lethal weapons in order to achieve the desired effect.

2.1.2.3.1 Lethal Effects: Current weapons employed by unmanned aircraft are in the 500-pound class or less and are usually Global Positioning System (GPS) or laser-guided.

2.1.2.3.2 Non-lethal Effects: Some non-lethal capabilities being considered for UAS employment include: electrical, directed energy, acoustics, chemical, kinetic energy, barriers and entanglements.

2.1.2.4 Cargo. Some UAS have the capability to utilize non-expendable payloads for delivery and/or pickup of supplies and equipment. One example is delivery of medical supplies to SOF units behind enemy lines, or, perhaps in the future to transport the wounded as well as personnel to various locations.

2.1.3 Human Element. This aspect of the UAS is typically not considered a separate element, but it is perhaps the most critical to successful UAS employment. The idea that UAS are "unmanned" is a misnomer. While the aircraft itself is not manned, the system is manned. UAS require a certain amount of human involvement to prepare and execute the mission. For most UAS, primary personnel tasks include, but are not limited to, the operator (aircraft and/or payload), maintainer, mission commander, and intelligence analyst (for some UAS, intelligence analysts are not considered as part of the system). UAS personnel must be qualified in their particular area of involvement, and they must maintain currency in their particular aspect of operations. Commanders should take into account UAS operator fatigue and ensure units are sufficiently manned to accomplish missions without interruption.

2.1.4 Control Element. The control element, whether ground-based, sea-based, or airborne, handles multiple mission aspects, such as Command and Control (C2), mission planning, payload control, and communications. The control element may contain various levels of C2 for the UAS. The portion of the control element where the UAS operator is physically located is referred to as the control station. Some UAS require two or more personnel to control the UA and payload, while other UA can be controlled by a single operator. Conversely, some control stations enable the control of multiple UA by a single operator. UA and payload control can be passed between control stations depending on the type of UAS and the mission requirements.

2.1.4.1 The physical location of the control station and transfer of control can vary greatly, depending on the mission and the commander's requirements. Control stations can be fixed or mobile, based upon system optimization. Some control stations operate via LOS and are located in the operating area. Other UA are controlled via BLOS satellite communication (SATCOM), with the control station located outside the joint operations area. Based upon the specific UAS and associated network, data products may be transmitted through either inter/intra-theatre BLOS SATCOM or LOS routing.

2.1.4.2 Currently, some UA are controlled by control stations that utilize proprietary software, which limits interoperability. There are NATO initiatives (e.g., STANAGs 4586, 7085) to migrate to interoperable control station software architectures (non-proprietary).

2.1.5 Data Links. Data links include all means of communicating among the UA, UAS control element, and user, and are used for any means of data transfer. Data products may be transmitted directly to the user for immediate action and/or to another network for further exploitation and dissemination. The UA data links can be transmitted via either LOS or BLOS.

2.1.6 Support Element. Like manned aircraft, UAS require logistical support. This support element includes all of the prerequisite equipment to deploy, transport, maintain, launch, and recover the UA, and enable communications. For a small hand-launched system, relatively little support equipment will be needed, while larger systems typically require more support equipment. Also similar to manned aircraft, NATO UAS must be able to share common aspects of UAS support equipment to enhance interoperability with various payloads and missions. For example, a UA should be able to fly into a NATO base that is compatible for re-tasking the UA as directed by the Air Tasking Order (ATO). This will require common technical standards that must be resolved to improve UAS development and acquisition. Pre-deployment planning must include the UAS logistical support requirement to initially deploy the UA and then enable sustained operations.

2.2 UAS Categories

2.2.1 Why UAS categories are important. Commonly accepted and understood UAS categories establish the foundation for NATO UAS terminology. Categories facilitate communication and knowledge sharing by providing a unifying framework for organisations with different viewpoints. Various NATO organisations refine standards and doctrine which increasingly include UAS considerations. UAS considerations into NATO STANAGs are better served with a common reference system. Categories can improve NATO operational planning and C2 by providing a common reference for grouping UAS. For operations conducted in non-segregated airspace, UAS categorization may help to establish certification and operational standards applicable to different groups of UAS. Additionally, classification may drive personnel selection and pilot/operator qualification requirements.

2.2.1.1 Each nation needs to organise, train, and equip its respective UAS forces. This document categorizes the entire UAS domain in a joint context. In recognition that the JFC and his staff will be employing joint assets, UAS Categories are included to assist the joint planner/operator with common terminology when referencing various UAS. The methodology of grouping like assets serves to assist NATO nations and civil authorities in defining standards (e.g., equipment, airworthiness and training requirements). Categorization allows the Services to organise, train, equip, and standardize UAS for optimum employment.

2.2.2 How NATO UAS Categories are derived. NATO UAS Categories are based on UA maximum gross take-off weight and normal operating altitude. Categories start with weight classes. These weight classes are further divided on the basis of the operational altitude of the UA.

2.2.2.1 CLASS I: Less than 150 kg (further divided down based on altitude). Under 150 kg the NATO certification Standards do not apply.

2.2.2.2 CLASS II: 150 kg to 600 kg. 600 kg is the maximum weight for the Light Sport Aircraft in civil terms, but over the 150 kg that is in use for NATO certification.

2.2.2.3 CLASS III: More than 600 kg (further divided based on altitude). Operates at the higher altitudes and with the higher speeds, range, endurance and size. Crew qualifications can be expected to be more extensive.

2.2.2.4 Conflicts in UAS classes are resolved with the respective weight class. For example, if a UA weighs 15 kg and operates up to 6000 AGL, it would still be considered a Class I UAS.

2.2.2.5 Although endurance is not a specific discriminator for UAS categories, the acronym HALE (High Altitude, Long Endurance) and MALE (Medium Altitude, Long Endurance) are legacy terms that remain in NATO lexicon.

UAV Classification Table

Class	Category	Normal employment	Normal Operating Altitude	Normal Mission Radius	Primary Supported Commander	Example platform
CLASS I (less than 150 kg)	SMALL >20 kg	Tactical Unit (employs launch system)	Up to 5K ft AGL	50 km (LOS)	BN/Regt, BG	Luna, Hermes 90
	MINI 2-20 kg	Tactical Sub-unit (manual launch)	Up to 3K ft AGL	25 km (LOS)	Coy/Sqn	Scan Eagle, Skylark, Raven, DH3, Aladin, Strix
	MICRO <2 kg	Tactical Pl, Sect, Individual (single operator)	Up to 200 ft AGL	5 km (LOS)	Pl, Sect	Black Widow
CLASS II (150 kg to 600 kg)	TACTICAL	Tactical Formation	Up to 10,000 ft AGL	200 km (LOS)	Bde Comd	Sperwer, Iview 250, Hermes 450, Aerostar, Ranger
CLASS III (more than 600 kg)	Strike/ Combat	Strategic/National	Up to 65,000 ft	Unlimited (BLOS)	Theatre COM	
	HALE	Strategic/National	Up to 65,000 ft	Unlimited (BLOS)	Theatre COM	Global Hawk
	MALE	Operational/Theatre	Up to 45,000 ft MSL	Unlimited (BLOS)	JTF COM	Predator B, Predator A, Heron, Heron TP, Hermes 900

Table 1 - NATO UAS Classification Guide. September 2009 JCGUAV meeting

2.3 UAS Capabilities and Limitations

2.3.1 General. Unique design features of UAS that enable a desired capability (e.g., long endurance, hand-launched) may also impose some limitations on performance.

2.3.2 Capabilities. UAS provide the commander with an effective lethal or non – lethal means for achieving his objectives across the full spectrum of operations. UAS capabilities may improve situational awareness in areas such as ISR, and reconnaissance, surveillance, and target acquisition (RSTA); laser designation; attack; damage assessment; CBRNE detection and monitoring; cargo delivery and logistics resupply and communications gateway extension (e.g., communications relay, network extension); combat search and rescue. They may also assist in psychological operations (PSYOP); combat identification; early warning; locating and monitoring enemy military equipment; monitoring borders for smuggling; detecting mines (land and sea) and Improvised Explosive Devices (IED); infrastructure reconstitution; geospatial intelligence and SIGINT support; maritime vessel identification; meteorological and oceanographic condition (METOC) monitoring support; personnel recovery (PR); and support to law enforcement.

2.3.3 Limitations. UAS share many of the limitations of manned aircraft. The limitations that most frequently affect UAS are reliance on data links and adverse atmospheric conditions such as wind, turbulence, and icing conditions.

2.3.3.1 Data Link. Currently, the most significant limitation associated with UAS involves the unique requirement of UAS to be controlled through a data link. Although most UAS can fly pre-programmed autonomous missions, they still require some form of data link for aircraft systems/mission monitoring and manual flight control. Data link limitations include: vulnerability to electromagnetic interference (EMI), physical distance and power strength of the signal, physical obstructions to the signal (e.g., lost link), bandwidth availability, and frequency allocation and deconfliction in saturated environments.

2.3.3.2 Winds. UA have crosswind limitations that may affect launch and recovery operations. The relatively slow airspeeds of many UA also make them susceptible to winds at altitude, which may influence the UA's effective mission time and increase fuel requirements. If winds at operating altitude are forecast to be greater than the UA's maximum sustainable airspeed, the UA may not be able to reach, remain on, or return from station. Winds in the target area may also influence target acquisition and weapons employment. Targets may be obscured by blowing smoke, sand, or dust.

2.3.3.3 Turbulence. Turbulence makes UA more difficult to control during all phases of flight and impact UA ability to maintain data links for mission execution. Turbulence may also affect stability of the sensor and potentially prevent weapons employment. In some cases, turbulence may cause the flight control servos to overheat or fail rendering the flight controls inoperative. If the turbulence exceeds the structural capability of the UA, structural failure may occur.

2.3.3.4 Icing. Most UA do not have anti-icing capabilities and cannot fly in freezing precipitation or icing conditions. This includes climbing or descending through icing in an attempt to reach non-icing conditions.

2.3.3.5 Miscellaneous Considerations. Launch and recovery method, acoustic footprint, day/night (e.g., some UA may not have IR sensors), airspace availability, special fuels, batteries, space weather effects (e.g., solar winds) on data link, data storage, fog, smoke, heavy precipitation, low cloud decks, thermal crossover, excessive heat, high altitudes (small UAS), high humidity and sea state (maritime UAS).

2.4 Capabilities / Limitations by Class

2.4.1 Class I.

2.4.1.1 Capabilities. Class I UAS are typically hand-launched, self contained, portable systems employed at the small unit level or for base security. They are capable of providing "over the hill" or "around the corner" type reconnaissance and surveillance. Payloads are generally fixed EO/IR, and they have a negligible logistics footprint.

2.4.1.2 Limitations. Class I UA typically operate within the operator's line of sight at low altitudes, generally less than 5,000 feet AGL and have a limited range/endurance.

2.4.2 Class II.

2.4.2.1 Capabilities. Class II UA are typically medium-sized, often catapult-launched, mobile systems that usually support brigade and below ISR/RSTA requirements. These systems operate at altitudes less than 10,000 feet AGL with a medium range. They usually operate from unimproved areas and do not usually require an improved runway. Payloads may include a sensor ball with EO/IR and an LRF/D capability. Class II UA are typically employed within tactical formations and usually have a small logistics footprint.

2.4.2.2 Limitations. Class II UA usually have less range/endurance, and less payload capability than Class III UA. They require a high degree of coordination / integration in combat and civilian air space.

2.4.3 Class III.

2.4.3.1 Capabilities. Class III UA are typically the largest systems, operate in the high altitude environment, and typically have the greatest range/endurance and airspeed. They perform specialized missions including broad area surveillance and penetrating attacks. Payloads may include sensor ball with EO/IR, radars, lasers, SAR, communications relay, SIGINT, AIS, and weapons.

2.4.3.2 Limitations. Most Class III UA require improved areas for launch and recovery. The logistics footprint may approach that of manned aircraft of similar size. They typically have the most stringent airspace requirements. Lack of SATCOM would prevent use when being operated BLOS. These UA typically have decreased endurance when carrying weapons due to decreased fuel load capability and aerodynamic effects associated with external hard points.

CHAPTER III

Employment Considerations

3.1 General

Many of the issues that need to be considered when employing UAS are the same or very similar to those of manned assets. However, there are some significant differences that determine how UAS should be employed. Whilst this document recognizes that Nations may employ UAS based on service–specific concepts, this chapter aims to provide a standard framework for UAS employment across the Alliance.

3.2 C2 of UAS

The JFC should be given the authority to determine the use and control of all UAS forces under his command. The functional component commanders will maintain C2 of their assigned or attached UAS unless the JFC transfers operational control (OPCON) or tactical control (TACON) to another component. The following should be considered;

3.2.1 Unique Aspects of UAS C2. C2 processes for UAS are similar to those for manned assets, but several aspects of UAS can make C2 particularly challenging. First, the physical separation of the UA from the operator requires robust C2 data links. Second, most UAS can be flown both manually and/or in a pre-programmed mode. In the pre-programmed mode, UAS still require some form of data link with the aircraft to allow an operator to monitor aircraft/systems status and switch to manual flight control. Third, UAS may be capable of transferring control of the aircraft and/or payloads to multiple operators while airborne.

3.2.2 C2 of UAS in Joint Operations. Two critical C2 functions in joint air operations are allocation and tasking of resources. Those UAS allocated by the JFC to the air component commander will comply with the tasking process described in AJP 3.0. Transfer of UAS C2 within a Service or functional component is handled through Service or functional command structures.

3.2.3 C2 of Theatre-Capable UAS. Like manned aircraft, theatre-capable UAS may be used to support the JFC, component commanders operations, or in support of other component commanders. As these scarce assets can be in high demand, careful consideration must be made by the JFC, when making apportionment and allocation decisions. The requirements of the component commanders should be balanced against the overall Joint Force requirements. How theatre-capable UAS operations are managed and planned will vary based on the type and phase of an operation.

3.2.3.1 Theatre-capable UAS are typically used for three types of missions: (1) ISR/RSTA, (2) tactical C2, and (3) Joint Fires. ISR/RSTA, in this context, describes the process of building activity patterns through repeated visits to a large set of targets. This data may require further exploitation to develop actionable intelligence. The ISR/RSTA planning process aims to maximize the number of collection targets for each sortie. Tactical C2 involves the collection of real-time, actionable, and often perishable data in direct support of a ground commander. Tactical C2 may involve many hours of tracking a single target, following vehicles, or examining planned routes. Support to Joint Fires involves the development of targeting data and may include the use of laser designation, or actual employment of a weapon. Support to Joint Fires may occur in the course of another mission or may be pre-planned. Current joint doctrine provides for parallel planning processes for ISR/RSTA and Joint Fires. These parallel processes have been sufficient for manned aircraft, but theatre-capable UAS, with long dwell times and multi-mission capability, including multiple missions on the same sortie, require significantly more coordination between the two processes. The requirement to provide support to C2 further stresses and complicates the use of theatre-capable UAS.

3.2.4 Factors to Consider When Tasking UAS. Planners and operators should request a desired condition or effect and not a specific UA to support a mission. For example, many different UAS can provide imagery, so depending on the desired effect, there may be more than one type of UAS to support the mission. Re-tasking a UAS during mission execution must be carefully considered; dynamic re-tasking of UAS should be determined by the appropriate commander (e.g., with OPCON or TACON) after evaluating the full impact of diverting the capability from the current mission.

3.2.4.1 Transfer of Control during Mission Execution. If a UAS is re-allocated to support another commander's objective, the supported commander should, to the maximum extent feasible, use the established C2 arrangements. Following UAS transfer of control, intelligence collection managers and ISR operations managers may adjust plans and reprioritize available ISR assets and capabilities.

3.2.4.2 C2 of UAS in Time-sensitive Targeting (TST). UAS can be effective in support of TST missions. Commanders should determine whether they are responsible for an TST and be aware that they may be required to act as a supporting commander for the TST mission. TST situations may require UAS to support close air support (CAS), strike coordination and reconnaissance, air interdiction (AI), other joint fires missions, and personnel recovery (PR). Specific tasks for the UAS may include: target acquisition/marking, terminal guidance of ordnance, providing precision coordinates for GPS aided munitions, delivery of onboard precision-guided ordnance, battle damage assessment (BDA), and retargeting (i.e., shoot-look-shoot). In the TST role, UAS are routed, controlled, and deconflicted in the same manner as fixed- and rotary-winged manned aircraft, as outlined in joint doctrine.

3.2.5 Future Direction of UAS C2. A networked architecture is the most likely solution for future joint C2 of UAS. Authorized users may be able to direct UAS missions in their areas of operation. The migration from current point-to-point data links to networked data links enables more users to have access to UA payload and telemetry data. Gateway nodes may distribute higher bandwidth data streams to selected users and provide lower bandwidth streams directly to the warfighter.

3.2.5.1 Some ground control stations (GCS) are capable of controlling multiple UA from a single location. Future network architectures will enable authenticated users to control multiple UA, and/or access products being distributed by multiple UA.

3.2.5.2 Advances in onboard computational and storage capacity may allow for higher levels of UA autonomy/automation. UA autonomous/automated/pre-programmed operations will present C2 and other challenges that must be addressed as the technology matures.

3.2.5.3 As data dissemination capability expands requests for support will increase. This may require support tools to be developed to collect, filter, and prioritize such requests.

3.3 Employment Considerations by UAS Categories

3.3.1 Class I. By virtue of size, Class I UAS are normally man-portable, hand-launched and operated by an individual controller, and normally have a range of less than 20 miles. They may be tracked using a force tracking system and typically have an endurance of up to two hours. Simplicity of launch and recovery allows a unit to employ Class I UAS assets quickly, within the constraints of airspace coordination measures.

3.3.2 Class II. By virtue of size, Class II UAS are limited in range and their ability to support large areas of operation. They are typically theatre based, require pre-surveyed launch and recovery areas, and may be tracked using force tracking systems. Simplicity of launch and recovery operations allows a unit to employ Class II UAS assets quickly, within the constraints of airspace coordination measures.

3.3.3 Class III. Most Class III fixed wing UAS require runways for launch and recovery, although some are catapult launch assisted. Mission focus dictates a forward or remote split operations (RSO) footprint (e.g., phase of the operations, major combat operations (MCO) versus Irregular Warfare (IW)/Counter Insurgency (COIN), supported commander etc.). Class III UAS are the most complex and provide the most capability. They will require more airspace considerations than other classes, leading to airspace management requirements on par with manned aircraft. Depending on weight, power, and size restrictions, this class can be tracked by either a force tracking system or a transponder.

3.4 Mission Planning Considerations

Current doctrinal planning considerations for manned aircraft are applicable to UA, with modification.

3.4.1 Flight Planning. Every UA flight requires some degree of flight planning, regardless of the size of the aircraft, the mission profile, or the flight location. Different phases of the mission may be executed by different personnel/crewmembers (e.g., takeoff/landing crews and mission crews). Planners must ensure the mission briefs, goals, tasks, etc., are coordinated among all pertinent crew to ensure mission understanding and success. The unique requirements of UA data links requires detailed planning for lost link and/or emergency recoveries. Larger Class II and Class III UA increasingly operate outside military controlled airspace. Planners must plan the route, determine communication, navigation, and surveillance requirements, verify weather, weight and balance, and file a flight plan with the controlling agency in order to obtain a flight clearance. For take off and landing of Class III UA they should consider the implications of integration with manned aircraft, if present. UAS operating in international airspace must comply with international laws, customs, and practices, and other multinational and bilateral agreements. Smaller Class II and Class I UA may have fewer planning requirements, but should still consider all these factors.

3.4.2 Airspace Coordination Order (ACO). UAS airspace coordination must be included in the ACO development process.

3.4.3 Airspace Management. UAS operate in both national and international airspace as well as under military and civilian air traffic control. Airspace management remains one of the top factors impacting

UAS integration with other airspace users. For the purposes of this document, airspace is divided between military airspace and civilian airspace. Military airspace is that airspace controlled by the military without the requirement for airspace users to coordinate with a civilian airspace control authority or adherence to civilian airspace policies or regulations. Civilian airspace is that airspace governed under normal peacetime policies and regulations. The joint operator must understand how airspace control measures apply to their systems.

3.4.4 Military Airspace. The Airspace Control Authority (ACA), typically the JFACC, is responsible for airspace management and should be aware of integration issues for all UAS. UA that fly above the coordinating altitude are required to appear in the ATO, and airspace management is accomplished using the same positive or procedural control measures in place for manned systems. Joint operators should be familiar with where their systems operate, procedural controls (such as identification manoeuvres), contingencies for loss of UA control, and clearance of fires procedures.

3.4.4.1 In this case, UAS operators will conduct operations, in accordance with JFACC guidance, normally found in the theatre airspace control plan. Transponder equipped UAS can be identified by radar with interrogator capability. If the UAS has no transponder or space coordinating measures are required to deconflict the UAS from other airspace users. Class I and II UA provide a challenge for identification because they currently do not carry transponders because of weight and power limitations, but can be tracked using off-board command and control systems (e.g., Force Tracking System, Tactical Airspace Integration System).

3.4.5 Civilian Airspace. Service or functional components are responsible for operation of the UA, within any civilian airspace control system. If the civil air traffic control infrastructure does not exist or is significantly degraded, the Airspace Control Authority may be requested to provide advisories to civil and commercial users of the airspace system, until the nation's ATC system can be reactivated. Similar to manned aircraft, UA operators must be aware of the various classes of airspace, requirements for operating in those airspace classes, and the certification process for obtaining approval to operate in national/international airspace, including aircrew qualifications requirements.

3.5 UA Emergency Planning

UA emergency response may be difficult because the UA operator is dependent on performance parameters transmitted via data link. Another factor is that the operator is interpreting UA data on a monitor and does not have the benefit of normal sensory inputs. Additionally, a major consideration for all UAS operations is the potential for losing the data link. All UA have pre-planned or pre-programmed lost link profiles that are created by the operator before flight. Operators must ensure that these lost link profiles are safe and consistent with all airspace requirements, follow ACO guidance, and deconflicted with other airspace users. Another emergency planning factor is the potential for recovery of armed UA into an emergency divert base. This divert base may have to be within LOS of a compatible launch and recovery element (LRE) to ensure safe UA recovery.

3.6 Manned-Unmanned (MUM) Integration

Manned systems can leverage UAS capabilities, and vice versa. Efforts are underway to allow for manned aircraft to control one or more UA. This collaboration may allow increased situational awareness and extended sensor coverage over an area. Manned aircraft may have the capability to control armed UA. MUM teaming may also include integration of UAS with unmanned ground vehicles (UGV), unmanned surface vehicles (USV), unmanned sea surface vehicles (USSV), and unmanned undersea vehicles (UUV).

3.7 Interoperability

Interoperability aims to increase mission flexibility and efficiency through sharing of assets and information generated by UAS. The goal of interoperability is to establish effective standards to enable data transmission between the GCS, the UA, and the Command, Control, Communication, Computer, and Intelligence (C4I) network. Currently, the level of interoperability among UAS varies widely, from systems that can pass full control of the aircraft and/or payload from one operator to another, to systems that can only transmit sensor data to various recipients.

3.7.1 Today, UAS predominantly do not meet levels of interoperability 3, 4, and 5 described below, but some are expected to in the future. The LOI from NATO STANAG 4586 should be used to identify the flexibility in control for all active UAS.

3.8 Direction, Collection, Processing and Dissemination (DCPD)

The UAS must be able to rapidly disseminate combat information, intelligence, and fire support data to the appropriate users. DCPD is part of the intelligence process. The following definitions are derived from NATO Doctrine:

3.8.1 Direction – Direction is the first stage in the intelligence cycle and consists of determination of intelligence requirements, planning the collection effort, issuance of orders and requests to collection agencies and maintenance of a continuous check on the productivity of such agencies.

3.8.2 Collection – Collection is the second stage in the intelligence cycle. It is 'The exploitation of sources by collection agencies and the delivery of the information obtained to the appropriate processing unit for use in the production of intelligence'. It is the process in which information and intelligence are collected in order to meet the commander's information and intelligence requirements which were identified in the Direction stage of the intelligence cycle.

3.8.3 Processing – Processing is the part of the intelligence cycle where the information which has been collected in response to the direction of the commander is converted into intelligence. Processing is a structured series of actions which, although set out sequentially, may also take place concurrently. It is defined as; 'The conversion of information into intelligence through collation, evaluation, analysis, integration and interpretation'.

3.8.4 Dissemination – Dissemination is defined as 'The timely conveyance of intelligence, in an appropriate form and by any suitable means, to those who need it'.

3.8.4.1 The Intelligence Cycle is the framework within which four discrete operations are conducted culminating in the distribution of the finished intelligence product. The sequence is cyclic in nature

LOI 1	"Indirect receipt of UAS related data."	This is equivalent to a node on a C4I network. This LOI is mutually exclusive of all other LOIs.
LOI 2	"Direct receipt of ISR/other data where "direct" covers reception of the UAV data by the UCS when it has direct communication with the UAV."	This LOI is mutually exclusive of all other LOIs.
LOI 3	"Control and monitoring of the UAV payload in addition to direct receipt of ISR/other data."	This LOI is includes LOI 2.
LOI 4	"Control and monitoring of the UAV, less launch and recovery."	This LOI is mutually exclusive of all other LOIs.
LOI 5	"Control and monitoring of the UAV (Level 4), plus launch and recovery functions."	This LOI is includes LOI 4.

Table 2 – Levels of Interoperability (LOI)

since intelligence requires constant reappraisal and updating if it is to remain current and relevant to the commander's needs.

3.8.4.2 Not all UAS are connected to a formal Intelligence architecture. Some UA units operate autonomously and have no means to transmit their data outside their GCS.

3.9 Spectrum Management

Spectrum management, like airspace management, may limit UAS employment. Required pre-planning includes conducting early spectrum surveys, database searches, and other methods of examining the electromagnetic environment to facilitate spectrum planning efforts. Close coordination with the JFCs frequency manager is critical to safety and mission success. Joint operators should be aware of the frequency characteristics of UAS, the bandwidth requirements for sensor products, communication relay throughput, platform emission patterns and characteristics for all links, as they relate to the electromagnetic environment where they plan to operate. Knowledge of these factors will enable the operator to clearly articulate radio frequency (RF) requirements to the frequency manager for frequency allocation and deconfliction.

3.9.1 Environmental Interference/Capacity. JUAS operators who use LOS links for control of UAS and receipt of sensor products must coordinate with the appropriate spectrum manager to deconflict from other users. Planners must consider other emitters in the local areas of both the GCS andUA to avoid mutual interference with other systems. While Tactical Common Data Link/Common Data Link (TCDL/CDL) may reduce some of the bandwidth requirements, it is not yet a mature capability and not all UAS use it. For BLOS operations, regulatory requirements, potential interference, and availability of military and/or commercial satellite access should be considered. Operators have little or no control over how much satellite capacity is available, but a better understanding of the spectrum environment and bandwidth limitations can maximize effective use of all assets.

3.9.2 Protecting the Electromagnetic Environment. Many communications systems (like GPS, other SATCOM systems, and even local UHF systems) are highly susceptible to electro-magnetic impulse (EMI). Operators should be aware of threats to UAS operations due to hostile EMI, approved civilian operations, and unintentional Friendly Force EMI. If operating in an area of known interference, the unit frequency manager may be able to suggest mitigation techniques.

3.10 Other Employment Considerations

3.10.1 Optimizing Basing Locations. To the maximum extent possible, planners should consider basing UAS as close to mission areas as feasible. Since many emerging targets and TST events may be concentrated, closer basing can decrease transit times and increase on-station time. These considerations should be balanced with other factors such as force protection and logistics re-supply.

3.10.2 UAS Vulnerability. Recent operations have demonstrated that UAS can be susceptible to counter UAS measures. Operational risk management procedures should be used during the mission planning process to evaluate the threat environment. UAS components should be evaluated to include susceptibilities and vulnerabilities to the GCS, UA, payloads, and communications. UAS data links are susceptible to jamming/interference/manipulation.

CHAPTER IV

UAS Operations in Joint or Coalition Context

4.1 General

UAS can be procured by individual nations but should be able to integrate into any operation in support of a NATO mission. This in turn requires full interoperability that can only be achieved through standardization. At present UAS are mostly employed in support of operations that are Land dominant, Maritime dominant and/or Joint in nature. In the future, UAS might be used in operations that are uniquely Air dominant (e.g. Combat Air Patrol (CAP), Offensive and Defensive Counter Air operations (OCA, DCA)).

4.2 Joint UAS Missions

4.2.1 The following missions can be conducted in the joint environment supporting not only the JFC but also the various component commanders involved in the overall campaign.

4.2.2 Intelligence, surveillance, and reconnaissance (ISR). ISR has been and continues to be the primary mission of UAS. It enables decision makers to have a near real time "eyes on" capability on a developing situation during the operation. It also provides an immediate assessment post an action (e.g. Battle Damage Assessment (BDA)) and can aid authorities in dealing with natural disasters (e.g. forest fires).

4.2.3 Strike. Unarmed UA can use their payload (laser designator) to assist in precision strike by third parties. UA armed with a variety of weapons can be deployed against targets in any location. These targets can be either time sensitive or pre-planned. These engagements are usually conducted by the armed UA on an ISR sortie. Armed UA can be used to great effect in classic air warfare missions such as Close Air Support, (CAS) and Suppression of Enemy Air Defence (SEAD).

4.2.4 Communications Relay. UA can include data relay node as part of their payload to act as a relay facility between any assets in the theatre of operation. These same nodes also enable the operator to control another UA at extended range.

4.2.5 Electronic Warfare. UA payloads can be used as a component of electronic warfare (EW). Either to protect own use of and to engage the opponents use of the electro magnetic spectrum.

4.2.6 Combat search and rescue (CSAR). UA can be used in support of combat search and rescue through ISR and Communications Relay to assist in the overall recovery. EO/IR sensor capability provides exceptional search and rescue capability. For example, photos take over time could show changes in the environment indicating the position and/or intentions of downed aircrew. This information can be used by the commander to develop his recovery plan, aid in situational awareness for the rescuing forces and for the political decision makers to judge wider implications.

4.2.7 Chemical, biological, radiological, nuclear and explosive events (CBRNE) detection. UA pay-load can include sensors to assess radiological, biological, chemical and meteorological activity in an area of operation. UA are ideally suited for this mission as they do not endanger human life. Radiological sensors can sense the presence of radiation and the distribution of nuclear yield in a given area. Biological sensors can detect the airborne presence of various microorganisms and other biological factors. Chemical sensors use laser spectroscopy to analyze the concentrations of each element in the air.

4.2.8 Logistic supply. Rotary wing UA can be used for logistic support of own units in remote and difficult to reach areas. In the future this might also include battle field evacuation and extraction.

4.2.9 IED detection. UA payload can be enhanced with sensors that can detect IEDs in the land and maritime domain.

4.3 The Maritime Domain

4.3.1 The operating environment for UAS in the maritime domain differs from that of the over land environment. This environment provides challenges for UA and sensor payload such as sea state, salt water corrosion, high humidity, large stretches of water with very little land to operate from, limited space on board maritime platforms, etc. Therefore UA and sensors should be adapted to operate in the maritime domain.

4.3.2 UA should be able to conduct rapid climb and descent to investigate surface contacts and to avoid adverse weather. They require modified launch and recovery gear when operating from maritime platforms. Sensors should be modified to counter the effects of the sea such as Inverse Synthetic Aperture Radar (ISAR) with Maritime Moving Target Indicator (MMTI) and to incorporate the maritime electro magnetic spectrum in EW suites.

4.3.3 The following are examples of maritime missions that UAS could support.

4.3.3.1 Under Water Warfare (UWW). UAS can support UWW by participating in Anti Submarine Warfare (ASW) and Mine Counter Measures (MCM) through the use of sensors such as ISAR/MMTI, EW suite, Laser, EO and IR to detect and classify opponents under water craft (e.g. submarines) and explosive devices (e.g. mines).

4.3.3.2 Anti Surface Warfare (ASuW). Anti Surface Warfare includes Maritime Interdiction Operations (MIO) in support of a joint campaign but also in countering other threats such as in Counter Piracy (CP) operations. It is aimed at denying an opponent the use of the sea in a dedicated area. UA sensor payload is used in detecting and classifying potential opposing contacts in the operating area.

4.3.3.3 Strike Warfare. Strike Warfare consists of organic ship borne aircraft, amphibious forces, missiles, naval fires support, and naval gunfire to create effects on land in aid of the overall joint campaign. UAS are used in the same way as in the over land missions.

4.3.3.4 CSAR. UA can aid CSAR conducted from maritime platforms in the same way as is done during over land missions.

4.4 The Land Domain

4.4.1 Although UAS support for Land dominant operations is largely compliant with those stated under Joint UAS missions, operations in urban environment posses the following unique challenges;

4.4.2 Establishing and maintaining communications with supported ground forces via voice radio (e.g., structures etc can interfere with any communications).

4.4.3 Adherence to Rules of Engagement (ROE) with regards to engaging legitimate targets in extreme close proximity to civilians (e.g., firing a Hellfire missile at a vehicle parked on the side of a busy road with civilians entering the missile impact area). This may include the presence of a FAC who can control and/or coordinate delivery of air-delivered weapons in this environment.

4.4.4 Maintaining positive identification of moving vehicles as they transit uncontrolled or congested intersections (e.g., tracking a common variant of white sedan as it approaches an intersection with 50 other white vehicles) and or conduct evasive manoeuvres (e. g. if weather or resolution forces the UA to be lower/closer to target and the vehicle makes a U-turn, UA may experience sensor/targeting system nadir).

4.4.5 Assessing dynamic or rapidly emerging scenarios (e.g., unknown vehicle drives through own convoy and multiple fire-fights begin) and getting that information to the appropriate organisations in a timely manner.

4.4.6 Minimizing UA acoustic signature, especially at night or when weather forces UA flight at lower altitude (e.g., sound from the UA may prevent high value targets [HVT] from exiting a safe house).

4.4.7 Airspace de-confliction between similar categories of UA/manned aircraft being controlled by different agencies operating in the same area in support of the same objective.

CHAPTER V

DOTMLPFI Considerations

5.1 Doctrine

5.1.1 Providing the warfighters with effective and accurate doctrine is essential to the successful employment of NATO coalition forces. This doctrine is promulgated through joint doctrine publications, service doctrine publications, joint tactics, techniques, and procedures (TTP), service TTP, and policy. Joint doctrine standardizes terminology, relationships, responsibilities, and processes among coalition forces to free joint force commanders and their staffs to focus their efforts on solving the strategic, operational, and tactical problems confronting them.

5.2 Organisation

5.2.1 Operating forces, support staffs, and logistical support systems should be organised to optimize UAS capabilities at the appropriate echelon and to meet mission objectives/requirements. Characteristics to examine when task-organising include, but are not limited to: training, experience, equipage, sustainability, operating environment, enemy threat, and mobility.

5.3 Training

5.3.1 Specific mission essential task (MET) training, meeting established standards, is critical if personnel are to provide the capabilities that support the combatant commanders and set conditions for mission success. Training should address joint operations and concepts across all phases of joint campaigns and throughout the spectrum of service, joint, interagency, intergovernmental, and multinational operations. Training should be appropriate, utilize existing operational information networks, and occur in realistic environments and conditions to adequately prepare personnel to the highest level possible.

5.4 Materiel

5.4.1 Each military department shall be equipped to accomplish all assigned UAS missions and shall have an equipment procurement and distribution program that is responsive to the combatant commanders' mission requirements and sustainable on those joint and other missions, including homeland defence. Sufficient equipment must be available to support the annual UAS training readiness requirements of each component unit and its personnel.

5.5 Leadership

5.5.1 Successful leadership transforms human potential into effective performance. Effective leaders are able to influence others to accomplish the UAS mission by providing a clear purpose, consistent direction, and inspired motivation. Coupled with leadership, education forms the foundation for achievement. Service members shall be provided opportunities to acquire basic educational and academic skills which are essential to successful UAS mission performance.

5.6 Personnel

5.6.1 NATO military objectives shall be accomplished using cost effective levels of manpower. They should refer to the ambition of the contributing Nations on the highest level of integration to enhance human interoperability, team activity, and cooperation. Manpower requirements are driven by workload and shall be established at the minimum levels necessary to accomplish UAS mission and performance objectives. Sufficient manpower positions shall be designated as military to enable development of combat-related skills or to promote career development in military competencies.

5.7 Facilities

5.7.1 The acquisition, management, and disposal of UAS related real property shall be performed to advance the overall mission of the Department of Defence. This property consists of all buildings, structures, utility systems, pavements, and underlying lands to support training and operational mission requirements.

5.8 Interoperability

5.8.1 Integration and Interoperability are keys to successful coalition operations. NATO's STANAG 4586 defines various levels of interoperability for UAS. When selecting UAS for NATO operations, planners should consider the systems' level of interoperability.

5.9 Network Integration

5.9.1 Command and Control as well as Information and Data sharing in NATO and Coalition Operations demand Network Enabled Capabilities to achieve commanders' desired effects. Interoperability is the prerequisite also for UAS to successfully be integrated in NATO's capability inventory. Future developments of UAS should address the common ground system that can operate various UAS in order to achieve full operational integration with respect to air space management, C2 of UAS, operational execution and information collection and dissemination.

ANNEX A

Operational Employment Vignettes

1. Operational Scenarios and Joint Mission Vignettes

1.1 To set the scene for deployment of forces under NATO's Concept of Operations, two aspects have been considered. These are Operational Scenarios and Joint Mission Vignettes which may not be determined only for UAS but for any capability serving NATO's and nations' intention. Hence there are new quality threats and risks since dispersion of the security environment we experienced in the last century, the classical Collective Defence scenario representing Article 5 ambition faces reduced gravity in the security architecture of NATO nations; it is notwithstanding an essential capability to protect the Alliance.

1.2 Standing Capabilities for threat prevention are part of the peacetime engagement like Air Policing, which could be supported by UAS, especially in the area of ISR, but also effective kinetic and non-kinetic engagement.

1.3 Current developments show significant threats which can only be encountered by networked internal and external security architectures including existing and future capabilities comprehensively. The typical Crises Response Operations (CRO), Peace Support Operations, Peace Enforce Operations, Peace Making Operations, and Peacekeeping Operations are conducted in Expedition and Extraction Scenarios. A typical development is an expansion of the area of employment which can be characterized by a greater distance between home base and engagement zone. UAS architecture is a response to the special challenges of the circumstances in modern operations and the estimated future.

1.4 Counter Terrorism Operations add a global security challenge with asymmetric aspects. There is a need to develop multinational comprehensive organisational structures and system architectures as an appropriate answer. UAS deliver flexibility, persistence, precision, and timeliness in support of a global security network.

1.5 Piracy as an aspect of organised crime increased under the circumstances of Weaponization and Profit Prospect. It can be assessed as a very special scenario which needs a comprehensive reaction as well. Given that the political framework of global security sets the applicable legal framework, UAS can deliver essential support in challenging this problem.

1.6 The prioritized operations and missions matrix, as shown in table 3, outlines three environments: maritime dominant, land dominant and a full joint environment. However, during the course of an operation, there will very rarely be such well defined boundaries in the employment of UAS. For instance, entry to the operational area may be facilitated from the maritime environment and merge into a period of intense land operations, whilst all the time being supported from the air. UAS will be able to operate across all boundaries, however blurred those boundaries may be.

2. NATO Article 5 Operations

2.1 Collective Defence Scenario.

2.1.1 The Collective Defence mission tasks the Alliance having to respond to a threat and attack on a NATO member nation by a hostile power. The NATO political aim is the protection, and if necessary, the restoration of the threatened Alliance member's territorial integrity together with maintaining the security of Alliance members as a whole.

2.1.2 Active Air Defence requires an all weather, day and night, full-spectrum weapons capability. Moreover, it should be a fully integrated, balanced, synchronised and netted 'sensor to shooter' system comprising a mix of surface, air and space based platforms which will create an optimal multilayered active AD system with multiple engagement opportunities.

2.2 Territorial Integrity Scenario.

2.2.1 Territorial Integrity supported by Air Policing Operations is an essential part of a countries' expression of sovereignty. A NATO Nation's capability to protect its territorial integrity is especially critical, as the violation of a country's borders easily could be interpreted as an attack on a NATO Member that would constitute an attack on NATO itself. Currently, NATO members without credible means to protect their borders are supported by other NATO Nations.

2.2.2 For the purpose of territorial integrity NATO has at its disposal a comprehensive system of air surveillance and airspace management measures. By means of radar sites, remote data transmission and central C2 centres the Alliance ensures constant control of its entire airspace.

3. Non-Article 5 Operations

3.1 Counter-Terrorism Scenario.

3.1.1 The Counter-Terrorism mission involves a NATO force conducting a United Nations (UN)-mandated intervention in a failed state that provides a safe basing area for a trans-national group which has launched a series of terrorist attacks in NATO member countries. The failed state has a weak central government with little or no control over large parts of the country. This group is affiliated with various indigenous groups operating within the country which oppose the central government. Together they are conducting a country-wide insurgency, using subversion and armed conflict to overthrow the government.

3.2 Expedition Scenario.

3.2.1 In general, non article 5 and crises response expedition operations, by their nature, may have similarities with article 5 and more "traditional" use of the assets and capabilities dedicated to the mission.

3.2.2 Expedition missions are characterised as heavy lift, large scale, combined and joint strike operations. NATO and national forces are supporting the United Nations (UN) or on other request in order to take control over a limited area of operations.

3.2.3 Peace Keeping Operations – PK (Peace Support Operations-PSO or Peace Enforcing Operations - PEO) may be planned and performed as Expeditionary Operations. Other crises response operations may assume expeditionary nature especially if conducted against interested of the Alliance.

3.3 Extraction Scenario.

3.3.1 The Extraction mission involves a NATO force conducting an operation at the request of the United Nations (UN) to secure the safe and timely withdrawal of a UN Peace Keeping force. The PK force has been deployed in a country in which the civil war peace negotiations between the central government and rebel forces have collapsed with the consequent return to armed hostilities. The mission also involves the evacuation of non-combatant personnel from International Organisations (IOs) and Non-Governmental Organisations (NGOs) operating in the country and wishing to leave.

3.4 Counter Piracy.

3.4.1 Counter Piracy and Sea Route Monitoring will gain importance under current global security development. The United Nation Convention on the Law of the Open Sea delivers significant legal implications for this area.

ANNEX B

Reference

STANAGs

3809 - Digital Terrain Elevation Data Geographic Information Exchange Standard

4575 - NATO Advanced Data Storage Interface (if advanced storage is required)

4545 - NATO Secondary Imagery Format

4559 - NATO Standard Image Library Interface

4607 - NATO GMTI Data Format (Emerging Standard)

4609 - NATO Digital Motion Imagery Format (Emerging Standard)

5500 - NATO Message Test Formatting System AdatP-3

7023 - Air Reconnaissance Imagery Data architecture

7024 - Imagery Air Reconnaissance (Digital Tape Storage)

7085 - Interoperable Data Links for Imaging Systems

7074 - Digital Geographic Information Exchange Standard (Version 2.1)

4670 - Recommended Guidance for the Training of Designated Unmanned Aerial Vehicle Operator (DUO)

4671 - UAS Air Worthiness Requirements

Other References

United States Joint Concept of Operations for Unmanned Aircraft Systems, November 2008

NATO Joint Air Power Competence Centre, The JAPCC Flight Plan for Unmanned Aircraft Systems in NATO, 2008

ANNEX C

Glossary

Airfield
An area that is used or intended to be used for the landing and takeoff of UAV, and includes its buildings and facilities, if any.

Automatic
The execution of a predefined process or event that requires UAV System crew initiation.

Autonomous
The execution of predefined processes or events that do not require direct UAV System crew initiation and/or intervention.

Communication System
A means that allows ATC communication between the UAV crew in the remote control station and the air traffic control service.

Data Link
A wireless communication channel between one or more UCS and one or more UAV, or between multiple UAV. Its utility may include but is not limited to exchange of command & control or payload data. A data link may consist of:
(1) Uplink – Transmittal of UAV crew commands from the UCS to the UAV.
(2) Downlink – Transmittal of UAV status data from the UAV to the UCS.

Designated UAV Operator
The UAV system designated UAV operator in the UAV Control Station tasked with overall responsibility for operation and safety of the UAV system. Equivalent to the pilot in command of a manned aircraft.

Emergency Recovery Capability
Procedure that is implemented through UAV crew command or through autonomous design means in order to mitigate the effects of critical failures with the intent of minimising the risk to third parties. This may include automatic pre-programmed course of action to reach a predefined and unpopulated forced landing or recovery area.

Flight Control System
The flight control system comprises sensors, actuators, computers and all those elements of the UAV System,necessary to control the attitude, speed and flightpath of the UAV.

Flight Control Computer
A programmable electronic system that operates the flight controls in order to carry out the intended inputs.

Forced Landing
A condition resulting from one or a combination of failure conditions that prevents the UAV from normal landing on its planned main landing site although the flight control system is still able to maintain the UAV controllable and maneuverable.

Ground Staff
Qualified personnel necessary for ground operations (such as supplying the UAV with fuel and maintenance) as stated in the UAV System Flight Manual or in the UAV Maintenance Manual.

Landing
The phase of a UAV system mission that involves the return of a UAV to the ground or sea surface. This also includes the return of the UAV to the surface via parachute.

Launch
Catapult and rocket assisted Take-off.

Line of Sight
A visually unobstructed straight line through space between the transmitter and receiver.

Link Budget
A calculation involving the gain and loss factors associated with the antennas, transmitters, transmission lines and propagation environment used to determine the maximum distance at which a transmitter and receiver can successfully operate.

Payload
Device or equipment carried by the UAV, which performs the mission assigned. The useful payload comprises all elements of the air vehicle that are not necessary for flight but are carried for the purpose of fulfilling specific mission objectives.

Shall
Used to indicate a mandatory requirement (see also "must").

Should
Used to indicate a preferred, but not mandatory, method of accomplishment.

Take-off
The process by which a UAV leaves the surface and attains controlled flight (includes launch via catapult or rocket assistance).

UA
An aircraft which is designed to operate with no human pilot on board and which does not carry personnel. Moreover a UA:
- Is capable of sustained flight by aerodynamic means,
- Is remotely piloted or automatically flies a pre-programmed flight profile,
- Is reusable,
- Is not classified as a guided weapon or similar one shot device designed for the delivery of munitions.

UA Control Station
A facility or device from which the UA is controlled and/or monitored for all phases of flight.

UA Crew
A UA crew is made up of one or more qualified people responsible for monitoring and controlling the flight-path and flight status of one or more UA. Includes the Designated UA Operator and also all staff responsible for operating on-board systems (e.g. payload).

UA System
A UA System comprises individual UA System elements consisting of the aerial vehicle (UA), the UA control station and any other UA System elements necessary to enable flight such as a command and control data link, communication system and take-off and landing element. There may be multiple UA, UCS, or takeoff and landing elements within a UA System.

Workload
The amount of work assigned to or expected from a person in a specified time.

Workstation
A computer interface between an individual UAV crew member and the UAV to perform the functions of mission planning, flight control and monitoring and for display and evaluation of the downloaded image and data (where applicable).

ANNEX D

Acronyms

ACA	Airspace Control Authority
ACC	Air Component Command
ACCS	Air Command and Control System
ACO	Allied Command Operations
ACO	Air Coordination Order
ACT	Allied Command Transformation
ADS-B	Automatic Dependent Surveillance-Broadcast
AEW&C	Airborne Early Warning and Control
AGL	Above Ground Level
AGS	Alliance Ground Surveillance
AGSIO	AGS Implementation Office
AI	Air Interdiction
Ain	Anti Intrusion
AIS	Automated Identification System
AJCN	Adaptive Joint C4ISR Node
ALTBMD	Active Layered Theare Ballistic Missile Defence
ANFS	Assured Naval Fire Support
AOI	Area of Interest
AP	Air Policing
APCTS	Assured Precision Counter Terrorism Strike
APS	Assured Precision Strike
AS	Airborne Surveillance
ASFAO	Anti Surface Fighter Air Operations
ASM	Airspace Management
ASOC	Air Sovereignty Operations Centre
ASuW	Anti Surface Warfare
ASW	Anti Submarine Warfare
ATC	Air Traffic Control
ATO	Air Tasking Order
AWACS	Airborne Warning and Control System
BACN	Battlefield Airborne Communications Node
BAMS	Broad Area Maritime Surveillance
BDA	Battle Damage Assessment
BLOS	Beyond Line-of-Sight
BP	Border Patrol
C2	Command and Control
C2ISR	Command, Control, Intelligence, Surveil-lance and Reconnaissance
C4I	Command, Control, Communications, Computers and Intelligence
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
C4ISTAR	Command, Control, Communications, Computers, Intelligence, Surveillance, Target Acquisition and Reconnaissance
CAOC	Combined Air Operations Centre

CAP	Combat Air Patrol
CAS	Close Air Support
CBRNE	Chemical, Biological, Radiological, Nuclear, or high yield Explosive
CJSOR	Combined + Joint Statement of Requirements
CM	Counter Mining
CNAD	Conference of National Armaments Directors
COE	Centre of Excellence
COIN	Counter Insurgency
CONOPS	Concept of Operations
CP	Counter Piracy
CS	Civil Support
CSAR	Combat Search and Rescue
C2	Command and Control
DARB	Daily Asset Reconnaissance Board
DCA	Defensive Counter Air
DCPD	Direction, Collection, Processing and Dissemination
DOTMLPF	Doctrine, Organisation, Training, Materiel, Leadership, Personnel, and Facilities
DPQ	Defence Planning Questionnaire
DRR	Defence Requirements Review
EA	Electronic Attack
ECM	Electronic Counter Measures
EMI	Electromagnetic Impulse
EMI	Electromagnetic Interference
EO	Electro-Optical
EW	Electronic Warfare
FAA	Federal Aviation Administration
FINAS	Flight in Non-Segregated Air Space
FMSC	Frequency Management Sub-Committee
FMV	Full Motion Video
FP	Force Protection
F2T2EA	Find, Fix, Track, Target, Engage, Assess
GCS	Ground Control Station
GMTI	Ground Moving Target Indicator
GPS	Global Positioning System
HALE	High Altitude Long Endurance
HD	Homeland Defence
HP	Harbour Protection
HVT	High Value Target
IC2DL	Interoperable Command and Control Data Link
ICC	Integrated Command and Control
IFC	Intelligence Fusion Centre
IO	International Organisation
IR	Infra-Red
ISAR	Inverse Synthetic Aperture Radar

ISR	Intelligence, Surveillance, Reconnaissance
ISRD	ISR Division
ISTAR	Intelligence, Surveillance, Target Acquisition, and Reconnaissance
ITU	International Telecommunications Union
IW	Irregular Warfare
JAPCC	Joint Air Power Competence Centre
JCGUAV	Joint Capabilities Group on Unmanned Aerial Vehicles
JFACC	Joint Forces Air Component Commander
JFC	Joint Forces Command
JOA	Joint Operations Area
JSTARS	Joint Surveillance and Target Attack Radar System
LCC	Land Component Command
LIDAR	Light Detection and Ranging
LOAM	Laser Obstacle Avoidance Monitoring
LOI	Levels of Interoperability
LOS	Line-of-Sight
LRE	Launch and Recovery Element
LRF/D	Laser Range Finder and/or Laser Designator
LTCR	Long Term Capabilities Requirements
MAJIIC	Multi-sensor Aerospace-ground Joint ISR Interoperability Coalition
MALE	Medium Altitude Long Endurance
MC	Military Committee
MCASB	Military Committee Air Standardization Board
MCC	Maritime Component Command
MCM	Mine Counter Measures
MCO	Major Combat Operations
MET	Mission Essential Task
METOC	Meteorological and Oceanographic Condition
MIO	Maritime Interdiction Operations
MMTI	Maritime Moving Target Indicator
MSA	Maritime Situational Awareness
MUM	Manned-Unmanned Integration
NACMA	NATO ACCS Management Agency
NADC	NATO Air Defence Committee
NAGSPO	NATO AGS Programme Office
NATO	North Atlantic Treaty Organisation
NC3A	NATO Consultation, Command and Control Agency
NC3B	NATO Consultation, Command and Control Board
NEC	CCIS Northern European Command, Command and Control Information System
NEO	Non-Combatant Evacuation Operation
NGO	Non-Governmental Organisations
NIIA	NATO ISR Interoperability Architecture

NRF	NATO Response Force
NSA	NATO Standardization Agency
OCA	Offensive Counter Air
PCC	Prague Capabilities Commitments
PDS	Planning/Decision Support
PEO	Peace Enforcing Operations
P-ISR	Persistent ISR Collection
PK	Peace Keeping
PoS	Protection of Shipping
PR	Personal recovery
PSO	Peace Support Operations
PSYOP	Psychological Operations
RF	Radio Frequency
RI	Renegade Interdiction
ROZ	Restricted Operating Zone
RMP	Recognised Maritime Picture
RPV	Remotely Piloted Vehicle
RSO	Remote Split Operations
RSTA	Reconnaissance, Surveillance and Target Acquisition
SAMon	Sensitive Area Monitoring
SAR	Synthetic Aperture Radar
SATCOM	Satellite Communication
SAVDS	Sense-and-Avoid Display System
SEAD	Suppression of Enemy Air Defence
SESAR	Single European Sky
SIGINT	Signals Intelligence
SOF	Special Operations Forces
SPINS	Special Instructions
STANAG	Standardization Agreement
TBD	To Be Determined
TCDL/CDL	Tactical Common Data Link/ Common Data Link
TST	Time-Sensitive Target
TTP	Tactics, Techniques and Procedures
UA	Unmanned Aircraft
UAS	Unmanned Aircraft Systems
UAV	Unmanned Aerial Vehicle
UCAS	Unmanned Combat Aircraft System
UCAV	Unmanned Combat Aerial Vehicle
UCS	UAV Control Systems
UGV	Unmanned Ground Vehicle
UHF	Ultrahigh Frequency
UN	United Nations
USSV	Unmanned Sea Surface Vehicle
USV	Unmanned Surface Vehicle
UUV	Unmanned Undersea Vehicle
UWW	Under Water Warfare

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