MIL-UAS-SPECIFIC: set the scene

Deliverable ID: D1
Revision number: 2.0
Issuing date: 17/11/2021
Final Review: 24/01/2022

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Document History				
Version	*Date*	*Authors*	*Reviewers*	*Notes*
0.1	25/10/2021	Marco Ducci Costantino Senatore Raimondo Cinquemani	Filippo Tomasello (EuroUSC Italia)	First draft
0.2	08/11/2021	Carlo Picotti	Maurizio Goiak (Leonardo)	Inclusion of military specificities chapter
1.0	15/11/2021	Marco Ducci	-	First issue including english-speaker proof reading
1.1	17/11/2021	Marco Ducci	-	Revision after initial comments from EDA
1.2	21/12/2021	Marco Ducci Carlo Picotti	Filippo Tomasello Maurizio Goiak	Revision after comments from external reviewers
2.0	24/01/2021	Marco Ducci	-	Second issue after approval from EDA

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ACRONYMS

The following list provides a list of acronyms used throughout this document.

Acronym	***Description***
AGL	Above Ground Level
AIP	Aeronautical Information Publication
AIS	Automatic Identification System
ARF	Airworthiness Regulatory Framework
ATI	Air Traffic Insertion
ATS	Air Traffic Services
BRLOS	Beyond Radio Line Of Sight
BVLOS	Beyond Visual Line Of Sight
CAA	Civil Aviation Authority
DAA	Detect And Avoid
EASA	European Union Aviation Safety Agency
EC	European Commission
ECM	Electronic Counter Measure
EDA	European Defence Agency
EDA pMS	EDA participating Member States
EDA PO	EDA Project Officer
EMI	Electromagnetic Interference
EUSC	EuroUSC Italia S.r.l.
EVLOS	Extended Visual Line Of Sight
E/O	Electro Optic
ESM	Electronic Support Measures
FTS	Flight Termination System
GAT	General Air Traffic
HALE	High Altitude Long Endurance
HIRF	High-Intensity Radiated Fields
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IED	Improvised Explosive Device
IFR	Instrument Flight Rules
IR	InfraRed

ISR	Intelligence, Surveillance, and Reconnaissance
ISTAR	Intelligence Surveillance Target Acquisition and Reconnaissance
JTAC	Joint Terminal Attack Controller
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
LDR	Laser Designator
LEO	Leonardo S.p.A.
LOS	Line Of Sight
LRF	Laser Range Finder
MAA	Military Aviation Authority
MAC	Mid-Air-Collision
MALE	Medium Altitude Long Endurance
MDI	Miss Distance Indicator
MIL	Military
MoC	Means of Compliance
MTI	Moving Target Indicator
MTOM	Maximum Take-Off Mass
MTOW	Maximum Take-Off Weight
NOTAM	Notice To AirMen
OAT	Operational Air Traffic
PDRA	Pre-Defined Risk Assessment
pMS	participating Member States
RA	Risk Assessment
RADAR	Radio Detection And Ranging
RAT	Risk AssessmentTool
RCS	Radar Augmentation System
RLOS	Radio Line of Sight
RP	Remote Pilot
RPAS	Remotely Piloted Aircraft Systems
RPASP	(ICAO) RPAS Panel
RPIC	Remote Pilot In Command
RTH	Return-To-Home
RWR	Radar Warning Receiver
SAA	See And Avoid

SAR	Synthetic Aperture Radar
SARPs	(ICAO) Standards and Recommended Practices (SARPs)
SCG	Stakeholder Consultation Group
SEC	SES Expert Community on RPAS ATI
SES	Single European Sky
SMS	Safety Management System
SORA	Specific Operations Risk Assessment
STOL	Short Take-Off and Landing
STS	Standard Scenario
TAS	Tactical Air Support
TC	Type Certificate
TRA	Temporary Reserved Area
TSA	Temporary Segregated Area
TUAS	Tactical UAS
UAS	Unmanned Aircraft Systems
UCS	Unmanned Control Station
VLL	Very Low Level
VLOS	Visual Line Of Sight
VTOL	Vertical Take-Off and Landing
WG	Working Group
WG-SRM	(JARUS) Working Group – Safety Risk Management
WP	Working Paper

DEFINITIONS

The following list provides a list of definitions used throughout this document.

Word	***Description***
BRLOS	BRLOS refers to any configuration in which the transmitters and receivers are not in RLOS. BRLOS thus includes all satellite systems and possibly any system where an RPS communicates with one or more ground stations via a terrestrial network which cannot complete transmissions in a timeframe comparable to that of an RLOS system.
Cross-border operations	Operations which are established over international borders (possibly in a restricted or reserved volume of airspace), or operations within the borders of a foreign country for specific operational requirements.

Dangerous goods	Dangerous goods are 'articles or substances, which are capable of posing a hazard to health, safety, property or the environment', which appear on the list of dangerous goods of the ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air (ICAO Doc 9284) [RD1].
JTCA	Joint Terminal Attack Controller is the word used to define a qualified service member who plans to direct the action of combat aircraft engaged in close air support and other offensive air operations from a forward position.
RLOS	RLOS refers to the situation in which the transmitter(s) and receiver(s) are within mutual radio link coverage and thus able to communicate directly or through a ground network provided that the remote transmitter has RLOS to the RPA and transmissions are completed in a comparable timeframe.
Target UAS	A target UAS is an unmanned aircraft, generally remotely controlled, usually used in the training of anti-aircraft crews.

1 INTRODUCTION

1.1 MIL-UAS-SPECIFIC Project Overview

1.1.1 Background

The current European Commission (EC) Regulation [RD2] on civil operations of Unmanned Aircraft Systems (UAS) defines three categories of UAS operations: OPEN, SPECIFIC and, CERTIFIED. These three categories are identical to the categories A, B, and C defined by the Joint Authorities for Rulemaking on Unmanned Systems (JARUS)[1] to which all EDA participating Member States (pMS) belong, with only three exceptions[2].

The Standards and Recommended Practices (SARPs) of the International Civil Aviation Organization (ICAO) apply only to the part of the Certified category when flying internationally under Instrument Flight Rules (IFR) at heights higher than 500 ft AGL. However, ICAO is in the process of formally recognizing the three categories in new part iv of Annex 6 [RD4]. The segment of the Foreword in these ICAO draft[3] SARPs elicits the basic features of the three categories of civilian UAS operations. For ease of reference, this text is reproduced in Appendix A.

To remain as close as feasible to the civilian regulations, some EDA participating Member States (pMS) also envisage applying a similar risk-based approach to UAS operations, diverging from the "traditional" weight-based classification. In this context, it is proposed to introduce three categories of Military UAS operations: MIL-UAS-OPEN, MIL-UAS-SPECIFIC, and MIL-UAS-CERTIFIED.

In the MIL-UAS-SPECIFIC category, an assessment of the Air and Ground Risks (similarly to the SPECIFIC category in the civil sector) is envisioned. Some EDA pMS have already defined a national Risk Assessment methodology but there is no harmonized European methodology yet. This causes difficulties to the industry offering products or services to both the civil and the military market, so leading to increased costs for military procurement.

Furthermore, this lack of harmonization also creates difficulties for operational or training cross-border operations since leading to additional burden as the requesting nation must know and apply several different methodologies from all the potential host nations, which would at least require additional time and effort.
The general objective of the Project MIL-UAS-SPECIFIC is therefore to develop a Risk Assessment Methodology to facilitate non-certified UAS operations in the Military Specific category of operations in the EDA pMS, proposing guidelines for adoption of dedicated procedures and tools.
The study in this document sets the foundations for evaluation of the existing methods, tools, and the specific military operational scenarios, which is essential to possibly promote standardization of risk assessment methodologies among EDA pMS.

1.1.2 Project's Objectives

The overall project objective to develop a Risk Assessment Methodology to facilitate non-certified UAS operations in the Military Specific category will be met through the following main strands of activity:

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[1] http://jarus-rpas.org/
[2] Cyprus, Hungary and Lithuania are not members of JARUS.
[3] Part IV was recommended by the 18th meeting of the RPAS Panel on 29 October 2021. Adoption by the ICAO Council is envisaged in 2024 for possible applicability in 2026.

1) Analyse existing methodologies and tools for Air and Ground Risk Assessment (including RAT, A-RAT, and SORA) to gather a clear state of the art.
2) Capture relevant expectations of EDA pMS, focusing on the Military UAS Specific operations and the Military specificities (concerning the Risk Assessment scenario and methodologies existing for civil UAS operations).
3) Identify additional requirements and inputs for the development of a Risk Assessment Methodology tailored for the MIL-UAS-SPECIFIC category.
4) Capture stakeholders (mainly relevant Military experts from EDA pMS) needs for cross-border operations.
5) Organize a Stakeholder Consultation Group (SCG) in coordination with the EDA Project Officer (PO) to engage a sufficiently wide audience in the review of the MIL-UAS-SPECIFIC project deliverables, so paving the way towards possible endorsement of the project results.
6) Perform a gap analysis between existing methodologies, including at least the RAT, the A-RAT, and a variant of the SORA (e.g., JARUS, EASA, UK CAA).
7) Develop a proposed standard RA Methodology and a prototype tool supporting its validation in the perspective of subsequent implementation for MIL-UAS-SPECIFIC operations.
8) Perform a preliminary validation of the Methodology and propose implementation guidelines and communication material to support the buy-in by all involved stakeholders, starting from the Military UAS users.
9) Develop a plan for the “next steps”, to be possibly implemented after termination of this project, identifying the activities recommended towards the adoption of a new and standardized RA Methodology.

This document presents the results of activities 1,2,3 and 6 as reported in section 1.1.3

1.1.3 Project structure

The project is composed of three main phases which are further divided in sub-tasks as follows:

1) **Setting the scene**

   Task T1.1 “Methodologies inventory and pMS expectations”

   This activity aims at identifying:

   a. All methods currently in use for the assessment of Ground and Air risk for military operations in the EDA pMS and,
   b. The pMs expectations about the characteristics of the methodology/tool to be proposed by this study.

   To achieve these objectives the project developed a survey to capture in a standardized way the inputs from the pMS. The survey was distributed to all members of the UAS ARF and the SEC UAS Integration groups.

   Following the completion of the survey, follow-up interviews with available stakeholders were organized to review some of the answers and better clarify the inputs and expectations.

   Task T1.2 “Gap analysis: Air and Ground Risk Assessment Methodologies and Tools”

   This task carried out a gap analysis to compare the RA methodologies identified in Task 1.1 with the expectations from EDA pMS in terms of scope and applicability of the methodology and topics addressed in the risk assessment process.

   Task T1.3 “Military specificities study”

   This task aims to identify and analyse the specific aspects related to military RPAS operations that can affect the risk assessment process, and in particular:

a. The differences between the military hierarchical organization and the civil UAS Operator structure and related roles and responsibilities of involved personnel;
b. Technical requirements and related RPAS performance, taking into consideration the payload (weapons, cameras or other carried goods), typology of UAS (fixed-wing, rotary wings, VTOL, STOL), endurance, MTOM, altitude/level (MALE/HALE);
c. Operational requirements (mainly, Cross Border ops – redeployment – SAR - reconnaissance);
d. Training issues (competencies of RP, RP Instructors, RPIC);

2) **Development**

Task T2.1 "Military Air and Ground Risk Models definition"

This task will define the Air and Ground Risk models to be used in the proposed Risk Assessment methodology. The model definition will consider the existing methods (e.g. RAT, A-RAT, SORA), their current developments (e.g. SORA new annexes, EASA Design Verification processes) and the expectations of the EDA pMs gathered in Phase 1. The Ground and Air Risk model will be defined trying to mix a qualitative and a quantitative approach to allow sufficient flexibility to cope with situations where quantitative data are not available or sufficiently reliable.

Task T2.2 "Military Risk Assessment Methodology Development"

This task will develop the complete Risk Assessment methodology by properly combing the Ground and Air Risk models defined in Task 2.1 into a set of parameters that can be used to measure the overall level of risk and determine its acceptability, considering the available mitigations and the reliability of the technical and operational components. The theoretical model identified in Task 2.1 will be translated into an operative procedure that can support the entire risk assessment process. This includes a clear description of the individual steps of the process, the definition of the interrelations between the parameters of the Ground and Air Risk models, the process to consider appropriate mitigations, and identifying applicable requirements. This task will also identify existing industry standards that can be used to support the implementation of the methodology.

Task T2.3 "Development of a prototype tool to support RA process"

This task will develop a static prototype of an online tool that implements the Risk Assessment methodology developed in Tasks 2.2. The prototype will include a set of static mock-ups that will display the main views that users will access and use. Moreover, a full list of available functionalities and the overall architecture will be described.

Task T2.4 "Methodology preliminary Validation"

Once the initial concept is available, the methodology will be presented to relevant stakeholders from EDA pMS to gather their feedback to fine-tune the proposed approach. This activity will also support the third phase of the project and the definition of suitable implementation guidelines.

3) **Implementation**

Task T3.1 "MRA Methodology implementation guidelines (procedures)"

This task will develop procedures to effectively implement the proposed methodology in the EDA pMS. This task will propose a set of standardized processes to ease the exchange of data and information between different EDA pMS. This might include the development of templates for the risk assessment output and proposals for sharing of best practices and processes.

Task T3.2: "MRA Methodology Dissemination and Communication – Input for Regulatory Framework"

This task will develop the dissemination and communication material to explain and promote the proposed methodology to all EDA pMS. The material produced will include PowerPoint presentations and leaflets as well as a full package of guidance material to apply the methodology.

Task T3.3: "Next Step – MRA Methodology Management Plan"
This task will develop a plan to maintain the methodology after its initial release following the feedback received by EDA pMS during its actual implementation and the developments of the parent methodologies (e.g.. SORA) taking place at the international level. With this respect, one key activity will be to continuously update the list of industry standards (both civil and military) that can support its effective implementation.

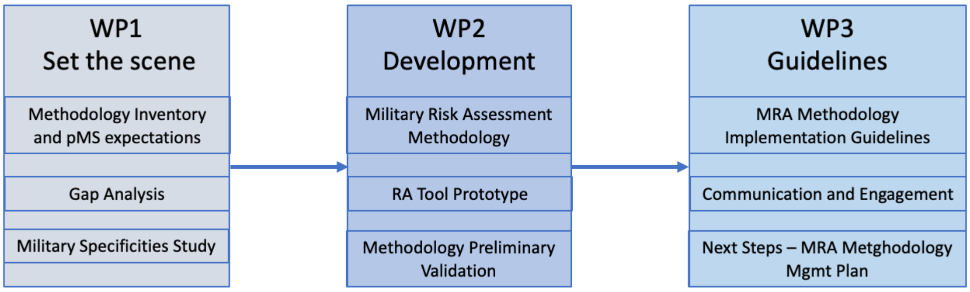

Figure 1: Project structure overview

1.1.4 *Project timeline*

The MIL-UAS-SPECIFIC study started in August 2021 and will run for one year according to the following timeline:

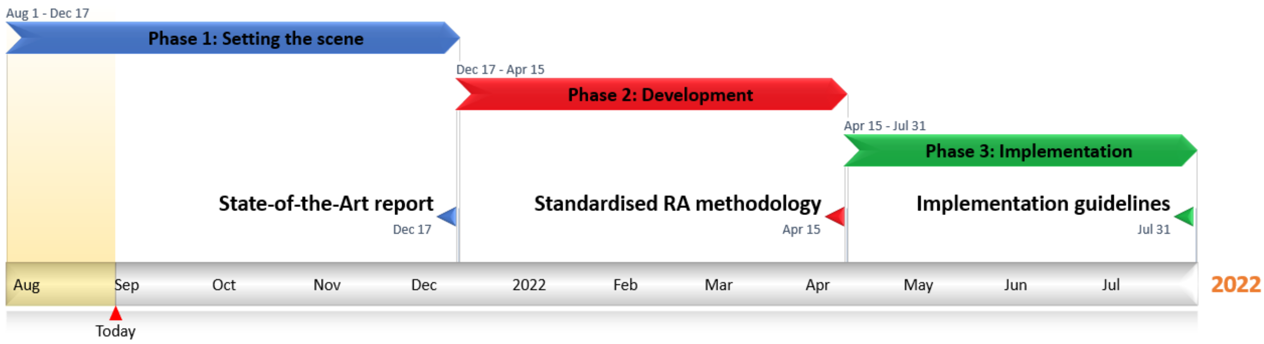

Figure 2: Project timeline

The first phase, whose results are contained in this document, will be completed by December 17 after all the received comments are addressed. Soon after, the development of the RA methodology will start followed by the definition of guidance material to support its implementation.

In addition to this document, two additional deliverables will be prepared as follows:

1. **MIL-UAS-SPECIFIC: Development (March 2022).** This document will include the outcomes of the core project activities, such as:
   - Risk models developed for Air and Ground Military UAS Specific operations;
   - Risk Assessment Methodology documented as the proposed methodology for MIL-UAS-SPECIFIC operations;

- the RA tool prototype, which can support the stakeholders in issuing dedicated risk assessment report to the relevant military authorities as part of the mission definition phase;
- the results of a preliminary methodology validation, to identify eventual inconsistencies or open points in the MIL-UAS-SPECIFIC Methodology, which need to be addressed with specific actions in the subsequent phases toward the methodology adoption.

2. **MIL-UAS-SPECIFIC: Guidelines (June 2022).** This report will include:
    - the preliminary guidelines for the implementation of the MIL-UAS-SPECIFIC RA Methodology
    - a comprehensive stepwise plan, resulting from Task 3.3, for utilization by the EDA pMS and proposing the next steps for the methodology exploitation.

1.2 Purpose of the document

The purpose of this document, **Deliverable D1 "Set the Scene**" is to provide a detailed analysis of:

- Existing RA Methodologies used by EDA pMS to assess the risk of military UAS operations including their feedback and expectations concerning what is already available, highlighting their specific needs, for enabling operations in non-segregated airspace.
- Identified gaps between currently available methodologies and expectations.
- Military specificities that can affect the risk assessment process of UAS operations.

This document is the key building block to initiate the development of a new Risk Assessment Methodology. The aim is to base this development on the existing methods and tools that have proved to be effective and integrate them considering the existing gaps and the expectations collected.

1.3 Structure of the document

This document breaks down into 5 chapters as follows:

- ***Chapter 1*** contains an overview of the project, the purpose of this deliverable, and the associated reference documents. A glossary of acronyms and a list of definitions are also provided in this chapter.
- ***Chapter 2*** reports the structure of the survey that was implemented through a questionnaire, to gather inputs as well as the main questions that were asked during the face-to-face interviews. In addition, all information gathered is presented highlighting the main commonalities and principal differences between the approaches used by different individual EDA pMS.
- ***Chapter 3*** presents the results of the gap analysis and compares the methodologies currently in use with the expectations of the pMS. The gaps are identified for both the Ground and the Air Risk.
- ***Chapter 4*** presents the outcomes of the analysis of the military specificities which led to the identification of the peculiar aspects that should be considered in the risk assessment process.
- ***Chapter 5*** proposes some conclusions and recommends the way forward for the development of a standard RA methodology for MIL-UAS-SPECIFIC operations.

1.4 References

The applicable versions of the following documents are the ones officially released at the time of the release of the present document.

1.4.1 Applicable documents

ID.	TITLE	ISSUING DATE (dd/mm/yyyy)	ISSUED BY
[AD1]	MIL-UAS-SPECIFIC_Technical Proposal	18/05/2021	MIL-UAS-SPECIFIC consortium
[AD2]	D0.1_MIL-UAS-SPECIFIC_Project Management Plan	01/09/2021	MIL-UAS-SPECIFIC consortium
[AD3]	Unmanned Aircraft Systems Risk Assessment: Review of Existing Tools and New Results	17/08/2018	Portuguese Military Airworthiness Authority
[AD4]	MIL-UAS-SPECIFIC Questionnaire	10/09/2021	MIL-UAS-SPECIFIC consortium
[AD5]	MIL-UAS-SPECIFIC Interview questions	29/09/2021	MIL-UAS-SPECIFIC consortium
[AD6]	Working Paper: Harmonisation of a minimum set of information to be submitted with the request for permission to operate a foreign UAS on the territory of another EDA member state	21/01/2021	EDA
[AD7]	Working Paper: Initial set of essential UAS-related Terms and Definitions.	06/04/2021	EDA

1.4.2 Civilian Regulatory Documents

ID.	TITLE	ISSUING DATE (dd/mm/yyyy)	ISSUED BY
[RD1]	List of dangerous goods of the ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air (ICAO Doc 9284)	05/03/2021	ICAO
[RD2]	Commission Implementing Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft, as lastly amended by Regulation 2021/1166	24/05/2019 (lastly amended on 15/07/2021)	European Commission
[RD3]	Commission Delegated Regulation (EU) 2019/945 on unmanned aircraft systems and third-country operators of unmanned aircraft systems as lastly amended by Regulation 2020/1058	12/03/2019 (lastly amended on 27/04/2020)	European Commission
[RD4]	Part IV (International RPAS Operations) of Annex 6 (Aircraft Operations) to Chicago Convention	29/10/2021 (recommended by RPASP/18 to ICAO for adoption)	ICAO
[RD5]	JARUS Recommendation UAS (Remote Pilot Competency (RPC) CAT A AND CAT B (JAR_doc_15)	12/08/2019	JARUS

[RD6]	Annex 11 – Air Traffic Services to Chicago Convention	15th edition 2018, including amendment 52 of 2020	ICAO
[RD7]	Commission Implementing Regulation (EU) No 923/2012 laying down the common rules of the air and operational provisions regarding services and procedures in air navigation and amending Implementing Regulation (EU) No 1035/2011 and Regulations (EC) No 1265/2007, (EC) No 1794/2006, (EC) No 730/2006, (EC) No 1033/2006 and (EU) No 255/2010, as lastly amended by Commission Implementing Regulation (EU) 2021/666	26/09/2012 (lastly amended on 22/04/2021)	

2 DATA GATHERING

2.1 Approach

The scope of task T1.1 was to gather information about the Risk Assessment (RA) methodologies currently used by EDA pMS to support UAS operations.

Data and information were collected through:

1) **Surveys**: questionnaires were developed to identify the methods currently used for the assessment of ground and air risk in military UAS operations and also to analyse which tools are in use (or are planned to be used). As shown in the table related to question Q.7 (see Appendix B.2), the elements characterising the RA methodology were captured using a mix between the parameters contained in table 6-1 of the paper entitled "Unmanned Aircraft Systems Risk Assessment: Review of Existing Tools and New Results" [AD3] and other documents identified by MIL-UAS-SPECIFIC team through the survey. The survey, based on the collected filled questionnaires, enabled also to analyse the pMS expectations concerning the desirable characteristics to be considered in the development of a possible and standardized MIL-UAS-SPECIFIC RA methodology.
   The questionnaires were initially circulated to the members of the SEC UAS Integration and the UAS ARF WGs and later also to other relevant stakeholders within EDA pMS.

2) **Interviews**: In addition to the questionnaires, a set of virtual face-to-face interviews was carried out. Each interview involved one pMS at a time. The interviews aimed to get additional details about the information provided during the survey to enable a deeper analysis of the military RA methodologies and expectations.

This chapter is broken down into three main sub-section:

1. *Survey of RA Methodologies*: it contains an overview of the survey process, specifying the parameters analysed to compare different RA methodologies.
2. *Interview process:* it contains a detailed description of the interview content used with selected pMS representatives to clarify and integrate the answers provided in the survey.
3. *Methodologies inventory and pMS expectations:* it contains the collection of the information on military RA methodologies and the elicited pMS expectations on the possible new harmonized RA methodology, which will be processed in the gap analysis in Chapter 3.

2.2 Survey of RA Methodologies

2.2.1 Structure of the questionnaire

The survey was implemented requesting pMS to fill a questionnaire. The *structure of the questionnaire* (see APPENDIX B for the whole questionnaire) consisted of three different sections:

a. **Section I – Contextual information and military specificities** containing questions on typical operational scenarios in the MIL-UAS-SPECIFIC category and military specificities to be considered in the Risk Assessment process.
b. **Section II – RA methodologies currently in use** for gathering data on currently used Risk Assessment Methodologies for the evaluation of the UAS military operations; This included how Safety parameters are evaluated in these methodologies.

c. **Section III – Expectations on MIL-UAS-SPECIFIC RA Methodology** attempted to collect expectations on key aspects to be covered by a possible future harmonized methodology developed by MIL-UAS-SPECIFIC. It included the analysis of the expected complexity and standardization potential foreseen for the MIL-UAS-SPECIFIC RA methodology.

All the information provided through the survey remains confidential and will not be distributed by MIL-UAS-SPECIFIC outside the project team. The general analysis of the results obtained from these surveys is included in this project deliverable whose level of confidentiality could be later determined by EDA.

2.2.1.1 Section I – Contextual information and military specificities

The first section of the questionnaire aimed at collecting information about:

- *UAS operations classification* to understand if the EDA pMS apply some form of categorization to their operations and on which factors this categorization is based such as Maximum Take-Off Mass (MTOM) and size of the aircraft, type of mission (VLOS or BVLOS), and operational limitations.
- *Type of operations* to assess the possible existence of typical operational situations for which a standardized approach could be used to reduce the effort necessary for risk assessment at the level of Tactical Unit.
- *Risk assessment usage* to understand if a risk assessment methodology is available and used in each pMS, how this impacts the authorization and/or the airworthiness certification processes, and in which of the categories/type of operation the assessment is applied.
- *Military specificities* to assess the military needs for the development of the new harmonized RA methodology, which will need to cover all these anticipated needs.

The list of the questions in Section I is reproduced in B.1, APPENDIX A

2.2.1.2 Section II - RA methodologies currently in use

This section of the questionnaire was designed to collect information on the RA methodologies currently used if any:

- *RA methodology and operational authorization process*: this set of questions concerned the organizational structure and the roles of different military entities for the operational authorization process. Understanding how the operations management is established allows to better put the safety aspects in the context of the RA methodology.
- *RA methodology characteristics*: A list of parameters was provided to the questionnaire respondents. The elements considered were captured using a mix between the parameters listed in table 6-1 of the paper entitled "Unmanned Aircraft Systems Risk Assessment: Review of Existing Tools and New Results" [AD3] and others added by MIL-UAS-SPECIFIC team. This set of questions enabled collecting information on the qualitative and quantitative features that are currently considered through the RA methodologies in use. The respondents were asked to rate the importance of each parameter in the RA process over a 1 to 5 Likert scale.
- *Complexity and standardization potential of the RA methodologies currently used*: the methodology to be developed by the MIL-UAS-SPECIFIC team should be optimized in terms of time and effort needed to complete the safety assessment and be user-friendly. The information collected on the time required using current methodologies, complexity, and standardization potential were analysed to define a baseline, centred on the needs of the tactical Unit, for conducting the Risk Assessment.

The list of questions in Section II is reported in B.2, APPENDIX A .

2.2.1.3 Section III - Expectations on MIL-UAS-SPECIFIC RA Methodology

This last Section of the questionnaire covered topics exclusively related to the design of the Risk assessment methodology that will be subsequently developed by the MIL-UAS-SPECIFIC Project.

The questions encompassed collecting data on:

- *Parameters to be considered for MIL-UAS-SPECIFIC RA Methodology*: like Section II, the parameters considered were studied to highlight the relevance for the Risk assessment methodology to be developed by MIL-UAS-SPECIFIC. This analysis was completely based on the EDA pMS needs and expectations about the new methodology. This enabled identifying and collecting aspects not considered in the previous Sections of the questionnaire.
- *Complexity and standardisation potential of the methodology to be developed for MIL-UAS-SPECIFIC*: EDA pMS were requested to elicit their expectations on the time needed to complete the RA, complexity and standardisation potential related to the future harmonised RA methodology. The information provided in this section of the questionnaire allowed to identify useful suggestions for designing a future tool considering several operational and technical aspects.

The list of questions in Section III is reproduced in B.3, APPENDIX B APPENDIX A .

2.3 Interview process

A series of interviews was organised after the distribution of the questionnaire to the EDA pMS, with the purpose to acquire a deeper and better understanding of the answers provided through the questionnaires. The interviews were conducted individually with each military organisation that agreed to participate to this data-gathering activity.

APPENDIX C contains the list of questions that were used to conduct all the interviews, to ensure a structured approach facilitating comparison of responses. Not all the questions were used during each interview, since in some cases the inputs provided through the questionnaire were already sufficient.

The questions for the structured interviews, were organised in five sections:

- *Section I – Contextual information and military specificities*: to gather additional details on what had been collected through the questionnaire with respect to the operational context.
- *Section II – RA for Air Risk*: to collect information on how the interviewed military entity deals with the assessment of Air Risk.
- *Section III – RA for Ground Risk:* to collect information on how the interviewed military entity deals with the assessment of the Ground Risk.
- *Section IV – RA Methodology and tools:* this last Section of the interview collected information on the currently used tools and was used to gather additional details on the expectations for the possible future harmonised tool.
- *Section V* - this last section covered other aspects not previously analysed (e.g. training, etc.).

The list of the questions in all the Sections of the interview is reported in APPENDIX A

2.4 Methodologies inventory and pMS expectations

This paragraph contains a summary of the information collected through both the survey and the interviews. These activities enabled us to achieve a vision of the current situation, needs, expectations, and most important, qualitative and quantitative data on the RA methodologies currently used.

This paragraph contains the following three sections:

1. Operational context and military specificities;
2. RA Methodology currently used; and
3. Expectations on MIL-UAS-SPECIFIC RA Methodology.

2.4.1 Operational context

2.4.1.1 Categories of operation

The surveys showed that different taxonomies of UAS operations and related categories are used by different European military organizations. It was noted that the majority of the pMS that provided information classify their UAS operations in three or at least two categories. One pMS considers “targets and Prototype” UAS operations as an extra category (four categories in total).

To better analyse the existing categories, the results are separately presented considering two possible options:

A) two categories of UAS operations (Table 1);
B) three categories of UAS operations (Table 2).

Each table summarises the characterizing features of each category in either option.

Option A): Two categories of military UAS ops
The distinction between the categories is mainly based on the MTOM, and the pMS applying this option usually distinguish: • an “open” category for unmanned aircraft below 20 kg or 25 kg MTOM; and • a “certified” category covering unmanned aircraft with a larger MTOM. The survey showed that the Open category is typically subject to operational limitations on the maximum allowed height that is generally set at 500 ft (150 m) AGL. In this context, no type of certification is applied to the open category. In addition, the RA methodology is sometimes used as an alternative means of compliance to the initial airworthiness certification process for UAS with MTOM less than 150 kg or, in other cases when an exemption to some of the limitations applicable to the “open” category is needed (e.g. flying at higher altitudes).

Table 1 – Organisations considering 2 categories of UAS ops

Option B): Three categories of military UAS ops

In this Option, the distinction between the categories is not only based on the MTOM but also on the type of operation (VLOS, EVLOS[4] , or BVLOS), characteristics of the ground areas, and airspace. Most of the EDA pMS using this scheme have defined three categories: Open, Specific, and Certified. This is in line with the three categories acknowledged by ICAO and implemented in the EU for civil UAS. More details on these categories are presented below.	
UAS Operation categories	
OPEN	• *MTOM* for operating in this category is below 25 kg. • *Type of operation*: The majority of EDA pMS only allow VLOS. Some pMS also allows EVLOS. In particular, for a pMS, EVLOS is allowed only if the airspace is segregated. • *Ground area:* Flying above uninvolved people is not allowed. A safe horizontal distance from uninvolved people or urbanized areas must be always kept. • *Airspace:* maximum flying height is set at 120m (400 ft) AGL. A pMS allows UAS carrying cargo depending on the type of cargo and the specification released by the UAS designer. A RA at the level of the tactical unit is not required for operating in this category. Verification of compliance with the established conditions and limitations would suffice. In comparison to EC Regulation 2019/947: – even on the civil side risk assessment at operator level is not required to fly in this category, which is therefore sometimes nicknamed 'buy and fly'; – but in the civil case, airworthiness, because of the low risk and not to increase the workload on authorities, although not demonstrated through a type certification process, is nevertheless verified though compliance with industry standards (e.g. ISO 21384-2 or EN 4709-001), attested by independent, competent and accredited third parties, named by the EC 'Notified Bodies'[5]. – An EDA pMS considers three OPEN sub-categories comparable to those designed (OPEN A1, A2 and A3) for the OPEN category described in the EC Regulation 2019/947. Differently from this regulation there are requirements related to safety, product conformity and to the capability of design, production and maintenance organisations: a. For UAS with MTOM ≤ 4 kg an EU declaration of conformity or a comparable standard is required; b. For UAS with MTOM > 4 kg the design, production and maintenance organisations must hold either a DIN EN ISO 9001 certification or a comparable standard. c. The NMAA has to conduct a safety inspection for UAS with MTOM > 250 g and issues a UAS model release in case the inspection results positive.

[4] Neither ICAO nor EASA have defined EVLOS. Even worse, for ICAO EVLOS is part of VLOS. On the contrary for EU/EASA EVLOS is already part of BVLOS. The three terms are however defined and differentiated in international standard ISO 21384-4. **UAS ARF WG** "Initial set of essential UAS - related Terms and Definitions" defines eVLOS as a condition in which the unmanned aircraft is within the extended visual line of sight of the remote pilot when the unmanned aircraft is beyond the visual line of sight of the remote pilot but within the visual line of sight of one or more unmanned aircraft extended visual observer(s) assisting the remote pilot in safely conducting the flight. A summary of such definitions is contained in APPENDIX D .

[5] https://ec.europa.eu/growth/tools-databases/nando/ Usually Notified Bodies are also used during aircraft production to verify conformity of thousands of so called 'standard parts' (e.g. metal alloys, nuts, piping, connectors, switches, etc.). Several of these parts are suitable for dual civil-military use.

SPECIFIC	• *MTOM*: For most EDA pMS there are no limitations on the MTOM in this category. One pMS limits the MTOM at or below 300 kg, depending on the type of UAS (fixed-wing, rotorcraft, or multicopter). In the civil field, the limit of 150 kg in former EASA Basic Regulation 216/2008 has been deleted by the EU Legislator in the new Basic Regulation 2018/1139 and so it no longer exists. Some States have authorised operations of UA up to around 650 kg in this category, although with stringent operational limitations (e.g. only above sea). • *Type of operations:* No pre-defined limitations apply to this category. Hence BVLOS, EVLOS, or VLOS are all allowed, which is like the civil specific category. • *Ground area*: most of the military organizations allows operations above sparsely populated areas while however keeping a safe horizontal distance from densely populated areas. • *Airspace to be used:* for the majority of EDA pMS operations are allowed only in segregated airspace (in some pMS a lateral safety buffer of 0,5 NM is applied to other non-segregated airspaces). No limitation on the altitude. For most of the EDA pMS implementing the specific category, a RA is required before operating in the specific category and apply for an operational authorisation. Airworthiness requirements are generally established at the central level of the organization, while the RA is completed at the level of a tactical unit. Other pMS prefer not to increase the burden on the tactical unit to complete the risk assessment and therefore they prefer using standard scenarios. In this case, the tactical unit has only to go through a checklist to verify that all conditions and limitations are satisfied. Some pMS allow operations in this category not only for reconnaissance ('aerial work' in civil terms) but also for carrying cargo. Transport of freight is also allowed in the civil specific category. For a pMS, armed UAS operations can be allowed in this category under specific conditions. In comparison to EC Regulation 2019/947: a) On the civil side operating in this category does not exclude an assessment of the design of the unmanned aircraft by the competent authority (i.e. EASA), which could culminate not in a formal Type Certificate (TC), but only in a report of 'design verification', which requires less time and effort; b) The approach to the specific category is centred on the legal entity of the UAS Operator, which does not apply to military services, in which the responsibility of the tactical unit is more limited; c) Transport of freight (even dangerous goods if the container is sufficiently crashproof) is allowed in the civil specific category; d) A key difference is that thanks to the assessment of the air risk, in the civil field flights in this category, are also possible in non-segregated, controlled or uncontrolled airspace; e) Standard Scenarios (STS) exempt the operator from applying for an operation authorization, since in this case, a simple 'declaration' would suffice. The competent authority only confirms the reception and completeness of the declaration. No pMS applies this process of declaration. f) Pre-Defined Risk Assessments (PDRA) are still based on RA carried out at the central level, but the operator needs to verify the availability of 'mitigations' and to apply for authorization.

CERTIFIED	• *MTOM:* No limitations on the MTOM. • *Type of operation:* Any (i.e. VLOS , EVLOS, or BVLOS, including long-range). • *Ground area to be overflown:* UAS operations can be conducted above every ground environment (including uninvolved people and densely populated areas if allowed by certification operating limitations). • *Airspace to be used:* Operations are typically carried out in airspace segregated at least temporarily or in airspace with an equivalent level of safety. No limitation on the altitude. For the majority of EDA pMS: – Carryiage of cargo is only allowed in this category. – All Armed UAS are in this category. To fly in this category a TC is always requested, but the RA is not required at the level of a tactical unit. In practice, operations in this category require compliance to applicable military airworthiness requirements (e.g. EMAR). Conversely, new ICAO standards in Part IV of Annex 6 to the Chicago Convention envisage that operators in this category will implement Safety Management System (SMS) and therefore 'predictive' risk assessment before a new type of operation.

Table 2 - Organisations considering 3 categories of UAS ops

2.4.1.2 *Military services operating UAS and typical missions*

Across the EDA pMS all military services (i.e. army, air force and navy) operate UAS. The typical operational missions currently implemented in one or all the UAS categories are:

- Cargo (even armament/munitions depending on specific conditions);
- Inspections;
- Training drill;
- Research & Development;
- Intelligence, Surveillance and Reconnaissance (ISR) flight:
- Aerial recordings;

2.4.1.3 *Use of Risk Assessment*

Most EDA pMS reported that a Risk Assessment is developed to support the authorization process in what they consider "Specific category" or when an exemption to fly in the OPEN category exceeding some of the limitations is needed.

Other pMS use the Safety RA methodology as an alternative means of compliance to the airworthiness certification process.

Finally, one military organization stated that the use of a RA methodology should not be requested at the level of a tactical unit in the specific category in favour of standard scenarios that would be less burdening and more suitable to take rapid decisions.

2.4.2 *RA Methodologies currently in use*

All the EDA pMS that use a specific RA methodology to support the risk assessment process employ RAT (Risk Assessment Tool), its variant A-RAT or SORA (Specific Operations Risk Assessment).

One MAA answered the survey explaining that they don't use a RA methodology similar to SORA. Instead, they subdivided the specific category into three subcategories (comparable to large standard scenarios) and defined the requirements necessary to ensure safe operation in these three subcategories based on their experience in the regulation of military UAS and taking into account the safety objectives of the existing EU UAS regulations. This approach relieves the operator of the burden of performing an extensive risk assessment like SORA, while allowing him to concentrate only on complying with all requirements associated to the subcategory for which the UAS model was released by the MAA after positive result of the corresponding safety inspection.

In most cases, the operator is identified in the tactical (operational) unit, which assigns the crew, including the Remote Pilot (RP) in command of the UAS flight. The operator is usually responsible to apply the RA methodology when so required. The high (central) command (specific for Army, Navy, or Air Force) then forwards the application, including the RA, to the Military Aviation Authority (MAA). The MAA analyses the application and the related RA and can issue recommendations/limitations for the intended operations based on the assessed feasibility and risk.

In other cases, airworthiness is assessed at the central level (possibly using RAT or A-RAT) and the operator is only responsible to assess the remaining risks at the operational level.

For cross border operations, there is currently neither mutual recognition nor harmonization among pMS: a military entity that needs to fly above another nation’s territory must again go through the operational authorization process, which includes completing the Risk Assessment process of that State (if available) or follow the regulations therein applicable.

2.4.2.1 Parameters considered by RA methodologies currently in use

Figure 3 shows the relevance of the Intrinsic Factors in the RA Methodologies currently in use. This was qualitatively evaluated by requesting the respondents to rate the importance of each factor over a 1 to 5 scale where 1=unimportant and 5=very important.

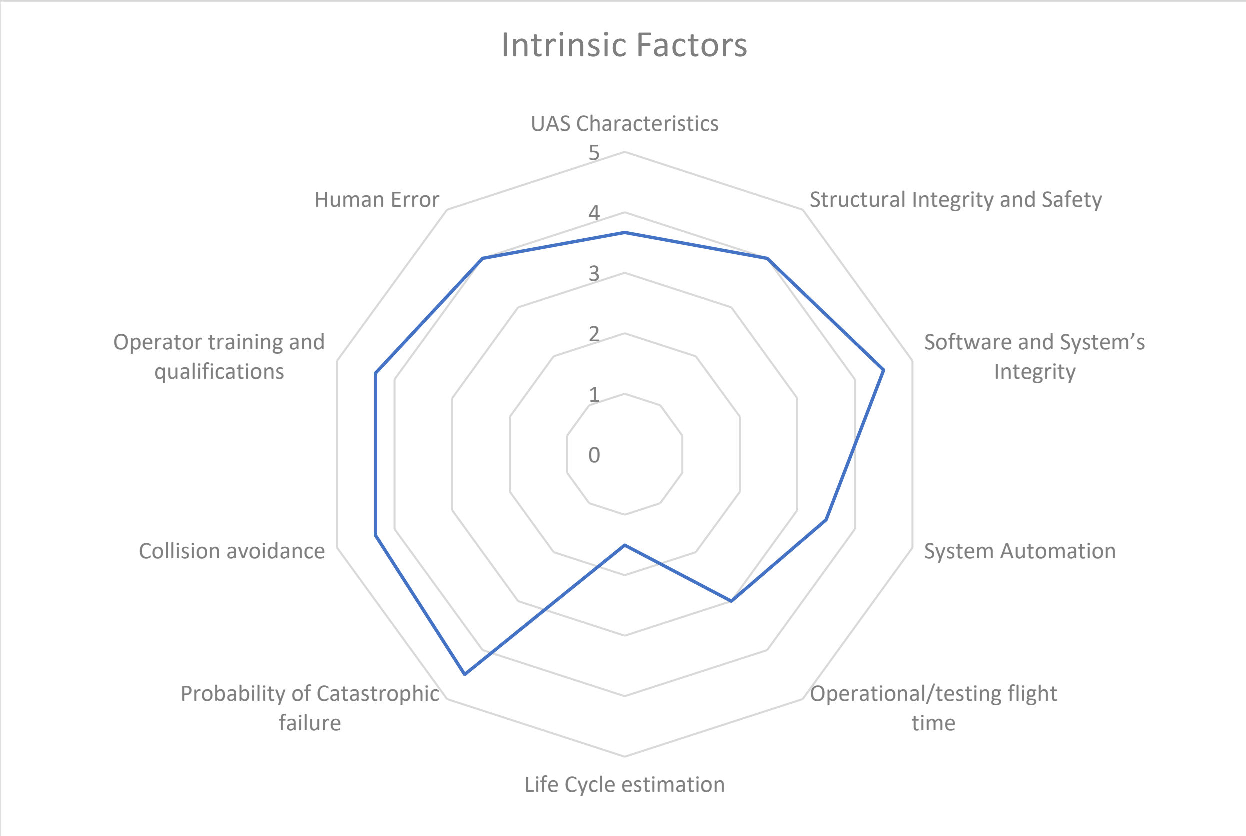

Figure 3 – Relevance of the intrinsic factors in the RA methodologies currently in use

As shown in the figure above, the parameters deemed most important are:

- Software and system's integrity;
- Structural Integrity and Safety;
- Collision avoidance;
- Probability of catastrophic failure;
- Operator training and qualifications (of all personnel, including remote pilots); and
- Human error.

For EDA pMS their methodologies should pay greater attention to the training aspects: now, military organizations, and personnel are considered always competent and no formal assessment is carried out during the RA process. Since each state might have different competency requirements, the RA process should verify that a basic level is achieved based on recognized standards. For example, in the civil field JARUS has published a comprehensive set of recommendations [RD5] for the competency of the remote pilots in the open and specific category.

As structural integrity and safety together with software and system integrity are two of the most relevant parameters to consider, some EDA pMs proposed to consider in the new RA methodology a **design integrity and verification** process like the one proposed by EASA for the civil sector, indeed in the specific category. This approach is less rigorous than the TC process but hence more rapid and possibly sufficient in the specific category.

2.4.2.2 Ground Risk evaluation

Figure 4 shows the relevance of the Ground Risk parameters within the currently used Risk Assessment Methodologies.

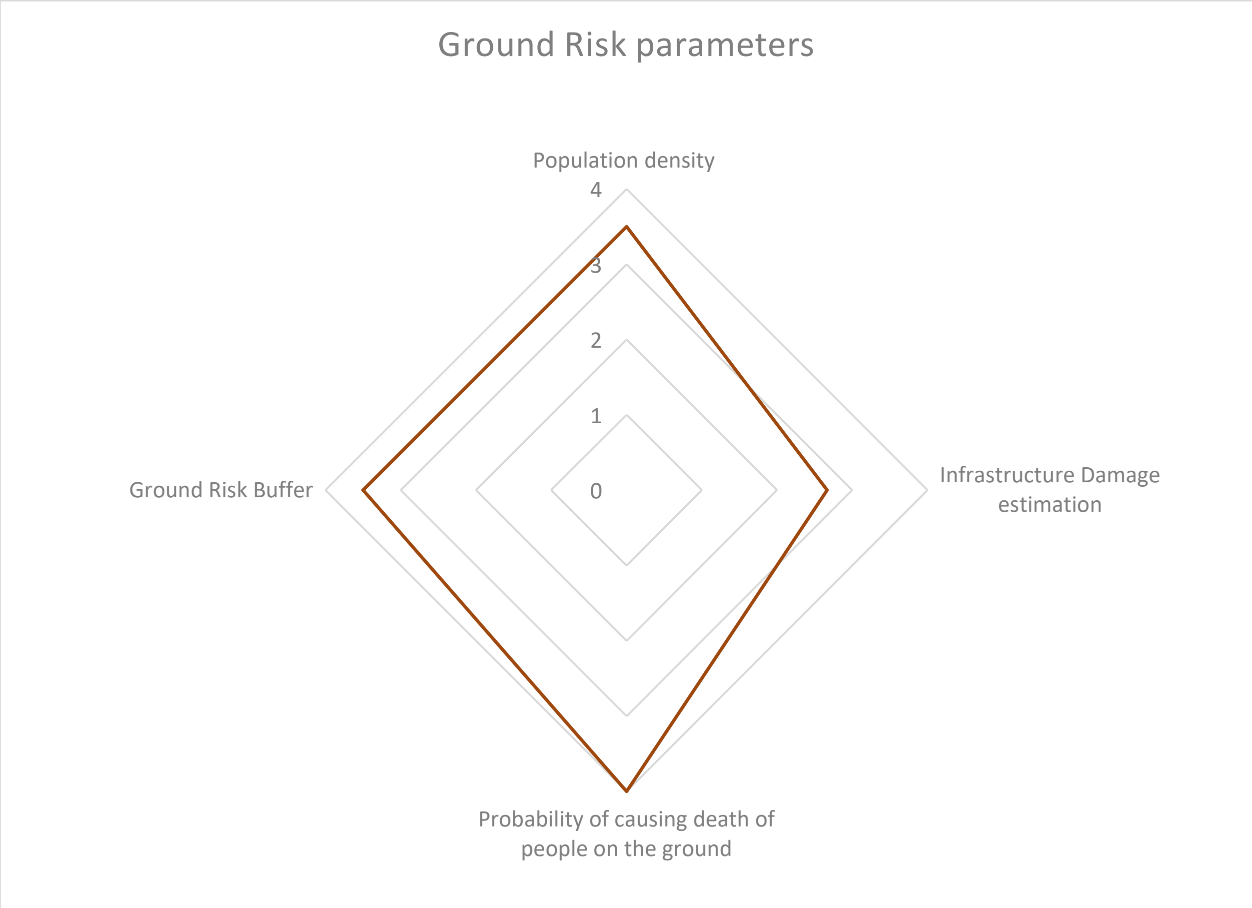

Figure 4 – Relevance of the ground risk parameters in the methodologies currently in use

The most relevant elements considered for the ground risk evaluation are:

- Probability of causing the death of people on the ground;
- Ground risk buffer; and
- Population density.

Some of the above elements are linked (e.g. population density and probability of causing deaths on the ground) but depending on the methodology used they are the leading parameters in the evaluation of the ground risk. With this respect, EDA pMS use different approaches to assess population densities and risk of deaths on the ground such as annual statistical risk maps based on population density value calculated during a given time interval and sheltering factors that consider the percentage of people protected in each area

Damage to critical infrastructures is currently not explicitly considered by neither RAT nor SORA, and this explains the relatively low score obtained.

Mitigation that is often used **to reduce the ground risk** is to set up a controlled ground area to limit the number of uninvolved people overflown during the flight.

2.4.2.3 Air Risk evaluation

The part of the survey dedicated to air risk aimed to collect information from the pMS on current situations related to managing UAS in the airspace and to analyse which methodology is applied by the pMS to assess the air risk about potential collision with other airspace users.

Military UAS operations are currently mainly conducted within reserved volumes of airspace, usually implemented as TRA (Temporary Reserved Area) or TSA (Temporary Segregated Area), included in the national AIP and activated by NOTAMs.

Because of the use of reserved areas, the air risk issues are not considered for each operation by the majority of EDA pMS. The reason is that the air risk is intrinsically mitigated when the reserved area is created and activated. In other words, the reserved area encompasses all the air risk requirements for the planned activity and no other assessment is needed.

This approach is however not always possible due to lack of appropriate tools. Civil involved parts are often not able to change their FMS during flight. Military, and sometimes also their civil counterparts, lack the tools to react in real-time to airspace changes. . Depending on the size and time between activation and de-activation, this approach may also disrupt civil air traffic.

Regarding the “size” of the reserved areas dedicated to UAS operations, only a few countries apply additional buffer to guarantee “spacing” between UAS in the area and other traffic (or other aeronautical activities) flying outside the reserved area.

For one of the EDA pMS, the dimension of the buffer around TSA depends on the type of airspace:

- a buffer of 0.5 NM laterally and 200ft vertically around volumes of uncontrolled airspace; or
- a buffer of 3 NM laterally and 1000ft vertically around TRA or TSA in controlled airspace.

Conversely, the absence of additional buffer around the segregated area minimizes the impact on the airspace used by GAT - General Air Traffic.

Furthermore, when military UAS and military manned aircraft fly in the same volume of reserved airspace, they are “spaced” by a military operational unit (No military/civil ATS Unit involved).

In this context, coordination procedures with civil ATS (or other) entities are, sometimes, established in the strategic phase (mission planning), limited to the development and implementation of the reserved areas and to the NOTAM activation process.

Some pMS have already implemented standard scenarios, in some cases like the civil ones, considering VLOS or BVLOS conditions and addressing the population density requirement.

At this stage operations implying crossing national borders during the flight are very rare (or non-existing).

Other mitigations currently considered by EDA pMS to reduce the air risk are:

- *Time of exposure* (e.g. The UAS operator wishes to cut the corner of a Class B airspace for flight efficiency. The UAS operator demonstrates that even though the Class B airspace has a high encounter rate, the UAS is only exposed to that higher rate for a very short time);
- *Daytime of the operation* (e.g. at night, a UAS operation that takes place next to an airport has less likelihood to encounter landing/departing aircraft than during the morning);
- *SAA (See And Avoid)* for VLOS (i.e. visual scanning of the airspace by the remote pilot on the ground);
- *DAA (Detect And Avoid)* for BVLOS (i.e. a technical system implemented on the UAS);
- *JTAC (Joint Terminal Attack Controller)*;
- *NOTAM (Notice To Airmen)* and cooperation with Civil ATS Providers.

2.4.2.4 Operations Environment characteristics

Figure 5 shows the relevance of the Operational environment parameters in the RA methodologies currently in use.

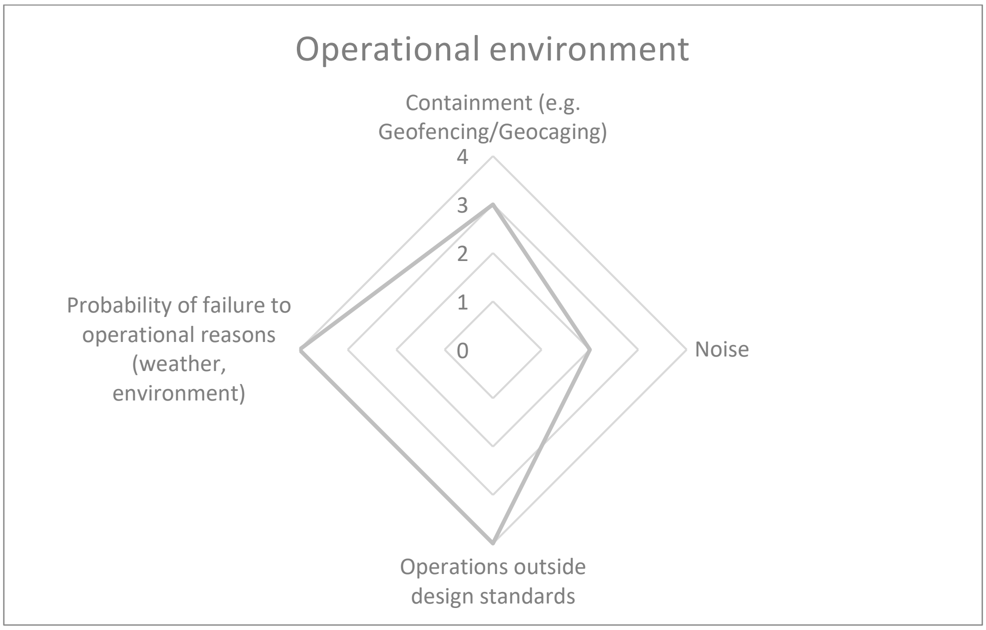

Figure 5 – Influence of operation environment parameters on the current methodologies

The most relevant operational environment parameters are:

- Probability of failure due to operational environmental factors;
- Operations outside design standards specified by the manufacturer; and
- Containment.

The probability to have a collision during a UAS flight (with manned traffic) is considered on average "important" by the pMS. Of course, operating in reserved airspace, the probability of encountering other traffic is strategically minimized, limiting this type of occurrences only to "incursion" or "excursion" events.

The civil/military coordination is considered quite "important" for air risk even if, at this stage, no formal coordination procedures are established by the majority of EDA pMS. Military and civil ATS Units are normally not involved in the tactical phase (flight phase) and, in some cases, they are only involved at a higher coordination level, in the strategic organization of national airspace, with the design and implementation of military reserved areas.

Additional aspects would need to be considered for operations in the specific category in non-segregated airspaces, such as the establishment of agreed civil/military and military/military coordination procedures.

UAS involved in "SPECIFIC" operations, could be flown by all the national military services (Army, Navy, Air Force, other military bodies) but usually only the Air Force has ATS Units or is the only service having a relationship with civil ATS Units.

Coordination between Air Force and the other military services is today not very effective because such coordination is not required to fly in segregated airspace. It however would become more relevant to fly in non-segregated airspace.

The use of "geocaging" or "geofencing" capability seems to be not considered very important by the EDA pMS. Different feelings result from the survey and no requirements and processes seem to be in force in the countries. However, since these systems are designed to ensure a UA stays where it is supposed to be without the need for direct pilot action, this allows for more focus on the mission. The interpretation of the survey results is thus that military consider these functions more relevant from an operational perspective than a safety one.

The Noise aspect is also neither covered by the currently used RA Methodologies nor considered paramount for military operations. This aspect could be not fully considered because the areas devoted to military UAS activities are mainly located above unpopulated areas and far from civilian buildings or infrastructures.

2.4.2.5 Complexity and standardization potential

For the evaluation of the overall complexity and standardization potential of the current methodologies, specific intrinsic factors were studied as presented in Table 3.

The two main methodologies currently applied among the EDA pMS (SORA and RAT) were separately analysed in terms of:

- qualitative/quantitative characteristics;
- The time needed to complete a full RA;
- Implementation into a tool that speeds up the process;
- Overall complexity; and
- Overall standardization potential.

SORA	RAT
1. Despite acknowledging that there are some quantitative analyses involved, most EDA pMS using SORA consider it a qualitative methodology. 2. Input parameters are considered standardized to allow an easy comparison of similar operational scenarios. 3. There were different points of view on the time needed to complete a full RA: some users think that is reasonable while for others the process is too complex and burdensome. 4. The overall complexity of the SORA methodology is considered HIGH. 5. The overall standardization potential of this RA methodology is considered neutral.	1. For most EDA pMS having experience on it, the RAT methodology is considered more quantitative than qualitative. 2. RAT input parameters are not considered sufficiently standardised. The assessment of the same aircraft involved in the same flight can lead to different results depending on who is making the assessment. This makes it difficult to compare the results. However, it was pointed out that the level of experience of the analyst can play a significant role in making the assessment results less subjective. 3. The time needed to complete a full RA is considered reasonable. 4. The overall complexity of the RAT methodology is considered HIGH. 5. The overall standardization potential of the RA methodology is considered neutral.

Table 3 - Complexity and standardization potential of the currently used methodologies

The following comments were also collected:

a. EDA pMS using RAT believe that SORA methodology is not adequate for military operations as it is lacking the flexibility to consider military specificities.
b. RAT methodology is considered more prescriptive than SORA. Now it is always used by starting the analysis of the UAS to determine as a result the areas where it is possible to fly safely. However, all RAT users confirmed that the opposite approach would be possible which means defining the

minimum characteristics of the UAS depending on the planned area of operation, which could be nicknamed ‘inverse RAT’.

c. RAT does not assess the Air Risk, which today is always mitigated by imposing airspace segregation. Clearly, this is quite an obstacle towards more flexible and less disruptive military UAS operations in non-segregated airspace.
d. Both RAT and SORA do not address the risk for critical infrastructures.
e. RAT process does not consider if the flight takes place in VLOS, BVLOS or EVLOS, since the emphasis is only on the UAS design in relation to ground risk.
f. Training and Maintenance aspects are not sufficiently addressed by RAT.

2.4.3 Expectations on MIL-UAS-SPECIFIC RA Methodology

This section presents the EDA pMS expectations on the methodology that the project MIL-UAS-SPECIFIC should develop.

2.4.3.1 Flexibility in the usage of UAS

The military UAS operations may have several options and may vary in time, environment, type of UA, payload, and other parameters. Each mission may be similar, but not the same as the previous one.

Military sorties, even if planned, need to be adapted to the “tactical” situation, shifting the time, changing the target, revising the trajectory and the level/altitude. In other words, military operations might change a few times before the take-off and the “mission profile” could even be changed on course and so depart from the planned operation.

Therefore, EDA pMS agree to expect a very “flexible” air risk assessment process, able to “adapt” to the mission and to the tactical evolving situation.

2.4.3.2 UAS operations in non-segregated airspace

Currently, military UAS operations are conducted in temporary or permanently reserved areas, published in the national AIP and activated by NOTAM. The air risk is well managed due to the complete and continuous availability of the segregated airspace for military purposes, for the required duration.

On the other hand, the use of rigidly pre-defined areas, such as those published in AIP, may limit the training objectives of military units, and reduce the possibility to replicate the “real operational conditions and situations”.

For these reasons, EDA pMS would welcome UAS operations also outside reserved areas, both in uncontrolled and controlled airspace, in either case non-segregated, so offering more flexibility to military operations and less disruption of civil air traffic.

In order to allow operations in non-segregated airspace an assessment of the air risk based, in turn, on the probability of encountering civil traffic (manned or unmanned), should be implemented on the basis of the methodologies already developed.

2.4.3.3 UAS operations in reserved areas with manned military aircraft

A military operation may involve ground, air, and maritime forces, in complex environments. The air component may involve fixed and rotary-wing aircraft while aircraft may be manned and unmanned.

Currently, based on the information collected from EDA pMS, when manned and unmanned aircraft fly in the same areas, they are "spaced" by a military operational body. The "separation" between the two types of traffic is mainly granted via a vertical "spacing" or, if the area is quite large, via geographical points.

The applied "distance" is sometimes based on typical ATC separation (i.e. 1000 ft vertically) or based on "national" military rules.

For the future, an air risk assessment could allow defining common separation criteria to be applied by the EDA pMS between manned and unmanned aircraft and, in addition, between two or more unmanned aircraft flying in the same volume of reserved airspace.

2.4.3.4 Probability of collision in flight

The probability of a collision during a UAS flight (with manned traffic) is considered "very important" by the pMS.

Of course, the probability of encountering other traffic in non-segregated airspace would increase, and therefore an air risk assessment could become necessary to identify the required mitigations and to verify their availability.

2.4.3.5 Civil/military coordination

The civil/military coordination is one of the main aspects included in the COMMISSION REGULATION (EC) No 2150/2005, laying down common rules for the Flexible Use of Airspace and it is considered on average "important" for the air risk in the future. To improve the possibility to have civil and military traffic in the same volume of airspace, civil/military coordination needs to be implemented based on agreed procedures. Military Units and civil ATS Units should be involved in the strategic, pre-tactical, and tactical phases.

2.4.3.6 Air risk buffer

The "buffer" to be applied in the future in the airspace volume dedicated to UAS operation is considered on average "moderately important" with relevant differences among the EDA pMS.

The differences might be due to the different assets operated by the pMS. For instance, fixed-wing and rotary-wing aircraft are very different in terms of total system error related to navigation performance and therefore in terms of dimensions of the volume of airspace to be engaged.

In any case, this aspect should be further evaluated to define the requirements for air risk assessment, including an adequate buffer in terms of lateral, vertical, and temporal parameters.

2.4.3.7 The possibility to define standard operational scenarios

Part of military UAS activities might be categorized and included in operational standard scenarios.

Requirements and conditions should be defined. Flight conditions (VLOS or BVLOS), overflown surface (populated or sparsely populated area), type of aircraft (fixed or rotary-wing), airspace (reserved, uncontrolled, controlled), MTOM (above or below a specific MTOM), altitude (above or below a specific altitude), technical performance (RTH, FTS, parachute, tethered or not tethered, weather and period/time (night, day, sunrise, …) may be part of the requirements to draw a scenario.

However, the 'declaration' process applied in civil aviation in this case, may not be necessary in the military context. In other words, having verified that the operation fits into a standard scenario, the tactical unit might fly it, without the need to involve the MAA.

2.4.3.8 *Parameters influence on MIL-UAS-SPECIFIC RA Methodology*

The following graphs show the expectations of the EDA pMS concerning the relevance of several parameters in the methodology to be developed by MIL-UAS-SPECIFIC. To allow for an easier comparison, the same parameters used for the evaluation of the current methodologies were considered.

From Figure 6 one can infer that the RA methodologies are mostly assessed as adequate in addressing the **intrinsic factors**. Life cycle estimation is the only parameter that is expected to have more relevance in the new proposed methodology.

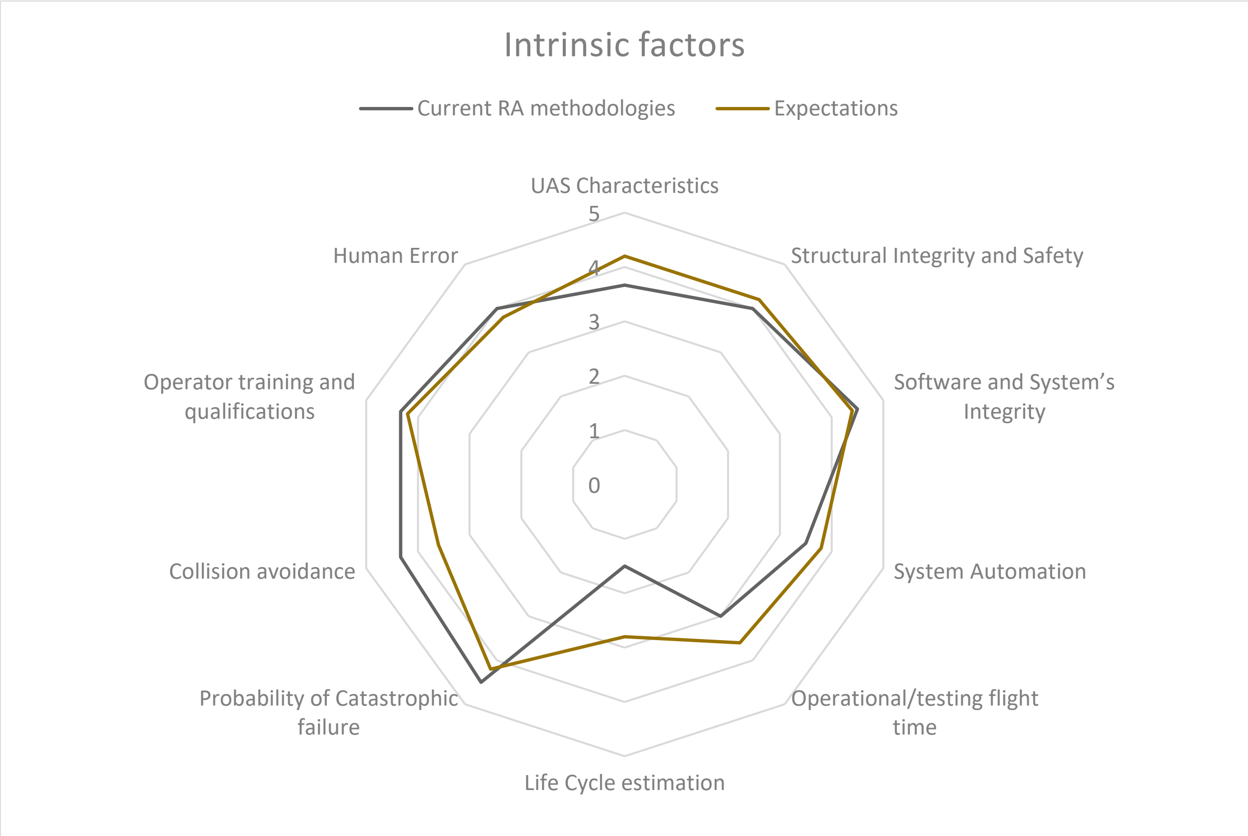

Figure 6 – Expected relevance of Intrinsic factors in MIL-UAS-SPECIFIC RA methodology

For **ground risk, air risk, and operational factors**, the expectations are in line with what is currently available. This is interpreted as an indication that the methodologies currently available are adequately addressing these aspects (Figure 7).

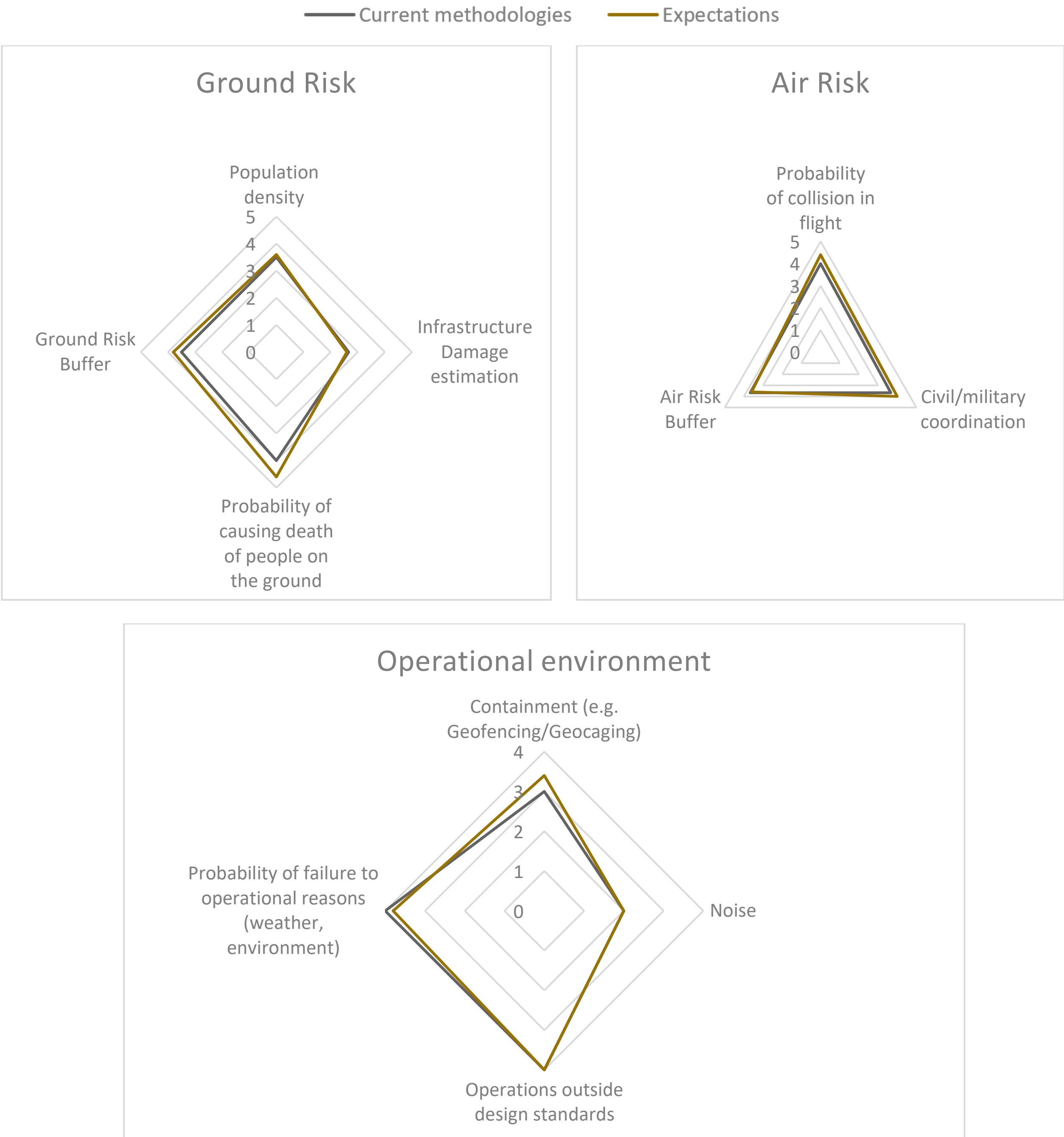

Figure 7 – Expected relevance of Ground Risk, Air Risk and Operational parameters in MIL-UAS-SPECIFIC RA methodology

Complexity and standardization potential are the aspects on which all EDA pMS that provided information agree that there is room for improvement concerning the current situation. They all consider it useful to have a tool integrating the RA Methodology developed by MIL-UAS-SPECIFIC. The proposed methodology itself should provide a higher level of standardization of both input parameters and outputs to enable easier comparison of similar operational scenarios.

There is no clear preference on whether the RA methodology to be developed for MIL-UAS-SPECIFIC should be quantitative and qualitative. Quantitative analyses are generally favoured when reliable data are available, while qualitative assessment can complement other areas.

Almost all the pMS agree on the usefulness of standard operational scenarios, including the air risk and airspace usage aspects, to offer flexibility in the mission planning, through a fast and dynamic process for assessment of the air risk. This streamlined process could enable effective and efficient UAS flights, in a timely fashion, while still ensuring safety.

2.4.3.9 Additional feedback on MIL-UAS-SPECIFIC RA Methodology

During the interviews additional considerations were made as listed below:

a. The MIL-UAS-SPECIFIC methodology should propose a systematic and systemic approach encompassing technical, human and organizational factors considering as well as the environment in which a function is performed.
b. **Military Training and Maintenance requirements** should be considered in the development of the proposed methodology, based on available references.
c. The competency of personnel and organizations is often disregarded in the current RA process because it is assumed that all military organizations have an adequate level of training and internal procedures. However, while this can be acceptable at a national level, for cross-border operations the RA process should address these aspects too.
d. **UAS Design integrity** is considered one of the most important drivers of the RA process. Some pMS suggested that EASA's guidelines on design verification can be used as a starting point to propose a similar process, quicker and simpler than type certification.
e. **Critical infrastructure** (E.g. ammunition storage) should be considered in the evaluation of the ground risk as well as **Transport of dangerous goods** (e.g. explosive and ammunition carriage).

3 MILITARY SPECIFICITIES

3.1 Scope

The scope of this chapter is to provide an overview of the military specificities that need to be considered for the development of a Risk Assessment methodology for the MIL-UAS-SPECIFIC category. The objective is therefore to identify:

1. Typical operations and use-cases
2. Organizational structure and personnel competence
3. Payload and type of operation

3.2 Overview

The questionnaire presented in section 2 was used to collect information on typical operations in the MIL-UAS-SPECIFIC category and military specificities to be considered in the Risk Assessment process;

In particular, the answers to the following questions were used to gather information (ref. B.1 of APPENDIX A):

- Q.1: Are there operational categories to differentiate the operations? If yes, what does the variation depend on (e.g. MTOM, size, type of UAS, Risk, etc)?
- Q.2: What are the typical operational scenarios in each of the above categories?
- Q.4: Which military specificities are considered in the RA process?

At the date of issue of this document, information was obtained from seven different EDA pMS. Given the limited number of inputs, this section is based on the answers received complemented by LEONARDO experience gathered by conducting TUAS ISR maritime and overland missions for international organizations such as Frontex and the United Nations.

3.3 Analysis of questionnaire's answers

The answers received to question Q.1 and Q.2 are reported in section 2.4.1.1. The information provided cannot be considered exhaustive to identify correctly operational categories and scenarios, but these inputs were considered to define a set of typical military scenarios in the following sections.

Considering question Q.4 the following answers were reported:

Military Specificities	pMS 1	pMS 2	pMS 3	pMS 4	pMS 5	pMS 6	pMS 7
Payload	*X*	*X*	*X*				*X*
Reliability of external services affects the safety of the operations.	*X*		*X*				*X*
Multi-crew coordination issues.			*X*				*X*
Environmental conditions (e.g. operations in a severe EMI/HIRF environment)		*X*	*X*	*X*			*X*
Issue related with carriage/usage of specific military payloads	*X*		*X*	*X*			*X*
Organizational aspects			*X*	*X*			*X*
Black operations at night; secretive ISR mission			*X*	*X*			*X*

Handover to another ground control station			*X*	*X*			*X*
Simultaneous operation of multiple UAS			*X*	*X*			*X*
Simultaneous operation with manned aircraft/helicopter	*X*		*X*				*X*
Operation from a moving platform (e.g., vehicle) including launch and recovery from it			*X*	*X*			*X*
Use of target UAS and Military prototype UAS	*X*		*X*	*X*			*X*
OTHER: Currently operating in civilian airspace subject to civilian rules that are prohibitive to certain specificities and therefore, these are not considered		*X*					*X*
Other: All the above items affect risk. But DESIGN INTEGRITY is the most important driver, always assessed in the Risk Equation.							*X*

Table 4 - Answer to question Q.4 of the survey

As reported in the table above, we have obtained no answer from pMS 5 and 6 and in addition, pMS 3 and 7 selected all options.

So, considering the few data reported above the pMS identify mainly the following military peculiarity to be considered in a RA:

- Payload and issue related to its carriage/usage;
- Environmental conditions (e.g. operations in a severe EMI/HIRF environment);
- Use of target UAS and Military prototype UAS.

However, given the limited number of responses, all the military peculiarities listed in question Q.4 will be considered and assessed in the following sections.

3.4 Operative scenarios and use-cases

The following operative scenarios can be considered for activities involving military UAS in a non-war[6] environment:

- MIL-UAS-S1: ISR/ISTAR;
- MIL-UAS-S2: Maritime Patrol;
- MIL-UAS-S3: IED identification & detection;
- MIL-UAS-S4: Reconnaissance for disaster
- MIL-UAS-S5: Reconnaissance for demonstration;
- MIL-UAS-S6: Training (including training for armament in firing range);
- MIL-UAS-S7: Ferry flight to dedicated training area;
- MIL-UAS-S8: Air show;
- MIL-UAS-S9: Transport/Delivery of medicines/goods.
- MIL-UAS-S10: Transport/Delivery of parts/equipment.

This list needs to be considered as an example of possible scenarios and is not intended to be exhaustive.

In the following paragraphs for each of the above scenarios, a description is provided considering the following points:

- UAS Type;

[6] e.g. NATO operation in Afghanistan, Operation performed by International Police, ONU operation for peacekeeping, support activities done by military forces for natural disaster

- Type of operation;
- Overflown Area;
- Operative range;
- Operative altitude;
- Airspace;
- Possibilities of Cross Border operation?
- Possible operation outside the state of registration?
- Ground Risk increasing factors;
- Air Risk increasing factors.
- Notes;

In describing each scenario, the following assumptions are considered:

- The characteristics of the overflown area (land and/or sea) are only described concerning the operative one since an operation can involve various types of areas (e.g. take off in airport sites, cruise in the dedicated corridor above populated areas, loitering activity in an unpopulated area) unless a type of scenario refers to a specific overflown area.
- Operative range and altitude, except in some cases, are reported in general terms since these data are also highly dependent on the type of UAS and on the type of mission to be performed.
- Regarding the airspace, TRA or TSA are considered only if peculiar for a given scenario. In general, TRA or TSA can be always applicable.
- Ground risk and air risk increasing factors are defined only considering the peculiar characteristics of a given scenario, so general risks related to the type of airspace (e.g., presence of air traffic cooperative or not cooperative) are not considered. In addition, increasing risk factors related to environmental conditions (e.g., HIRF environment) are not considered unless peculiar to a specific scenario.

Even if not specifically reported in the description of a scenario, some type of operation are generally always possible. For example:

- Simultaneous operation of multiple UAS;
- Operation from moving platform (e.g. ships). This applies particularly for mini/micro and rotary UAV;
- Night operation;

In addition, mitigation to reduce the risk (e.g., flight level separation) are not herein considered because is out of the scope of this document

3.4.1 S1 – ISR/ISTAR Scenario

This scenario is related to flights for intelligence, surveillance, reconnaissance, and possibly also target acquisition activity over a land area. The operational area can have variable population density.

Two possible scenarios can be considered. One with tactical/strategic UAS (e.g. peacekeeping activities in the politically unstable area) and one with Mini/Micro UAS (e.g. state border monitoring for illegal entry).

3.4.1.1 S1.1 – ISR/ISTAR over large areas

#	Description
UAS Type	*Tactical and strategic UAS (e.g. TUAS, MALE, HALE)*
Flight conduction	*RLOS and BRLOS*
Overflown Area	*Populated and sparsely populated areas*

Operative range	*50 km ÷ 500 km*
Operative altitude	*Above 500 ft AGL and below FL600*
Airspace	*Uncontrolled*
Possibilities of Cross Border operation	*YES*
Possible operation outside the state of registration?	*YES*
Ground Risk increasing factors	*Carriage of the external tank*
Air Risk increasing factors	*Secretive mission*
Notes	*/*

Table 5 - ISR/ISTAR over large areas

3.4.1.2 S1.2 – ISR with Mini/Micro

#	Description
UAS Type	*Mini/Micro UAS with MTOM < 25 kg*
Flight conduction	*Mainly VLOS/EVLOS (RLOS possible)*
Overflown Area	*Sparsely populated areas / unpopulated areas*
Operative range	*Up to 500 m VLOS (10 km LOS)*
Operative altitude	*Up to500 ft AGL*
Airspace	*Uncontrolled*
Possibilities of Cross Border operation	*YES*
Possible operation outside the state of registration?	*YES*
Ground Risk increasing factors	*/*
Air Risk increasing factors	*/*
Notes	*/*

Table 6 - ISR with Mini/Micro UAS

3.4.2 S2 – Maritime Patrol Scenario

This scenario is related to maritime patrolling (including coast and international waters) surveillance flights. The operational area has zero population density (excluding the airport surrounding area and the coastal zones). Two possible scenarios can be considered. One with tactical/strategic UAS (e.g. mine detection, illegal ship movements) and one with Mini/Micro UAS (e.g. inspection of suspect ships).

3.4.2.1 S2.1 – Maritime Patrol with Tactical/Strategic UAS

#	Description
UAS Type	*Tactical and strategic UAS (e.g. TUAS, MALE, HALE)*
Flight conduction	*RLOS and BRLOS*
Overflown Area	*Populated / sparsely populated areas during take-off and landing. Unpopulated areas over the sea*
Operative range	*50 km ÷ 500 km*
Operative altitude	*Above 500 ft AGL and below FL600*
Airspace	*Controlled airspace during take-off and landing. Uncontrolled airspace over the sea*
Possibilities of Cross Border operation	*YES*
Possible operation outside the state of registration?	*YES*
Ground Risk increasing factors	*Carriage of the external tank, sonobuoy*
Air Risk increasing factors	*Secretive mission*
Notes	

Table 7 - Maritime Patrol with Tactical/Strategic UAS

3.4.2.2 S2.2 – Maritime Patrol with Mini/Micro UAS

#	Description
UAS Type	*Mini/Micro UAS with MTOM < 25 kg*
Flight conduction	*Mainly VLOS (RLOS possible)*
Overflown Area	*Unpopulated areas (but over ships passengers/crew)*
Operative range	*Up to 500 m VLOS (2 km LOS)*
Operative altitude	*Up to 500 ft AGL*
Airspace	*Uncontrolled*
Possibilities of Cross Border operation	*YES (*)*
Possible operation outside the state of registration?	*YES (*)*
Ground Risk increasing factors	*Operation from moving ships*
Air Risk increasing factors	*/*
Notes	*Operation from moving ships*

Table 8 - Maritime Patrol with Mini/Micro UAS

(*) International water.

3.4.3 S3 – IED Identification and detection

This scenario is related to an activity of IED identification and detection (e.g. terrorism fights purposes, detection of old war ammunition)

#	Description
UAS Type	*Mini/Micro UAS with MTOM < 25 kg*
Flight conduction	*Mainly VLOS/EVLOS (RLOS possible)*
Overflown Area	*Assembly of people (e.g. urban area)*
Operative range	*Up to 500 m VLOS (2 km LOS)*
Operative altitude	*Up to 500 ft AGL*
Airspace	*Uncontrolled*
Possibilities of Cross Border operation	*NO*
Possible operation outside the state of registration?	*NO*
Ground Risk increasing factors	*/*
Air Risk increasing factors	*/*
Notes	*/*

Table 9 - IED identification and detection

3.4.4 S4 – Reconnaissance for disasters

This scenario is related to activities of reconnaissance in zones where there has been a natural disaster (e.g., earthquakes ruins, floods zones, hurricanes ruins, volcano activities). Can be considered in this scenario also flight for monitoring of industrial disasters (e.g., nuclear power plant disaster).

In general, a sparsely populated area / unpopulated area can be considered assuming that people have been evacuated or are missing. The populated area however can be also considered as applicable.

Two possible scenarios can be considered. One with tactical/strategic UAS (e.g., monitoring of flame front progress of a large fire) and one with Mini/Micro UAS (e.g., searching of people in earthquakes area).

3.4.4.1 S4.1 – Reconnaissance for disaster with tactical/strategic UAS

#	Description
UAS Type	*Tactical and strategic UAS (e.g. TUAS, MALE, HALE)*
Flight conduction	*RLOS and BRLOS*
Overflown Area	*Sparsely populated areas / unpopulated areas*
Operative range	*10 km ÷ 50 km*
Operative altitude	*Above 500 ft AGL and below FL600*
Airspace	*Uncontrolled*
Possibilities of Cross Border operation	*YES*
Possible operation outside the state of registration?	*YES*
Ground Risk increasing factors	*Carriage of the external tank*
Air Risk increasing factors	*Presence of manned aircraft/helicopter in the same area*
Notes	*Possibilities of TRA in operation. Particular severe weather/environmental conditions can be present (e.g. high-intensity wind, volcanic powders).*

Table 10 - Reconnaissance for disaster with tactical/strategic UAS

3.4.4.2 S4.2 – Reconnaissance for disaster with Mini/Micro UAS

#	Description
UAS Type	*Mini/Micro UAS with MTOM < 25 kg*
Flight conduction	*Mainly VLOS/EVLOS (RLOS possible)*
Overflown Area	*Sparsely populated areas / unpopulated areas*
Operative range	*Up to 500 m VLOS (10 km LOS)*
Operative altitude	*Up to 500 ft AGL*
Airspace	*Uncontrolled*
Possibilities of Cross Border operation	*YES*
Possible operation outside the state of registration?	*YES*
Ground Risk increasing factors	*/*
Air Risk increasing factors	*/*
Notes	*Possibilities of TRA in operation*

Table 11 - Reconnaissance for disaster with Mini/Micro UAS

3.4.5 S5 – Reconnaissance for demonstration

This scenario is related to activities of reconnaissance with military UAS as support to police in zones where an assembly of people is present. Two possible scenarios can be considered.

One with tactical/strategic UAS (e.g., high altitude city monitoring during a political demonstration) and one with Mini/Micro UAS (e.g., use of micro UAS by the army for monitoring of dedicated city areas during a political demonstration).

3.4.5.1 S5.1 – Manifestation reconnaissance with tactical/strategic UAS

#	Description
UAS Type	*Tactical and strategic UAS (e.g. TUAS, MALE, HALE)*
Flight conduction	*RLOS and BRLOS*
Overflown Area	*Assembly of people / populated areas (e.g. urban area)*
Operative range	*2 km ÷ 20 km*
Operative altitude	*Above 500 ft AGL and below FL600*
Airspace	*Uncontrolled (controlled airspace possible over capital cities)*
Possibilities of Cross Border operation	*NO*
Possible operation outside the state of registration?	*NO*
Ground Risk increasing factors	*Carriage of the external tank*
Air Risk increasing factors	*Presence of manned aircraft/helicopter in the same area*
Notes	*Possibilities of TRA in operation*

Table 12 - Manifestation reconnaissance with tactical/strategic UAS

3.4.5.2 S5.2 – Manifestation reconnaissance with Mini/Micro UAS

#	Description
UAS Type	*Mini/Micro UAS with MTOM < 25 kg*
Flight conduction	*Mainly VLOS/EVLOS (RLOS possible)*
Overflown Area	*Assembly of people (e.g. urban area)*
Operative range	*Up to 500 m VLOS (2 km LOS)*
Operative altitude	*Up to 500 ft AGL*
Airspace	*Uncontrolled*
Possibilities of Cross Border operation	*NO*
Possible operation outside the state of registration?	*NO*
Ground Risk increasing factors	*/*
Air Risk increasing factors	*/*
Notes	*Possibilities of TRA in operation*

Table 13 - Manifestation reconnaissance with Mini/Micro UAS

3.4.6 S6 – Training (including training for armament in firing range)

This scenario is related to activities of training with various kinds of UASs in restricted/segregated zones.

Three possible scenarios can be considered. One with target UAS (e.g. target training into military firing range), one with tactical/strategic UAS (e.g. fire training), and one with Mini/Micro UAS (e.g. during extensive military training manoeuvres).

3.4.6.1 S6.1 – Training with target UAS

#	Description
UAS Type	*Target UAS*
Flight conduction	*Mainly RLOS (BRLOS possible)*
Overflown Area	*Controlled area (military firing range)*
Operative range	*Up to 100 km*
Operative altitude	*Above 0 m AGL and below FL600*
Airspace	*Uncontrolled but reserved/segregated*
Possibilities of Cross Border operation	*NO*
Possible operation outside the state of registration?	*NO*
Ground Risk increasing factors	*Characteristics of the UAS (e.g. high speed), operation at low altitude.*
Air Risk increasing factors	*Characteristics of the UAS (e.g. high speed, high load factor manoeuvres). Presence of other military manned aircraft/helicopters in the same area*
Notes	*Dedicated NOTAM is issued*

Table 14 - Training with target UAS

3.4.6.2 S6.2 – Training with mini/micro UAS

#	Description
UAS Type	*Mini/Micro UAS with MTOM < 25 kg*
Flight conduction	*Mainly VLOS/EVLOS (RLOS possible)*
Overflown Area	*Controlled area*
Operative range	*Up to 500 m VLOS (10÷50 km LOS)*
Operative altitude	*Up to 3000 ft*
Airspace	*Uncontrolled*
Possibilities of Cross Border operation	*NO*
Possible operation outside the state of registration?	*NO*
Ground Risk increasing factors	*/*
Air Risk increasing factors	*Operative altitude above 500 ft considering the presence of other military aircraft / helicopters*
Notes	*Dedicated NOTAM is issued. Operation from moving platform are possible.*

Table 15 - Training with mini/micro UAS

3.4.6.3 S6.3 – Training with tactical/strategic UAS

#	Description
UAS Type	*Tactical and strategic UAS (e.g. TUAS, MALE, HALE)*

Flight conduction	*RLOS and BRLOS*
Overflown Area	*Controlled area (e.g. military firing range)*
Operative range	*Up to 100 km*
Operative altitude	*Above 0 ft AGL and below FL600*
Airspace	*Controlled and/or uncontrolled but reserved / segregated*
Possibilities of Cross Border operation	*YES*
Possible operation outside the state of registration?	*YES*
Ground Risk increasing factors	*Carriage of dangerous payloads (e.g. bombs, missiles), operation at low altitude.*
Air Risk increasing factors	*Presence of other military manned aircraft/helicopters in the same area. Carriage of dangerous payloads (e.g. missiles).*
Notes	*Cross-border operation and operation outside the state of registration can be considered for joint military training activities with allies (e.g. NATO training operation). Dedicated NOTAM is issued*

Table 16 - Training with tactical / strategic UAS

3.4.7 S7 – Ferry flight to a dedicated training area

This scenario is related to the ferry flight of a tactical/strategic UAS to reach a segregated/restricted area in which it will be carrying out the training activity (assumption of no dedicated airport usable near the military firing range). During the ferry flight, the UAS flies over populated areas with dangerous payload (even if segregated airways need to be established).

#	Description
UAS Type	*Tactical and strategic UAS (e.g. TUAS, MALE, HALE)*
Flight conduction	*RLOS and BRLOS*
Overflown Area	*Populated area / sparsely populated areas*
Operative range	*50 km ÷ 500 km*
Operative altitude	*Above 500 ft AGL and below FL600*
Airspace	*Controlled and/or uncontrolled*
Possibilities of Cross Border operation	*YES*
Possible operation outside the state of registration?	*YES*
Ground Risk increasing factors	*Carriage of dangerous payloads (e.g. bombs, missiles)*
Air Risk increasing factors	*Carriage of dangerous payloads (e.g. bombs, missiles ECM)*
Notes	*Dedicated flight corridors are defined*

Table 17 - Ferry flight to dedicated training area

3.4.8 S8 – Air show

This scenario is related to a flight activity during an air show. A BRLOS scenario can also be considered when the UCS cannot be physically carried in the airport where the air show will be done.

#	Description
UAS Type	*Tactical and strategic UAS (e.g. TUAS, MALE, HALE)*
Flight conduction	*RLOS (BRLOS possible)*
Overflown Area	*Controlled areas with an assembly of people*
Operative range	*Up to 20 km*
Operative altitude	*Up to 3000 ft*[7]
Airspace	*Segregated/reserved*
Possibilities of Cross Border operation	*NO*
Possible operation outside the state of registration?	*NO*
Ground Risk increasing factors	*Presence of assembly of people near the exhibition area*
Air Risk increasing factors	*Possibility of exhibition simultaneously with other aircraft/helicopters*
Notes	*Dedicated NOTAM is issued*

Table 18 – Air show

[7] Operation for transmit images (e.g. for television purposes) can be not considered in this scenario, but in the S5.1 "Reconnaissance for demonstration"

3.4.9 S9 – Emergency / delivery of goods

This scenario is related to a flight activity for transport/delivery of goods for emergency reason.

Two possible scenarios can be considered. One with tactical/strategic UAS (e.g. delivery of medicine/goods to areas affected by natural disasters) and one with Mini/Micro UAS (e.g. transport of dangerous goods as organs/plasma between hospitals).

3.4.9.1 S9.1 – Delivery with tactical / strategic UAS

#	Description
UAS Type	*Tactical and strategic UAS (e.g. TUAS, MALE, HALE)*
Flight conduction	*RLOS and BRLOS*
Overflown Area	*Sparsely populated areas*
Operative range	*50 km ÷ 500 km*
Operative altitude	*Above 500 ft AGL and below FL600*
Airspace	*Uncontrolled*
Possibilities of Cross Border operation	*YES*
Possible operation outside the state of registration?	*YES*
Ground Risk increasing factors	*Carriage of payload that increases the mass of the UAS, flight near the ground during deployment/launch phases.*
Air Risk increasing factors	*Presence of manned aircraft/helicopter in the same area*
Notes	*Possibilities of TRA in operation. Particular weather/environmental conditions can be present (e.g. high-intensity rain).*

Table 19 – Emergency Delivery with tactical/strategic UAS

3.4.9.2 S9.2 – Delivery with mini / micro UAS

#	Description
UAS Type	*Mini/Micro UAS with MTOM < 25 kg*
Flight conduction	*RLOS and BRLOS*
Overflown Area	*Populated area (e.g. urban area)*
Operative range	*Up to 500 m VLOS (10 km LOS)*
Operative altitude	*Up to 500 ft AGL*
Airspace	*Uncontrolled*
Possibilities of Cross Border operation	*YES*
Possible operation outside the state of registration?	*YES*
Ground Risk increasing factors	*Carriage of dangerous goods (e.g. blood)*
Air Risk increasing factors	*/*
Notes	*/*

Table 20 – Emergency Delivery with mini / micro UAS

3.4.10S10 –Delivery of parts / equipment

This scenario is related to a flight activity with tactical/strategic UAS for transport/delivery of parts/equipment (e.g. from an airbase to a military detachment unit).

#	Description
UAS Type	*Tactical and strategic UAS (e.g. TUAS, MALE, HALE)*
Flight conduction	*RLOS and BRLOS*
Overflown Area	*Populated area / sparsely populated areas*
Operative range	*50 km ÷ 500 km*
Operative altitude	*Above 500 ft AGL and below FL600*
Airspace	*Controlled and/or Uncontrolled*
Possibilities of Cross Border operation	*YES*
Possible operation outside the state of registration?	*YES*
Ground Risk increasing factors	*Carriage of payload that increases the mass of the UAS, flight near the ground during deployment/launch phases.*
Air Risk increasing factors	*/*
Notes	*/*

Table 21 - Delivery of parts / equipment

3.4.11 Summary of possible operative scenario

The following table summarizes the various operative scenario described above.

#		Mission	UAS Type	Flight conduction	Overflown area	Op. range	Op. height	Airspace	Cross Border ?	Op. outside state of reg.?	Ground risk increasing factor	Air risk increasing factors	Notes
S1	S1.1	ISR/ISTAR	Tactical / Strategic UAS	RLOS and BRLOS	Populated and sparsely populated areas	50 km ÷ 500 km	Above 500 ft AGL and below FL600	Uncontrolled	YES	YES	Carriage of an external tank to extend the endurance	Secretive mission	/
	S.1.2		Mini/Micro UAS with MTOM < 25 kg	Mainly VLOS / EVLOS (RLOS possible)	Sparsely populated areas / unpopulated areas	Up to 500 m VLOS (10 km LOS)	Up to500 ft AGL	Uncontrolled	YES	YES	/	/	/
S2	S2.1	Maritime Patrol	Tactical / Strategic UAS	RLOS and BRLOS	Populated areas during take-off and landing. Unpopulated areas over sea	50 km ÷ 500 km	Above 500 ft AGL and below FL600	Controlled airspace during take off and landing. Uncontrolled airspace over sea	YES	YES	Carriage of an external tank to extend the endurance, sonobuoy	Secretive mission	/
	S2.2		Mini/Micro UAS with MTOM < 25 kg	Mainly VLOS (RLOS possible)	Unpopulated areas (but over ships passengers/crew)	Up to 500 m VLOS (10 km LOS)	Up to500 ft AGL	Uncontrolled	YES	YES	Operation from moving ships	/	Operation from moving ships
S3		IED identification and detection	Mini/Micro UAS with MTOM < 25 kg	Mainly VLOS / EVLOS (RLOS possible)	Assembly of people / populated areas (e.g. urban areas)	Up to 500 m VLOS (2 km LOS)	Up to500 ft AGL	Uncontrolled	NO	NO	/	/	/

#		Mission	UAS Type	Flight conduction	Overflown area	Op. range	Op. height	Airspace	Cross Border ?	Op. outside state of reg.?	Ground risk increasing factor	Air risk increasing factors	Notes
S4	*S4.1*	*Reconnaissance for disasters*	*Tactical / Strategic UAS*	*RLOS and BRLOS*	*Sparsely populated areas / unpopulated areas*	*10 km ÷ 50 km*	*Above 500 ft AGL and below FL600*	*Uncontrolled*	*YES*	*YES*	*Carriage of an external tank to extend the endurance*	*Presence of manned aircraft/helicopter in the same area*	*Possibilities of TRA in operation. Particular severe weather/environmental conditions can be present (e.g. high-intensity wind, volcanic powders).*
	S4.2		*Mini/Micro UAS with MTOM < 25 kg*	*Mainly VLOS / EVLOS (RLOS possible)*	*Sparsely populated areas / unpopulated areas*	*Up to 500 m VLOS (10 km LOS)*	*Up to 500 ft AGL*	*Uncontrolled*	*YES*	*YES*	*/*	*/*	*Possibilities of TRA in operation*
S5	*S5.1*	*Reconnaissance for demonstration*	*Tactical / Strategic UAS*	*RLOS and BRLOS*	*Assembly of people / populated areas (e.g. urban area)*	*2 km ÷ 20 km*	*Above 500 ft AGL and below FL600*	*Uncontrolled (controlled airspace possible over capital cities)*	*NO*	*NO*	*Carriage of an external tank to extend the endurance*	*Presence of manned aircraft/helicopter in the same area*	*Possibilities of TRA in operation*
	S5.2		*Mini/Micro UAS with MTOM < 25 kg*	*Mainly VLOS / EVLOS (RLOS possible)*	*Assembly of people (e.g. urban area)*	*Up to 500 m VLOS (2 km LOS)*	*Up to500 ft AGL*	*Uncontrolled*	*NO*	*NO*	*/*	*/*	*Possibilities of TRA in operation*
S6	*S6.1*	*Training with target UAS*	*Target Drone*	*Mainly RLOS (BRLOS possible)*	*Controlled area (military firing range)*	*Up to 100 km*	*Above 0 m AGL and below FL600*	*Uncontrolled but reserved/segregated*	*NO*	*NO*	*Characteristics of the UAS (e.g. high speed), operation at low altitude.*	*Characteristics of the UAS (e.g. high speed, high load factor manoeuvres). Presence of other military manned aircraft/helicopters in the same area*	*Dedicated NOTAM is issued*

#		Mission	UAS Type	Flight conduction	Overflown area	Op. range	Op. height	Airspace	Cross Border ?	Op. outside state of reg.?	Ground risk increasing factor	Air risk increasing factors	Notes
	S6.2	*Training with mini/micro UAS*	*Mini/Micro UAS with MTOM < 25 kg*	*mainly VLOS / EVLOS (RLOS possible)*	*Controlled area*	*Up to 500 m VLOS (10÷50 km LOS)*	*Up to 3000 ft AGL*	*Uncontrolled*	*NO*	*NO*	*/*	*Operative altitude above 500 ft considering the presence of other military aircraft/helicopters*	*Dedicated NOTAM is issued. Operation from moving platform is possible.*
	S6.3	*Training with tactical/strategic UAS*	*Tactical / Strategic UAS*	*RLOS and BRLOS*	*Controlled area (e.g. military firing range)*	*Up to 100 km*	*Above 0 ft AGL and below FL600*	*Controlled and/or uncontrolled but reserved/segregated*	*YES*	*YES*	*Carriage of dangerous payloads (e.g. bombs, missiles), operation at low altitude.*	*Presence of other military manned aircraft/helicopters in the same area. Carriage of dangerous payloads (e.g. missiles).*	*Cross-border operation can be considered for joint military training activities with allies (e.g. NATO training operation). Dedicated NOTAM is issued*
S7		*Ferry flight to the dedicated training area*	*Tactical / Strategic UAS*	*RLOS and BRLOS*	*Populated areas / sparsely populated areas*	*50 km ÷ 500 km*	*Above 500 ft AGL and below FL600*	*Controlled and/or uncontrolled*	*YES*	*YES*	*Carriage of dangerous payloads (e.g. bombs, missiles)*	*Carriage of dangerous payloads (e.g. bombs, missiles, ECM)*	*Dedicated flight corridors are defined*
S8		*Air show*	*Tactical / Strategic UAS*	*RLOS and BRLOS*	*Controlled areas with an assembly of people*	*Up to 20 km*	*Up to 3000 ft*	*Segregated/reserved*	*NO*	*NO*	*Presence of assembly of people near the exhibition area*	*Possibility of exhibition simultaneously with other aircraft/helicopters*	*Dedicated NOTAM is issued*
S9	*S9.1*	*Emergency/ delivery of goods*	*Tactical / Strategic UAS*	*RLOS and BRLOS*	*Sparsely populated areas*	*50 km ÷ 500 km*	*Above 500 ft AGL and below FL600*	*Uncontrolled*	*YES*	*YES*	*Carriage of payload that increases the mass of the UAS, flight near the ground during deployment/launch phases.*	*Presence of manned aircraft / helicopter in the same area*	*Possibilities of TRA in operation. Particular environmental condition can be present (e.g. high-intensity rain).*
	S9.2		*Mini/Micro UAS with MTOM < 25 kg*	*RLOS and BRLOS*	*Populated areas (e.g. urban area)*	*Up to 500 m VLOS (10 km LOS)*	*Up to 500 ft AGL*	*Uncontrolled*	*YES*	*YES*	*Carriage of dangerous goods (e.g. blood),*	*/*	*/*

#	Mission	UAS Type	Flight conduction	Overflown area	Op. range	Op. height	Airspace	Cross Border ?	Op. outside state of reg.?	Ground risk increasing factor	Air risk increasing factors	Notes
S10	*Transport/delivery of parts/equipment*	*Tactical / Strategic UAS*	*RLOS and BRLOS*	*Populated areas / sparsely populated areas*	*50 km ÷ 500 km*	*Above 500 ft AGL and below FL600*	*Controlled and/or uncontrolled*	*YES*	*YES*	*Carriage of payload that increases the mass of the UAS, flight near the ground during deployment/launch phases.*	*/*	*/*

Table 22 - Summary of possible operative scenario

3.5 *Organizational structure*

Regarding the organizational structure, no detailed information can be extracted by the questionnaire the pMS answered.

It is worth noting that two different organizations are involved:

- The armed forces (e.g., army, aviation, marine) define the operational scenario and perform the initial risk assessment and submits the request of authorization to the MAA.
- The Military Airworthiness Authority authorizes or not the activity, or requests mitigation/proposes additional limitation.

In addition to those, also the Design Holder of the UAS can be involved providing technical support to the risk assessment.

While the organizational structure among pMS might be different it is understood that armed forces are mainly defining the operational scenarios. However, they might not be capable of performing the risk assessment. This process may be conducted by the MAA in order to define standard scenarios or pre-defined risk assessments and facilitate the armed forces operations.

Considering the assumption that all armed forces are structured and have a high level of competence (e.g. pilot licensing, maintenance staff, organizational aspects) it can be stated that generally no increasing risk factors are present. However it could be important to evaluate the actual level of competence and its impact on the overall safety of the operations since the management of UAS can pose new challenges for UAS crew and an assessment is needed to confirm that there is no additional risk and that this aspect can be rather considered as mitigating risk factor. It is important to consider that coordination between Military Authority and Civil Authority is necessary. Some operational scenarios, even if done with military UAS, can be inside air space managed by civil aviation.

3.6 Payload and type of operation

In section 3.4 possible operative scenarios are reported where military UAS are used.

The following table summarizes the possible payloads that can be installed in the UAS considering the operative scenario and considering the type of UAS involved.

This table needs to be considered as an example of a possible payload that can be installed and is not intended to be exhaustive.

	Type of Operation																		
	Scenario	ISR/ISTAR		Maritime Patrol		IED detection	Reconnaissance for disaster		Reconnaissance for demonstration		Training			Ferry to a training area	Air show	Emergency delivery of goods		Delivery of parts / equipment	Dangerous?
	#	S1		S2		S3	S4		S5		S6			S7	S8	S9		S10	
		S1.1	S1.2	S2.1	S2.2		S4.1	S4.2	S5.1	S5.2	S6.1	S6.2	S6.3			S9.1	S9.2		
	UAS Type	Tactical / Strategic	Mini / Micro	Tactical / Strategic	Mini / Micro	Mini / Micro	Tactical / Strategic	Mini / Micro	Tactical / Strategic	Mini / Micro	Target UAS	Mini / Micro	Tactical / Strategic	Tactical / Strategic	Tactical / Strategic	Tactical / Strategic	Mini / Micro	Tactical / Strategic	
Payloads	**E/O**	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	
	IR	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	
	LRF	X		X									X	X		X		X	
	LRD												X	X					✓
	RADAR MTI	X		X			X						X	X					
	RADAR Meteo	X		X			X						X	X		X		X	
	SAR	X		X			X						X	X					
	AIS			X															
	ESM	X		X			X		X				X	X		X		X	
	ECM										X		X	X					✓
	RF Seeker	X		X									X	X					
	RWR	X		X									X	X					
	Hyperspectral Sensor	X		X			X												
	High Intensity Lights							X											
	RCS augmentation										X								
	IR augmentation										X			X					

	Seeker Simulator										*X*								
	Smoking cartridge										*X*		*X*	*X*	*X*				✓
	MDI										*X*								
	External Tank	*X*		*X*			*X*		*X*				*X*	*X*				⍰	✓
	Sonobuoy			*X*									*X*						✓
	Bombs												*X*	*X*					✓
	Missiles												*X*	*X*					✓
	Goods[8]																	*X*	[9]
	Lifesaving Goods[10]															*X*			[9]
	Hospital Good[11]																*X*		✓

Table 23 - Possible payload and type of operation

[8] It can include spare parts/equipment.
[9] can be considered dangerous depending on its mass.
[10] It can include lifesaving equipment like medicine, food, clothes, life jackets etc.
[11] It can include plasma, organs.

3.7 *Impact of military specificities on MIL-UAS-SPECIFIC methodology*

The analysis of military specificities allowed the identification of a number of parameters and aspects which should be taken into account by the MIL-UAS-SPECIFIC methodology. The table below lists the risk factors identified and propose how to address them in the MIL-UAS-SPECIFIC methodology. The methodology developed will be then tested using the scenarios presented in section 3.4 as test cases with the aim of demonstrating that relevant military specificities are correctly taken into account.

Table 24: Risk factors and MIL-UAS-SPECIFIC proposed approach

Risk factor	MIL-UAS-SPECIFIC
Carriage of an external tank to extend the endurance	*Evaluate the additional risk posed by the carriage of external tanks and how this affects the acceptable probability of a catastrophic failure.*
Carriage of dangerous payloads (e.g. bombs, missiles)	*Evaluate the additional risk posed by the carriage of dangerous payload and how this affects the acceptable probability of a catastrophic failure.*
Presence of assembly of people near the exhibition area	*Requirements for containment to ensure that the probability of the UAS leaving the operational volume is below a given threshold.*
Carriage of dangerous goods (e.g. blood),	*Identify requirements on crashproof containers to ensure the dangerous good does not cause harm in case of accident.*
Secretive mission	*Develop and Air Risk model that considers a situation in which the UAS cannot be seen and avoided by other aircraft.*
Presence of manned aircraft/helicopter in the same area	*Develop an Air Risk model to evaluate the risk of collision with manned aircraft and the risk of jamming caused by the presence of other UAS.*
Multiple UAS flying in the same area possibly controlled by the same GCS	*Address the Risk of Collision between UAS flying in the same operational volume.*

The proposed approach from MIL-UAS-SPECIFIC is further analysed in section 4 where gaps with respect to existing RA methodologies are identified when the above point are not adequately addressed.

4 GAP ANALYSIS

The scope of this section is to compare the methodologies currently in use by EDA pMS with their expectations to derive requirements for the development of the MIL-UAS-SPECIFIC RA methodology.

The gaps are first identified based on the information collected and presented in Sections 2 and 3 and then assessed using a Multi-Criteria Analysis (MCA) to quantitatively evaluate the differences between expectations and the current situation.

4.1 Methodology - MULTI-CRITERIA ANALYSIS (MCA)

The principles of 'better regulation'[12], mandate the European Commission (EC) and its Agencies (including EASA) to carry out an impact assessment whenever something new is proposed.

The impact assessment allows to compare different options or to define priorities, for example assessing across several identified gaps, which one should be filled with priority, since having more adverse impact than others.

Among these methods, the guidelines[13] of the EC on Impact Assessment (IA) mention also the Multi-Criteria Analysis (MCA), which offers distinctive benefits, since enabling to:

a) calculate a simple non-dimensional numerical score which combines parameters expressed in different quantitative units of measurements (e.g., safety in several accidents and economic values in monetary terms);
b) combine qualitative and quantitative evaluations in said numerical score;
c) assign different weights to several 'criteria' to account for the different societal relevance (e.g., 4 for safety and 1 for regulatory harmonization);
d) analyse in a limited time;
e) revise the assessment in a group in a structured way, which enables the quick update of the assessment, by simply changing some scores.

The identified gaps for the air risk and the ground risk are hence assessed in this document using the MCA, which culminates into a final non-dimensional numerical weighted score. This score may allow taking decisions on which gaps could require more urgent action.

The first step is hence to list the possible gaps, emerging from the survey and interviews.

The second step is to define the 'criteria' which will be considered to compare the relevance of each gap.

The third step is to assign a 'weight' to each criterion, based on its relevance for the community.

This document proposes to use the following criteria and related weights:

No.	Criterion (step 2)	Description	Weight (step 3)	Rationale

[12] https://ec.europa.eu/info/sites/default/files/better-regulation-guidelines-better-regulation-commission.pdf
[13] https://ec.europa.eu/info/sites/default/files/better-regulation-guidelines-impact-assessment.pdf

A	Safety	Does the gap prevent the RA methodology to adequately assess safety?	3	Both in civil and in military aviation safety, including for third parties, is always the top priority
B	Non-segregated airspace	Does the gap prevent the RA methodology to adequately assess safety of UAS operations in non-segregated airspace?	2	Accessing non-segregated (controlled and uncontrolled) airspace would greatly enhance operational flexibility, without disrupting civil traffic
C	Time and effort	Would the gap lead to increased time and effort required to conduct the RA	2	The effort has an impact on the required human resources, while time may conflict with urgency to take operational decisions
D	Cross-border	Does the gap prevent the methodology to assess safety in a consistent and harmonized fashion, so forcing to duplicate processes?	1	Cross-border operations (both trainings in a different State and crossing borders in flight) enhance interoperability of military assets

Table 25 - Criterion evaluation

The fourth step is to define a scale to assess each gap against each criterion. The assessment may be based on qualitative considerations, validated in a group to reduce subjectivity. In the end the assessment is expressed in the form of an unweighted non-dimensional score, which is a numerical single digit:

Scale for assessment of impacts	Unweighted Score
The persistence of the gap would have a highly positive effect	+3
The persistence of the gap would have a slightly positive effect	+1
Neutral (or not applicable) - Persistence of the gap would have no significant effect	0
The persistence of the gap would have a slightly negative effect	-1
The persistence of the gap would have a highly negative effect	-3

Table 26 - Impact assessment scale

The assigned scores are then multiplied by the weight to obtain for each gap a weighted score related to each of the criteria.

The assessment results in a table, in which the gaps are listed in the rows and the criteria in the columns.

In it the weighted scores are inserted in the cells:

Gap	Criterion				TOTAL Weighted SCORE
	A	B	C	D	
Weight	3	2	2	1	
Weighted Score					
1					
2					
3					
4					
5					
6					

Table 27 - Total weighted score

Finally, in the last column, all the weighted scores are algebraically summed.

Differences in the order of magnitude of these final scores support the decisions on which gas should be filled with priority.

4.2 Identification and assessment of gaps

4.2.1 Identification of Air Risk Gaps

Since all military flights are currently carried out in reserved (segregated) airspace volumes, it is not necessary to assess the air risk analytically as part of the RA process. The air risk is so considered intrinsically mitigated when the reserved area is created and activated. To eliminate the constraint to always operate in segregated airspace, an agreed Air Risk methodology should be available. RAT and all its known variants do not include any consideration on the Air Risk. Therefore, about all the identified gaps concerning the air risk, in the following sections, SORA is considered the reference methodology to address the Air Risk from the operator point of view. In fact, according to the collected information, there are no other methodologies currently in use that could fill the gaps for the air risk.

4.2.1.1 Airspace characterization

The RA methodology to be developed by MIL-UAS SPECIFIC should address UAS flights in all types of airspace: uncontrolled, controlled, and segregated. This can be done by taking a qualitative approach where categories of airspaces are linked to classes of risk, or by leveraging on quantitative analyses to determine the resulting probability of a Mid-Air-Collision in each airspace. The second option would require carrying out airspace characterisation studies because the risk of collision may vary significantly within given airspace depending on its design and air route structure. Historical traffic data would be needed, but, as it is emerging from the JARUS WG on Safety Risk Management (WG-SRM) activities, these data are hardly available.

Some EDA pMS would prefer a quantitative Air Risk Model, while the currently available version of SORA utilizes a qualitative approach, supported by some simple quantitative analyses.

The above considerations lead to the identification of the following gap:

AR_GAP1: A quantitative approach to the evaluation of the Air Risk is not available in existing RA methodologies.

4.2.1.2 Air Risk Model scope

The current version of the SORA Air Risk model is only addressing the risk of having a MAC (Mid-Air-Collision)[14] with manned aircraft. Therefore, risks related to collisions between UAS or to other hazards that can be encountered while in flight (e.g. wake turbulence, birds, weather) are not considered.

Even though a collision between two UAS is mainly a ground risk issue, addressing this risk from an air risk perspective is needed especially in military operations which might involve operating more UAS at a time. This can happen also when multiple UAS controlled by the same RPS/GCS are operated simultaneously.

Other hazards should instead be considered especially for those types of military activities which involve flying in adverse weather or other complex environments. These considerations lead to the identification of the following gaps:

AR_GAP2: Risk of collision between UAS not addressed by any RA methodology
AR_GAP3: Risk related to other hazards (e.g. wake turbulence, birds, weather) not addressed by any RA methodology

Another aspect that is not currently considered by the SORA Air Risk model is the frangibility of the UAS. Any MAC is assumed to be catastrophic resulting in the loss of the manned aircraft and the death of several people. This assumption makes the Air Risk model conservative but might not be valid especially when small UAS are used. This is therefore identified as a gap since a better characterization of the consequences of an impact would lead to more accurate risk analysis. The following gap is therefore identified:
AR_GAP4: Frangibility of UAS not considered by existing RA methodologies to assess the probability of catastrophic MAC

4.2.1.3 Air Risk mitigations

SORA Air Risk model currently considers mitigations at both strategic and tactical levels. Strategic mitigations are intended to reduce the initial Air Risk before the flight takes place. Among the strategic mitigations, SORA defines those “by structures and rules” to exploit the availability of common flight rules or specific airspace structures to mitigate the Air Risk. These mitigations do not explicitly include considerations about the availability of external services that can positively affect the safety of the flight, such as U-space services. These services can also be exploited at tactical level to ensure separation between airspace users in a given airspace. Although U-space is being developed for civil operations, we can assume that these services might be made available to military users as well or they can be deployed directly by military entities to facilitate the integration of military UAS in non-segregated airspace at VLL. The upcoming SORA Annex H is expected to fill this gap, but adaptation to military specificities would be needed anyway. The above considerations lead to the identification of the following gap:
AR_GAP5: availability of U-space services and contribution to risk reduction at strategic and tactical level not adequately considered by existing RA methodologies.

Operations in non-segregated airspace that is shared between civil and military users will likely require coordination between military and civil ATS units. This coordination can be considered as effective strategic and/or tactical mitigation. However, the quantification of the benefit provided by such coordination depending on the characteristics of the airspace and its initial Air Risk is not assessed explicitly by SORA. Since

[14] Mid-air Collision is defined by IATA (International Air Transport Association) as an aviation accident category defined as a collision between aircraft in flight. This accident category is rare but when it occurs, it is catastrophic.

this can be key mitigation for military flights taking place in civil airspace, it should be explicitly addressed to facilitate the evaluation of the risk reduction. This leads to the identification of the following gap:
AR_GAP6: Coordination between military and civil ATS units not considered as risk mitigation by existing RA methodologies

In order to properly address the above gaps an assessment at airspace level would be needed. This would require the involvement of the entities responsible for the regulation and management of the airspace rather than the operator that will execute the mission.

4.2.2 *Assessment of Air risk gaps*

The following subsections report the assessment of each of the identified gaps against the four criteria.

4.2.2.1 Safety

Gaps	1	2	3	4	5	6
	Quantitative model	Collision btw UAS	Other hazards	Frangibility	U-space services	Civil-military coordination
Assessment	The lack of a quantitative evaluation can reduce the accuracy of the analysis and lead to an underestimation of the existing risks with a negative effect on safety	The absence of a model to address the risk of collision between UAS can affect the correct evaluation of the operation's safety	The absence of a model to address other hazards can affect the correct evaluation of the operation's safety. However, the impact is estimated as negligible.	Slightly positive impact since not considering frangibility has the effect of making the risk assessment more conservative	Slightly positive impact since not considering the availability of U-space services has the effect of making the risk assessment more conservative	Slightly positive impact since not considering coordination as a mitigation strategy has the effect of making the risk assessment more conservative
Score (un-weighted)	-1	-1	0	+1	+1	+1
Criteria weight	Multiply the un-weighted score by 3					
Score (weighted)	**-3**	**-3**	**0**	**+3**	**+3**	**+3**

Table 28 - Safety evaluation for Air Risk

4.2.2.2 Flight in non-segregated airspace

Gaps	1	2	3	4	5	6
	Quantitative model	Collision btw UAS	Other hazards	Frangibility	U-space services	Civil-military coordination
Assessment	The lack of a quantitative evaluation can reduce the accuracy of the analysis and lead to an underestimation of the existing risks especially in non-segregated airspaces	No specific impact related to operations in non-segregated airspace	No specific impact related to operations in non-segregated airspace	No specific impact related to operations in non-segregated airspace	Not considering U-space services can negatively affect the correct evaluation of the risk in non-segregated airspaces possibly preventing flights there	Not considering coordination btw civil and military ATS can negatively affect the correct evaluation of the risk in non-segregated airspaces possibly preventing flights there
Score (un-weighted)	-1	0	0	0	-1	-1
Criteria weight	Multiply the un-weighted score by 2					
Score (weighted)	**-2**	**0**	**0**	**0**	**-2**	**-2**

Table 29 - Flight in non-segregated airspace evaluation for Air Risk

4.2.2.3 Time and effort

Gaps	1	2	3	4	5	6
	Quantitative model	Collision btw UAS	Other hazards	Frangibility	U-space services	Civil-military coordination
Assessment	The lack of a quantitative model in favour of a qualitative one would significantly reduce the time and effort for the assessment. A quantitative model would require long airspace characterisation studies	No specific impact on time and effort	Considering all the other hazards would increase the time required for the analysis	No specific impact on time and effort	No specific impact on time and effort	No specific impact on time and effort
Score (un-weighted)	+3	0	+3	0	0	0
Criteria weight	Multiply the un-weighted score by 2					
Score (weighted)	**+6**	**0**	**+6**	**0**	**0**	**0**

Table 30 - Time and effort evaluation for Air Risk

4.2.2.4 Cross-border flights

Gaps	**1**	**2**	**3**	**4**	**5**	**6**
	Quantitative model	Collision btw UAS	Other hazards	Frangibility	U-space services	Civil-military coordination
Assessment	The lack of a quantitative model in favour of a qualitative one would help in harmonizing the approach. If a quantitative model is used this would require each airspace to be characterized differently in terms of risk	A model considering collision btw UAS is needed to ensure full replicability of the proposed methodology in all operating conditions	A model considering other hazards is needed to ensure full replicability of the proposed methodology in all operating conditions	A model considering frangibility is needed to ensure full replicability of the proposed methodology in all operating conditions	A model considering U-space services is needed to ensure full replicability of the proposed methodology in all operating conditions	A model considering civil-military coordination is needed to ensure full replicability of the proposed methodology in all operating conditions
Score (un-weighted)	+1	-1	0	-1	-1	-1
Criteria weight	Multiply the un-weighted score by 1					
Score (weighted)	**+1**	**-1**	**0**	**-1**	**-1**	**-1**

Table 31 - Cross-border flights evaluation for Air Risk

4.2.2.5 *Final assessment of Air Risk Gaps*

The table below shows an overview of the assessment of the 6 gaps identified on the Air Risk model.

Gap	Criterion				TOTAL Weighted SCORE
	A	B	C	D	
	Safety	Non-segregated airspace	Time and effort	Cross-border	
Weight	3	2	2	1	
Weighted Score					
1 (Quantitative model)	-3	-2	+6	+1	**+2**
2 (Collision btw UAS)	-3	0	0	-1	**-4**
3 (Other hazards)	0	0	+6	0	**+6**
4 (Frangibility)	+3	0	0	-1	**+2**
5 (U-space services)	+3	-2	0	-1	**0**
6 (Civil-military coordination)	+3	-2	0	-1	**0**

Table 32 - Total weighted score for Air risk

From the table, one may observe that persistence of gaps 1, 3, and 4 would have a positive score. Therefore, action to fill such gaps may not be a priority. Conversely, gap 2, related to the possibility of collision between UAS, having a significant negative score should be filled with priority. Filling gaps 5 and 6 could also be beneficial since their score is neutral (zero), and their persistence is linked with a reduced possibility of flying in non-segregated airspace. Addressing these gaps would in fact allow the RA methodology to correctly consider the safety benefit deriving from U-space services and Civil-military coordination thus allowing an easier integration of UAS in non-segregated airspace. The identification of this gaps indicates also that the Air Risk model is required to address a wider perspective than the one of the operators. The establishment of U-space services and Civil-military coordination will be in fact the result of an assessment of the Air Risk at airspace level carried out by the entities responsible for regulating and managing it.

4.2.3 *Identification of Ground Risk gaps*

According to the information collected RAT and its variants are considered adequate to evaluate the Ground Risk. In addition, since RAT is the result of a cooperative effort of the UAS ARF WG and already includes a shared vision on how to address ground risk, it is considered as the baseline for the identification of Ground Risk gaps. This is justified also by the fact that SORA, the other methodology used by some EDA pMS, considers the same factors even though with a different approach.

The following gaps are therefore identified by comparing RAT with the expectations provided by the EDA pMS.

GR_GAP1: Damage to critical infrastructure not addressed by any RA methodologies
Damage to critical infrastructures is considered neither by RAT or SORA. Since some EDA pMS mentioned the need to include critical infrastructures within the scope of the assessment this is identified as a gap.

GR_GAP2: Operator's organization and competencies not addressed by RAT

The operator's organisation and personnel competencies are not addressed by RAT. From the information collected it seems that the reason behind this choice is twofold: on one side RAT mainly focuses on airworthiness aspects thus excluding the need to assess the operator's organization; secondly military organizations are considered inherently adequate and their personnel competent without the need to further assess this aspect. However, this is identified as a gap because the requirements in terms of competencies and organization may vary from one EDA pMS to another. Therefore, to have a harmonized RA methodology, this aspect needs to be addressed to ensure it is addressed in the same way in all EDA pMS.

GR_GAP3: Containment requirements not addressed by RAT concerning the characteristics of adjacent areas

Containment requirements are included in SORA to reduce the probability of the UAS leaving the operational volume. They depend on the characteristics of the adjacent areas and airspace and they affect the required level of integrity and reliability of all those systems whose failure could lead the UAS outside the operational volume. System integrity and reliability are addressed also by RAT, but this is not related to the characteristics of the adjacent areas. For this reason, it could happen that the required system integrity is not sufficient to adequately reduce the probability of flying outside the operational volume, especially if the overflown area is non-populated while the adjacent one is populated. This is therefore identified as a gap because including a specific requirement for containment in RAT would make the methodology more complete.

GR_GAP4: Existing RA methodologies include limited references to recommended industry standards for demonstration of compliance

Referring to recognized industry standards as the acceptable means to demonstrate compliance to the safety requirements emerging from the RA process can improve the standardization potential of the MIL-UAS-SPECIFIC methodology. These references are currently limited in RAT and SORA. However, as all major Standard Design Organisations (i.e. ASTM, EUROCAE, RTCA, SAE) are developing several standards for UAS, their use could make the RA process much less subjective since the use of specific standards can constitute a presumption of compliance. This is therefore identified as a gap to the existing RA methodologies that do not provide sufficient references to allow a good level of standardization.

GR_GAP5: Use of critical payloads (e.g. weapons) not addressed by existing RA methodologies

This gap is identified because carriage and use of critical payload were reported as the main military specificity that is currently not addressed by existing RA methodologies.

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4.2.4 Assessment of Ground Risk gaps

4.2.4.1 Safety

Gaps	1	2	3	4	5
	Critical infrastructures	Operator's organisation and competences	Containment requirements	Industry standards	Payloads
Assessment	The lack of a model to evaluate the damage to critical infrastructures can reduce the accuracy of the analysis and lead to an underestimation of the existing risks with a negative effect on safety	The assumption often made that military organisations and personnel are always competent may not be always accurate. Therefore, without a proper evaluation, the RA can underestimate the existing risks with a negative effect on safety	If containment requirements are not determined concerning the characteristics of the adjacent areas, this could lead to an underestimation of the risk of exiting the operational volume with a negative impact on safety	The limited number of recommended industry standards has no impact on safety but rather on the harmonization of the assessment process.	The lack of a model to evaluate carriage of specific payloads can reduce the accuracy of the analysis and lead to an underestimation of the existing risks with a negative effect on safety
Score (un-weighted)	-1	-1	-1	0	-1
Weight	Multiply the un-weighted score by: 3				
Score (weighted)	**-3**	**-3**	**-3**	**0**	**-3**

Table 33 - Safety evaluation for Ground Risk

4.2.4.2 Flight in non-segregated airspace

Gaps	1	2	3	4	5
	Critical infrastructures	Operator's organisation and competences	Containment requirements	Industry standards	Payloads
Assessment	No specific impact in relation to flights in non-segregated airspace given that all gaps refer to the Ground Risk				
Score (un-weighted)	0	0	0	0	0
Weight	Multiply the un-weighted score by: 2				
Score (weighted)	**0**	**0**	**0**	**0**	**0**

Table 34 - Flight in non-segregated airspace evaluation for Ground Risk

4.2.4.3 Time and effort

Gaps	1	2	3	4	5
	Critical infrastructures	Operator's organization and competences	Containment requirements	Industry standards	Payloads
Assessment	The lack of an assessment of risks towards critical infrastructure reduces the time and effort required to complete the analysis	No impact estimated as the assessment of Operator's organizations and competences would not increase significantly the time required to carry out the RA process	No impact was estimated as the assessment of containment requirements about adjacent areas would not increase significantly the time required to carry out the RA process	The reduced number of recommended industry standards is estimated to harm the time required to complete the analysis because each applicant needs to identify a proper MoC	No impact was estimated as the assessment of specific payloads would not increase significantly the time required to carry out the RA process
Score (un-weighted)	+1	0	0	-1	0
Weight	Multiply the un-weighted score by: 2				
Score (weighted)	**+2**	**0**	**0**	**-2**	**0**

Table 35 - Time and effort evaluation for Ground Risk

4.2.4.4 Cross-border

Gaps	1	2	3	4	5
	Critical infrastructures	Operator's organisation and competences	Containment requirements	Industry standards	Payloads
Assessment	A model considering the damage to critical infrastructures is needed to ensure full replicability of the proposed methodology in all operating conditions	The impact is very negative because foreign NMAA would probably need to assess the operator's organization and competences as this cannot be considered adequate by default given the differences among EDA pMS.	A model linking containment requirements to the characteristics of the adjacent areas would increase the acceptability and replicability of the proposed RA methodology	The reduced number of recommended industry standards is expected to reduce the harmonization of the approaches to demonstrate compliance to the safety requirements thus severely limiting cross-border operations	A model considering specific payloads would increase the acceptability and replicability of the proposed RA methodology
Score (un-weighted)	-1	-3	-1	-3	-1
Weight	Multiply the un-weighted score by: 1				
Score (weighted)	-1	-3	-1	-3	-1

Table 36 - Cross-border evaluation for Ground Risk

4.2.4.5 *Final Assessment of Ground Risk gaps*

Gap	Criterion				TOTAL Weighted SCORE
	A	B	C	D	
	Safety	Non-segregated airspace	Time and effort	Cross-border	
Weight	3	2	2	1	
Weighted Score					
1 (Critical Infrastructures)	**-3**	0	+2	-1	-2
2 (Operator)	-3	0	0	-3	-6
3 (Containment)	0	0	0	-1	-1
4 (Standards)	0	0	-2	-3	-5
5 (Payloads)	-3	0	0	-1	-4

Table 37 - Total weighted score for Ground risk

From Table 37 we can conclude that filling gaps 2, 4, and 5 might be a priority because these three gaps lead to a significantly negative weighted score. Less urgent, but still desirable would be to fill gaps 1 and 3 since also they have a negative score, albeit smaller.

5 CONCLUSION & WAY FORWARD AT D1 STAGE

From the information collected and the analysis of the identified gaps the following conclusions can be drawn:

1. RAT is considered generally adequate to evaluate the Ground Risk. The following aspects could be improved to increase its standardization potential and facilitate its use among all EDA pMS:
    a. Reverse the process by starting from the assessment of the overflown area and the characteristics of the UAS from which a Target Level of Safety is derived. From this a minimum score to be achieved from the Design and Integrity Checklist is derived. To get the approval, the applicant will then need to demonstrate that the required minimum score is achieved by the selected UAS and the operator's organization. This minimum score can be also decomposed for each group of requirements and defined in relation to each mission type.
    b. Review the Design and Integrity Checklist applicability to different UAS Designs (e.g. rotorcraft with MTOM > 150kg) and Target Levels of Safety.
    c. Add considerations about risk related to damage to critical infrastructures and carriage of dangerous payloads for the definition of the minimum required RAT score.
    d. Add the evaluation of the operator's organization and the personnel competencies as a contributing factor for the definition of the RAT score.
    e. Refer to industry standards as AMC as much as possible starting from those already references by MAA (e.g. DO-178C, DO-254, MIL-STD-461, etc.).
2. Most military operations are currently carried out in segregated airspace; therefore, the need for an Air Risk evaluation is currently limited. The methodology proposed by MIL-UAS-SPECIFIC will need to also address the Air Risk to apply also to flights in non-segregated airspace. Since SORA is the only RA methodology currently used by some EDA pMS which include an Air Risk model this will be considered as the baseline with the following improvements:
    a. A qualitative approach for the evaluation of the Air Risk can be used. Quantitative analyses to better characterize the airspace can support improving the accuracy of the analysis but are not considered a priority.
    b. The risk of collision between UAS needs to be addressed.
    c. Availability of tactical and strategic mitigations such as U-space services and coordination between military and civil ATS units needs to be included in the model. This drives the need for an Air Risk assessment which is not only operator-centric but relies on the experience and information of the entities responsible for the regulation and management of the airspace. The MEDUSA methodology proposed by SESAR project CORUS could be considered the main reference for this process.
    d. The updates of SORA Air Risk model currently under development within JARUS will be considered and evaluated for a possible inclusion in MIL-UAS-SPECIFIC methodology. This refers in particular to the revision of the Tactical Mitigations Performance Requirements (TMPR).

Other aspects such as considering frangibility for the Air Risk model or improving the evaluation of containment requirements for the Air Risk are not currently considered priorities.

Given the above conclusions the MIL-UAS-SPECIFIC RA methodology will be developed along the following lines:

- Ground Risk Model
    - RAT will be taken as the baseline.
    - The RAT process will be reversed to start from the assessment of the overflown area. This assessment will be complemented with considerations about the payload (carried and used) and the presence of critical infrastructures. From this assessment, a minimum score is derived. Reaching this score guarantees that the flight can be carried out with an acceptable level of risk.
- Air Risk Model
    - SORA Air Risk Model will be taken as the baseline.
    - Risk of collision between UAS will be added to the model as well as consideration on how to consider relevant mitigations strategy at both strategic and tactical level.
    - The Air Risk evaluation from the operator’s perspective will be integrated with the airspace regulator and manger perspective.
    - The Air Risk Evaluation will lead to the definition of a minimum score to guarantee an acceptable level of risk.
- Combining Ground and Air Risk
    - The score from the Ground and Air Risk evaluations are combined to derive an overall minimum score.
    - The RAT Design Integrity Assessment checklist will be used to derive the safety requirements and the associated MoC to be used to meet the required minimum score.
    - The RAT Design Integrity Assessment will be integrated to include the evaluation of the operator’s organization and personnel competencies.
    - Industry standards will be proposed as AMC to the safety requirements.

APPENDIX A – ICAO Categories of UAS Operations

Extract from Working Paper (WP)/13 presented by Andrew Ward and Lance King, Rapporteurs of Working group (WG)/5 to the 18th meeting of the Remotely Piloted Aircraft Systems Panel (RPASP), held from 25 to 29 October 2021 - Amendment Proposal to Annex 6 Standards And Recommended Practices

An example of a categorization scheme is outlined below:

a) Open (low risk). Provided that operations are conducted within defined limitations (e.g. Visual line-of-sight (VLOS) only, specified distances from aerodromes and people, maximum height above ground level (AGL), etc.), flights can take place **without the need for any authorization from the appropriate authority**.

b) Specific (medium risk/regulated lower risk). This category of operation would require an **operational authorization** from an appropriate authority before the flight(s) taking place; appropriate limitations/restrictions would be applied based on the type of operation, the complexity of the UAS, and the specific qualifications and experience of operating personnel. Approval for the operation would be based on analysis of a risk assessment and any mitigations employed to reduce any risks to an acceptable level. This category encompasses operations where the risk to persons being overflown is greater than what would be permitted in Category A, or involves sharing the airspace with other manned or unmanned aircraft, but is at a level below that where the full application of manned aviation principles would be warranted.

c) Certified (**certified airworthiness approach**). This category utilizes the same method used for regulating manned aviation, because the aviation risks, and hence the aviation safety requirements, associated with the operation have increased to an equivalent level. Operator certification, remote flight crew licensing and RPA certification will be required due to the higher associated risk. Operations in this category are primarily considered to be flown beyond visual line-of-sight (BVLOS), however, portions of the flight (e.g. launch and recovery) may operate within VLOS.

The SARPs within Part IV to Annex 6 fit within this category.

APPENDIX B MIL-UAS-SPECIFIC Questionnaire

This Appendix includes the questionnaire that was used to collect information from EDA pMS. It is reported here as reference.

B.1 Section I – Contextual information and military specificities

B.2 Section II – RA methodologies currently in use

B.3 Section III – Expectations on MIL-UAS-SPECIFIC RA Methodology

APPENDIX C – MIL-UAS-SPECIFIC Interview questions

This Appendix includes the questions that were asked during the interviews with EDA pMS. It is reported here as reference.

	Questions	**Answers**	**Notes**
Section I – Contextual information and military specificities			
1	Based on which rules/documents do you perform the RA for a UAS operation?		
2	Based on which rules/documents do you plan and execute a UAS operation?		
3	Which military services operate UAS?		
4	Which type of mission/UAS may be included in the MIL-SPECIFIC operations?		
5	How your Armed Services manage UAS Operations? • who is in charge for RA, • who is in charge to manage live ops, …		
6	Which services/units are mainly involved in the RA process?		
Section II – RA for Air Risk			
7	Which are the more challenging issues for the air risk assessment?		
8	How do you assess air risks when planning a UAS mission? Which parameters are considered in the evaluation of the Air Risks?		
9	How do you manage RA for UAS operations in relation to VLOS EVLOS/BVLOS conditions?		
10	How do you manage RA for UAS operations in controlled airspace?		
11	How do you manage RA for UAS operations in uncontrolled airspace?		
12	How do you manage RA for UAS operations in segregated/reserved airspace?		
13	Which are, if any, civil/mil coordination for RA of UAS mil operations?		
14	How do you manage RA for UAS operations in relation to collision avoidance and separation from civil traffic (or other mil traffic)? Do you apply any additional buffer for air risk?		
15	How do you assess Air RA of UAS cross-border operations?		
16	Which mitigations, if any, you apply for air risk?		

Section III – RA for Ground Risk			
17	Which are the more challenging issues for the ground risk assessment?		
18	How do you assess ground risks when planning a UAS mission? If yes, which parameters are considered in the evaluation of the Ground risks?		
19	How do you manage RA for UAS operations concerning density of population?		
19	How do you manage RA for UAS operations in relation to the infrastructures?		
20	Do you apply any additional buffer for ground risk?		
21	How do you assess the risk originating from different payloads?		
22	How do you assess Ground RA of UAS cross-border operations?		
23	How do you manage RA in relation to privacy and the environment (including noise effect)?		
24	Which mitigations, if any, you apply for ground risk?		
Section IV – RA Methodology and tools			
25	Which improvements the methodology which you currently use for RA, may be advisable to better respond to your needs?		
26	Which tools (if any) do you use for RA of UAS missions?		
27	What about the possibility to have standard operational scenarios to manage your main missions? Which scenarios you expect mainly to have?		
28	How competence/training/requirements are you considering for RA?		

Table 38 - MIL-UAS-SPECIFIC Interview questions template

APPENDIX D – Definitions for VLOS, EVLOS, BVLOS

Term	Acronym	Definition	Source
Beyond Visual Line-of-Sight	BVLOS	An operation in which the remote pilot or RPA observer does not use visual reference to the remotely piloted aircraft in the conduct of flight	ICAO RPAS CONOPS
		a type of UAS operation which is not conducted in VLOS	EC Implementing Regulation 2019/947
		operation of a UAS other than VLOS or EVLOS	ISO 21384-4
Extended Visual Line-of-Sight	EVLOS	operation beyond the unaided visual range of the remote pilot, but where the remote pilot is supported by vision systems or by one or more visual (airspace) observers	ISO 21384-4
Visual line of sight	VLOS	a type of UAS operation in which, the remote pilot can maintain continuous unaided visual contact with the unmanned aircraft, allowing the remote pilot to control the flight path of the unmanned aircraft in relation to other aircraft, people, and obstacles to avoid collisions	EC Implementing Regulation 2019/947

Term	Acronym	Definition	Source
Beyond Visual Line-of-Sight	BVLOS	Beyond Visual Line of Sight means a type of UAS operation which is not conducted in VLOS	Definitions from EDA UAS ARF WG "Initial set of essential UAS - related Terms and Definitions" (version 6th April 2021)
Extended Visual Line-of-Sight	EVLOS	The unmanned aircraft is within the extended visual line of sight of the remote pilot when the unmanned aircraft is beyond the visual line of sight of the remote pilot but within the visual line of sight of one or more unmanned aircraft extended visual observer(s) assisting the remote pilot in safely conducting the flight. The unmanned aircraft extended visual observer(s) must be able to immediately notify the remote pilot of any danger that may prevent the remote pilot to conduct the flight safely	
Visual line of sight	VLOS	Visual Line of Sight means a type of UAS operation in which, the remote pilot is able to maintain continuous unaided visual contact with the unmanned aircraft, allowing the remote pilot to control the flight path of the unmanned aircraft in relation to other aircraft, people and obstacles for the purpose of avoiding collisions.	