SDU UAS CENTER

UAS Safety and Risk Assessment

Presentation by :

GUY MAALOUF

WildDrone PhD Candidate

Safe UAS BVLOS Operations

guym@mmmi.sdu.dk

Why care?


SDU
UAS CENTER
University of Southern Denmark
University of
BRISTOL
Flight Research Lab

EASA
European Aviation Safety Agency

easa.europa.eu

[Easy Access Rules]

Trafikstyrelsen
Danish Civil Aviation and Railway Authority

trafikstyrelsen.dk

[droneregler.dk]

Operational Categories

OPEN 01

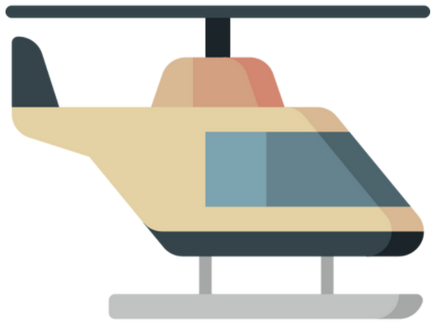
Low level of risk:

- Leisure activities
- Low-risk commercial activities (i.e. photography, inspection)

SPECIFIC 02

Medium level of risk:

- National drone delivery
- Remote operations
- Heavy drones (> 25kg)



CERTIFIED 03

High level of risk:

- International cargo drone flight
- Air taxis
- IFR (Instrument Flight Rules)

Open Category

Low risk operations

- VLOS (Visual Line of Sight) ~ 500m
  - **See the drone without any aids.**
  - **See and avoid any obstacles or other aircraft.**
- Altitude < 120m AGL (Above Ground Level)
- MTOM (Maximum Take-Off Mass) < 25kg
- Safe distance from public
  - **A1: Minimise overflying** uninvolved persons.
  - **A2: > 30m (1:1 ratio)** from uninvolved persons, or **5m in slow speed mode.**
  - **A3: 150m away** from residential, commercial or industrial areas.
- No-fly zones (dronezoner.eu)
- Pilot must be certified (A1/A3, A2)

C-Class	Max Take off mass	Subcategory
Privately build	<250g 	A1 Not over assemblies of people (can also fly in subcategory A3)
legacy < 250g		
C0		
C1	<900g 	
C2	<4kg 	A2 Fly close to people (can also fly in subcategory A3)
C3	<25kg 	A3 Fly far from people
C4		
Privately build		
Legacy drones (art 20)		

EASA European Aviation Safety Agency

Specific Category

Medium risk operations

- **Standard scenario (STS).**
  - STS-01: VLOS, < 120m, controlled ground area, populated environment, CE class C5 UAS.
  - STS-02: BVLOS, 2km from the pilot, airspace observers, < 120m, controlled ground area, sparsely populated environment, CE class C6 UAS.
- **Pre-Defined Risk Assessment (PDRA).**
  - PDRA-S01: VLOS, <150m *(Agriculture, Short-range cargo)*
  - PDRA-S02: BVLOS 2km, <150m *(Surveillance, Agriculture, Short-range cargo)*
  - PDRA-G01: BVLOS + Observer, <150m *(Surveillance, Long-range cargo)*
  - PDRA-G02: BVLOS, Segregated Airspace, <150m *(All range of ops)*
  - PDRA-G03: BVLOS, Close to obstacles *(Linear inspection, Agriculture)*
- **Specific Operation Risk Assessment (SORA).**
- **Light UAS operator Certificate (LUC).**
  - Safety management system
  - Remote pilot competencies
  - Documentation system
  - LUC safety manual

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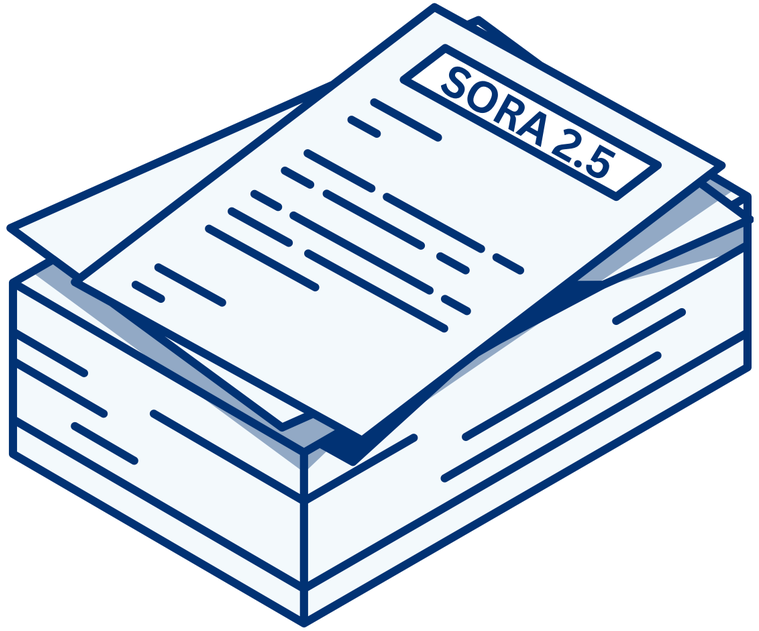
Specific Operation Risk Assessment (SORA)



Publication date: 13/5/24

Joint Authorities for Rulemaking on Unmanned Systems

jarus-rpas.org

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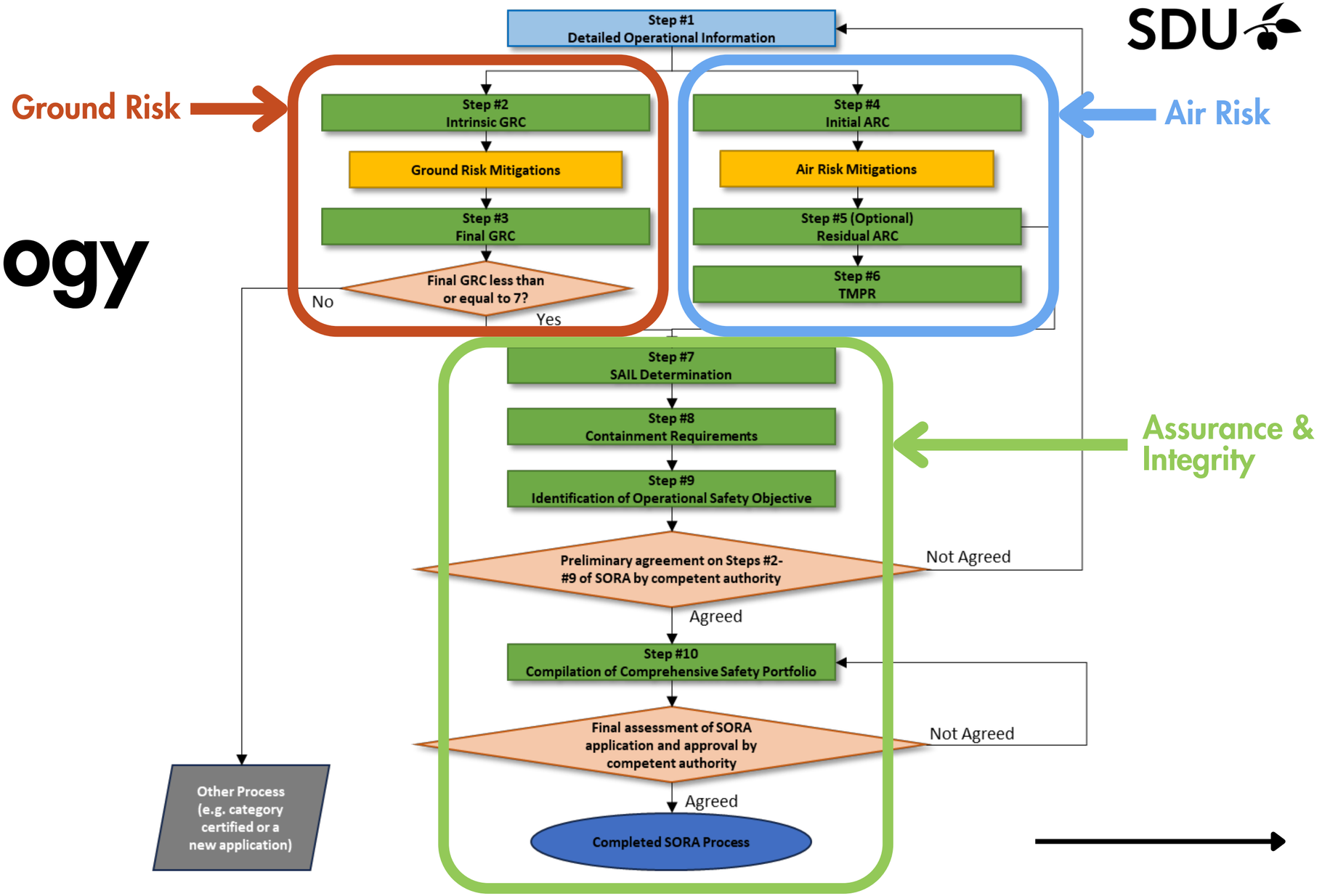
SORA Methodology



Example

Mission:

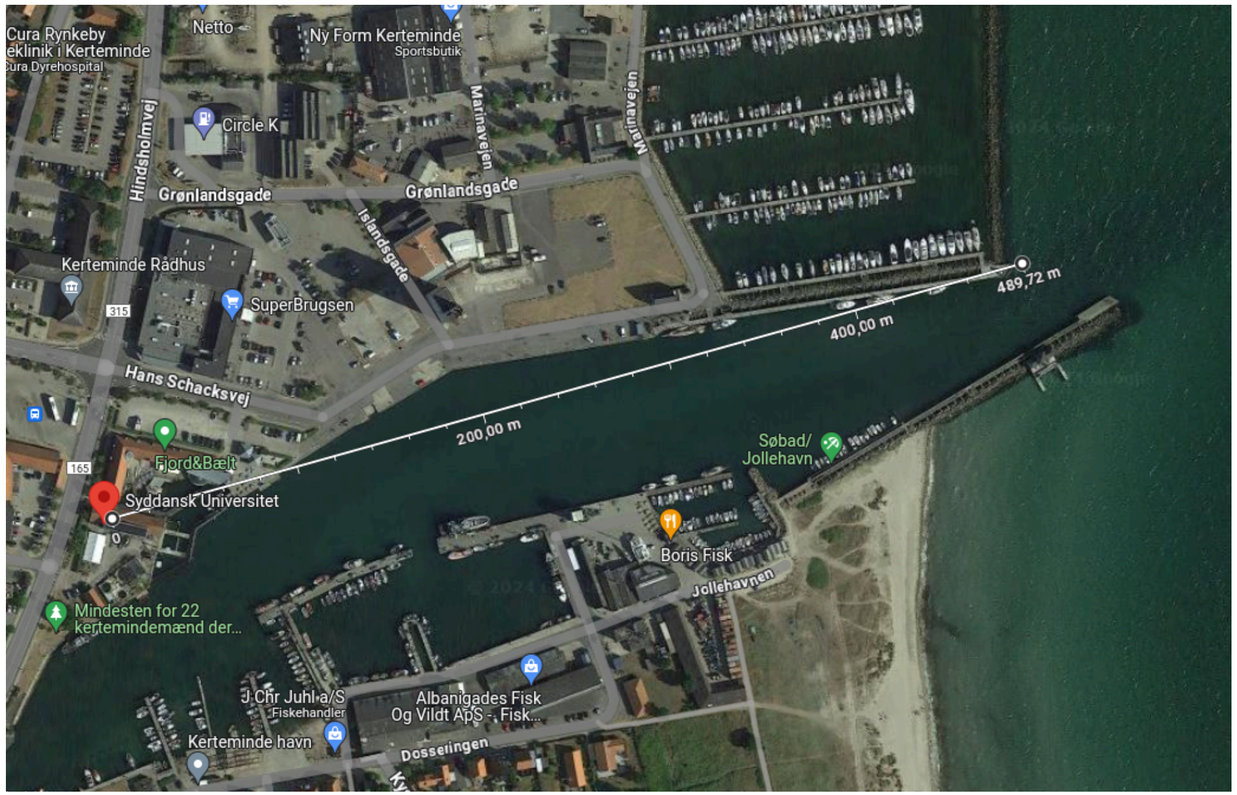
The SDU marine biologists are **studying purpoises** in Kerteminde bay.

They currently fly drones in the **Open Category**, so they take a boat and fly **VLOS** below **120m**.

Help the SDU biologists fly drones **BVLOS** from their office in Kerteminde.

@helo_hamel_photography

Closer look


Cura Rynkeby
eklinik i Kerteminde
ura Dyrehospital
Netto
Ny Form Kerteminde
Sportsbutik
Circle K
Hindsholmvej
Grønlandsgade
Grønlandsgade
Marinavejen
Marinavejen
Islandsgade
Kerteminde Rådhus
315
SuperBrugsen
489,72 m
400,00 m
Hans Schacksvej
200,00 m
Søbad/
Jollehavn
Fjord&Bælt
165
Syddansk Universitet
0
Boris Fisk
Jollehavnen
Mindesten for 22
kertemindemænd der...
J.Chr Juhl a/S
Fiskehandler
Albanigades Fisk
Og Vildt ApS - , Fisk...
Kerteminde havn
Dosseringen


Tårup
Hyrningevej
STAVRE
Great Northern
Bedst bedømte
Kerteminde
Johannes Larsen Museet
Syddansk Universitet
Kerteminde Bugt
Kerteminde Strand hiking
Lundsgaard Gods
SKRÆKKENBORG
Revninge
Sibirien
Google

1- Documentation of Proposed Operations

What you want to do?

Where you want to fly?

Which UAS you intend to use?

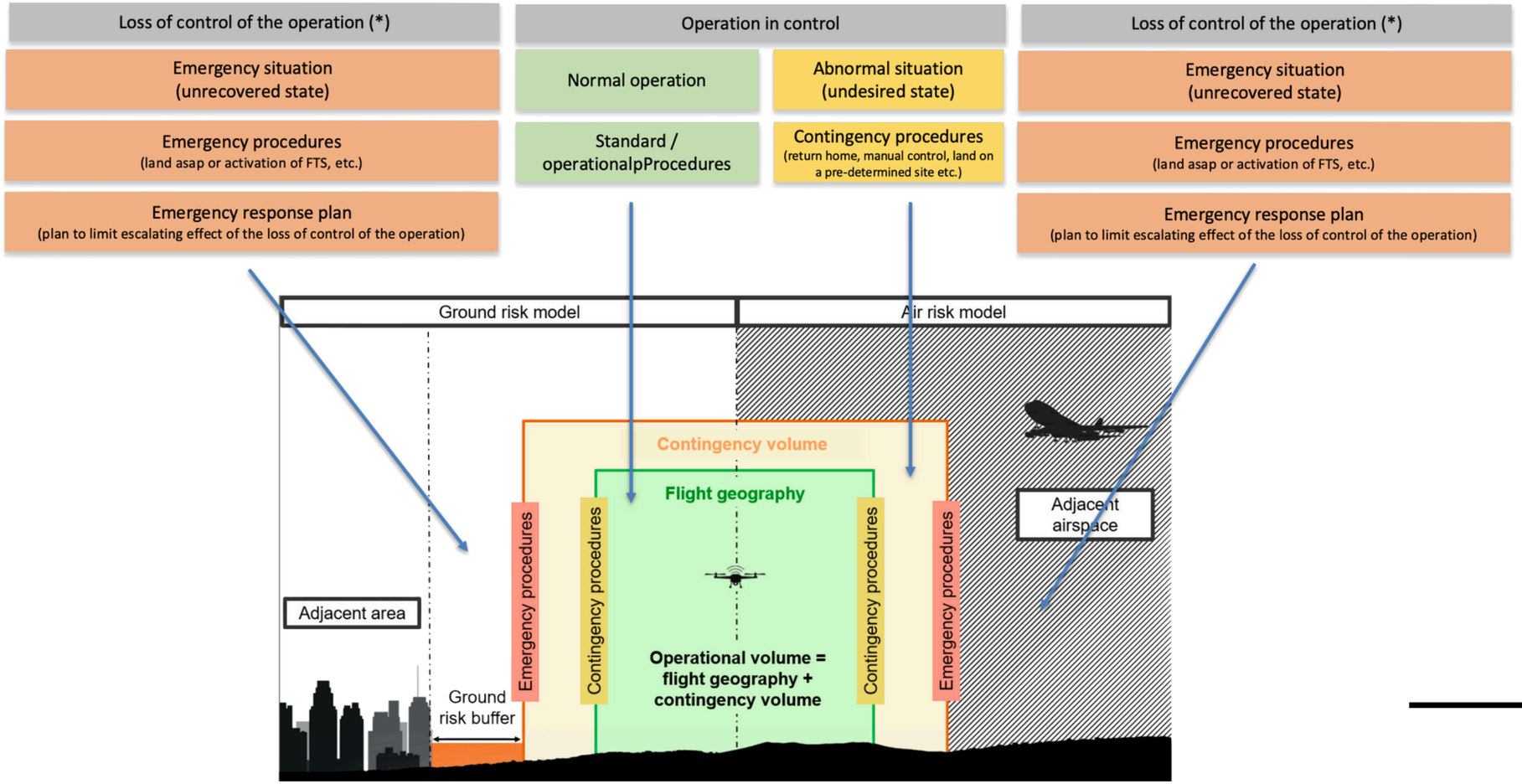
Step 1: Proposed Ops

What? ⟶ BVLOS flight

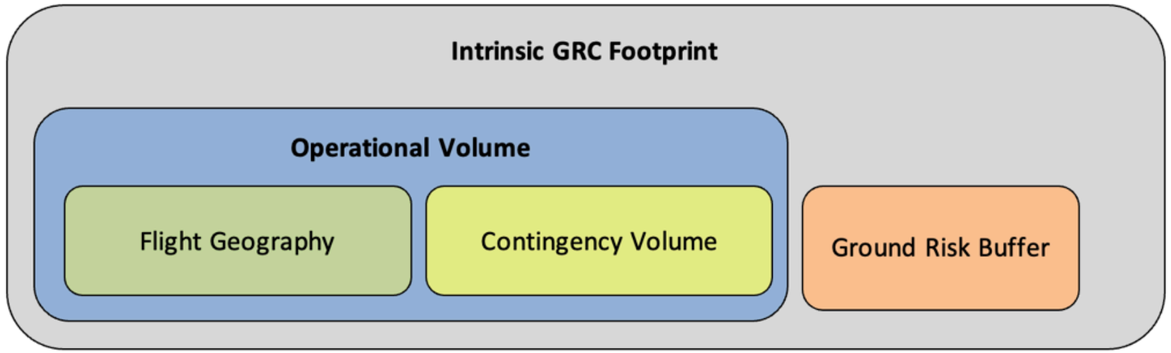
Where? ⟶ Kerteminde bay

Which UAS? ⟶ DJI Mavic 3 pro

SORA semantic model



2- intrinsic Ground Risk Class (iGRC)



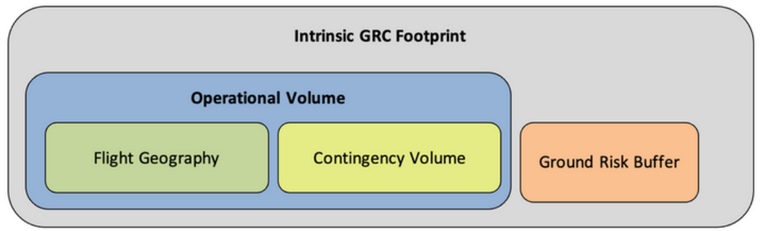
Alternatively, use the equations described in Annex F (python package, online calculator)

Intrinsic UAS Ground Risk Class						
Maximum UA characteristic dimension		1m / approx. 3 ft	3 m / approx. 10 ft	8 m / approx. 25 ft	20 m / approx. 65 ft	40 m / approx. 130 ft
Maximum speed		*25 m/s*	*35 m/s*	*75 m/s*	*120 m/s*	*200 m/s*
Maximum iGRC population density (people/km²)	**Controlled Ground Area**	1	1	2	3	3
	< 5	2	3	4	5	6
	< 50	3	4	5	6	7
	< 500	4	5	6	7	8
	< 5,000	5	6	7	8	9
	< 50,000	6	7	8	9	10
	> 50,000	7	8	**Not part of SORA**		

- A UA weighing less than or equal to 250 g and having a maximum speed less than or equal to 25 m/s is considered to have an iGRC of 1 regardless of population density.
- A UA expected to not penetrate a standard dwelling will get a -1 GRC reduction in Step 3 from the M1(A) sheltering mitigation when not overflying large open assemblies of people, see Annex B for additional details.

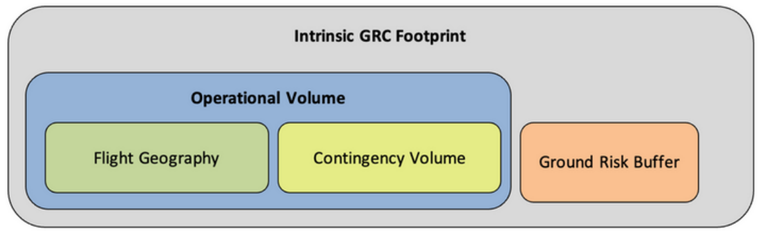
Step 2: iGRC

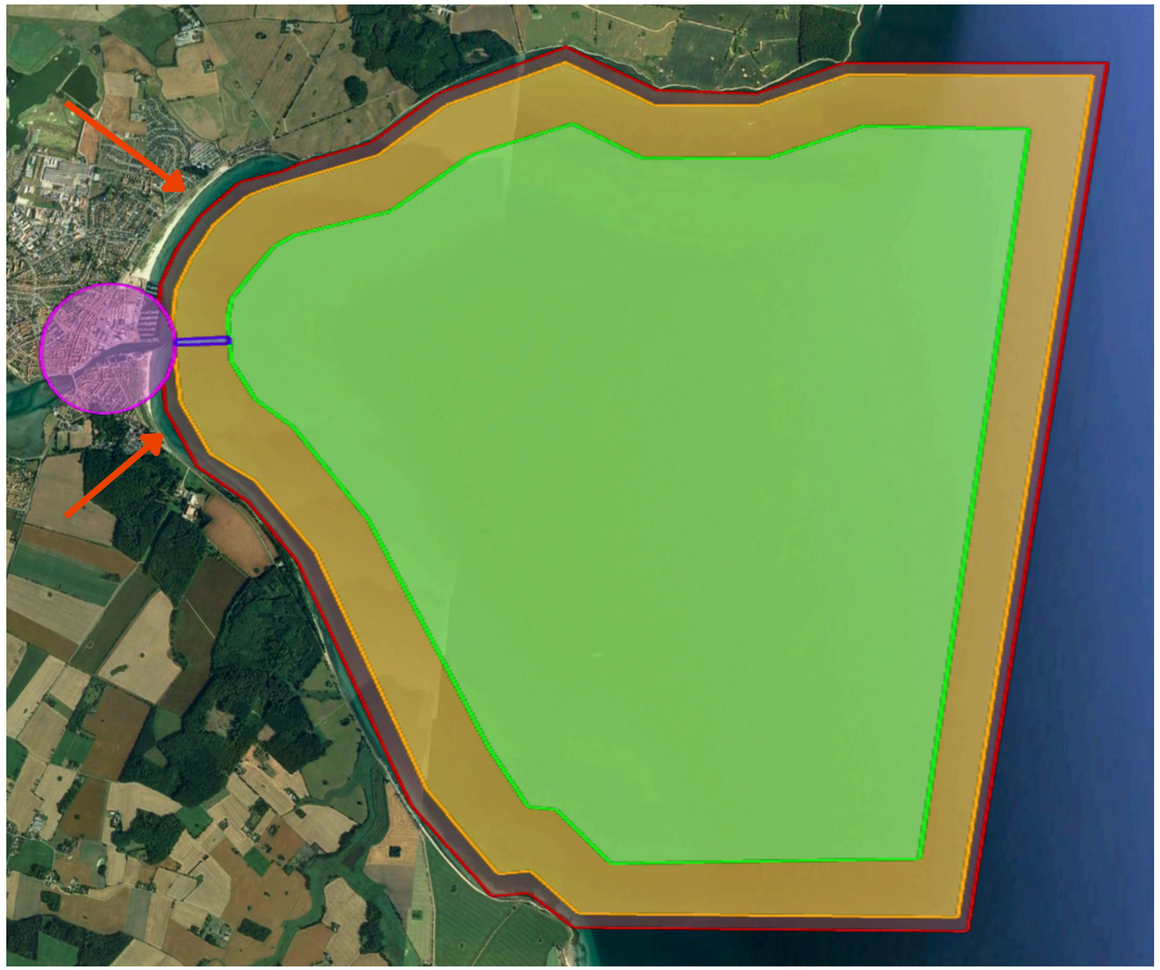
Intrinsic UAS Ground Risk Class						
Maximum UA characteristic dimension		1m / approx. 3 ft	3 m / approx. 10 ft	8 m / approx. 25 ft	20 m / approx. 65 ft	40 m / approx. 130 ft
Maximum speed		*25 m/s*	*35 m/s*	*75 m/s*	*120 m/s*	*200 m/s*
Maximum iGRC population density (people/km²)	**Controlled Ground Area**	1	1	2	3	3
	< 5	2	3	4	5	6
	< 50	3	4	5	6	7
	< 500	4	5	6	7	8
	< 5,000	5	6	7	8	9
	< 50,000	6	7	8	9	10
	> 50,000	7	8	**Not part of SORA**		



Step 2: iGRC - V2

Intrinsic UAS Ground Risk Class						
Maximum UA characteristic dimension		1m / approx. 3 ft	3 m / approx. 10 ft	8 m / approx. 25 ft	20 m / approx. 65 ft	40 m / approx. 130 ft
Maximum speed		*25 m/s*	*35 m/s*	*75 m/s*	*120 m/s*	*200 m/s*
Maximum iGRC population density (people/km²)	**Controlled Ground Area**	1	1	2	3	3
	< 5	2	3	4	5	6
	< 50	3	4	5	6	7
	< 500	4	5	6	7	8
	< 5,000	5	6	7	8	9
	< 50,000	6	7	8	9	10
	> 50,000	7	8	**Not part of SORA**		



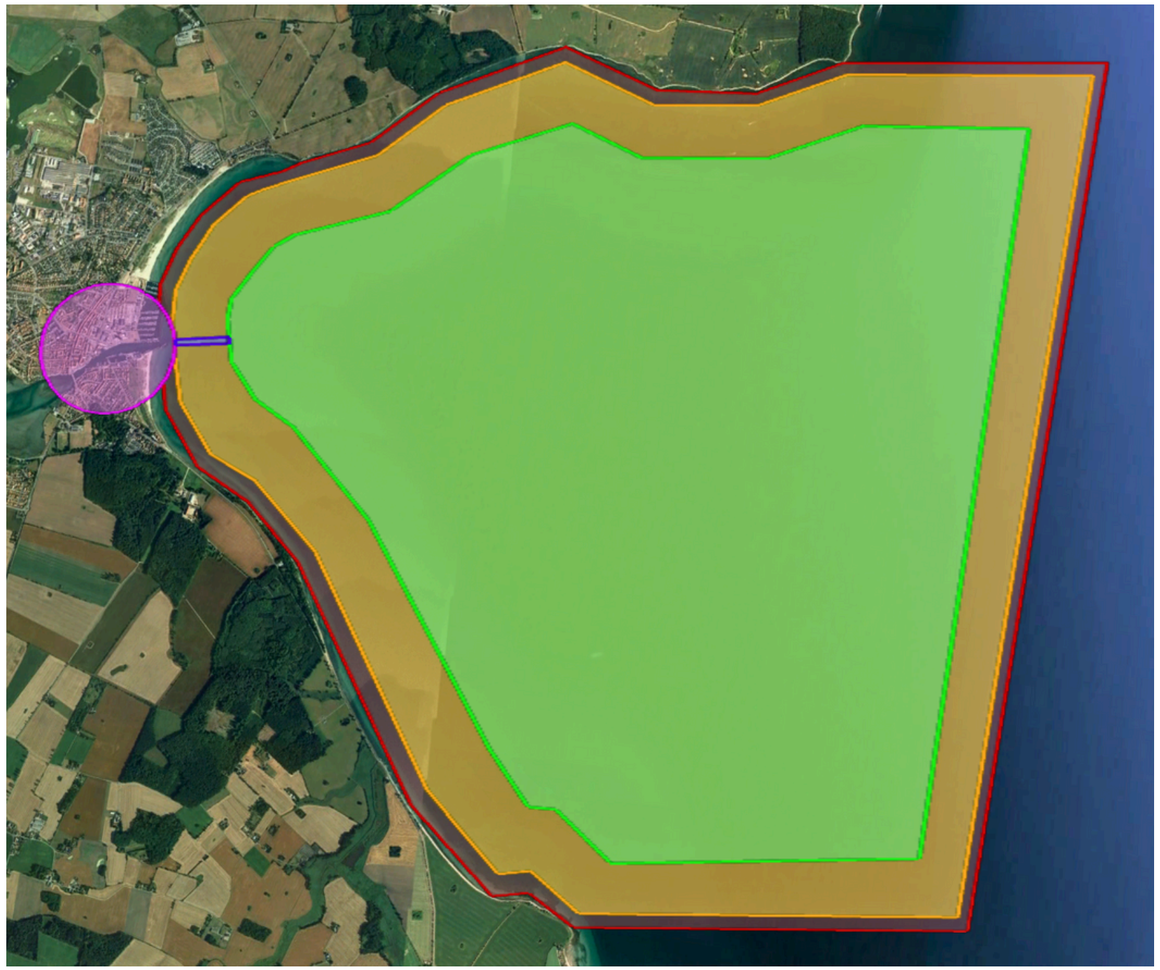


3- Final Ground Risk Class (GRC)

	Level of Robustness		
Mitigations for ground risk	**Low**	**Medium**	**High**
M1(A) - Strategic mitigations - Sheltering	**-1**	**-2**	**N/A**
M1(B) - Strategic mitigations - Operational restrictions	**N/A**	**-1**	**-2**
M1(C) - Tactical mitigations - Ground observation	**-1**	**N/A**	**N/A**
M2 - Effects of UA impact dynamics are reduced	**N/A**	**-1**	**-2**

Step 3: GRC

	Level of Robustness		
Mitigations for ground risk	**Low**	**Medium**	**High**
M1(A) - Strategic mitigations - Sheltering	**-1**	**-2**	**N/A**
M1(B) - Strategic mitigations - Operational restrictions	**N/A**	**-1**	**-2**
M1(C) - Tactical mitigations - Ground observation	**-1**	**N/A**	**N/A**
M2 - Effects of UA impact dynamics are reduced	**N/A**	**-1**	**-2**



4- Initial Air Risk Class (iARC)

1- Rural area

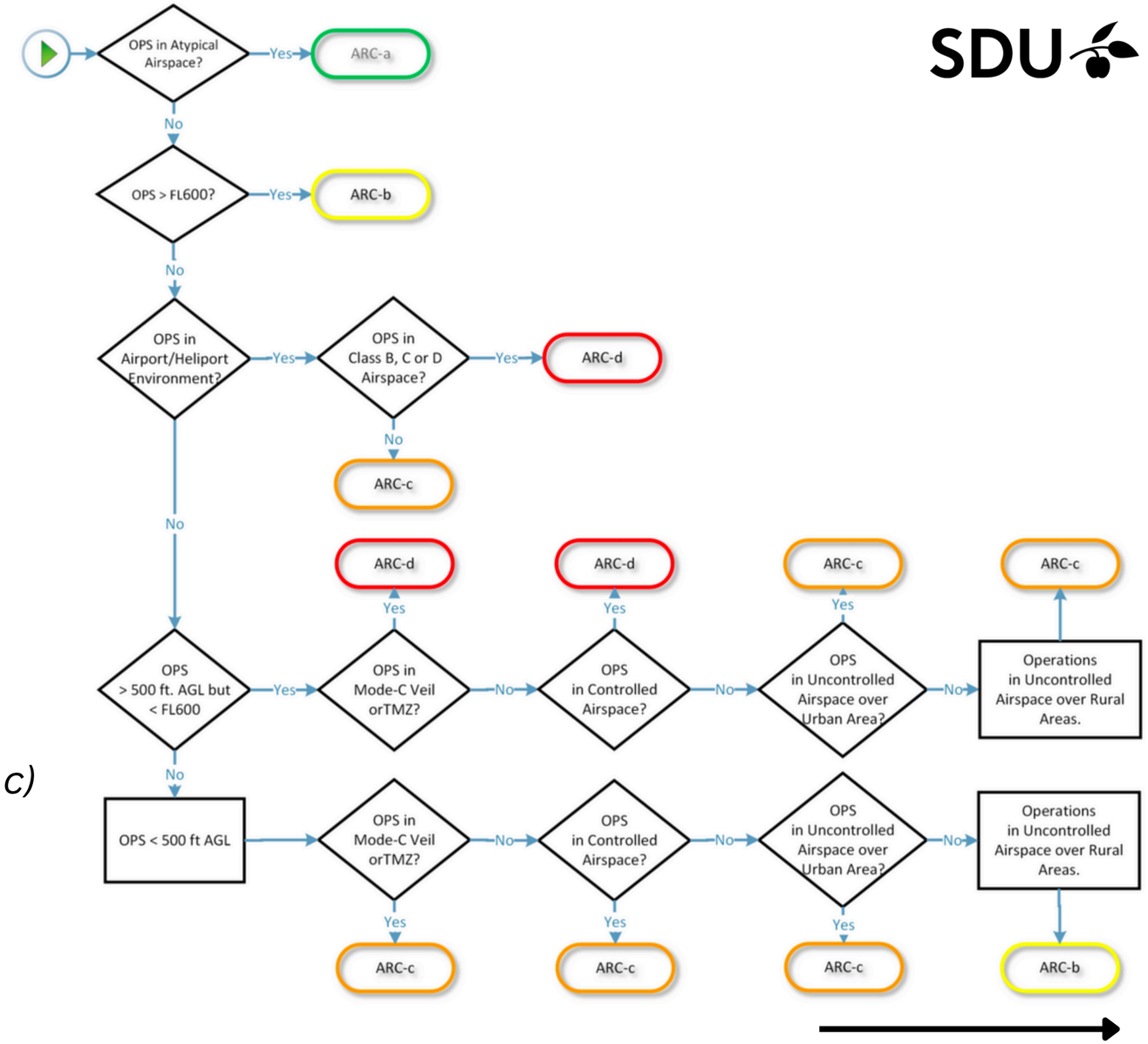
Medium encounter rate above 150m (ARC c), lower below 150m (ARC b)

2- Urban area

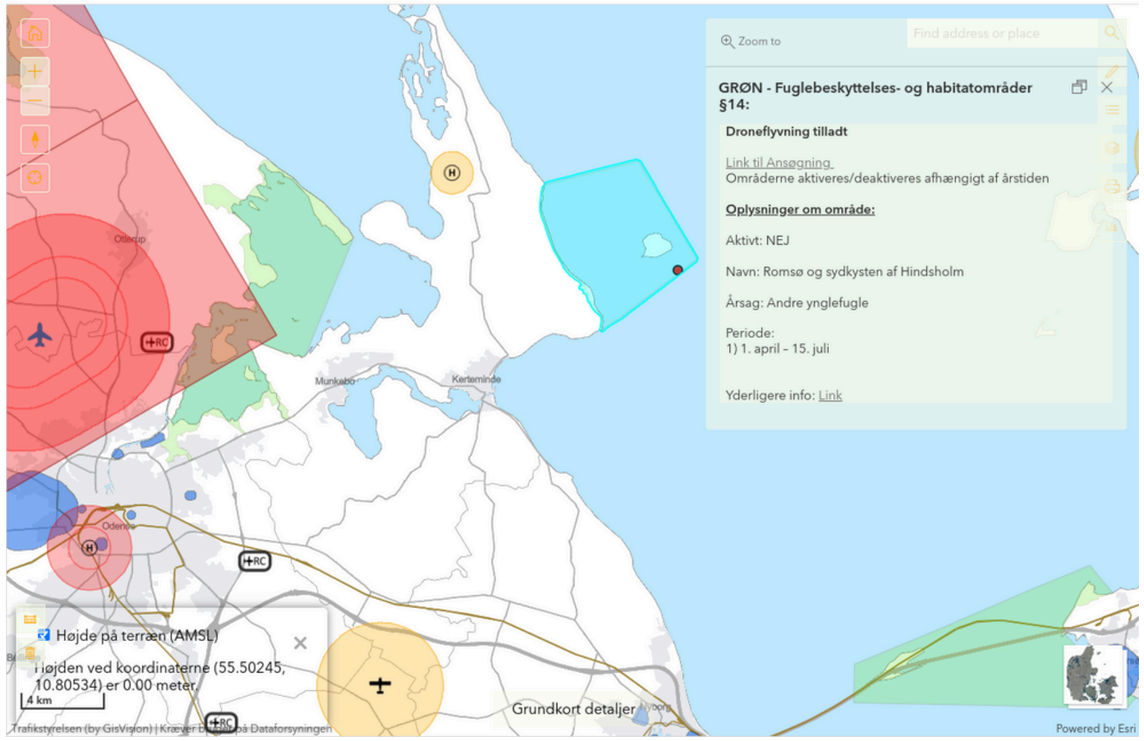
Medium encounter rate even at low level (ARC c)

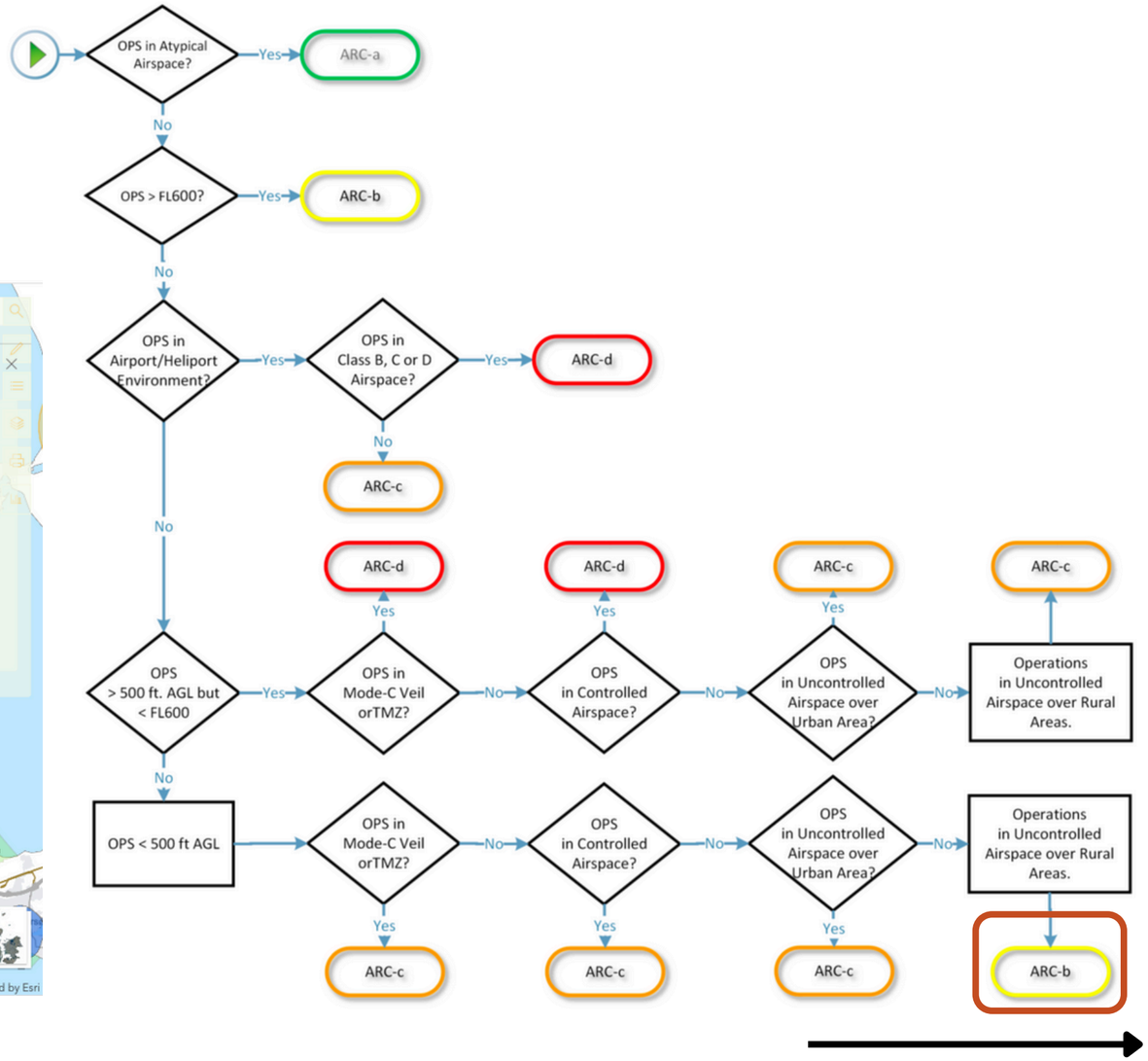
3- Proximity of airport

Very high encounter rate (ARC d)



Step 4: iARC


Zoom to
Find address or place
GRØN - Fuglebeskyttelses- og habitatområder §14:
Droneflyvning tilladt
Link til Ansøgning
Områderne aktiveres/deaktiveres afhængigt af årstiden
Oplysninger om område:
Aktivt: NEJ
Navn: Romsø og sydkysten af Hindsholm
Årsag: Andre ynglefugle
Periode:
1) 1. april – 15. juli
Yderligere info: Link
Munkebo
Kerteminde
Odense
Højde på terræn (AMSL)
i højden ved koordinaterne (55.50245, 10.80534) er 0.00 meter.
4 km
Grundkort detaljer
Powered by Esri


OPS in Atypical Airspace?
Yes
ARC-a
No
OPS > FL600?
Yes
ARC-b
No
OPS in Airport/Heliport Environment?
Yes
OPS in Class B, C or D Airspace?
Yes
ARC-d
No
ARC-c
No
OPS > 500 ft. AGL but < FL600
Yes
OPS in Mode-C Veil orTMZ?
No
OPS in Controlled Airspace?
No
OPS in Uncontrolled Airspace over Urban Area?
No
Operations in Uncontrolled Airspace over Rural Areas.
ARC-d
ARC-d
ARC-c
ARC-c
Yes
No
OPS < 500 ft AGL
OPS in Mode-C Veil orTMZ?
No
OPS in Controlled Airspace?
No
OPS in Uncontrolled Airspace over Urban Area?
No
Operations in Uncontrolled Airspace over Rural Areas.
ARC-c
ARC-c
ARC-c
ARC-b

5- Strategic Mitigations

1. Operational Restrictions

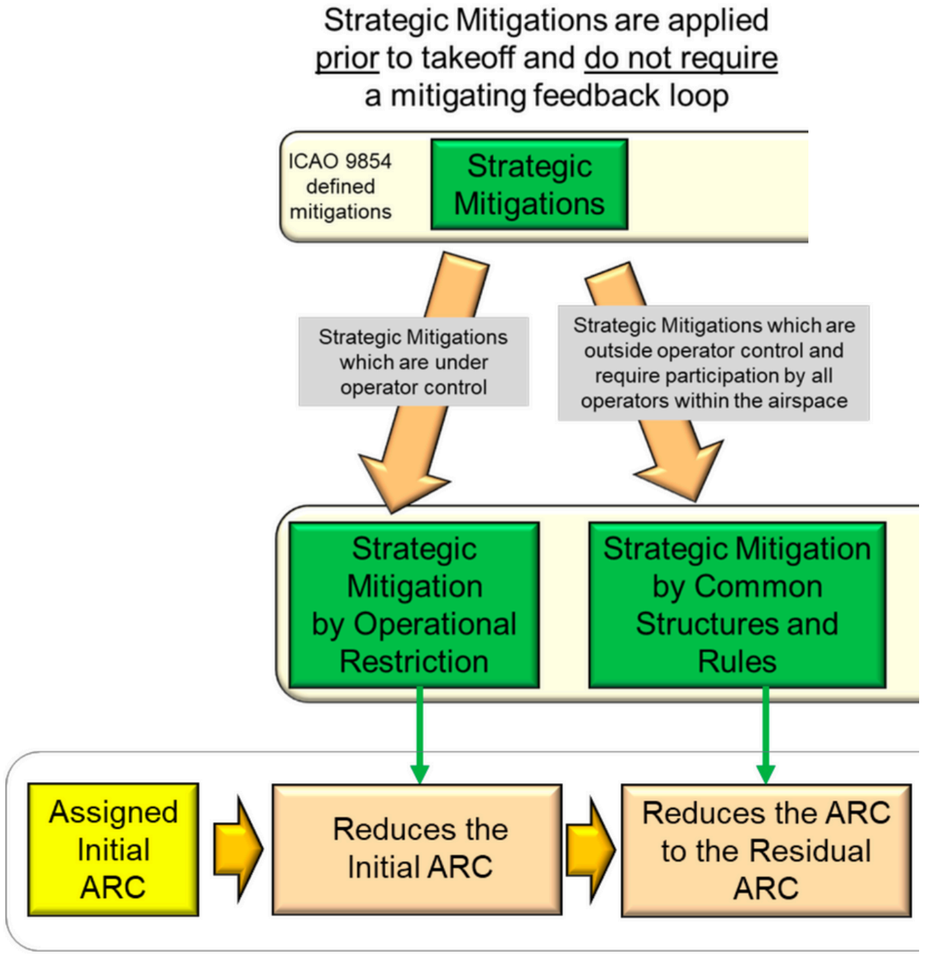
a. Boundary (i.e., low-altitude)
b. Chronology (i.e., time of day)
c. Exposure (i.e., high risk for a limited time)

2.1. Common rules

a. Electronic conspicuity
b. Anti-collision lighting
c. File a flight path (UTM/ANSP/...)

2.2. Airspace structures

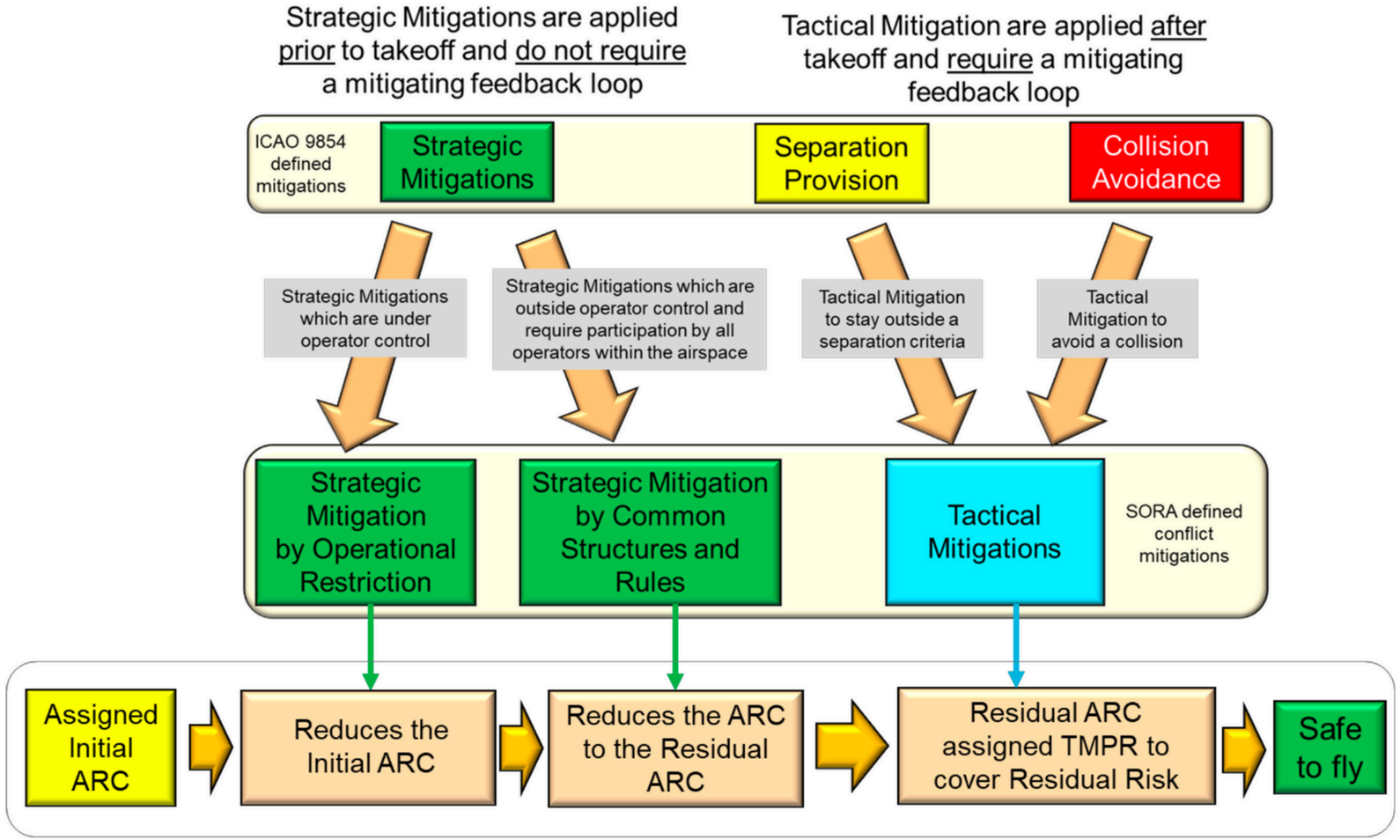
a. Drone corridors
b. Procedural controls by UTM (take-off windows, reporting points, ...)



6- Tactical Mitigations

Performance Requirements (TMPR)

1. **Detect** other aircraft.
2. **Decide** how to separate.
3. **Command** the UA.
4. **Execute** the separation.
5. **Feedback loop.**



6- Tactical Mitigations

Performance Requirements (TMPR)

1. **Detect** other aircraft.
2. **Decide** how to separate.
3. **Command** the UA.
4. **Execute** the separation.
5. **Feedback loop.**

	Function	TMPR Level				
		VLOS	No Requirement (ARC-a)	Low (ARC-b)	Medium (ARC-c)	High (ARC-d)
Tactical Mitigation Performance Requirements (TMPR)	Detect[1]	No Requirement	No Requirement	The expectation is for the applicant's DAA Plan to enable the operator to detect approximately 50% of all aircraft in the detection volume[2]. This is the performance requirement in absence of failures and defaults. It is required that the applicant has awareness of most of the traffic operating in the area in which the operator intends to fly, by relying on one or more of the following: • Use of (web-based) real time aircraft tracking services • Use Low Cost ADS-B In /UAT/FLARM[3]/Pilot Aware[3] aircraft trackers • Use of UTM Dynamic Geofencing[4] • Monitoring aeronautical radio communication (i.e. use of a scanner)[5]	The expectation is for the applicant's DAA Plan to enable the operator to detect approximately 90% of all aircraft in the detection volume[2]. To accomplish this, the applicant will have to rely on one or a combination of the following systems or services: • Ground based DAA /RADAR • FLARM [3/6] • Pilot Aware [3/6] • ADS-B In/ UAT In Receiver[6] • ATC Separation Services[7] • UTM Surveillance Service[4] • UTM Early Conflict Detection and Resolution Service[4] • Active communication with ATC and other airspace users[5]. The operator provides an assessment of the effectiveness of the detection tools/methods chosen.	A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.

Step 6: TMPRs

Detect	Decide	Command	Execute	Feedback loop
Low (ARC-b)	Low (ARC-b)	Low (ARC-b)	Low (ARC-b)	Low (ARC-b)
The expectation is for the applicant's DAA Plan to enable the operator to detect approximately 50% of all aircraft in the detection volume[2]. This is the performance requirement in absence of failures and defaults. It is required that the applicant has awareness of most of the traffic operating in the area in which the operator intends to fly, by relying on one or more of the following: • Use of (web-based) real time aircraft tracking services • Use Low Cost ADS-B In /UAT/FLARM[3]/Pilot Aware[3] aircraft trackers • Use of UTM Dynamic Geofencing[4] • Monitoring aeronautical radio communication (i.e. use of a scanner)[5]	The operator must have a documented de-confliction scheme, in which the operator explains which tools or methods will be used for detection and what the criteria are that will be applied for the decision to avoid incoming traffic. In case the remote pilot relies on detection by someone else, the use of phraseology will have to be described as well. Examples: • The operator will initiate a rapid descend if traffic is crossing an alert boundary and operating at less than 1000ft. • The observer monitoring traffic uses the phrase: 'DESCEND!, DESCEND!, DESCEND!'.	The latency of the whole command (C2) link, i.e. the time between the moment that the remote pilot gives the command and the airplane executes the command must not exceed 5 seconds.	UAS descending to an altitude not higher than the nearest trees, buildings or infrastructure or ≤ 60 feet AGL is considered sufficient. The aircraft should be able to descend from its operating altitude to the 'safe altitude' in less than a minute.	Where electronic means assist the remote pilot in detecting traffic, the information is provided with a latency and update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria. For an assumed 3 NM threshold, a 5 second update rate and a latency of 10 seconds is considered adequate (see example below).

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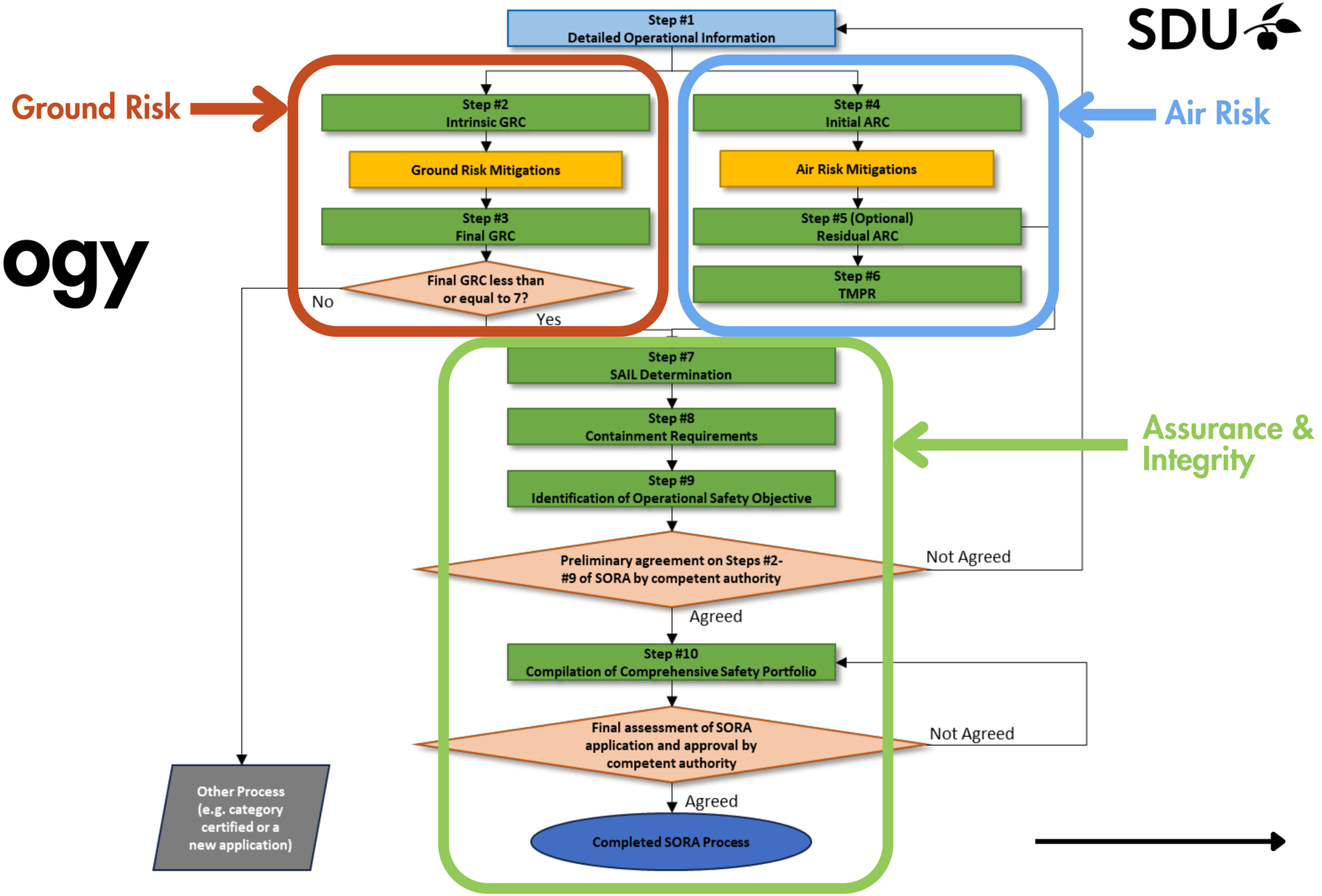
SORA Methodology



7- SAIL
(Specific Assurance and Integrity Levels)

The SAIL represents the **level of confidence** that the UAS **operation will stay under control**.

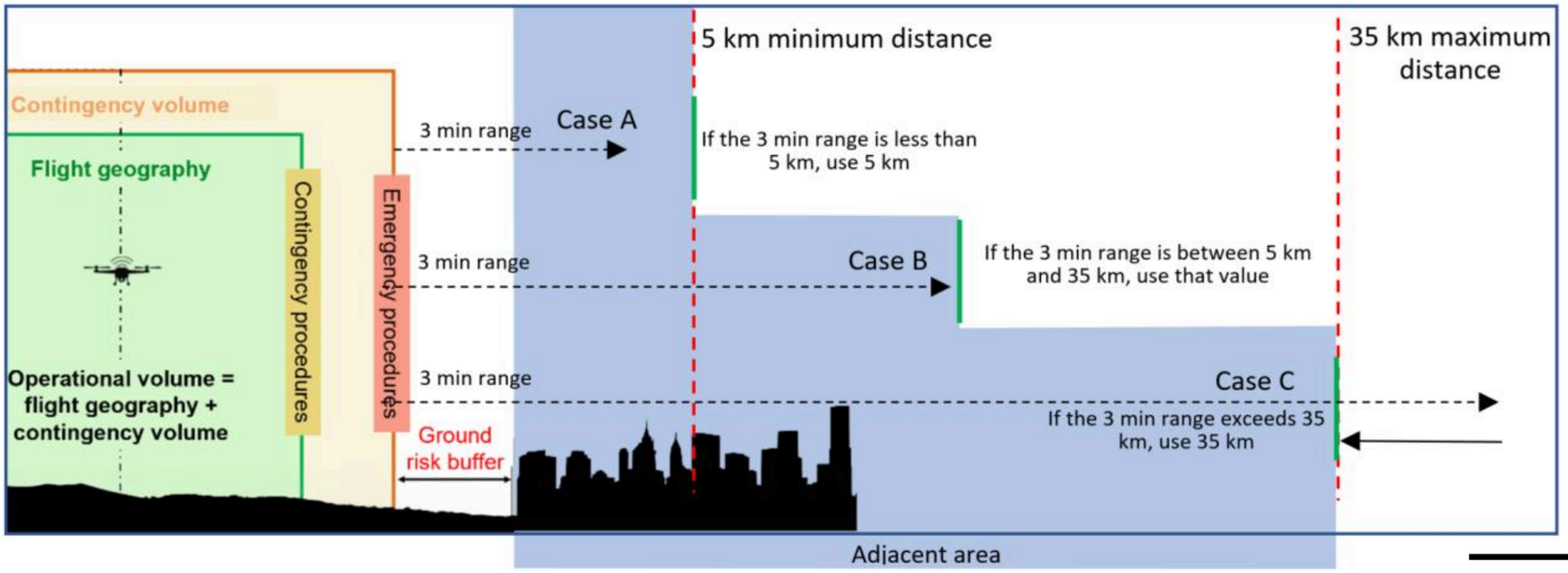
SAIL Determination				
	Residual ARC			
Final GRC	a	b	c	d
≤2	**I**	**II**	**IV**	**VI**
3	**II**	**II**	**IV**	**VI**
4	**III**	**III**	**IV**	**VI**
5	**IV**	**IV**	**IV**	**VI**
6	**V**	**V**	**V**	**VI**
7	**VI**	**VI**	**VI**	**VI**
>7	Category C (Certified) operation[10]			

Step 7: SAIL

SAIL Determination				
	Residual ARC			
Final GRC	a	b	c	d
≤2	I	II	IV	VI
3	II	II	IV	VI
4	III	III	IV	VI
5	IV	IV	IV	VI
6	V	V	V	VI
7	VI	VI	VI	VI
>7	Category C (Certified) operation[10]			

8- Containment Requirement

The containment requirements ensure that the **target level of safety** can be met for both ground and air risk in the **adjacent area**.



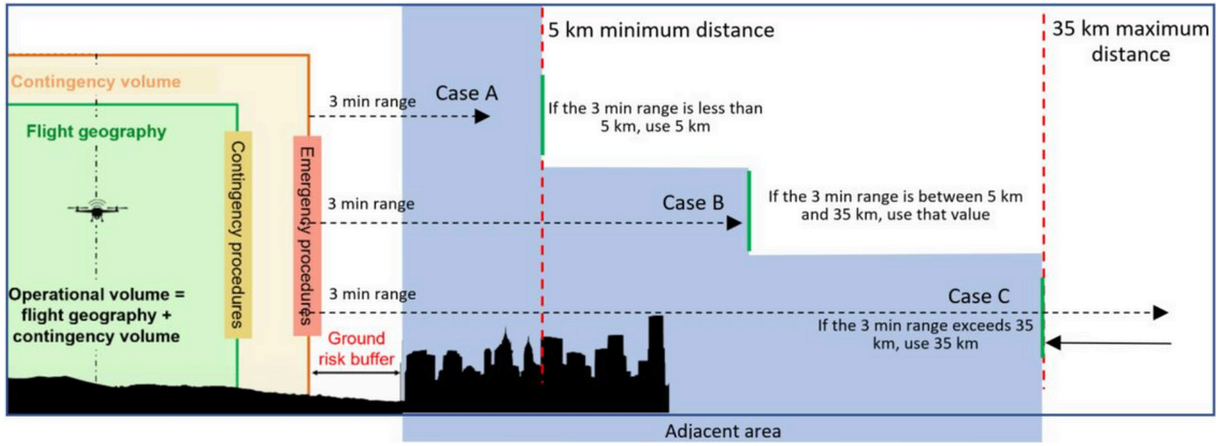
8- Containment Requirement

1 m UA (< 25 m/s) Sheltering assumed applicable for the UA in the adjacent area			
Average Population density allowed	No Upper Limit		< 50,000 ppl/km^2
Outdoor Assemblies allowed within 1km of the OPS volume	> 400k	Assemblies of 40k to 400k	Assemblies < 40k
SAIL			
I & II	High	Medium	Low
III	Medium	Low	Low
IV - VI	Low	Low	Low
V-VI	Low	Low	Low

8- Containment Requirement

Containment	LEVEL of INTEGRITY		
	Low	Medium	High[2]
Criterion #1 (Operational Volume Containment)	(Qualitative) No **probable**[1] single failure of the UAS or any external system supporting the operation shall lead to operation outside of the operation volume. OR (Quantitative) The probability of the failure condition "UA leaving the operational volume" shall be less than 10-3/Flight Hour (FH).		(Qualitative) No **remote**[3] single failure of the UAS or any external system supporting the operation shall lead to operation outside of the operational volume. OR (Quantitative) The probability of the failure condition "UA leaving the operational volume" shall be less than 10-4/FH.
Comments	*[1] Failures anticipated to occur one or more times during the entire operational life of an item.*		*[2] This may be achieved by a tether that prevents the drone from exiting the operational volume.* *[3] Failures unlikely to occur with each UA during its operational life but that may occur several times when considering the total operational life of a number of UA of this type.*

Step 8: Containment Req.



Aircraft

Takeoff Weight	Mavic 3 Pro: 958 g Mavic 3 Pro Cine: 963 g
Max Descent Speed	6 m/s
Max Horizontal Speed (at sea level, no wind)	21 m/s

*dji.com

3 min range = 3m * 60s * 21m/s = 3,780m

3.78Km < 5Km --> **Case A: Use 5Km**

Step 8: Containment Req.

Population 1. January by urban and rural areas, population area and population density and time
Unit: -

	2024
440-10674 Kerteminde	
Population	6,044.0
Area (km2)	3.4
Population density (km2)	1,753.4

Stenløse and Ølstykke cities (respectively 1. January 2017 6,802 and 14,833 inhabitants) since 2010 by the Agency for Data Supply and Efficiency merged into one city. From 1. January 2017 are those of SDFE again classified as independent cities. From 1. January 2018 are Grenå strand separated from Grenå by, Lind separated from Herning, Egsmark separated from Ebeltoft by and Resenbro separated from Silkeborg.

*statbank.dk

1 m UA (< 25 m/s) Sheltering assumed applicable for the UA in the adjacent area			
Average Population density allowed	No Upper Limit		< 50,000 ppl/km^2
Outdoor Assemblies allowed within 1km of the OPS volume	> 400k	Assemblies of 40k to 400k	Assemblies < 40k
SAIL			
I & II	High	Medium	Low
III	Medium	Low	Low
IV - VI	Low	Low	Low

Containment reqs:

Annex E - p.59-65

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9- OSOs
(Operational Safety Objectives)

OSO ID	Operational Safety Objective	SAIL						Dependencies (Crit. references as per Annex E)		
		I	II	III	IV	V	VI	Operator	Training org	Designer
OSO#01	Ensure the Operator is competent and/or proven	NR	L	M	H	H	H	x		
OSO#02	UAS manufactured by competent and/or proven entity	NR	NR	L	M	H	H			x
OSO#03	UAS maintained by competent and/or proven entity	L	L	M	M	H	H	Crit. 1 Crit. 2		Crit. 1
OSO#04	UAS components essential to safe operations are designed to an Airworthiness Design Standard (ADS)	NR	NR	NR	L	M	H			x
OSO#05	UAS is designed considering system safety and reliability	NR	NR(c)	L	M	H	H			x
OSO#06	C3 link characteristics are appropriate for the operation	NR	L	L	M	H	H	x		x
OSO#07	Conformity check of the UAS configuration	L	L	M	M	H	H	Crit. 1 Crit. 2		Crit. 1
OSO#08	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H	x		Crit. 1
OSO#09	Remote crew trained and current	L	L	M	M	H	H	x	x	
OSO#13	External services supporting UAS operations are adequate to the operation	L	L	M	H	H	H	x		
OSO#16	Multi crew coordination	L	L	M	M	H	H	Crit. 1 Crit. 3	Crit. 2	
OSO#17	Remote crew is fit to operate	L	L	M	M	H	H	x		
OSO#18	Automatic protection of the flight envelope from human errors	NR	NR	L	M	H	H			x
OSO#19	Safe recovery from human error	NR	NR	L	M	M	H			x
OSO#20	A Human Factors evaluation has been performed and the HMI found appropriate for the mission	NR	L	L	M	M	H	x		x
OSO#23	Environmental conditions for safe operations defined, measurable and adhered to	L	L	M	M	H	H	x		x
OSO#24	UAS designed and qualified for adverse environmental conditions	NR	NR	M	H	H	H			x

9- OSOs
(Operational Safety Objectives)

TECHNICAL ISSUE WITH THE UAS		LEVEL of INTEGRITY		
		Low (SAIL II)	**Medium (SAIL III)**	**High (SAIL IV to VI)**
OSO #01 **Ensure the Operator is competent and/or proven**	Criterion	The applicant is knowledgeable of the UAS[1] being used and as a minimum has the following relevant operational procedures[2]: • checklists, • maintenance, • training, • responsibilities, and associated duties.	Same as Low. In addition, the applicant has an organization appropriate[3] for the intended operation, with at least the following in place: • a method to continuously evaluate whether the operator is operating according to the terms of the operational authorization and check whether the mitigations proposed as part of the operational authorization are still appropriate; • occurrence analysis procedures and reporting to the designer in case of design-related in-service events.	The applicant has a safety management system in place in line with ICAO Annex 19 principles.
	Comments	*[1] Including monitoring of any related airworthiness directives or recommendations issued by National Aviation Authorities and designer recommendations (Service Bulletin, Service Information Letter, etc.)* *[2] Operational procedures (checklists, maintenance, training, etc.) can be justified in the context of other applicable OSO.*	*[3] For the purpose of this assessment appropriate should be interpreted as commensurate/proportionate with the size of the organization and the complexity of the operation.*	*N/A*

TECHNICAL ISSUE WITH THE UAS		LEVEL of ASSURANCE		
		Low (SAIL II)	**Medium (SAIL III)**	**High (SAIL IV to VI)**
OSO #01 **Ensure the Operator is competent and/or proven**	Criterion	The elements delineated in the level of integrity are available.	Prior to the first operation, a competent third party performs an audit of the organization.	The applicant holds an Organizational Operating Certificate or is/has a recognized flight test organization. In addition, a competent third party recurrently verifies the Operator's competence.
	Comments	*N/A*	*Audits should be adapted to the size and scope of the organization and focus on items that can be connected to the applicable OSOs and their robustness depending on the SAIL of the operation. Audits can take the form of desk reviews, if deemed appropriate.*	

Step 9: OSOs

OSO ID	Operational Safety Objective	SAIL						Dependencies (Crit. references as per Annex E)		
		I	II	III	IV	V	VI	Operator	Training org	Designer
OSO#01	Ensure the Operator is competent and/or proven	NR	L	M	H	H	H	x		
OSO#02	UAS manufactured by competent and/or proven entity	NR	NR	L	M	H	H			x
OSO#03	UAS maintained by competent and/or proven entity	L	L	M	M	H	H	Crit. 1 Crit. 2		Crit. 1
OSO#04	UAS components essential to safe operations are designed to an Airworthiness Design Standard (ADS)	NR	NR	NR	L	M	H			x
OSO#05	UAS is designed considering system safety and reliability	NR	NR[(c)]	L	M	H	H			x
OSO#06	C3 link characteristics are appropriate for the operation	NR	L	L	M	H	H	x		x
OSO#07	Conformity check of the UAS configuration	L	L	M	M	H	H	Crit. 1 Crit. 2		Crit. 1
OSO#08	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H	x		Crit. 1
OSO#09	Remote crew trained and current	L	L	M	M	H	H	x	x	
OSO#13	External services supporting UAS operations are adequate to the operation	L	L	M	H	H	H	x		
OSO#16	Multi crew coordination	L	L	M	M	H	H	Crit. 1 Crit. 3	Crit. 2	
OSO#17	Remote crew is fit to operate	L	L	M	M	H	H	x		
OSO#18	Automatic protection of the flight envelope from human errors	NR	NR	L	M	H	H			x
OSO#19	Safe recovery from human error	NR	NR	L	M	M	H			x
OSO#20	A Human Factors evaluation has been performed and the HMI found appropriate for the mission	NR	L	L	M	M	H	x		x
OSO#23	Environmental conditions for safe operations defined, measurable and adhered to	L	L	M	M	H	H	x		x
OSO#24	UAS designed and qualified for adverse environmental conditions	NR	NR	M	H	H	H			x

10- Comprehensive Safety Portfolio (CSP)

01 Detailed operational description (Step #1)

02 Safety claims

03 Derived requirements

04 Compliance evidence

05 Justified safety case

06 Compliance matrix

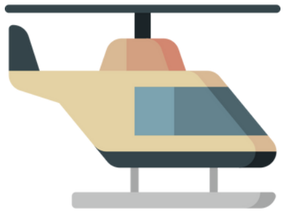
Conclusion

OPEN 01

- 120m
- VLOS (500m)
- < 25kg
- Away from public & no-fly zones
- Certified pilot (A1-3/2)

SPECIFIC 02

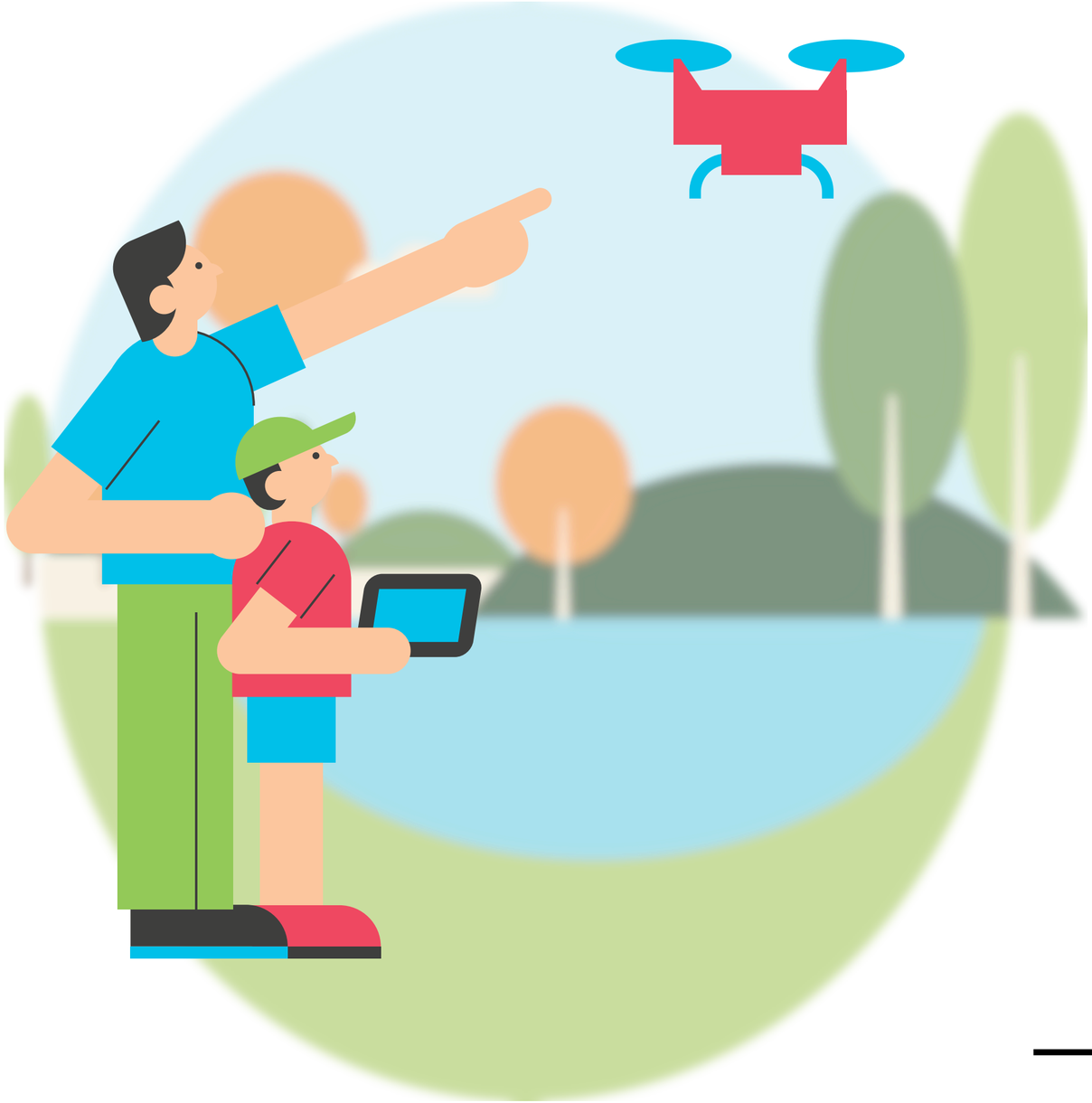
- STS & PDRA
- SORA
  - 10 steps methodology
  - Air & Ground risk
- LUC



CERTIFIED 03

- High-risk operations
- Very complex procedure
- Need to amend current aviation regulations

Now you are ready to fly safely!



Any Questions?

Let’s talk about Kenya!

- **Objective:** Conduct a simple, **low-risk 2km BVLOS** operation using **off-the-shelf** drones.
- **Purpose:**
  - Gain r**eal-world experience** in the field.
  - Understand the unique **environmental conditions** at Ol Pejeta.
  - Refine our **operational procedures** to ensure safety and efficiency.
- **Long-Term Goal:** Use the insights from this expedition to **prepare for more complex and challenging operations** planned for January 2025, as part of the broader WildDrone project.

Needed Permits

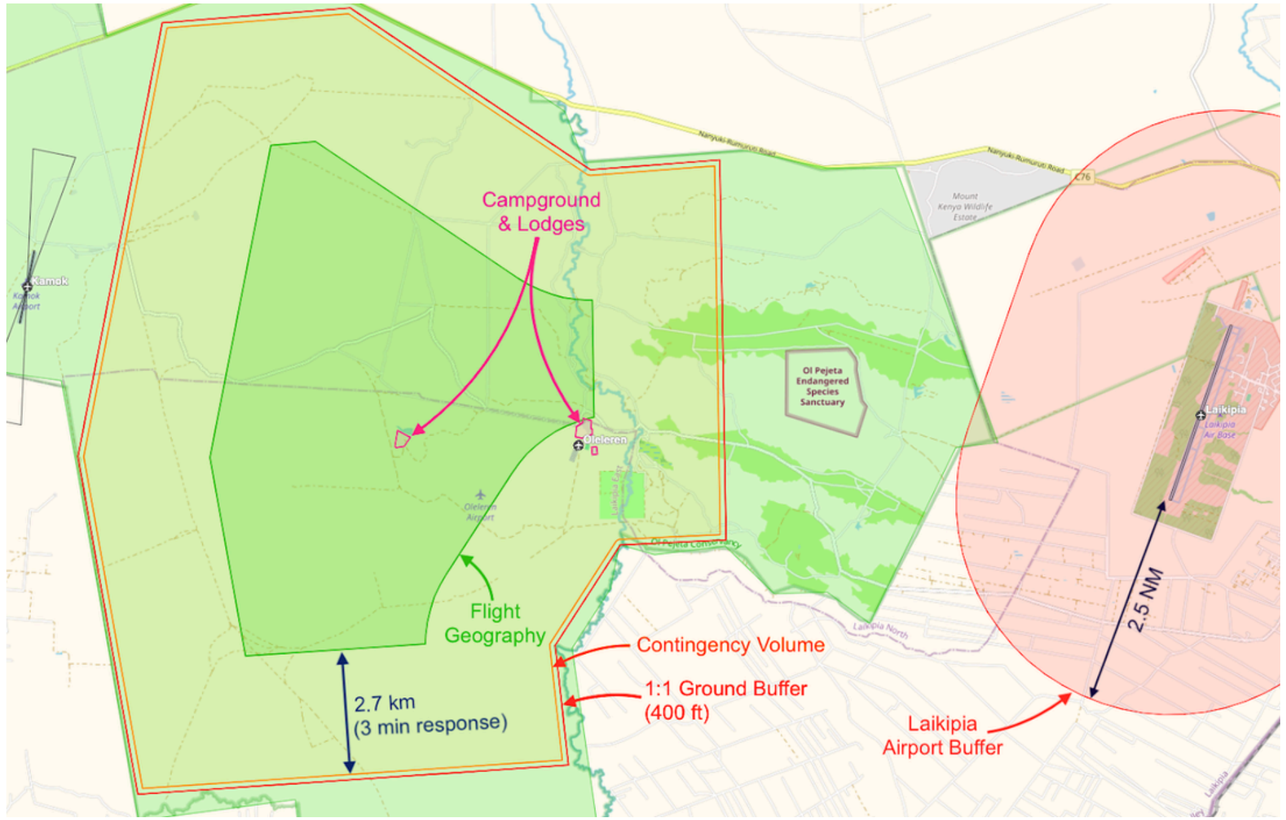
Wildlife permits:

- Letter of No Objection - Kenya Wildlife Service (KWS)
- Letter of No Objection – Ol Pejeta Conservancy (OPC)
- Research Permit - Wildlife Research & Training Institute (WRTI)
- Research License – National Commission for Science, Technology & Innovation (NACOSTI)
- Filming License – Kenya Film Classification Board (KFCB)

UAS Permits:

- Remote Aircraft Operator (ROC) Lease – Kenya Flying Labs (KFL)
- UAS Temporary Import Permit – Kenya Civil Aviation Authority (KCAA)
- UAS Operating Authorization - Kenya Civil Aviation Authority (KCAA) + Kenyan AirForce (KAF)

Our BVLOS Application



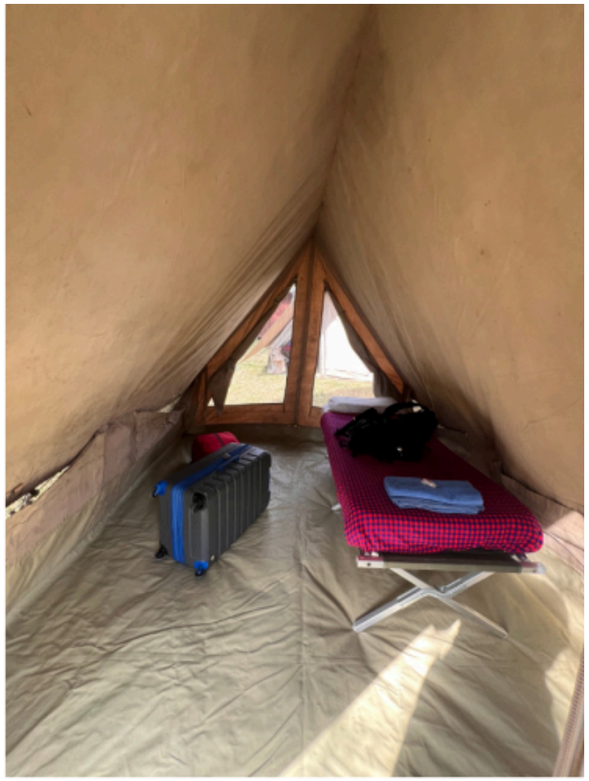
Ground Mitigations:

- Operational Location (West side of the park)
- Road Overflight Minimisation
- No flights above Campgrounds and Lodges

Airspace Mitigations:

- 2km BVLOS limit
- 400 ft (120m) AGL vertical limit
- 3 min response time contingency volume
- Segregated airspace (1000 ft vertical buffer)
- Radio Line of Sight (RLoS)
- Communication with military ATC
- ADS-B monitoring

The expedition

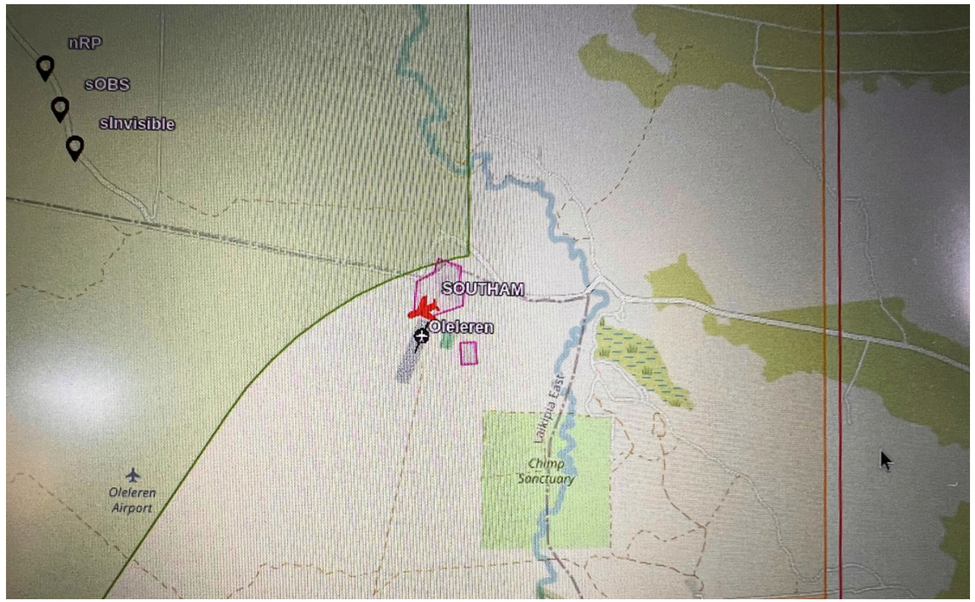


How we operated

- Operational Checklists
  - Operation Planning
  - Pre-Operation
  - Pre-Flight
  - In-Flight
  - Post-Flight
  - Post-Operation
  - Contingency Procedures
  - Emergency Procedures
- Pilot & Observer Teams (with comms)
- Constant Comms with ATC + ADS-B
- Team roles:
  - Pilot
  - Assistant Pilot
  - Ground Observer
  - Airspace Observer

Main challenges

- Weather conditions
- Threat of wildlife
- Airspace safety
  - planes not adhering to ATC guidance
  - low-flying tourist planes
  - limitations on height set by ATC



Main Outcomes

- Managed to fly 2km BVLOS **safely** and **in compliance** with regulations.
  - Learned a lot about the operational environment
  - Refined operational procedures
- Tested Wildbridge with live streaming over Starlink!

Next Steps

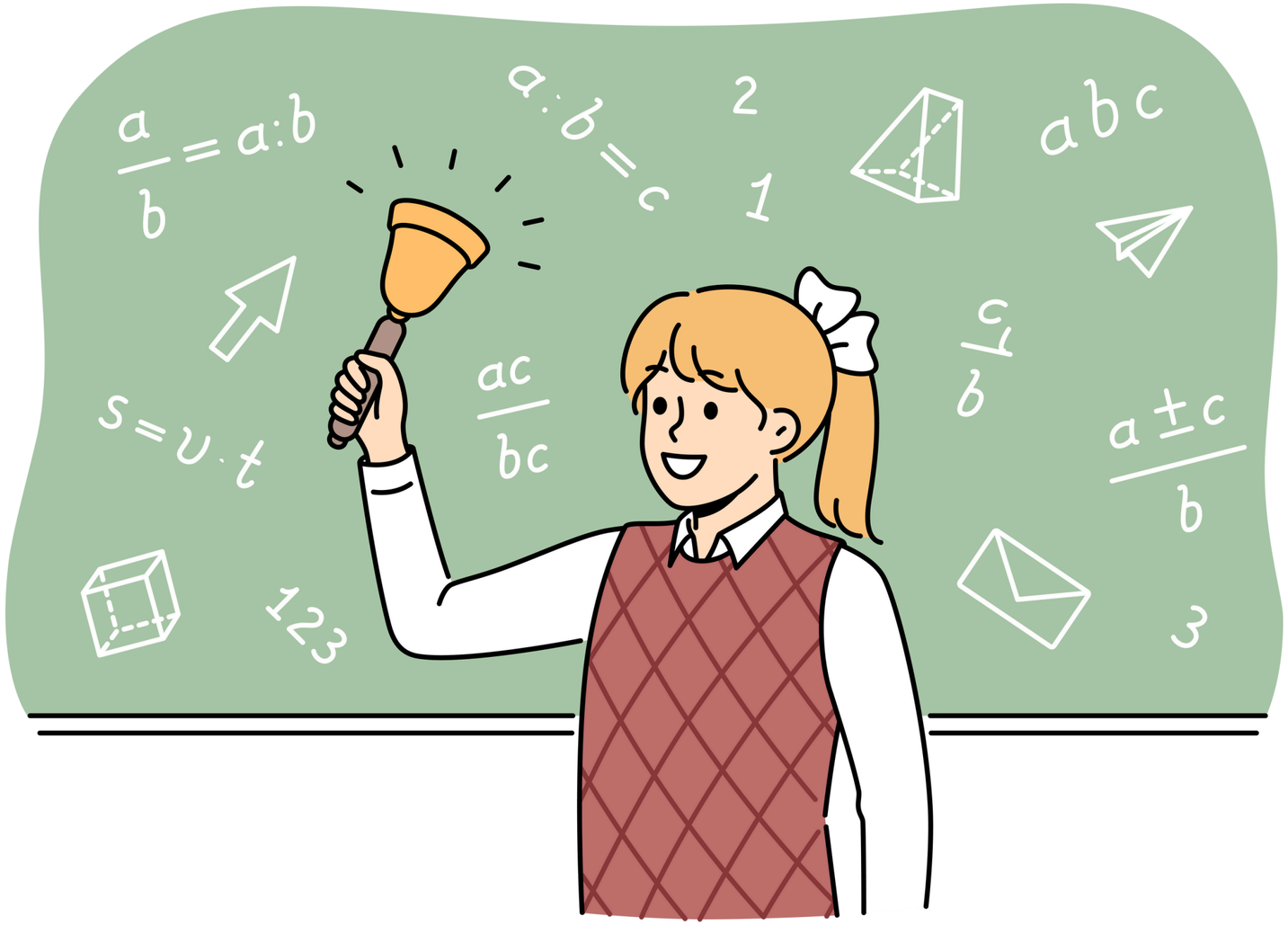
Kenya January 2025:

- 5km BVLOS at night
- 6 ground teams

How it ended

Any Questions?

Time for some practice!



SDU

Before we start, please download the following:

Google earth Pro: https://www.google.com/earth/about/versions/#earth-pro

SORA documents: http://jarus-rpas.org/publications/

Exercise:

Mission:

Ditlevsdal Bison Farm want to fly an EbeeX drone **BVLOS** to monitor their bisons.

Help them complete their **SORA** assessment by filling **this document** which goes through the 10 steps of SORA.

Try to **minimise the final SAIL score** to make the operation easier to perform.

Tip: *try to maximise the operational geography, not necessarily the whole farm.*

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EbeeX Tech Specs

RESULTS | HARDWARE | SOFTWARE | OPERATION

Wingspan	116 cm / 45.7 in
Weight (incl. camera & battery)	1.3 kg - 1.6 kg / 2.2 - 3.6 lbs, depending on camera and battery
Electric motor	Low-noise, brushless
Radio link range [3]	3 km nominal (up to 8 km) / 1.9 mi (up to 5 mi)
Detachable wings	Yes
Cameras (supplied)	None
Cameras (optional)	S.O.D.A. 3D, Aeria X, S.O.D.A., Corridor, Duet T, Duet M, Parrot Sequoia+
GNSS grade	Survey

RESULTS | HARDWARE | SOFTWARE | OPERATION

Cruise speed	11-30 m/s (40-110 km/h or 25-68 mph)
Wind resistance	Up to 12.8 m/s (46 km/h or 28.6 mph)
Maximum flight time	Up to 90 minutes, depending on camera and battery
Endurance extension available (fly more than 60 minutes)	Yes
Nominal coverage at 120 m (400 ft)	220 ha / ~550 ac, with S.O.D.A. / no endurance extension
Maximum coverage at 120 m (single flight)	500 ha / ~1,250 ac, with S.O.D.A. 3D / with endurance extension
Max. flight range	Standard: 37 km / ~23 mi. Endurance: 55 km / ~34 mi
Post-processed kinematic (PPK)	Yes
Real-Time Kinematic / Virtual Base Station	Yes
Real-Time Kinematic / Base Station Unknown point	Yes
Real-Time Kinematic / Base Station Known point	Yes
Ground control points (GCPs)	Not required
Oblique imagery	Yes, with S.O.D.A. 3D
Hand launch	Yes
Landing	Automatic linear landing (5 m / 16.4 ft accuracy in 20° angle cone)

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Stay safe, and feel free to reach out!

SCAN ME

Guy Maalouf

WildDrone PhD Candidate
Safe UAS BVLOS Operations
guym@mmmi.sdu.dk