# AW DRONES

AW-Drones - Supporting evaluation of drone standards



- What is AW-Drones?
- Objectives
- Methodology
- Scope
- Involvement of external experts
- Expected Outcomes





- AW-Drones is a **3-years** Coordination and Support Action (CSA) funded under the EU H2020 program.
- Consortium:
  - Coordinator:





























- Collect information on on-going and planned work with regards to technical and operational standards developed for drones worldwide
- Carry out a critical assessment/benchmarking of all collected data to identify best practices, gaps, bottlenecks and applicability ... in other words a "metastandard"
- Propose and validate a well-reasoned set of standards for each category of drone operations
- Create a knowledge base (online repository) to explore the data
- Engage with key stakeholders and end-users, i.e. representatives
  of the whole drone value chain



# Methodology – Collecting and categorizing

#### **Collection of drone standards**

→ airworthiness, operations & procedures, ....



EUSCG RDP
ANSI Roadmap

Collection of drone-related and applicable general standards

EUROCAE, RTCA, ISO, ASTM, ...

→ component, subcategories, industrial level

Assessment of standards - categorization & evaluation

→ maturity, safety, cost, suitability ...





### Data collection structuring

### Data collection of drone (-related) standards

**General Data** 

**Domain Topic | Subtopic**  **Document Data** 

Type | N° | Title | **Organization | Status | Description** 

**Drone** Category

Open | Spec | Cert

**Categorization** 

**Affected OSOs** #01 ... #24

**Affected GRM** M1 [1...2] | M2 | ERP Affected ARM Strat | Tact

**SORA** STEP #9

**Actual Data** 







EUSCG Rolling development plan



ANSI Standardization Roadmap for Unmanned Aircraft Systems



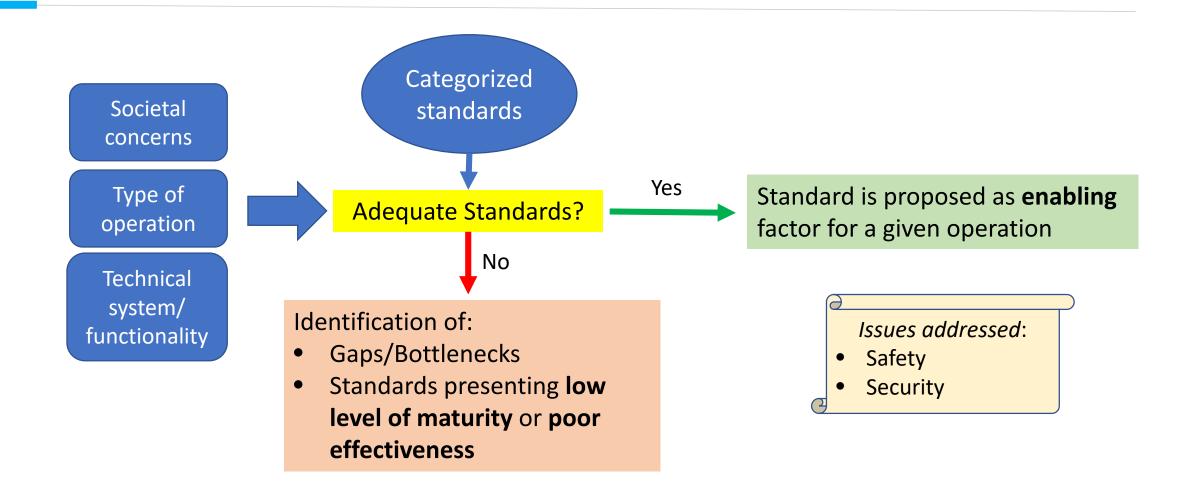
**ASTM UAS Roadmap** 



Collection of other applicable standards (ASTM, ISO, DIN, RTCA, SAE, ...)



# Methodology - Developing a "meta" standard





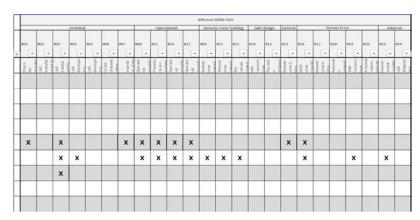
# Collection and mapping of standard

#### 1. Collection of standards

1	General	and classificatio	Х		AS6969		AS-4UCS Unmanned Systems (UxS)	ongoing	set of definitions for quantity types used in data models for unmanned systems. In this data dictionary, a quantity is
2	General	and classificatio		х	ARP6128	Unmanned Systems Terminology Based on the ALFUS Framework	AS-4JAUS Joint Architecture for	published	infis sale nerospace kecommended Practice (ARP) describes terminology specific to unmanned systems (UMSs) and definitions for those terms. It focuses only on terms used
3	General	and classificatio	X		AS####	UAS Propulsion System Terminology	E-39 Unmanned Aircraft Propulsion	planned	
4	General	and classificatio			ASTM WK62416	New Standard Terminology for Unmanned Aircraft Systems	ASTM F38 Unmanned Aircraft Systems	planned	Develop a standard that presents a lexicon for unmanned aircraft systems (UAS). The Standard Terminology for Unmanned Aircraft Systems ("Standard Terminology") is
5	General	and classificatio	X		ISO 21895	Requirements for the categorization and classification of civil UAS	ISO TC20/SC16/WG1	ongoing	Requirements for the categorization and crassification or civil UAS. The standard applies to their industrial regulation, development and production, delivery and
6	General	and classificatio	X			General requirements for UAS for civil and commercial applications, UAS terminology and classification	ISO TC20/SC16/WG1	ongoing	and references relevant to the whole Standard, the purpose of which is to provide a safety quality standard for the safe
7	General	and classificatio	X		ASTM WK62744	General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS)	ASTM F38 Unmanned Aircraft Systems	onging	This standard deriffes one requirements for General Operations Manual for Professional Operator of Light Unmanned Aircraft Systems (UAS). The standard addresses
8	General	Manuals	Х		ASTM WK62743	Development of Maintenance Manual for Small UAS	Aircraft Systems	onging	This specification provides the minimum requirements for a General Maintenance Manual (GMM) for an unmanned aircraft system (UAS) designed, manufactured, and
9	General	and classificatio	X		ANSI/CTA - 2063	Small Unmanned Aerial Systems Serial Numbers	Handled and In- Vehicle Electronics	published	This standard outlines the elements and characteristics of a serial number to be used by small unmanned aerial systems.

### 2. Mapping on SORA

- 1. Harm barriers
- 2. Strategic Mitigations
- 3. Tactical Mitigations
- 4. Operational safety objectives (OSO)







#### Three different cases can be identified:

- CASE 1: a standard potentially suitable to comply with a certain requirement (e.g. OSO #6)
- CASE 2: NO standard suitable to comply with a certain requirement (e.g OSO #XX)
- CASE 3: a standard not mappable with any requirement ("orphan" standard)



Each CASE will be assessed using "tailored" Multi Criteria Analysis



# Multi Criteria Analysis Tool

- Analytic method to compare and rank options
- Allows to translate any assessment (qualitative or quantitative with different units of measurements) into non-dimensional numerical scores ... which can be algebraically summed
- Scores may have different 'weight'
- Allows to scope analysis considering any relevant perspective:
- > Standards maturity
- > Effect on Safety
- > Cost
- > Regulatory compliance
- > Effect on environment



Recommendations for Authorities/ Standard Making Bodies on the basis of the results (i.e. the weighted algebraic totals)

> Etc.





# Example Criterion: Maturity

Although the exact wording may differ, all organisations/groups involved in developing standards apply a similar process, or work flow.

In essence the following development phases can be distinguished:

- **Drafting**
- Internal Consultation
- **External Consultation**
- **Published**
- Recognised / accepted / used by EU Authorities/FAA

-2 (lowest ranking)	-1	0	1	2 (highest ranking)
Drafting	Internal Consult.	External Consult.	Published	Recognised / accepted / used





### **Current Status**

### **Progress**



Data collection



Data mapping to SORA



Data assessement

### **Status**

Currently > 600 standards collected

~50% mapped to SORA requirements

~70% of the mapped stadards assessed

- Year 1: Standards required to support effectively the Specific Operations Risk Assessment (SORA) methodology
- Year 2: Standards supporting the development of U-Space in Europe
- Year 3: Standards needed to support the operation of highly automated UAS and to ensure that they can be operated safely in

a variety of applications

Iterative approach
Results will be regularly
updated



# Project timeline



- An yearly report about "State-of-the-Art" of standards for UAS
- An yearly report containing a "well-reasoned" set of standards:
  - Applicability
  - Maturity
  - Safety Effectiveness
- An open repository containing structured information about technical rules, procedures and standards for drones worldwide, including applicability to different UAS OPS categories and different SAIL = metastandard



http://www.aw-drones.eu/







# Thank you for the attention

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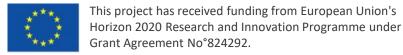
Dissemination Manager:

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# Backup slides





# Data collection structuring

69				,															Affected SOR	RA OSO		-					TF	M	Gr L (Generic)	round Risk Miti	gations		TE	Strateg	Co gic Mitigation	collision Risk (	Air Risk) Tacti	ical Mitigation	=			—
612	Domain	Ту	lype		Dos	cument			-	UAS Category			Ter	chnical			Operation	ial	Remote cr	rew training	Safe desig	ration of		Human Error	,	Adver Operat Conditi	rse ting ions	Strategic M.	Tethered o	M2	Effects of grou	und impact) El		Operational Restrictions			6	BVLOS	700	n des S		
N° Domain	Subtopic	Standard/Spe ciff cation	Best Practices information/ Guil dance	cument N° Ti	Fitle	Organization	Status	Description +	open +	specific	certified	#01 #02	#03 #0	04 #05	#06 #07	#08	W11 W14	#21	#15	5 #22	#10 #12	#13	#16 #17	#18 #	19 #20	#23 #	124	M1 581 M1 5	82 M1 T81	M1 TH2 M2 I	#1 M2 #2	M2 #3 M3#	Boundary	Chronology +	Exposure Common Flight Rufes	Airspace Saucture VLOS	Detect + Decide	Command	Execure Feedback to op	Comments	Access	Responsible * Assessed
5 General	Classification of dro	nes X	ISO	21895 Requirements for the ca classification of civil UAS		ISO TC20 / SC16 / WG1 or	ongoing o	Requirements for the categorization and classification of civil UAS. The standard	х	х	х																													No clear mapping four	nd EuroUS	sc X
6 General	Definitions	x	ISO	classification	is, UAS terminology and	ISO TC20 / SC16 / WG1 or	ongoing o	Provides the foundation and common terms, definitions and references relevant to the This standard defines the	х	х	x																										Ш			No clear mapping four	Euroos	sc X
7 General	Manuals	х	AST WK		al Operations Manual for of Light Unmanned Aircraft	ASTM F38 Unmanned or Aircraft Systems	onging r	requirements for General Operations Manual for	х	х	x	x			)	κ x	<b>x</b>	х					х		х	х														A draft is not available preliminary mapping i performed.	is EuroUS	sc X
20 Avionics & Equipment	Command and Cont Link	X		MOPS (Terrestrial LOS)		WO-200	ongoing F	Minimum Operational Performance Standard for the terrestrial Line of Sight	х	х	х			хх	х			ᆚ	Ш		x x	x													$\perp \! \! \perp \! \! \perp$		Ш	х	х	OSO #4 "This should b standard similar to the MOPS for SATCOM wit	e EuroUS th	sc X
21 Avionics & Equipment	Command and Cont Link	orol (C2)		MOPS (SATCOM)		EUROCAE WG-105	ongoing F	Minimum Operational Performance Standard for the satellite Command and Control	х	х	х			х	х				ш		x x	x													Ш		Ш	х	х	OSO #4"Since the C21 is part of the UAS, the this standard provides MASPS define	n EuroUS	sc X
Avionics & Equipment	Command and Cont Link	rol (C2) X		for the Command and Co		WG-105	ongoing		х	х	х			хх	х			$\perp$	Ш		x >	x		Ш		$\perp$	Ш						4	Ш	$\perp \!\!\! \perp$		Ш	х	x	X requirements at syste (sub-system) and not		sc X
Avionics & Equipment	Detect & Avoid	х		(End-to-end Requireme DAA of IFR Flights in clas	ents at system level) for iss A-C airspace.	EUROCAE WG-105	ongoing		х	х	х			х				4	44								Щ						4	Ш		4	X   2	x x	х	Tactical Mitigation: Detect The DAA functionalities include The draft is still not	EuroUS	sc X
52 Avionics & Equipment	Detect & Avoid	х			pment level) for DAA of airspace.	WG-105	ongoing				х			хх				$\perp$	$\perp \perp$					Ш			_						1		$\perp$	_		хх	х	available. Preliminary mapping is made takin he OSED only defines	16	≤ X
53 Avionics & Equipment	Detect & Avoid	х		Description for DAA for I	DAA in Class D-G	EUROCAE WG-105	ongoing		х	х	Х			х				4	44															Ш		4	-	x x	х	high level requirement and environmental The draft is still not		sc X
54 Avionics & Equipment	Detect & Avoid	х		DAA against conflicting t	traffic for RPAS operating	MG-106	ongoing			х	Х		+	хх				_																	$\perp$	_		хх	х	available. Preliminary mapping is made takin The draft is still not	EuroUS	.c X
Avionics & Equipment  Avionics &	Detect & Avoid	х		(Requirements at equip	pment level) for DAA ic for RPAS operating	WG-105 pl	planned			х	Х			х				4	44																4	4	_	x x	X	available. Preliminary mapping is made takin Tactical	ng .	^
56 Equipment  Avionics &	Detect & Avoid	х		Description for DAA in v Minimum Operational P	very Low Level Operations Performance Standard		ongoing		Х	х	х			хх		Х		х								x										_		x x	X	Mitigation:Detect : Th DAA functionalities A draft is not availabe	at	^
57 Equipment  Avionics &	Detect & Avoid	Х		(Requirements at equip. Very Low Level (VLL) INREC 4811	pment level) for DAA at	WG-105 PI	planned	To detail comprehensive	Х	Х	х			х		х		Х								х								Ш		4	X   2		X	the moment. Prelimin mapping is made Standard: "UAV	nary EuroUS	^
58 Equipment  Design &	Detect & Avoid			Ed. A Ver.1		FINAS PI	published g	guidance and recommended practice for the development of Operational Services and	X		X	х		x x	×	X		x x							,	(							-	Н	×		X 2	<u>*</u>	х	emergency procedure should mirror those fo OSO #4:ATOL capabilit	or ty	_
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103 Design & Airworthines	Dorino	х	F32	Standard Specification for and Verification of Fixed	for Design, Construction, rd-Wing Unmanned	ASTM F38 Unmanned P	published a	minor it may appear to be, This specification covers the airworthiness requirements for	х	х	х			хх							x x	ĸ					甫													mentioned in ASD-ST/ OPEN: may be considered for	r FT controlled DELAIR	R X
Design & Airworthines	Ground control stati	ion X		(End-to-end Requireme:	em Performance Standard	Aircraft Systems  EUROCAE  WG-105	ongoing	the design of fixed-wing	х	х	х			хх	х										x >	(	T										1	x	$\Box$	OSO #4 "The design of UAS includes the design of the RPS.	la	.sc <b>X</b>
Design & Airworthines	s Design	х	STA	NAG 4702 Rotary Wing Unmanned Airworthiness Requirem	d Aerial Systems	NATO FINAS	published r	set of technical airworthiness requirements intended for the airworthiness certification of		х	х	х	х	хх	x x	(					x x	х				х	х													OI UNE RES.	IAI	х
130 Oversight	Qualified entitites	х	AST 19	TM F3364- Standard Practice for Inc for Unmanned Aircraft C	dependent Audit Program Operators	ASTM F38 Unmanned Aircraft Systems	ongoing r	Minimum requirements, responsibilities, qualifications for entities conducting internal		х	х	хх	х	хх	x x	¢ χ	х :	хх	x :	хх	x >	хх	х х	х	x >	х	х	х	х	x :	к х	x >	κ .				$\prod$			Tthis standard can potentially support a high	EuroUS	sc X
131 Oversight	Qualified entitites	х	AST WK	62731 UAS Operator Compliant		ASTM		-How to conduct a third party audit program for those who execute audits to meet the		х	х	х	х	х	x x	( x	<b>x</b>	х х	x :	х	x x	х	х	х	x >	х	х	х	х	x 2	к х	x >	<b>(</b>							The draft is not availal A preliminary mappin made considering the	g is EuroUS	sc X
139 Operations	UAS-ATM (IFR above and below FL 600)	e VLL X		Aerial Vehicles (UAV) as	ise of Military Unmanned is Operational Air Traffic ed airspace specification		published 2	This specification addresses aspects of military UAV ATM, dealing briefly with extant	х	х	х					х					х														х		х			Standard: "UAV emergency procedure should mirror those fo		ft X



# Categorization to domains

General	Definitions Classfication of UAS operations Manuals Classification of drones
Design & Airworthiness (at product level)	Manufacturer organization (design & production) Maintenance Design Production Systems safety assessement Electrical System Propulsion systems Fuel Noise & Environment Level of Automation/Autonomy Flight Control System Management of Continuos Airworthiness Electromagnetic Compatibility and Lightning Protection Software Development & Assurance Emergency capabilities & Health monitoring Structures Flight Handling Perfomance Ground Control Station
Avionics & Equipment	General Communication Detect and Avoid Navigation Lights Cyber-security Instruments Traffic surveillance (tracking) Command and Control (C2) Link

	General
	Security (operator's responsibility)
	Marking and Registration
	Level of Automation/Autonomy
	Operator organization
	C2 Link Service Provider
Operations	RPS Service Provider
	Ground Handling Service
	Standard Scenarios
	Accident/Incident investigation
	UAS-ATM (IFR above VLL and below FL 600)
	Take-off/Landing zones (urban vertiports)
	Risk Assessment (Operations)
	Remote Pilot competence
	UAS Maintenance personnel competence
	Additional crew members competence (non-regulated professions)
Personnel	Human Factors
Personnei	Instructors
	Examiners
	Assessors
	Training organizations
	General
	E-Identification
U-Space	Service Providers
	Tracking
	Geo-awareness
Oversight	Notified bodies and Qualified Entities

- CASE 1: standard potentially suitable to comply with a certain requirement (e.g. OSO #6)
- Assessment criteria

Item	Level -2 (lowest ranking)	Level -1	Level 0	Level 1	Level 2 (highest ranking)
Effectiveness to fulfill KPA requirement	N.A.	N.A.	Partial coverage	N.A.	Full coverage
Maturity	Drafting	Internal Consult.	External Consult.	Published	Recognized / Accepted / Used
Type of standard	N.A.	N.A.	Information Guidance	Best Practice	Standard Specification
Cost of compliance	Very High	High	Medium	Low	Very Low
Environmental impact	Bad	N.A.	Neutral	N.A	Good
Impact on EU Industry competitiveness	Very negative	Negative	No impact	Positive	Very Positive
Social Acceptance	Very negative	Negative	No impact	Positive	Very Positive



### Example Criterion: Effectiveness to fulfill reqs.

- This criterion will address the effectiveness of the candidate standard to fulfil a given requirement with respect with its relevant Key Performance Area (e.g. Safety, Security)
- The primary material on which the assessment of a standard will be performed will be the beginning of the standardisation document, i.e. sections such as the abstract, scope, applicability and background information.
- It will be assessed to what extent the standard covers a requirement: low, medium, high or full coverage.
- In case of an incomplete coverage the applicant must demonstrate by other means that the requirement is met. There is a risk that missing aspects will be overlooked by either the applicant or the regulator.
- At this stage, it is conservatively assumed that the missing aspects are overlooked. Therefore partial coverage and full coverage of a requirement corresponds with respectively a neutral and positive effect on KPAs.
- In case of partial coverage of a requirement the gaps must be indicated.

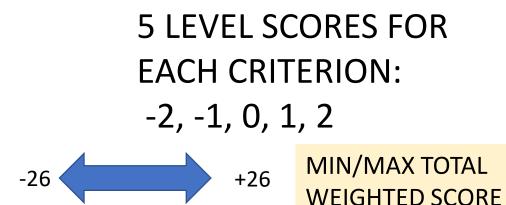
-2 (lowest ranking)	-1	0	1	2 (highest ranking)
		No coverage	Partial coverage	Full coverage





- CASE 1: a standard potentially suitable to comply with a certain requirement (e.g. OSO #6)
- Assessment criteria

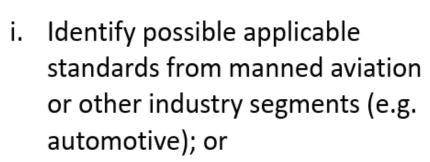
Criterion	Weight
Effectiveness to fulfill KPA requirement	3
Maturity	1
Type of standard	1
Cost of compliance	2
Environmental impact	1
Impact on EU Industry competitiveness	1
Social Acceptance	1



+20

-20

CASE 1: a standard potentially suitable to comply with a certain requirement (e.g. OSO #6)



ii. Recommend the amendment of the standard

standard listed as possible AMC subject to decision by Authority (possibly case-bycase)

+10

standard is recommended as preferred AMC