Project no.: 314680 (Call: FP7-AAT-2012-RTD-1)

ULTRA

Unmanned Aerial Systems in European Airspace

Thematic Priority: AAT.2012.7-25. Assessment of the potential insertion of unmanned aerial system in the air transport system

Instrument: Coordination and Support Actions (CSA)

D4.1 – Most relevant user cases for civil UAS in the European Airspace in the 2013-2014 timeframe

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1.0	28/01/2013	BRTE / David Esteban	All	Final version

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1. INTRODUCTION

1.1. Project Objective

The overall objectives of the ULTRA project are:

• To provide a comprehensive set of recommendations for the incremental insertion of civil Light RPAS (RPA with operating mass up to 150 Kg) in the European airspace in the short-term (i.e. within 5 years from now)

• To provide specific recommendations for selected “Use Cases” to be explored as “quick win” business cases.

• Highlight what needs to be done in order to unlock the full potential of the civil Light RPAS market in the long-term (i.e. 10-15 years from now)

These overall objectives are further divided into the following technical objectives in order to address the European Commission expectations for this project:

• Current RPAS status: Analyze current and past work relative to civil RPAS, including existing best practices – regulatory authorities and qualified entities (certification & operations), commercial (manufacturers & RPAS operators) and non-commercial (research, scientific, governmental non-military) – , and propose a starting point for Light RPAS operations in the short term.

• Realistic business model and short term, applications: Develop a business model for civil Light RPAS applications. Explore short-term, high value applications, and analyze their sustainability and level of impact on European industry and society

.

• Social acceptance and building trust with the regulators: Perform an in-depth analysis on how to overcome the barriers and mistrust of (Light) RPAS by the general public. Follow a step-by-step approach to build trust between the (Light) RPAS industry and the regulators.

• Foster innovation in and support SMEs access to market: Foster the European innovation in terms of aviation automation and provide a path which facilitates access to market for European SMEs.

• Set of Recommendations: Develop recommendations to support a sustainable civil Light RPAS market in the short-term and highlights the steps needed in order to unlock the full potential of the (Light) RPAS market in the long-term.

1.2. Background

The ULTRA project is an 18-month duration “*Coordination and Support Action (CSA)*” funded under the call *FP7-AAT-2012-RTD-1* of the *Transport* (including “Aeronautics”) Cooperation Theme of the European Commission (EC) 7th Framework Programme (FP7) to address the activity: *AAT.2012.7-25. Assessment of the potential insertion of unmanned aerial system in the air transport system*, for which the following content, scope and expected impact were established by the EC:

Content and scope: *The study should establish the minimum requirements in terms of standards equipments and regulations to allow the safe insertion of UAS in the civil airspace. It should also anticipate the steps required for the certification and the validation of the insertion. In the light of this, the path to exploitation will be investigated: market trends, adaptation of infrastructures and investments, obstacles to social acceptance. The consortium should gather a representative group of stakeholders including among others manufacturers, regulators, air navigation service providers, and customers*.

Expected impact: *Proposals should demonstrate contributing to analyze and assess the innovation steps needed to allow the insertion of Unmanned Aerial Systems (UAS) for civil application in the air transport system*.

To address these requirements, with the focus on Light RPAS, the ULTRA Consortium defined the project objectives indicated in sec. 1.1, and organized the work in the following work packages:.

WP1 – *Regulatory and Certification Base* o Identification of gaps and new/modified regulations within the existing regulatory framework

- o Proposed set of actions to fill the gaps in the existing regulatory framework

• WP2 – *Adaptation of Infrastructures* o State-of-the-art report of civil RPAS solutions and enabling technologies

- o Time-phased alternative solutions for all equipment and infrastructure enablers

• WP3 – *Safety and Social Acceptance* o Safety aspects of civil (Light) RPAS operations

- o The social dimension of civil (Light) RPAS operations
- o Impact of (Light) RPAS (on society)

• WP4 – Business Case and Impact on European Industry o Most relevant use cases for civil (Light) RPAS in Europe in the 2013-2014 timeframe

- o Civil (Light) RPAS applications in Europe: Deployment plan and economic sustainability of the business case

• WP5 – Conclusions and Recommendations o Project Final Report

- o Dissemination activities and material, and project website

• WP6 – Coordination

As indicated in the “project objectives” (sec.1.1), one of the main objectives is *to provide specific recommendations for selected “Use Cases” to be explored as “quick win” business cases*. Therefore, the work developed by the different work-packages will feed into the “selected use cases” in order to provide specific recommendations for them from the different key aspects addressed in the project, and support the development of the corresponding business cases. This work logic is depicted in Figure 1.

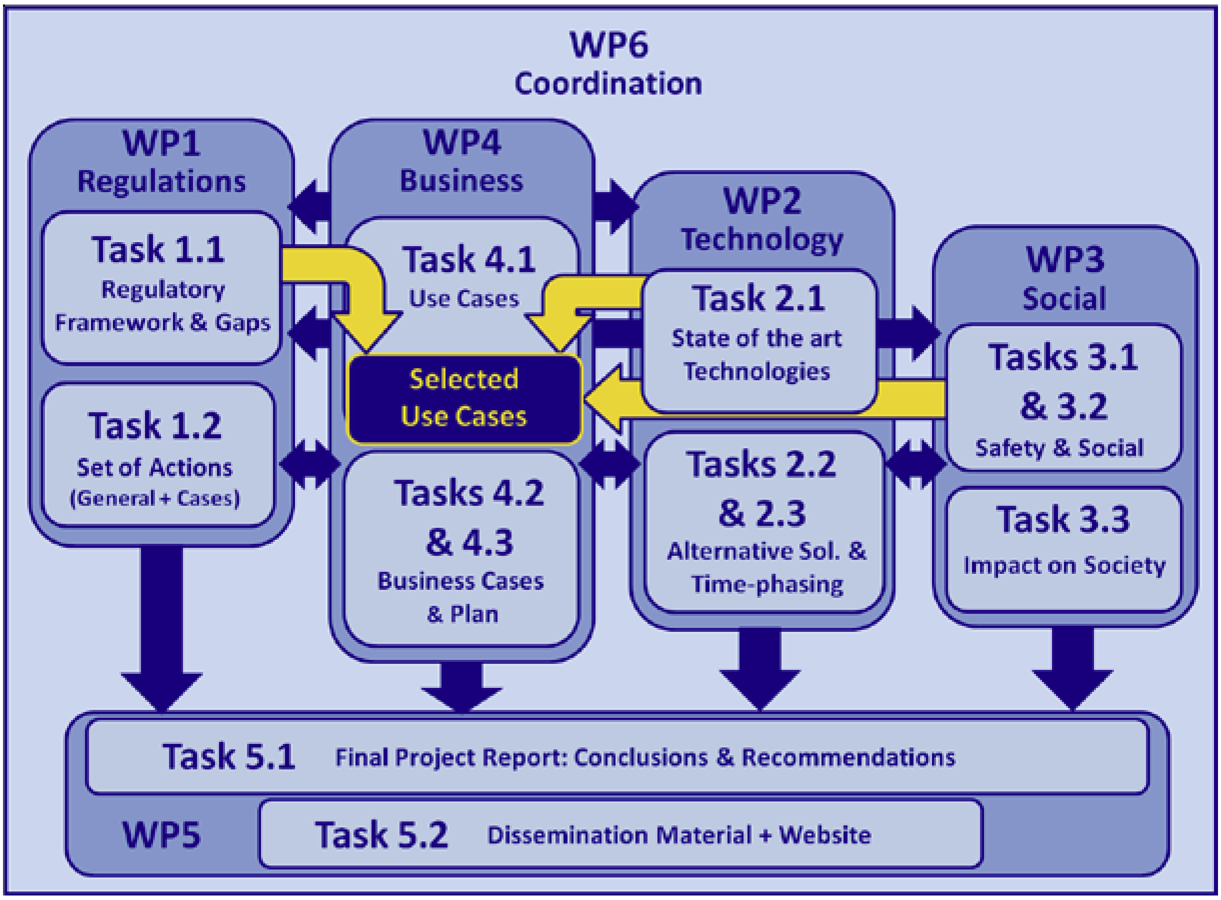

Figure 1 - ULTRA WP Work Logic

The project started in June 2012 and its duration is 18 months. The ULTRA Consortium gathers a representative group of stakeholders including large and small organizations, as illustrated in Figure 2.

Figure 2 - ULTRA Consortia

It is worth noting that the ULTRA Consortium is a member of the European RPAS Study Group (ERSG) of the European Commission.

1.3. Purpose of the Document

This document is the first deliverable as part of the ULTRA Work Package 4 “Business Case and Impact on European Industry”. This fourth work package provides the necessary analysis to firstly identify potential civil UAS uses cases which could be implemented in the short term; and secondly assess their economic sustainability.

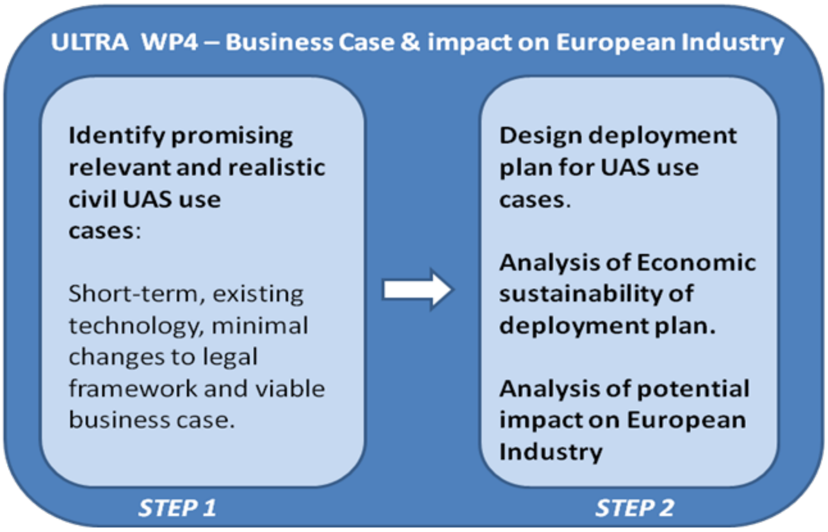

Figure 3 -ULTRA WP4 Objectives

The purpose of this document is to present the reader with an overview of the work conducted in the first part of WP4 (step 1). The document deals only with the first part of WP4 and identify a number of relevant and realistic use cases which can be implemented in the short term by means of existing technology and minimal changes to the current legal framework. More specifically, this document is a report with the identification and description of those three cases considered as most relevant for civil UAS operations from a European perspective.

Further work in WP4 (step2) includes the design a deployment plan for each of the selected use cases including an analysis of economical viability of each deployment plan in terms of economic sustainability.

1.4. Document Structure

The document is structured to reflect the approach followed in identifying and selecting "quick wins" use cases.

- Firstly an Introduction, which provides a description of the document purpose and indicates the references and acronyms list used throughout this document;
- The second section gives an overview of the identification of RPAS quick wins. It presents the reader with the considerations and criteria used for the preliminary identification.
- The following section provided some tables and approach to selecting the most (three or four) relevant use cases identified. Filtering the identified preliminary use cases based on the following ranking schema and characteristics: short-term, existing technology, minimal changes to legal framework and viable business case.
- A description of the most relevant use cases is provided in the following sections.
- Conclusions

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1.5. Sources & Reference Documents

R.1 Grant Agreement (Contract) ref. ACS2-GA-2012-314680-ULTRA (Grant Agreement no. 314680). 7th Framework Programme. Coordination and Support Action. European Commission DG-Research & Innovation. June, 2012.

R.2 Annex I of the Grant Agreement (no. 314680) – Description of Work (DoW). 15/05/2012.

R.3 ULTRA Consortium Agreement. 22/06/2012.

R.4 ULTRA Kick Off Meeting (KOM) – Minutes of Meeting. Ref. ULTRA-WP6-INDRA-N-KOMM-CO-v1.0. INDRA. 11/07/2012.

R.6 ICAO; Unmanned Aircraft Systems (UAS), Circular 328-AN/190, ISBN 978-92-9231-751-5, 2011.

R.8 Commission Staff Working Document (SWD) 259 (2012) – Towards a European strategy for the development of civil applications of Remotely Piloted Aircraft Systems (RPAS). Final. 04/09/2012.

R.9 Unmanned Aircraft System Roadmap (2005-2030). US Department of Defense. Office of the Secretary of Defense. 2005.

R.11 RPAS – The Global Perspective – 2012/2013. Blyenburgh & Co. / UVS International. Paris. 10th Edition. June 2012.

R.22 List of Swedish RPAS approved operators: http://www.transportstyrelsen.se/sv/Luftfart/Luftfartyg-och-luftvardighet/Obemannade-luftfartyg-UAS/Lista-over-godkanda-UAS-operatorer/ (retrieved 30/11/2012)

R.23 List of French RPAS approved operators: http://www.developpement-durable.gouv.fr/document132439 (retrieved 07/12/2012)

R.24 List of Australian RPAS approved operators: http://www.casa.gov.au/scripts/nc.dll?WCMS:STANDARD::pc=PC_100959 (retrieved 20/11/2012)

R.25 List of COAs granted by the FAA: http://www.faa.gov/about/initiatives/uas/

Websites accesses (Jul – Dec 2012):

R.27 Lightweight camera RPAS configurations; http://www.uasvision.com/2012/05/29/rpas-nano-rpas-a-new-reality/

R.28 VLOS vs BVLOS (EC SESAR) http://ec.europa.eu/enterprise/docs/uas/23_Calvo.pdf

R.29 UAS Firefighting and Rescue http://www.wmfs.net/content/emergency-response

R.30 EU JRC Wildfire http://effis-viewer.jrc.ec.europa.eu/wmi/viewer.html

R.31 Power line monitoring
http://www.microdrones.com/references/case-study/microdrones-power-line-monitoring-casestudy.pdf

R.32 UAS Environmental Impact
http://www.barnardmicrosystems.com/L4E_environment.htm

R.33 Interference with manned airspace
http://www.fas.org/sgp/crs/natsec/R42718.pdf

R.34 Aerial Photography current utilization
http://uav-aerial-photo.com/

R.35 UAV Search & Rescue
http://www.nsf.gov/news/news_summ.jsp?cntn_id=104453

R.36 Crop monitoring & management
http://www.rhea-project.eu/index.php

R.37 TRL typical UAV operations (2009)
http://www.aviationtoday.com/av/military/Unmanned-Persistent-ISR_28586.html#.UJuB-r9EJUA

R38 Wind Turbine Maintenance and Condition Monitoring;
http://www.wwindea.org/technology/ch03/en/3_4_3.html

1.6. Glossary

CA	Consortium Agreement
DoW	Description of Work
DVP	Development Plan
EC	European Commission
FP	Framework Programme
GA	Grant Agreement
GA	General Assembly
HBK	(Project) Handbook
KOM	Kick-Off Meeting
MoM	Minutes of Meeting
R&D	Research and Development
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft System
SC	Steering Committee
TPC	Technical Project Coordinator
UAV	Unmanned Aerial Vehicles
UAS	Unmanned Aircraft System
ULTRA	Unmanned Aerial Systems in European Airspace
URL	Uniform Resource Locator
WG	Working Group
WP	Work Package
WPL	Work Package Leader
WPM	Work Package Member

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2. INDENTIFICATION OF USE CASES

Unmanned aircrafts, or Remote Piloted Aircraft Systems (RPAS), should not be seen or recognized as a "competition" to manned aircrafts. RPAS will allow VLOS/BVLOS "Aerial Work" not possible with manned helicopter aircrafts. RPAS must be seen as a complimentary technology to manned aviation. Some examples include:

- Low height (5-100 m) aerial photography, inspections and other aerial works
- Movi shooting in urban environments
- Low height wildlife observation where low noise signatures are required
- Operations in Durt Dully and Dangerous envirnoments
- Rain and snow fall situations
- "Zero" visibility situation such at night and fog
- Real-time on-demand short bird views for assessments, situational awareness
- Law enforcement operations where low noise signatures are required
- Cost constrained operations where manned helicopters cost are not practicable

In fact, the number of uses cases where RPAS may show benefits as an alternative or complementary to the use of manned aviation is extensive and growing fast.

Following the EC directive to concentrate on a pragmatic approach based on specific viable business cases, as previously indicated, ULTRA focuses on a reduced number of selected viable business cases, among the most promising ones in the short term ("quick wins") for the use of light RPAS (< 150 Kg).

2.1. Introduction

This section provides an overview on the approach followed to indentify "quick wins" RPAS use cases - Discussions regarding methodology to reach to those use cases include the review of current RPAS applications and filtering "promising" use cases based on relevant criteria & ranking, including: short-term applications, existing technology, minimal changes to legal framework and viable business case.

Viable business cases are highly dependent on the safety characteristics of the RPAS to be used and the following considerations' need to be acknowledged when identifying use cases:

"RPAs are flying objects and as such, they may crash at a rate that depends on the technologies that have been used in their design."

- Applications that do not make the RPA overfly population can be performed with simple RPAs having no stringent fail safe characteristics. These RPAs will have a limited cost with associated operations restrictions;

- RPAs designed according to fail safe standards should be able to overfly population thanks to their low risk of technical failures. Technologies appear to be mature to reach such a status although airworthiness requirements have not been published yet. The cost of RPA built according to high safety standards will be significantly higher than in the previous case.

"RPAs are flying objects and as such they may collide with other airspace users."

- Applications that can be made either within line of sight of the pilot or in sections of the airspace that are not used by other airspace users can be performed without any on-board detect and avoid equipment. It makes them clear to fly today without any problem;

- Applications different from those that have been described above will be made possible when a detect and avoid function is implemented either on board the RPA or ground based. The technology for this is not available yet.

"RPAs are highly automated. A bug in the automation may result in an undesired commanded behavior. Such behaviour can be avoided through the use of high design assurance level developed software or dealt with via a kill mechanism."

- Applications that do not require overflying population can be performed with RPA with a kill mechanism triggered in case of undesired commanded behavior.

- Applications performed above or near population will have be performed with RPA having software developed to high design assurance levels.

"RPAs are remotely piloted and as such, a risk of failure of the command and control link can occur. Several strategies can be implemented to deal with such a situation."

- Applications that do not make such an event critical will be easy.

- The RPAs design can implement simple to complex procedures in case of loss of link.

2.2. Market research and collection of use cases

In order to identify and select a number of use cases for this study, a large number of sources and material was researched to gain an understanding of the many and varied UAS use cases currently being explored. This section highlights the main sources used for market research and background work that helped in identifying potential civil RPAS use cases:

- Collect Use Cases from previous FP6, ongoing FP7
- Industry activities
- Utilize pre-existing aviation operations (per ECCAIRS 4)
- UAS Unmanned Aircraft Systems – Global Perspective

Use Cases	Scenario Applications	VLOS RPAS Current Utilization?
Aerial Advertising	Aerial Advertising	YES
	Tornado/Dangerous Storm Protection Advertising	
Aerial Observation	Crowd Control	YES
	Public Gathering Monitoring	YES
Aerial Patrol	Infrared	
	Border Surveillance	
	Event Security (sport events, concerts...)	YES
	Crime Scene (surveillance, recording, awareness…)	YES
	Anti- Poaching	
	Coast Guard Border Patrol	
	Coast Guard Anti-Piracy	
	Illegal Cultivation (drugs, mining, logging, excavation…)	YES
	Anti-Drug Trafficking/Human Trafficking	YES
	Illegal Immigrant Control	
	Infrastructure Controls (power cable, wind turbine inspection...)	YES
Aerial Survey	Photogrammetric	YES
	Bird watching (Bird strike control, recreational…)	YES
	Metrological Research (replacing weather balloons)	
	Traffic Surveillance	
	Archaeological Site Mapping	YES
	Resource Monitoring (forestry management, petroleum…)	YES
	Environmental Monitoring	YES
	Quarry and Mine Surveillance	
	Magnetic Field Surveillance (minerals)	YES

Agricultural	**Crop Spraying (fertilizer)**	**YES**
	Seeding	
	Pesticide/Herbicide Spraying	**YES**
	Invasive Species Monitoring	**YES**
	Crop Monitoring and Managing	**YES**
Fire Fighting	**Water Bombing**	
	Spotting/Monitoring (pre-fire, during fire, post fire)	**YES**
	"Sky Jell-o" fire retardant dumping	
Photography	**Coastal Mapping**	**YES**
	Geophysical surveys	**YES**
	Cinematic Photography	**YES**
Search & Rescue	**Natural Disaster S&R (earthquake, avalanche, flooding…)**	
	Search for Missing Persons	
Disaster Relief	**Care Packages (flood victims, ship collisions...)**	**YES**
	First-Aid Support (plane/train crashes, earthquakes...)	**YES**
	Hospital-Hospital Organ Transplant	
	Nuclear Radiation/Contamination measurement	**YES**
Disaster Detection/Prevention	**Storm/Tornado/Hurricane (barometers, wind patterns…)**	**YES**
	Dike Inspection	**YES**
	Flooding	**YES**
	Tsunami and Tidal Surge	
	Earthquake/Volcanic Eruption	**YES**

2.3. "Quick Wins" criteria and considerations

Having researched into an extensive range of RPAS operations, the next step involved the selection of a few "quick wins" based on some predefined goals and criteria, as well as some considerations – see 2.1 - regarding safety, social acceptance, minimal interference with manned airspace and technology readiness.

As part of the selection criteria the following considerations were made:

a) To meet EC requirements about "RPAS Quick Wins" we must select concrete cases, possible to deploy today. This will include all operations, deployed out of the controlled airspace, not over dense populated areas, and with the lowest risk for mid air collisions.

b) Mandatory platform below 150Kg

c) The preferred mode of operation will be VLOS, followed by an extension of the VLOS for specific operations. RPAS for VLOS operations will have an excellent cost/performance ratio and become interesting for SME´s.

d) Both VLOS and BLOS will be considered. Although at first sight RPAS use cases requiring BLOS operations may seem to have a higher cost/performance ratio, and is some cases more than manned solutions this really depends on how the business case is presented and calculated. There are indeed applications where satellite is more cost-effective than terrestrial solutions[1].

Based on all of the above the following table with the relevant criteria to identify "quick wins" was drawn. For each of the criteria, a "relevance" weighting, from 1-4 (4 being the most relevant) was assigned to further evaluate each case. As an example, Safety has a higher relevance than environmental impact when it comes to selecting potential civil RPAS quick wins use cases.

Criteria	"Quick Wins" Relevance
Social Acceptance	4
Current Utilizations	4
Safety (Population Flyover)	4
Technology Readiness	4
No Interference with manned airspace	3
VLOS or BVLOS	3
Environmental Impact	2
Weight Limit (<150kg)	1

Table 1 - Quick Wins Criteria and Relevance

[1] At the 2012 RPAS Civil Ops UAS Forum there was a presentation stating that RPAS operation costs were half the amount of manned operation costs, based on a real use case.

2.4. Metric System and Ranking approach.

A number of factors needed to be considered when selecting promising uses cases, including UAS mode of operation, duration of the UAS operation, physical characteristics of the UAS, UAS flight performance, other airspace users, weather restrictions, command and control characteristics, detect and avoid capabilities, collision avoidance capabilities, communication, navigation and surveillance, airspace classifications, flight rules, populated areas, pilot qualifications, ATM requirements…

As part of the work conducted in WP4 a metric system to rank a number of RPAS use cases has been created:

Criteria	"Quick Wins" Relevance	Level of Compliance	Score (Relevance x Compliance)	Total Score
Social Acceptance	4	4	16	100
Current Utilizations	4	4	16	
Safety (Population Flyover)	4	4	16	
Technology Readiness	4	4	16	
No Interference with manned airspace	3	4	12	
VLOS or BVLOS	3	4	12	
Environmental Impact	2	4	8	
Weight Limit (<150kg)	1	4	4	

Table 2 - Ranking Approach based "Quick Wins" Criteria Relevance and Compliance

Each of the above criteria, was broken down into 4

Criteria	Level of Compliance	Description
Social Acceptance	4	Nearly unanimous foreseen social support. Use applications involve performing at ethically supreme standards. (Ex. Saving lives, protecting the environment,…)
	3	High levels of predicted social acceptance. Value added to society largely outweighs negative sentiments (Ex. Organ transplants, natural disaster monitoring,…)
	2	Compromised public support, with a predicted split-opinion acceptance. Includes Uses that are too oriented towards private sector or with benefits only seen by big business
	1	Low social support due to violated ethical or personal boundaries, or Use considered too dangerous by public. (Ex. Police "big brother" patrol, urban crowd monitoring or skyscraper maintenance,...)
	0	Unfeasibly low public support; Uses with morally or ethically questionable intentions (Ex. Armed RPAS, spying,…)
Current Utilizations	4	Proposed RPAS Use case represents basic technology and utilization that is already used commonly by manned aerospace applications (Ex. Aerial photography, event

		security, care package drop,...)
	3	Proposed RPAS Use case represents non-basic technology and utilisation that is periodically used by manned aerospace applications (Ex. Crop spraying, border surveillance, forest fire support,…)
	2	Proposed RPAS Use case represents non-basic technology that is uncommonly used in manned aerospace applications but could feasibly be done with RPAS (Ex. Anti-poaching, search & rescue,...)
	1	Proposed RPAS Use case represents advanced technology that is typically unused in manned aerospace applications but could feasibly be done with RPAS (Ex. Radiation measuring,…)
	0	Proposed RPAS Use case with technology that is impossible to utilise with manned airspace; futuristic applications that should be presently ignored.
Safety	4	No "overflown" population. Potential RPAS failure due to loss of communication or ground signals would cause no damage to infrastructure of any kind (Ex. Firefighting, maritime aerial photography,…)
	3	Little to no "overflown" population. Potential RPAS failure unlikely to cause damage to ground infrastructure (Ex. Infrastructure surveillance)
	2	Some "overflown" population and/or some risk to infrastructure damage (Ex. Cinematic photography, crowd control monitoring,…)
	1	Substantial levels of "overflown" population and/or significant risk to infrastructure damage (Ex. Sporting event security, urban aerial photography,…)
	0	Unacceptable amounts of "overflown" population and severe risk of damage to infrastructure
TRL	4	8 or 9 (ready)
	3	6 or 7
	2	4 or 5
	1	Between 1 and 3
	0	0 (N/A)
Interference with Manned Airspace	4	No interference with manned airspace
	3	Very rare interference with manned airspace; interference only in select circumstances or when acknowledged accompaniment of manned vehicles (Ex. Wildfire support, Crime scene surveillance,…)
	2	Notable interference with manned airspace (ex. Many aerial photography applications, general or gratuitous surveillance,…)
	1	High levels of interference with manned airspace (Ex. Aerial-to-aerial cinematic photography, bird watching)
	0	Unfeasible levels of manned airspace conflict
VLOS vs BVLOS[3]	4	RPAS Uses that require nothing more than basic VLOS capabilities (Ex. Wind turbine monitoring, cinematic photography,…)
	3	RPAS Uses that almost exclusively utilise VLOS capabilities in unobstructed LOS scenarios (wildfire prevention surveillance, resource monitoring, border surveillance,…)

	2	RPAS that requires substantial amounts of BVLOS capabilities in day-to-day functions (pipeline infrastructure monitoring, illegal cultivation surveillance, search & rescue,…)
	1	RPAS Uses that almost exclusively utilise BVLOS capabilities
	0	RPAS Uses that require full BVLOS. Undesirable per FP7 regulations.
Weight Limit	4	RPAS weight range 1-25kg. Optimal performance with less fuel required, minimal damage in the event of a downed RPAS
	3	RPAS weight range 26-75kg
	2	RPAS weight range 76-125kg
	1	RPAS weight range 126-150kg. Sub-optimal performance with more fuel required to support less endurance. Significant potential damage from downed RPAS
	0	RPAS weight range > 150kg. Not considered within ULTRA scope
Environmental Impact	4	Obvious and unequivocal benefit to the environment (via greenhouse gas reductions, firefighting, toxin or pollutant removals,…)
	3	Benefits to the environment outweigh potential damage due to fuel combustion (Ex. Fire control monitoring, resource monitoring, natural disaster relief,…)
	2	Operations not necessarily environmentally friendly, but daily missions support environmental healthiness (Ex. Nuclear radiation detection, anti-poaching, crop management,…)
	1	Overall negligible effect on the environment. Operations are not focused on environmental friendliness, yet damage to the environment is also insignificant
	0	Harmful to the environment in any respect. Should be wary of any Use Cases with this ranking, as it is a direct affront to European initiatives like CleanSky.

Table 3 - Criteria Definition

2.5. Selection of "Quick Wins" Use Cases.

As a result from the above ranking over the identified preliminary use cases, those only being considered as potential quick wins with an attractive business case to the RPAS industry include:

Wind Energy Monitoring				
Facet	Rank (1-4)	Importance Weight (1-4)	Facet Score (Rank x Weight)	**Overall Score/100**
Social Acceptance	3	4	12	**82**
Current Utilisation[1]	4	4	16	
Safety (Population Flyover)	4	4	16	
TRL (S&A necessity, etc)[12]	2	3	6	
No Interference with manned airspace	4	3	12	
VLOS or BVLOS	4	3	12	
Environmental Impact	2	2	4	
Weight Limit (<150kg)[2]	4	1	4	

Wildfire Assistance (monitoring)				
Facet	Rank (1-4)	Importance Weight (1-4)	Facet Score (Rank x Weight)	**Overall Score/100**
Social Acceptance[5]	4	4	16	**81**
Current Utilisation	4	4	16	
Safety (Population Flyover)	3	4	12	
TRL (S&A necessity, etc)[12]	3	4	12	
No Interference with manned airspace	3	3	9	
VLOS or BVLOS	2	3	6	
Environmental Impact	3	2	6	
Weight Limit (<150kg)	4	1	4	

Wildfire Assistance (firefighting)				
Facet	Rank (1-4)	Importance Weight (1-4)	Facet Score (Rank x Weight)	**Overall Score/100**
Social Acceptance[5]	4	4	16	**78**
Current Utilisation[4]	2	4	8	
Safety (Population Flyover)	4	4	16	
TRL (S&A necessity, etc)[12]	2	4	8	

No Interference with manned airspace	4	3	12	
VLOS or BVLOS	3	3	9	
Environmental Impact	4	2	8	
Weight Limit (<150kg)	1	1	1	

Aerial Photography

Facet	Rank (1-4)	Importance Weight (1-4)	Facet Score (Rank x Weight)	**Overall Score/100**
Social Acceptance	2	4	8	**72**
Current Utilisation[9]	4	4	16	
Safety (Population Flyover)	2	4	8	
TRL (S&A necessity, etc)	4	4	16	
No Interference with manned airspace	2	3	6	
VLOS or BVLOS	4	3	12	
Environmental Impact	1	2	2	
Weight Limit (<150kg)	4	1	4	

Pipeline Monitoring (BVLOS)

Facet	Rank (1-4)	Importance Weight (1-4)	Facet Score (Rank x Weight)	**Overall Score/100**
Social Acceptance	2	4	8	**70**
Current Utilisation[6]	4	4	16	
Safety (Population Flyover)	3	4	12	
TRL (S&A necessity, etc)[12]	3	4	12	
No Interference with manned airspace	3	3	9	
VLOS or BVLOS	1	3	3	
Environmental Impact	3	2	6	
Weight Limit (<150kg)	4	1	4	

Illegal Cultivation Patrol (BVLOS)

Facet	Rank (1-4)	Importance Weight (1-4)	Facet Score (Rank x Weight)	**Overall Score/100**
Social Acceptance	3	4	12	**68**
Current Utilisation	4	4	16	
Safety (Population Flyover)	2	4	8	
TRL (S&A necessity, etc)[12]	3	4	12	
No Interference with manned	2	3	6	

airspace				
VLOS or BVLOS	2	3	6	
Environmental Impact	2	2	4	
Weight Limit (<150kg)	4	1	4	

Crop Spraying (Seeding)				
Facet	Rank (1-4)	Importance Weight (1-4)	Facet Score (Rank x Weight)	**Overall Score/100**
Social Acceptance	3	4	12	**69**
Current Utilisation[11]	3	4	12	
Safety (Population Flyover)	4	4	16	
TRL (S&A necessity, etc)[12]	2	4	8	
No Interference with manned airspace	2	3	6	
VLOS or BVLOS	3	3	9	
Environmental Impact	2	2	4	
Weight Limit (<150kg)	2	1	2	

Crop Spraying (Fertilizing)				
Facet	Rank (1-4)	Importance Weight (1-4)	Facet Score (Rank x Weight)	**Overall Score/100**
Social Acceptance	2	4	8	**59**
Current Utilisation[11]	4	4	16	
Safety (Population Flyover)	2	4	8	
TRL (S&A necessity, etc)[12]	2	4	8	
No Interference with manned airspace	2	3	6	
VLOS or BVLOS	3	3	9	
Environmental Impact	1	2	2	
Weight Limit (<150kg)	2	1	2	

Organ Transplant Delivery (BVLOS)				
Facet	Rank (1-4)	Importance Weight (1-4)	Facet Score (Rank x Weight)	**Overall Score/100**
Social Acceptance	4	4	16	**66**
Current Utilization	4	4	16	
Safety (Population Flyover)	1	4	4	
TRL (S&A necessity, etc)	4	4	16	
No Interference with manned airspace	2	3	6	

VLOS or BVLOS	1	3	3	
Environmental Impact	1	2	2	
Weight Limit (<150kg)	3	1	3	

Search and Rescue				
Facet	Rank (1-4)	Importance Weight (1-4)	Facet Score (Rank x Weight)	**Overall Score/100**
Social Acceptance	4	4	16	**70**
Current Utilisation[10]	4	4	16	
Safety (Population Flyover)	3	4	12	
TRL (S&A necessity, etc)[12]	2	4	8	
No Interference with manned airspace	3	3	9	
VLOS or BVLOS	1	3	3	
Environmental Impact	1	2	2	
Weight Limit (<150kg)	4	1	4	

Table 4 – Use Case Ranking

3. SELECTION OF USE CASES

Based on the above identification of RPAS use cases and using the described metric and ranking system in 2.4, the following RPAS use cases have been selected as part of the ULTRA study to be the most relevant and realistic operations. These uses cases are described at a high level and will need to be specifically detailed in the next stages to understand their business case and economic viability as well as the socio-economic impact on industry.

3.1. Use Case 1: Aerial photography & Video

RPAS allows a new dimension of aerial photography and video. From an operational aspect, they allow to shoot aerial photos and videos at very low altitudes not possible with conventional methods based on dolly cams, jibs and cranes or even manned helicopters; Furthermore, the miniaturization of professional image sensors can be carried onboard of small RPAS, often with costs over EUR 40.000 for the camera head only.

These new capabilities waked up a huge demand for professional close range very low altitude aerial shots. E.g. Harry Potter, 007 Skyfall, Hancock are only the tip of the movie iceberg that have used R/C helicopters. Large demand exists for low altitude photographing and video recording that is too precarious for manned helicopters. From a business perspective 90% of aerial video operators are small companies composed by video operators and R/C pilots without any aviation skills. In addition, aerial photography and video revenue is still quite high, with tendency to lower soon due the overflowing of offering by mushroom style popping up companies. Radio Controlled Multi-rotor/helicopter market is exploding, ranging for few thousands up to 50.000 EUR.

Figure 4 – RPAS Rotorcraft used in Aerial photography (source: a2tech.eu)

Table 1 below gives an overview of the main operational characteristics involved in RPAS flights for aerial photography use case.

RPAS mode of operation:	VLOS
Duration of the RPAS operation:	Multiple flight tasks of 10 - 20 min each
Physical characteristics of the RPAS:	Electric driven multi-rotor up to 15 kg MTOW; Electric/gasoline driven helicopter up to 25 kg MTOW
RPAS flight performance:	Electric driven flight time of up to 20 min; gasoline driven flight time of up to 60 min
Other airspace user:	N/A
Weather restrictions:	Rain limited; very low temperature limited
C2 characteristics:	Hand held standard R/C controller; 2.4 GHz
Detect & avoidance capabilities:	N/A
Collision avoidance capabilities:	Pilot skills against building & structures
Communication, navigation & surveillance:	N/A
Airspace classifications:	Class G
Flight rules:	VFR; VMC
Populated areas:	Low to urban density if recovery parachute is available; segregated ground area
Pilot qualification:	VLOS FCL
ATM requirements:	N/A
Fail safe:	Loss of link, battery/fuel threshold monitoring, panic button
Flight termination:	Pneumatic/spring loaded recovery parachute with max 6 m/s descent rate

Table 5 - Aerial Photography Operational Characteristics

3.2. Use Case 2: Wind energy monitoring

Wind energy generation is booming. The world´s wind power capacity grew by 31% in 2009. The global wind market for turbine installations in 2009 was worth about 45 billion EUR or 63 billion US$. (Source GWEC) Europe has 96.606 MW wind power capacity installed by end of 2011, the largest total amount in the world. (Source GWEC) Wind turbine inspection is perfect for RPAS, it doesn't get in conflict with manned aerial work.

Inspection of on-shore wind farms are an expensive and dangerous job. Wind farms are composed by a small (5) to a high (100) numbers of wind turbines. A large number of wind turbines are installed around the globe. E.g. only the zone of Andalucia in Spain counts an active installation of 1.995 wind turbines. Spain itself counts 902 wind farms, Germany 3.688 wind farms.

From a business demand perspective 143 wind turbine manufacturer are looking for lower cost, faster and safer inspection modes. The link http://en.wikipedia.org/wiki/List_of_wind_turbine_manufacturers shows the Top 10 turbine manufacturers by annual market share.
Europe wind energy capacity is 94.084 MW and there is growing demand for high professional maintenance personnel.

Companies such as VisioDrones, France provide wind turbine blade inspections by RPAS - http://www.visiodrones.com/produits/

Figure 5 – Wind Energy monitoring by RPAS (source: microdrones.com)

Table 2 below gives an overview of the main operational characteristics involved in RPAS flights for wind energy monitoring use case.

RPAS mode of operation:	VLOS; BLOS
Duration of the RPAS operation:	multiple flight tasks of 10 - 20 min up to few hours each
Physical characteristics of the RPAS:	Electric driven multirotor up to 8 kg MTOW; Electric/gasoline driven helicopter up to 25 kg MTOW
RPAS flight performance:	electric driven flight time of up to 20 min; gasoline driven flight up to few hours
Other airspace user:	N/A
Weather restrictions:	rain limited; high wind gusts limited
C2 characteristcs:	Hand held standard R/C controller, BackPack GCS, Van based GCS; 2.4 GHs, 868 MHz
Detect & avoidance capabilities:	N/A
Collision avoidance capabilities:	pilot skills against turbine structure
Communication, navigation & surveillance:	Waypoint navigation for automatic turbine approach
Airspace classifications:	Class G
Flight rules:	VFR; VMC
Populated areas:	N/A
Pilot qualification:	VLOS and BLOS FCL
ATM requirements:	N/A
Fail safe:	Loss of link, battery/fuel threshold monitoring, panic button
Flight termination:	Pneumatic/spring loaded recovery parachute with max 6 m/s descent rate

Table 6 – Wind Energy Monitoring Operational Characteristics

This project has been carried out under a contract awarded by the European Commission

3.3. Use Case 3: Disaster Management & Fire fighting assistance

RPAS may bring some benefits, in situations involving damage assessment after natural or man-made disasters; these situations require in many circumstances low height aerial imaging where manned aircraft can´t operate; is VLOS.

Fire fighters and Civil defence have a need for low cost, low altitude and close range Point of Interest view for damage assessment, and logistic assistance. RPAS allows to fly-in in dangerous zones and building without creating moistures and danger shock waves, usually created by full size helicopter blades.

Highly man transportable and extreme ruggedized systems are mandatory to secure a safe and useful operation.

Highly skilled personnel with excellence communication skills are requested in order to smoothly integrate RPAS operations in the operational workflow.

If operated in environments with an explosive atmosphere, ATEX certification of the RPAS is required.

This particular use case brings excellent social acceptance, which is a factor to consider when using RPAS in civil operations.

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Figure 6 – Fire fighting assistance using RPAS (source:Unvex12.com)

Table 3 below gives an overview of the main operational characteristics involved in RPAS flights for fire fighting operations.

RPAS mode of operation:	VLOS
Duration of the RPAS operation:	multiple flight tasks of 10 - 20 min up to few hours each
Physical characteristics of the RPAS:	Electric driven multi-rotor up to 8 kg MTOW; Electric/gasoline driven helicopter up to 25 kg MTOW
RPAS flight performance:	electric driven flight time of up to 20 min; gasoline driven flight up to few hours
Other airspace user:	SAR, law enforcement, news gathering helicopters
Weather restrictions:	All weather capability requested
C2 characteristics:	Hand held standard R/C controller, Back-Pack GCS, Van based GCS; 2.4 GHs, 868 MHz
Detect & avoidance capabilities:	Flash lights, navigation lights
Collision avoidance capabilities:	Onboard ADS-B Out; GCS with ADS-B In
Communication, navigation & surveillance:	VHF & UHF communication
Airspace classifications:	Class G
Flight rules:	VFR; NVFR; VMC
Populated areas:	low to urban populated
Pilot qualification:	VLOS FCL
ATM requirements:	Emergency Operation Center coordination
Fail safe:	Loss of link, battery/fuel threshold monitoring, panic button
Flight termination:	Pneumatic/spring loaded recovery parachute with max 6 m/s descent rate

Table 7 – Disaster Management & Fire fighting Operational Characteristics

This project has been carried out under a contract awarded by the European Commission

3.4. Use Case 4: Pipeline & Power line inspection

This type of application is already happening using existing technologies. There is a huge market: Utilities (Oil, Gas, and Electricity) and infrastructure companies. There is a need for cost effective solutions, provision of reliable and timely accurate data as well as capability for rapid deployment and enhanced safety. BLOS missions could be considered for monitoring, inspection, survey and mapping and possibly communications relay.

From a cost benefit perspective Pipeline & Power line inspection and monitoring are considered the most remunerative industrial application for long range RPAS operations. RPAS operation must be cost effective compared to manned operations.
Customer requests are to perform few hundred km at single flight, multiple flight tasks at day.

Figure 7 - Inspection of oil/gas pipelines [Source: IDEAS Project Final Report (EDA Project)]

From an operational perspective BLOS operation mode with IFR flight plan and NOTAM is requested. Typically the payload for inspection and monitoring is based on thermal, E/O and LIDAR and collision avoidance as well as detect & avoid must be based on cooperative solutions.

RPAS mode of operation:	VLOS take-off and landing; BLOS
Duration of the RPAS operation:	multiple flight tasks few hours each
Physical characteristics of the RPAS:	Gasoline driven multi engine fixed-wing up to 150 kg MTOW
RPAS flight performance:	Cruise speed 50-100 km/h; cruising altitude not less that 500 ft AGL
Other airspace user:	General aviation
Weather restrictions:	Rain limited
C2 characteristics:	Van based GCS; 2.4 GHs, 868 MHz for take-off and landing; SAT link for BLOS
Detect & avoidance capabilities:	Flash lights, navigation lights, Flare
Collision avoidance capabilities:	Onboard ADS-B Out; GCS with ADS-B In; TCAS
Communication, navigation & surveillance:	VHF & UHF radio communication; waypoint navigation; ELT; Iridium link; 2G/3G link
Airspace classifications:	Class G
Flight rules:	IFR
Populated areas:	low to urban populated
Pilot qualification:	BLOS FCL
ATM requirements:	NOTAM; automatic air call
Fail safe:	Loss of link, battery/fuel threshold monitoring
Flight termination:	Pneumatic/spring loaded recovery parachute with max 6 m/s descent rate

Table 8 – Pipeline & Power Line Inspection Operational Characteristics

4. PRIORITIZE AND VALIDATE USE CASE SELECTION

As part of the work conducted in the identification and selection of use cases, ULTRA's work in identifying and selecting promising quick wins use cases was validated through market research and gaining insight on current and foreseen operations.

ULTRA participated at the RPAS Civ. Ops Conference- December 4-5, Brussels, Belgium. This conference, organized under the auspices of UVS International, in cooperation with the Royal Military Academy, is positioned as the European Civil RPAS Operators' Forum, and endeavours to bring the international civil RPAS operators' community together.

The conference main objectives include the increase of awareness to currently on-going civil RPAS operations, highlighting the diversity of potential applications and presenting relevant business case examples. Furthermore, the conference was an opportunity to bring civil RPAS operators, manufactures, industry, regulatory and R&D stakeholders together to discuss the future for civil RPAS operations.

ULTRA gained operational insight from the users and operators in the RPAS community to better understand business and operational requirements.

A few examples of the type of operations being presented and promoted at the conference, which served to prioritize and validate the ULTRA use case selection, included:

i) Wind Turbine Blade Inspections by RPAS –VisioDrones, France.

ii) Using RPAS to fight forest fires – NitroFirex, Spain.

iii) Rapid Response – CybAero, Sweeden.

iv) RPAS employment in the oil, gas & energy industries – CyberHawk Innovations, UK.

v) Use of RPAS for oil spill monitoring – Northern Research Institute, Norway.

vi) RPAS applications for disaster management – National University of Public Service, Hungary.

vii) RPAS for Mapping – EDF Energy, UK

viii) Support crisis/disaster management – Airbeam Project Consortium (VITO), Belgium

ix) RPAS scenarios for search and rescue – ICARUS consortium, Belgium

5. CONCLUSIONS AND CONSIDERATIONS

In summary, the report gives a sense of the myriad of potential RPAS civil use cases which are currently or shortly foreseen to be in demand.

The main RPAS civil use cases and topics being currently looked at by the European community and where there may be a potential business case in the short term include:

- Monitoring & Inspection (Wind turbine, Pipe Line, Oil & Gas & Energy industry)
- Disaster Management, Search and rescue (Fire fighting)
- Aerial Photography (Cinema industry, archeology, nature reserve monitoring, Real estate, advertising…)

Today most of the RPAS operations are done without any regulation and rules in place. Aerial work companies' requests to put RPAS on the same equivalent level as manned aircrafts are. An important part to make this happen is to show the potential business case and economic viability for RPAS usage.

Following on from this work, and having identified and selected potential quick wins RPAS civil use cases, ULTRA deep dives into each of the use cases as part of the next WP4 stage. Further work planned under WP4, requires a detailed deployment plan for each use case to be be developed. The plan will consider the inputs and work generated by the various ULTRA work packages in relation to regulation compliance, safety assessments, technology availability and tactical operations plan. This work will serve as the basis for analyzing both the economical viability of each deployment plan in terms of economic sustainability as well as the potential impact of the proposed plans on the European industry.

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