Welcome

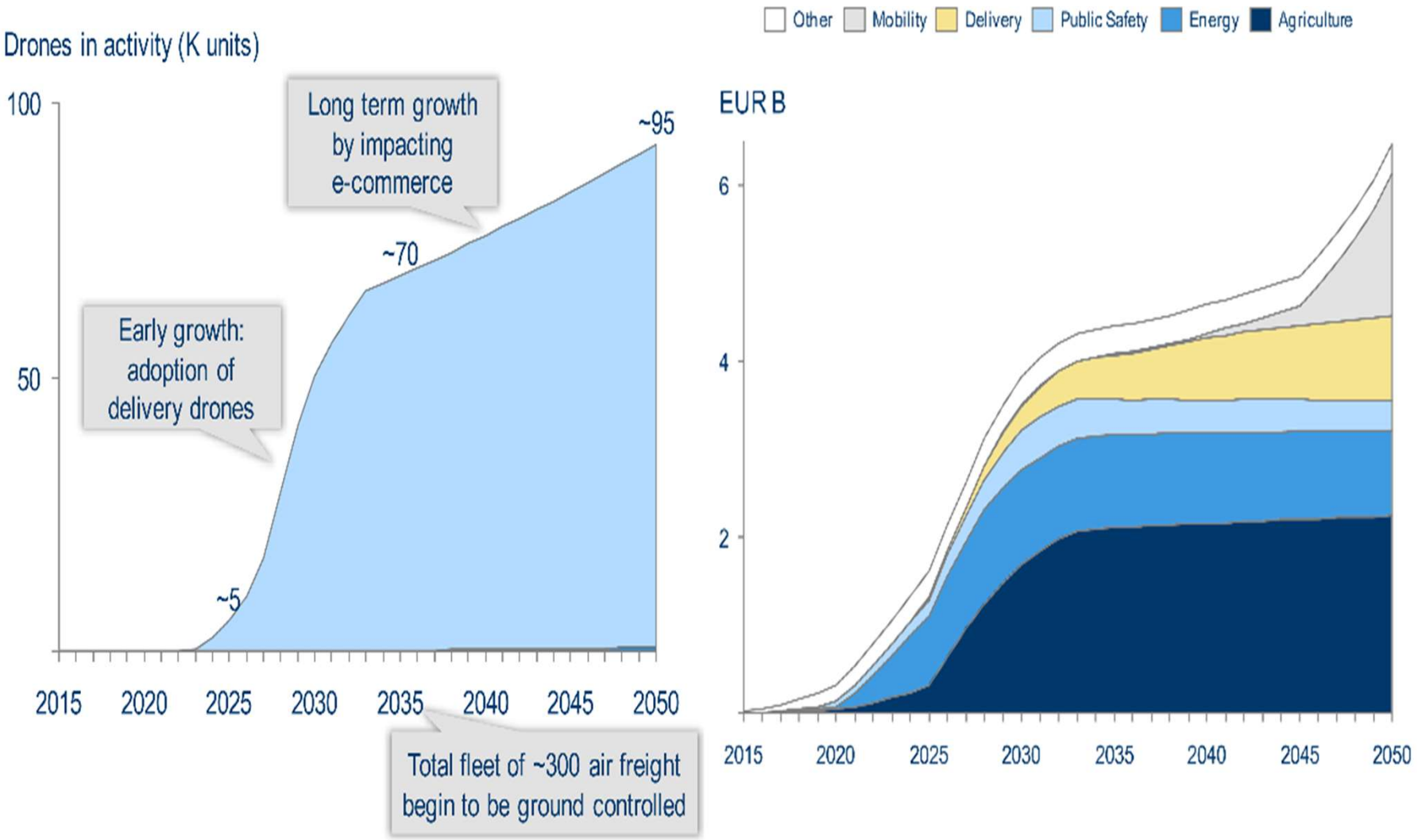
CORUS dissemination

30th September, 2019

Philippe Merlo
Director DECMA
EUROCONTROL

This project has received funding from the SESAR Joint Undertaking under grant agreement 763551
under European Union's Horizon 2020 research and innovation programme.

Drones: many promises, ambitions, expectations



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Materialise Warsaw U-Space declaration

"U-Space" emerges

24 November 2016

MINISTRY OF INFRASTRUCTURE AND CONSTRUCTION

EASA European Aviation Safety Agency

CIVIL AVIATION AUTHORITY

WARSAW DECLARATION

"Drones as a leverage for jobs and new business opportunities"

Warsaw - 24 November 2016

develop operational concept

full participation by whole EU drone community

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CORUS Cooperation framework

U-space Community Network, 500+ members

CORUS advisory board; 21 organisations

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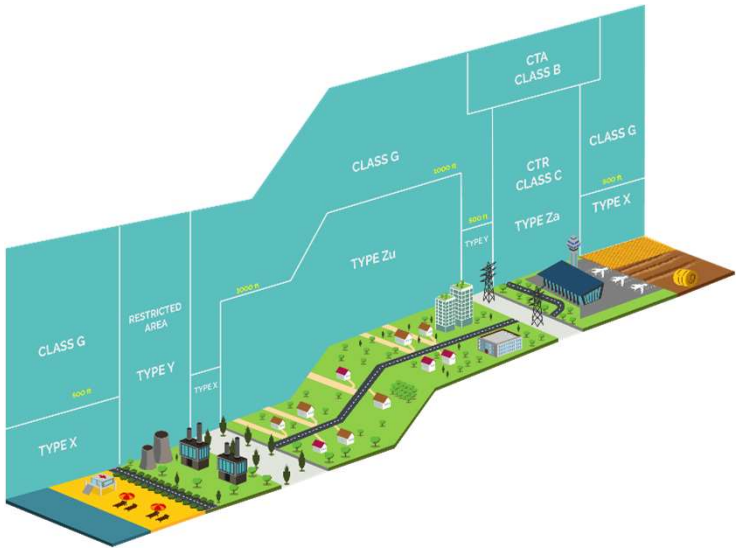
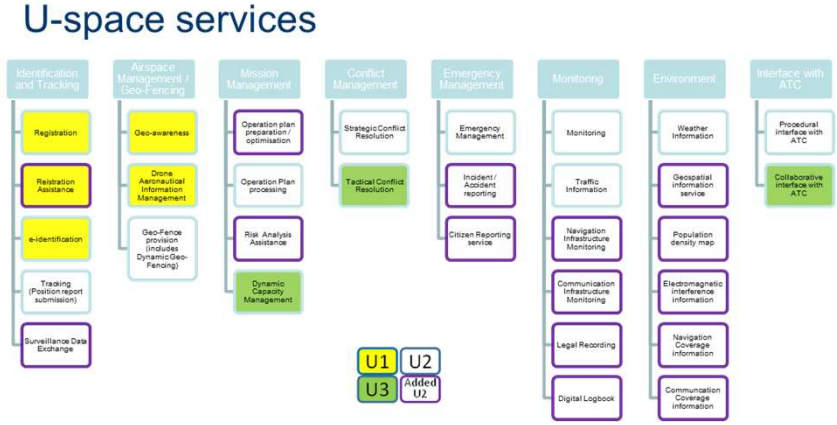
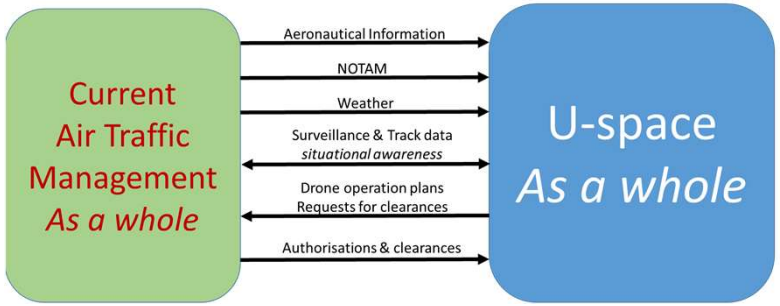
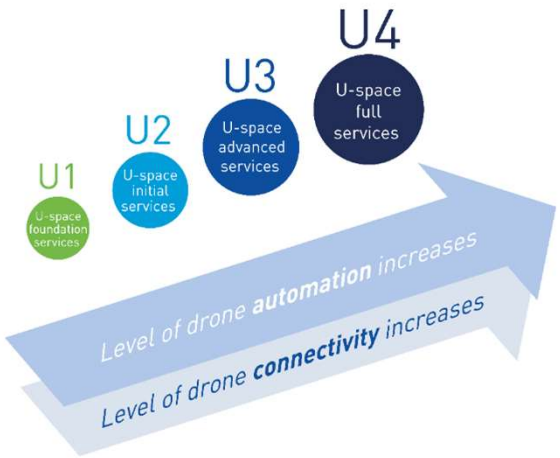
Foundations of U-Space Conops





Connection U-Space / ATM





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Other CORUS interests

Integration with manned aviation

Public Acceptance of Drones

Regulatory environment for Drones

The way forward

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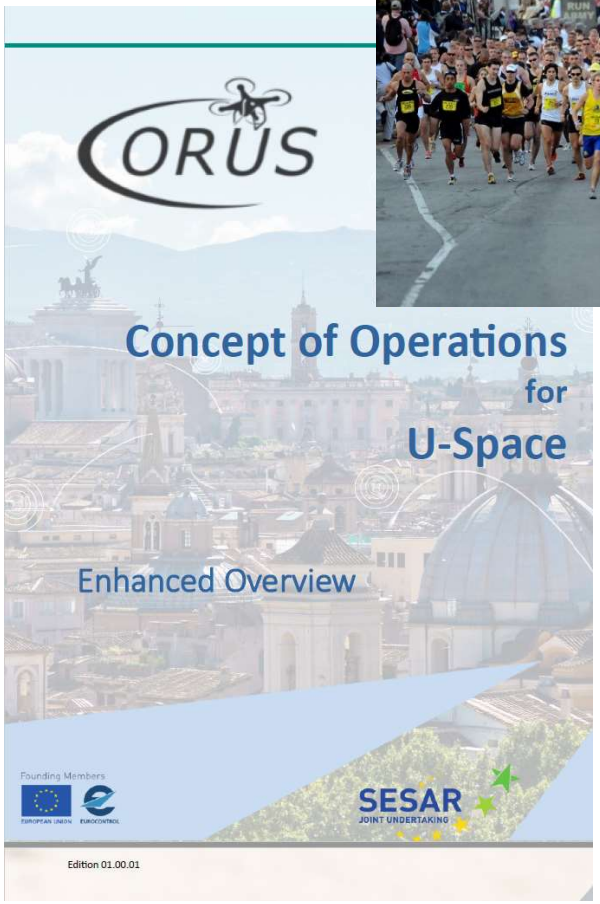
CORUS next steps ?



SESAR JOINT UNDERTAKING

EASA
European Union Aviation Safety Agency

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EUROCONTROL

ORUS

THANK YOU

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U-space Concept of Operations

An overview

Andrew Hately
CORUS technical coordinator
30th September 2019

The CORUS project very briefly

- SESAR2020 Exploratory Research project
- 9 consortium members
- 21 member advisory board
- 70+ cooperating organisations in
  - 8 “sibling” projects simultaneously explore technology questions
  - 10 related demonstration projects
- 500+ member U-space Community Network

- CORUS has run three large workshops
  - 100+ attendees at each
  - With diverse interests
  - Coming from far and wide

- CORUS seeks to develop a Concept of Operations for U-space
  - Which enables a wide range of UAS uses
  - Which will accommodate the level of traffic today and in that expected in the future
  - Which takes on board the best ideas from around the world
  - Which is accepted by a wide range of stakeholders

- CORUS has made three iterations of the ConOps.
- Today we present the final, finished version

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What has changed since the previous version – *the quick guide*

- We've aligned ourselves with European regulations
  - Categories of flight
  - SORA terminology for ground & air risk
  - Geo-awareness
  - Remote ID in two forms
- We've removed the half-baked stuff
  - Virtue points, automation
  - Rules of the air
  - U4 and integration with manned aviation
- Lots of areas have been revised
  - MEDUSA is further described
  - We take account progress in the field
- The documents are easier to read
  - We've clarified lots of things
  - We are more conscious of what we want to say
  - There is less repetition
- A number of Annexes have been improved
  - Brought up to date
  - More examples
- We've been working hard on the EATMA portal
  - There is much more material to explore interactively
  - ...while we remain agnostic about deployment choices

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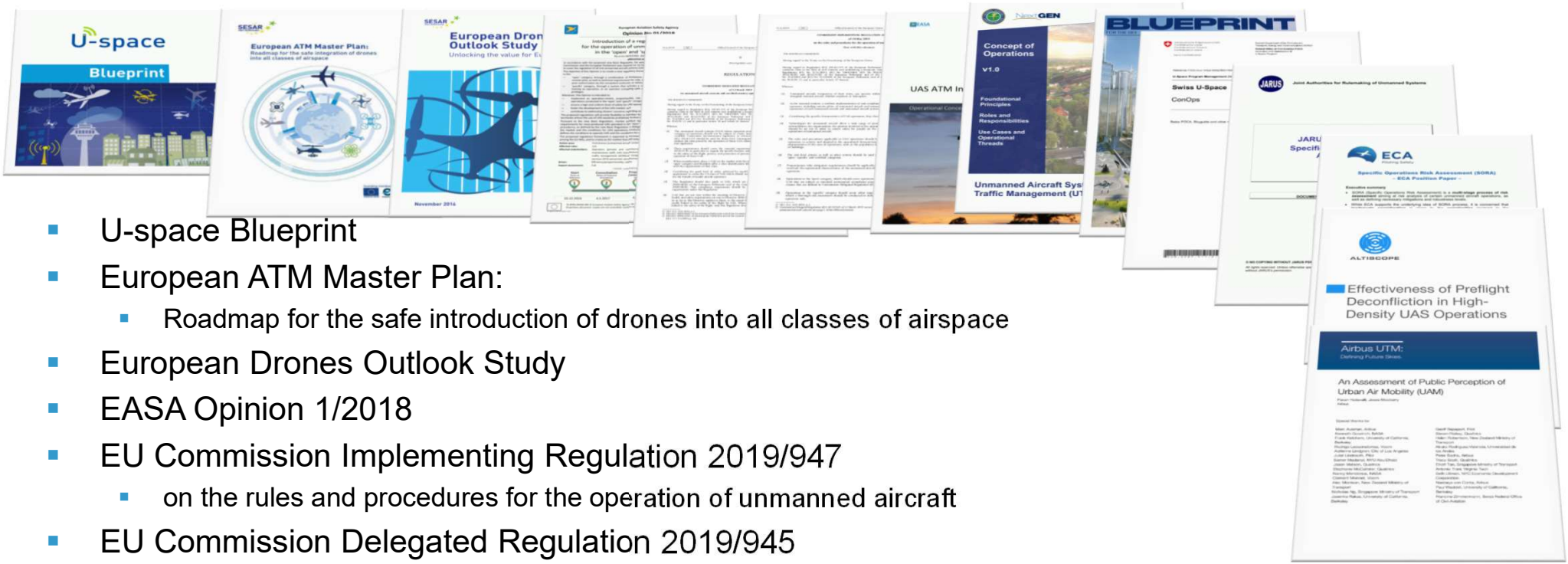
CORUS input documents



- U-space Blueprint
- European ATM Master Plan:
  - Roadmap for the safe introduction of drones into all classes of airspace
- European Drones Outlook Study
- EASA Opinion 1/2018
- EU Commission Implementing Regulation 2019/947
  - on the rules and procedures for the operation of unmanned aircraft
- EU Commission Delegated Regulation 2019/945
  - on unmanned aircraft intended for use in the ‘open’ category, and on third-country operators of unmanned aircraft systems
- EASA / EUROCONTROL UAS ATM Integration Operational Concept
- and more…

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Stakeholder inputs

- The first workshop aimed to find our what users want from U-space.
  - The workshop ran as a series of rooms each presenting a theme, asking the audience specific and general questions
  - The audience visited the rooms in small groups
  - Hundreds of inputs were received, analysed and clustered

- The second workshop presented the initial U-space ConOps and invited comment
  - Again a series of theme-rooms were used and these were visited by small groups.
  - Again hundreds of inputs were received, analysed and clustered.

- Before the third workshop, the intermediate version of the conops was sent for comment
  - More than 1000 comments were received, sorted, grouped and analysed.
  - Some could be acted on immediately, others needed discussion.
  - The third workshop allowed these comments to be discussed – and further comments captured

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CORUS project organisation

- Four ‘content’ work packages:
  - WP2: Operations & UTM Requirements
  - WP3: Contingency & Constraints
  - WP4: Societal and Institutional
  - WP5: Architecture & Solutions
- Four ‘supporting’ work packages:
  - WP1: Project management
  - WP6: ConOps Integration
  - WP7: Communications & Dissemination
  - WP8: Ethics
- The presentations today are organised in these work packages

Start	Subject	Work package
09:45	ConOps Overview	WP6
10:20	Problem Statement	WP2
10:45	**Coffee**	
11:10	U-space services	WP2
11:40	Airspace Structure	WP2
12:10	**Lunch**	
13:15	Society	WP4
13:55	Safety	WP3
14:30	Contingency	WP3
14:45	Accident and Incident reporting	WP3
15:10	**Tea**	
15:45	Architecture	WP5
17:00	Outlook	WP1
17:15	Closing remarks	WP1
17:30	**Networking drink**	WP7

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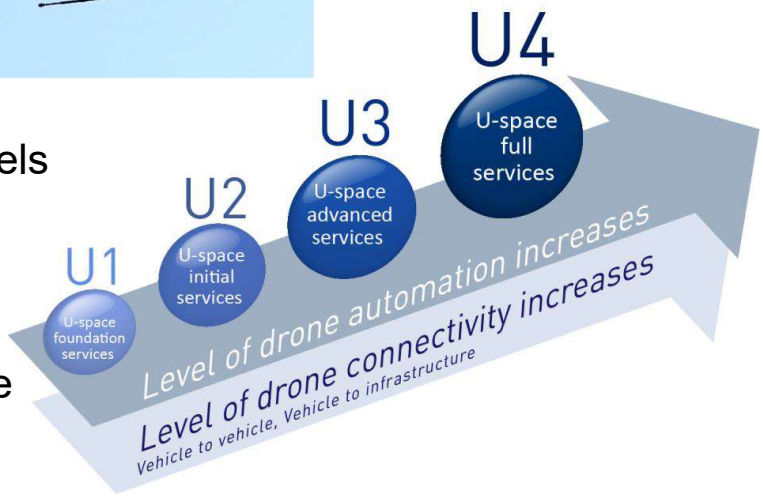
CORUS scope



- U-space is initially concerned by VLL
  - = below VFR, but including CTR
- U-space can be thought of as serving small drones
  - In fact it serves anything flying in the volume
- CORUS inherits the definition of U-space in services and levels
  - From Blueprint and Roadmap
  - Although services may appear when ready
- CORUS considers a much higher traffic level than now
- CORUS initially describes a way of working in the reasonable cases
  - then works towards the more difficult situations
- CORUS main concern is traffic management
  - Avoiding conflict
- CORUS makes very few assumptions about technology
- CORUS defines an architecture top-down
  - The sibling projects explore the same architecture bottom-up

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ConOps Structure

- Volume 1: Enhanced Overview
  - Everything, briefly.
- Volume 2: Reference Manual
  - The details of the Operational Concept
- Volume 3: Annexes
  - Examples
  - Subjects not covered in Vol 2
  - More details on some topics

Annexes:

A. Use-cases
B. Requirements
C. SORA examples
D. MEDUSA process and example
E. A list of threats and events
F. Safety occurrence reporting
G. Examples of contingency plans
H. Social acceptance indicators
I. Best practice for Drone Operators
J. A snapshot of the current regulations in Europe
K. U-space architecture
L. Usage model

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ConOps Vol 2 Structure

1. Summary
   - About the CORUS project
2. Background Framework, Assumptions
   - Relation with the framing regulation
   - Safety, the risk approach, SORA
   - U-space, Area of interest of VLL U-space
   - Assumptions & definitions
   - Overall Approach
   - High level principles
3. Airspace rules and procedures
   - Volumes
   - Operational Practice
   - Spacing & Conflict Resolution
4. Safety & Social aspects
   - Privacy, Confidentiality and Electronic conspicuousness
   - Contingency, Accident and Incident Investigation
   - Uncooperative Drones, Cyber security of U-space
   - Best practices
5. U-space Services and High Level Architecture
6. Terms and acronyms, References

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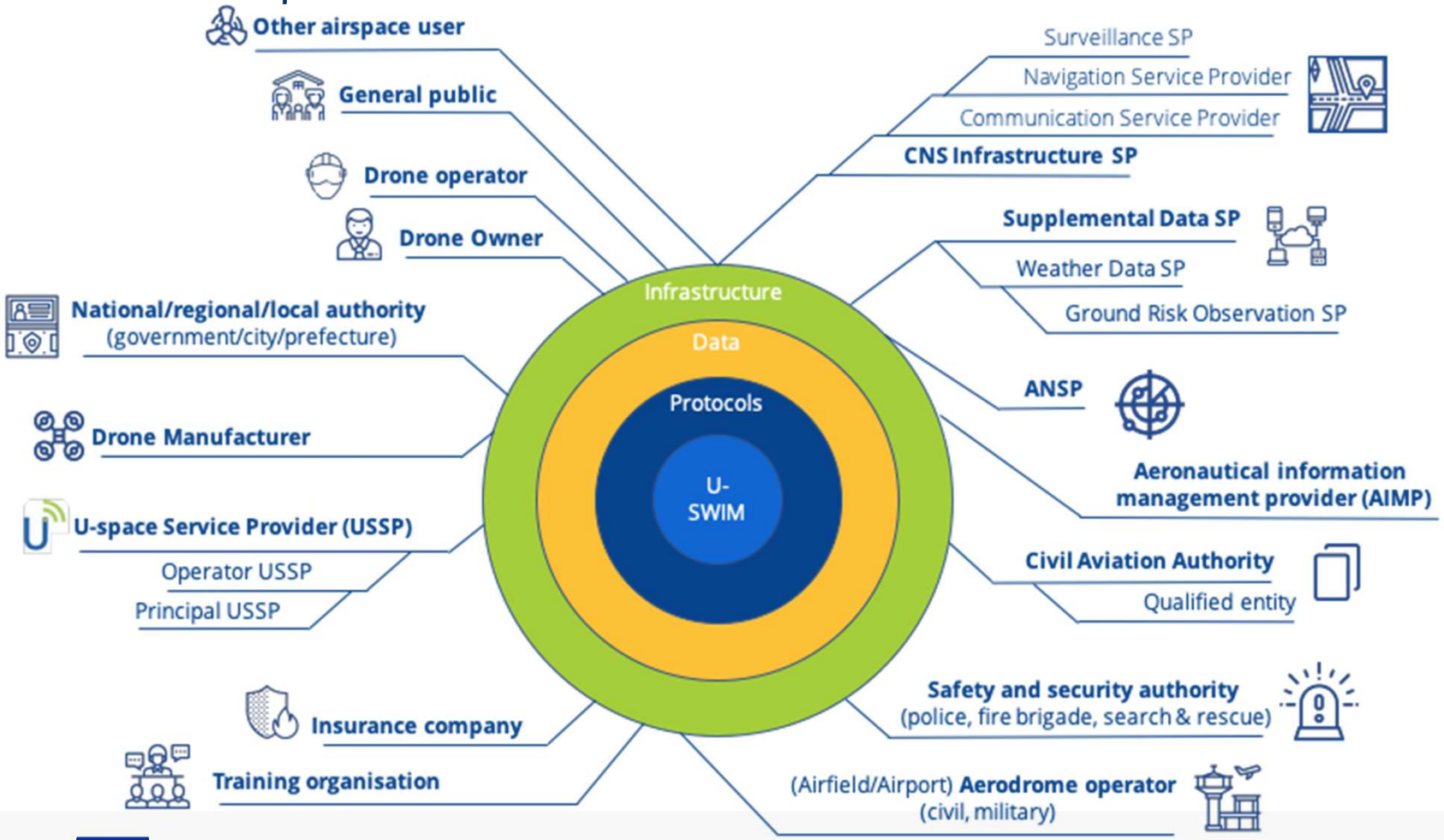
What is U-space ?



U-space is a set of services

Principles:

Safety first

Open market

Social acceptance

Equitable access

ECAC wide

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Operations

EASA Categories

- Open:
  - Little training of pilot
  - Limitations on aircraft
  - Limitations on where the flight can take place
- Specific
  - Risk assessment & Mitigation required per flight
  - Trained Pilot
- Certified
  - As current manned operations
  - Certificate of air worthiness for aircraft
  - Certified pilot
  - Operator's certificate

CORUS Use Cases – *illustrative, not exhaustive*

- Photo activity
- Farming activity
- Building inspection
- Vineyard fungicide spraying
- Seed sowing
- Police surveillance
- Recreational activity
- Runway inspection
- ILS measurement

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Airspace Volumes

- Focus on VLL
- All VLL is divided into
- X, Y and Z volumes
- X = low risk
- Y = higher risk
  - Access only with approved operation plan
  - Specific technical requirements per volume
- Z = highest risk
  - Access only with approved operation plan
  - Za = ATC controlled airspace
  - Zu under U-space

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Airspace and Conflict Resolution

- X:
  - No conflict resolution
  - Enables VLOS
  - Pilot remains responsible to remain well clear
- Y:
  - Approved flight plan required
  - Conflict resolution before take off
  - Usually:
    - Position reporting required
    - Information given to pilot during flight
      - Conformance & Geo-awareness
      - Warnings & Traffic information
  - Y airspace may not have these if primary goal is to manage access
    - National park
- Z:
  - Conflict resolution before flight **and** in flight
  - Requires tracking
    - Separation minima in function of system perfomance
  - Za
    - ATC controlled airspace, e.g airport
    - U-space provides
      - Situational awareness to ATC
      - Communication tools
      - Standard ways of working
  - Zu
    - U-space (software) provides conflict resolution during flight, from the ground

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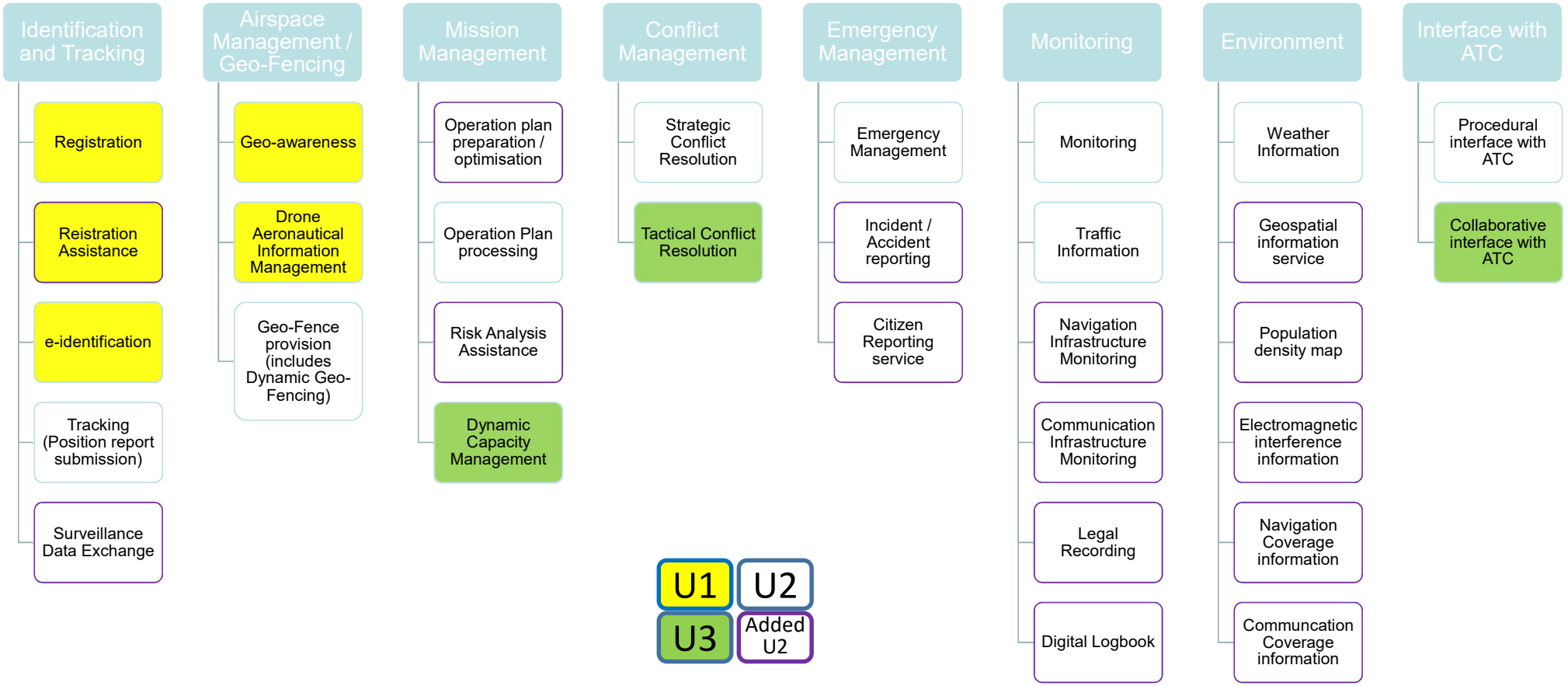
U-space Services



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Safety considerations

Annex C - SORA example

3.1 Ground Risk Class (GRC)

The GRC is determined based on the largest dimension of the drone on the one hand and the operational scenario on the other, the latter being defined by the way of operation (VLOS or BVLOS) and the operational environment. The corresponding values are provided in a table in the range from one to eleven, whereby a high GRC correlates with a high risk.

Max UAS characteristics dimension	1m / approx. 3ft
Typical kinetic energy expected	<700J (approx. 529ft lb)
Operational scenario	
BVLOS over populated environment	5

3.2 Harm Barriers for GRC

SORA offers several opportunities to mitigate the Ground Risk. The robustness of the offered mitigations must be chosen from a list and allows correcting the initial GRC. A rationale is needed to justify the chosen robustness, except for "Low/None". If the operator can offer additional mitigations, he can add them to a list, allocate robustness and give a rationale. In these cases an entitled entity has to review the additional mitigations.

Harm barriers for GRC adaptation	Robustness	*Rationale*	*Correction Factor*
An Emergency Response Plan (ERP) is in place, operator validated and effective	High	It can be assumed, that the pharmacy has terms and conditions to comply with, thus having an ERP is one of them.	-1
Effects of ground impact are reduced (e.g. emergency parachute, shelter)	High	Since the drone is flying over populated area a parachute should be obligatory.	-2
Technical containment in place and effective (e.g. tether)	Low/None	N/A	0

3.3 Air Risk Class (ARC)

The ARC reflects the probability of encountering manned aviation, which is chiefly dependent on the operational airspace. However, the collision risk of a local operational volume might deviate from this assignment. If the classification is too stringent or if mitigations are in place, the ARC can be

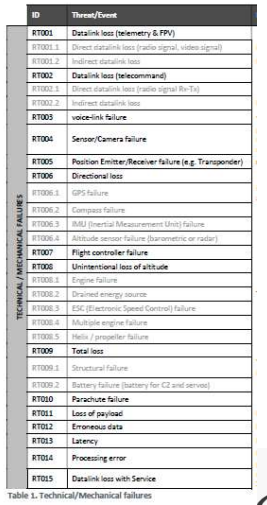
Annex E - list of Threats and Events

Annex F - Safety Occurrence Reporting

Threats & Events

- Drone
  - Technical / Mechanical failures
  - Meteorological / Environmental event
  - Human / Operational
  - Security

U-Space



ID	Threat/Event
RT001	Datalink loss (telemetry & FPV)
RT001.1	Direct datalink loss (radio signal, video signal)
RT001.2	Indirect datalink loss
RT002	Datalink loss (telecommand)
RT002.1	Direct datalink loss (radio signal Rx-Tx)
RT002.2	Indirect datalink loss
RT003	voice-link failure
RT004	Sensor/Camera failure
RT005	Position Emitter/Receiver failure (e.g. Transponder)
RT006	Directional loss
RT006.1	GPS failure
RT006.2	Compass failure
RT006.3	IMU (Inertial Measurement Unit) failure
RT006.4	Altitude sensor failure (barometric or radar)
RT007	Flight controller failure
RT008	Unintentional loss of altitude
RT008.1	Engine failure
RT008.2	Drained energy source
RT008.3	ESC (Electronic Speed Control) failure
RT008.4	Multiple engine failure
RT008.5	Helix / propeller failure
RT009	Total loss
RT009.1	Structural failure
RT009.2	Battery failure (battery for C2 and servos)
RT010	Parachute failure
RT011	Loss of payload
RT012	Erroneous data
RT013	Latency
RT014	Processing error
RT015	Datalink loss with Service

TECHNICAL / MECHANICAL FAILURES

Table 1. Technical/Mechanical failures

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Best practices

- General responsibilities of drone operators
- Manned aircraft & people on the surface
- Training and Proficiency
- Security and privacy
- Environmental Issues

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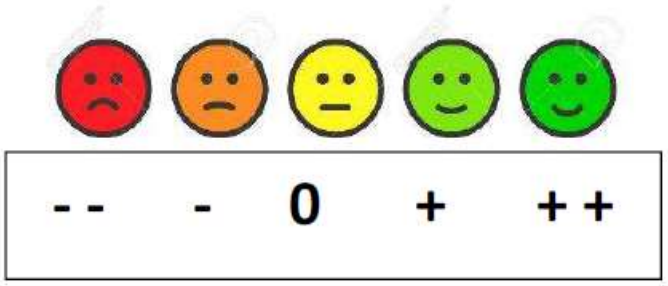
Social Acceptance Indicators

- Safety indicators — Benefits/risks that drones pose to airspace users / people on ground
- Economic indicators — Economical expectations of the new emerging drone market
- Political indicators — Includes noise, privacy, visual impact environmental considerations



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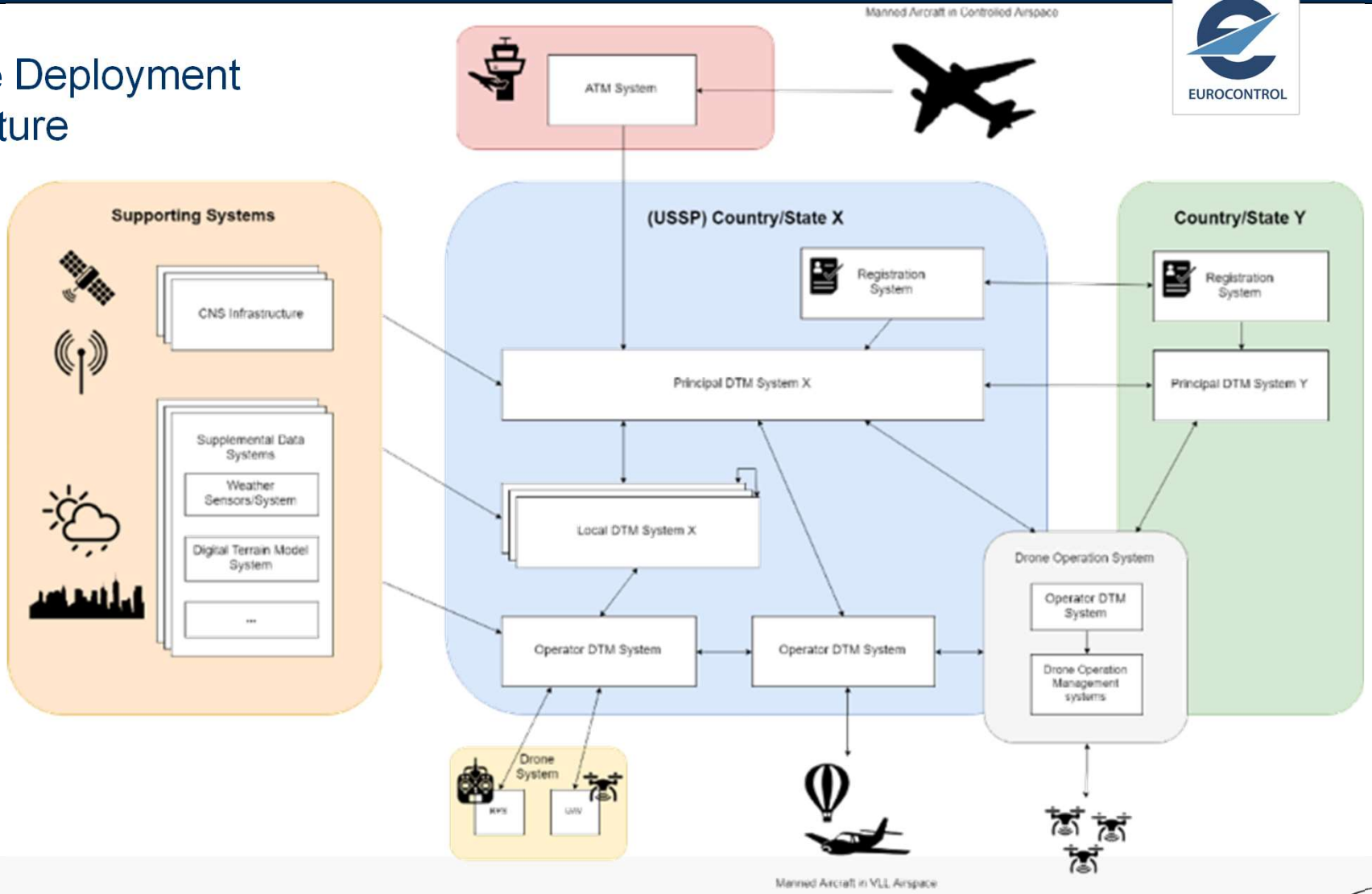
Possible Deployment Architecture



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The ConOps is available for download today

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The need for U-space

Problem statement

U-space CONOPS and research dissemination conference in Brussels, 30th of September 2019

Introduction

"UAVs are tackling everything from disease control to vacuuming up ocean waste to delivering pizza, and more."

from:
38 ways drones will impact society: from fighting war to forecasting weather, UAVs change everything
https://www.cbinsights.com/research/drone-impact-society-uav/

Contents

- The context
- The assumptions
- The challenges

The context

Drones applications

Aircraft inspection

Armed drone

Taxi drone

Agricultural work

Package delivery

ILS inspection

Leasure

Activities in VLL

Incidents

A passenger jet pilot swerved to avoid drone near Gatwick Airport
edition.cnn.com

Dayton Research Institute

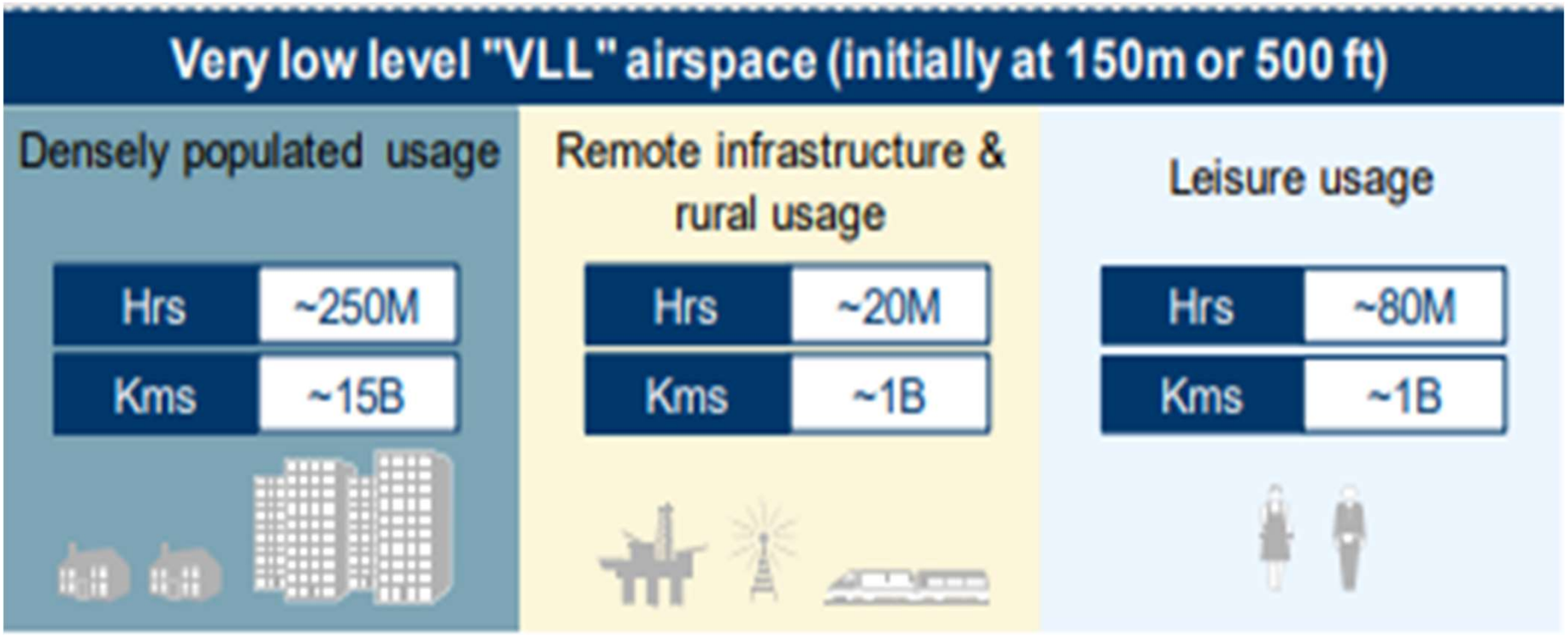
Drone crash near kids leads Swiss Post and Matternet to suspend autonomous deliveries
techcrunch.com

2 arrested in Michigan Stadium drone incident
espn.com

Manned aviation environment

The assumptions

What we expect in 2050



Source: European drone outlook study, November 2016

What CORUS assesses

Parameter	High forecast	Low forecast
Number of UAS operations per day for a 1 million inhabitant city	1 million	1 thousand
Average number of flights per minute in that city	~700	< 1
Average number of drones airborne in that city at any moment	~10 thousand	~10
Projection for a country with 20 million inhabitants	20 million ops/day	20 thousand ops/day
Average number of flights per minute in that country	~ 14 thousand	~14
Average number of drones airborne in that country at any moment	~210 thousand	~210
Average number of drones airborne per square kilometre	~1.2	~0.0012

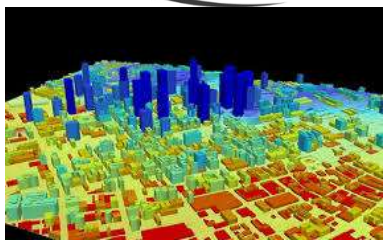
The scale of the problem – CORUS ConOps

CORUS consideration

The challenges

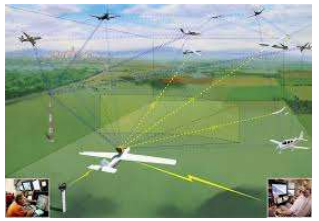
Technical challenges

Services(tracking, 3D mapping…)



Communications, infrastructures

Drone equipment(detect and avoid…)



NASA

Drone integration in the airspace

Human challenges

Societal and airspace users acceptance

Drone user education

User-friendly services

Safe and easy access to airspace for all users

Conclusion

Conclusion

VUTURA

SAFIR

SAFEDRONE

GOF

DIODE

DOMUS

EURODRONE

GEOSAFE

USIS

AIRPASS

PODIUM

DROC2COM

PERCEVITE

SECOPS

TERRA

IMPETUS

CORUS

DREAMS

CLASS

The Need for U-Space

Dissemination Workshop

Brussels 30th Sep 2019

Enric PASTOR
UPC BarcelonaTECH

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Why U-space?

The EU Commission view:

- ***Drones mean innovation, new services for citizens, new business models and economic growth.***

The SESAR view:

- ***U-space is a set of new services relying on a high level of digitalisation and automation of functions and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones.***

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Who should drive the U-space design?

Drone?

Sensors?

Avionics?

Operators?

Safety?

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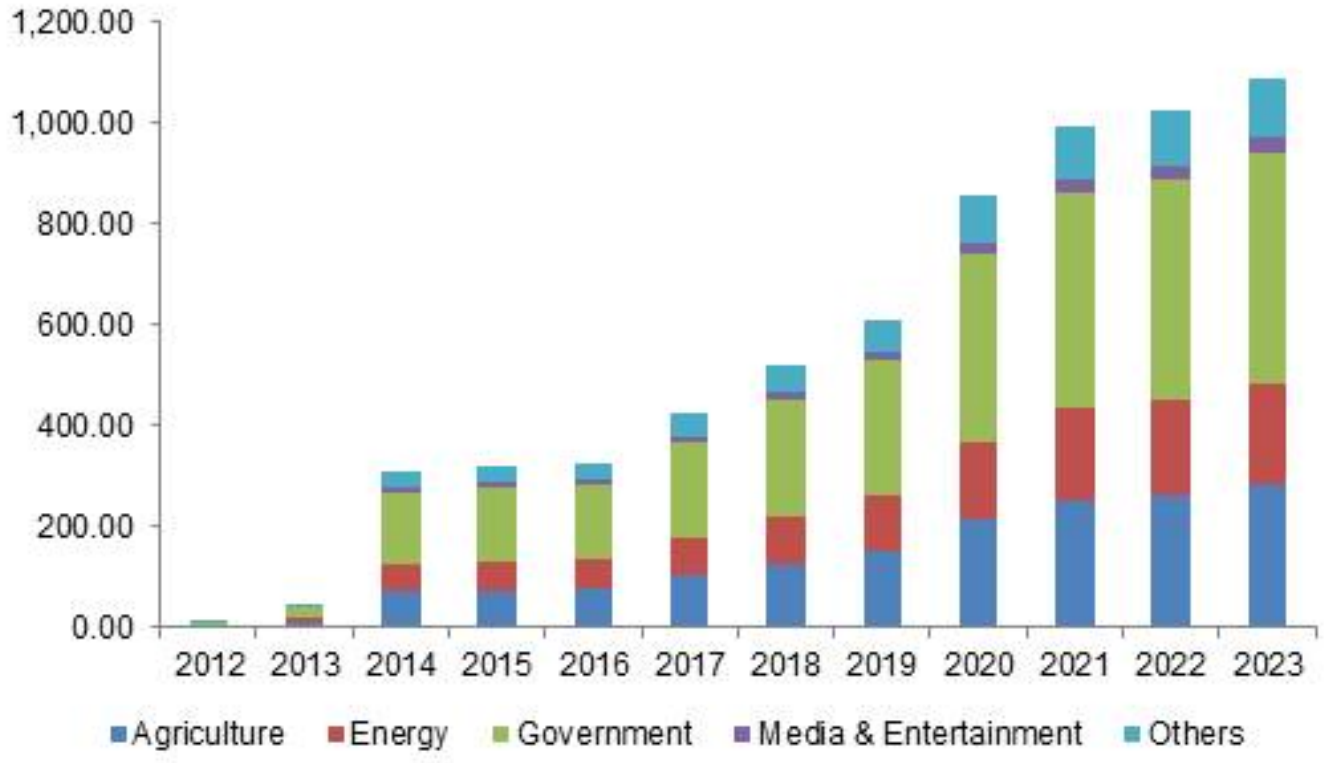
Should market growth drive U-space?



Operators ⟷ End Clients

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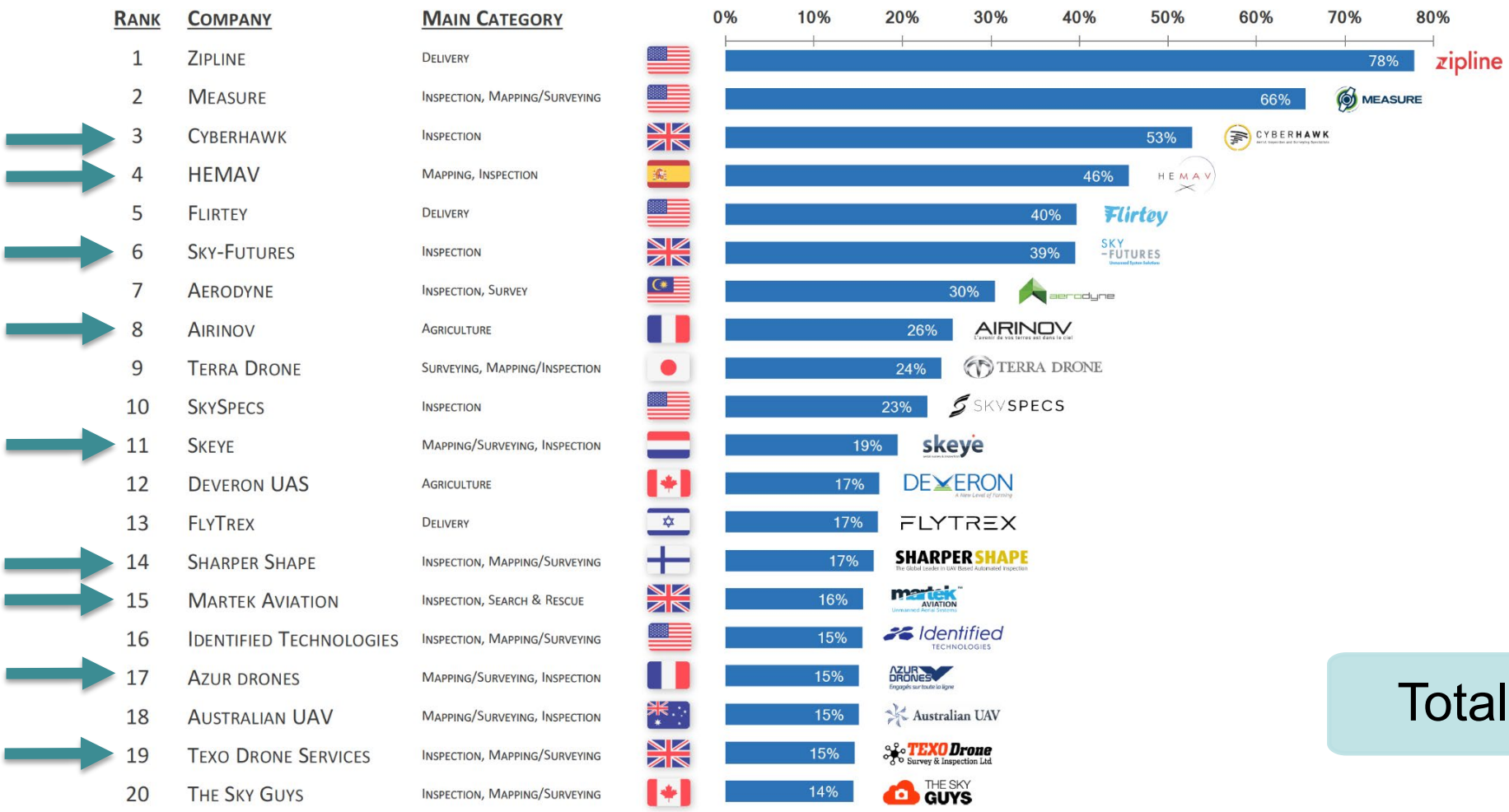
Are we taking care of the EU market?

TOP20 Drone Operator Ranking 2018



Total: 9

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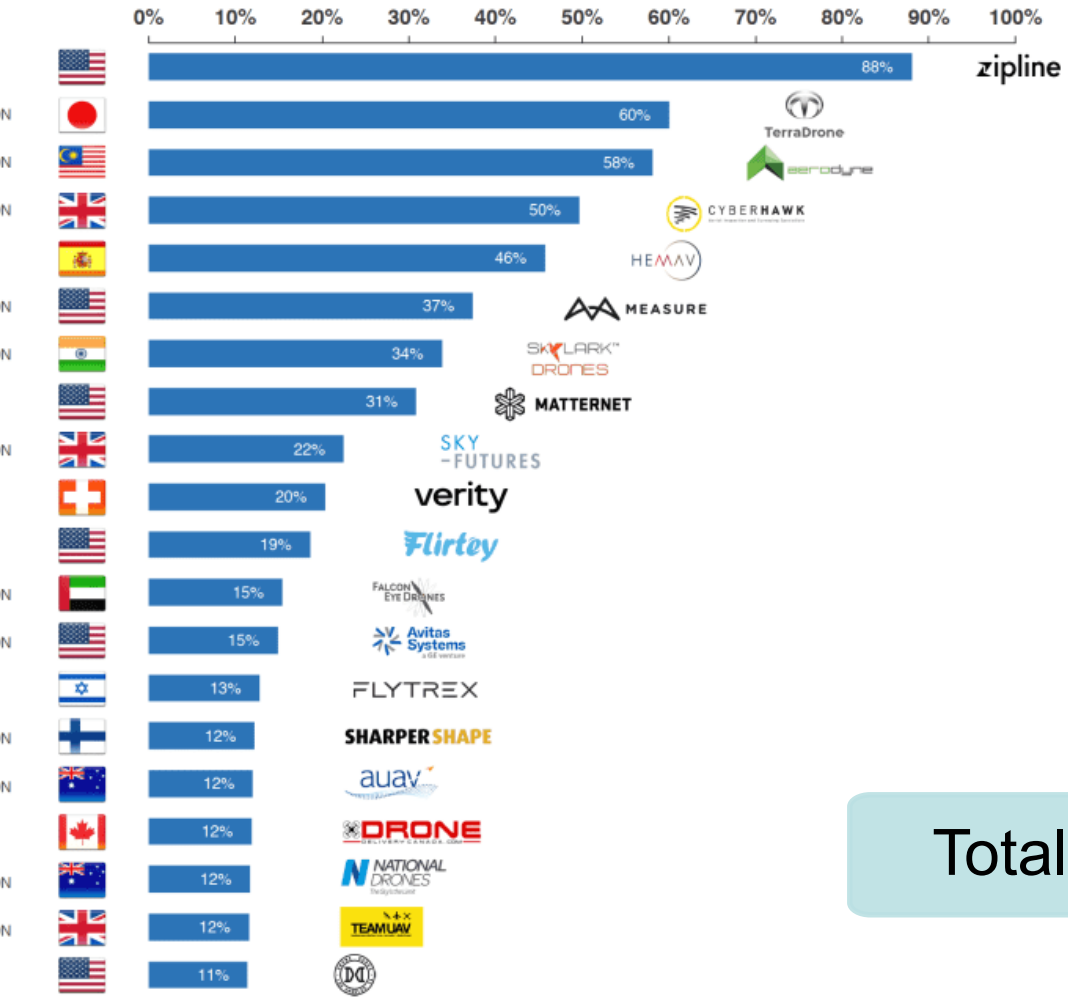
Are we taking care of the EU market?

TOP 20 Drone Service Providers 2019

Rank	Company	Main Category
1	Zipline	Delivery
2	Terra Drone	Mapping/Surveying, Inspection
3	Aerodyne Group	Mapping/Surveying, Inspection
4	Cyberhawk	Mapping/Surveying, Inspection
5	Hemav	Mapping/Surveying
6	Measure	Mapping/Surveying, Inspection
7	Skylark Drones	Mapping/Surveying, Inspection
8	Matternet	Delivery
9	Sky-Futures	Mapping/Surveying, Inspection
10	Verity Studios	Drone Shows
11	Flirtey	Delivery
12	Falcon Eye Drones	Mapping/Surveying, Inspection
13	Avitas Systems	Mapping/Surveying, Inspection
14	FlyTrex	Delivery
15	SharperShape	Mapping/Surveying, Inspection
16	Australian UAV	Mapping/Surveying, Inspection
17	Drone Delivery Canada	Delivery
18	National Drones	Mapping/Surveying, Inspection
19	Team UAV	Mapping/Surveying, Inspection
20	Drone Dudes	Photography/Videography



Total: 6

MEMBER OF SESAR JOINT UNDERTAKING
HORIZON 2020

This project has received funding from the SESAR Joint Undertaking under grant agreement 763551
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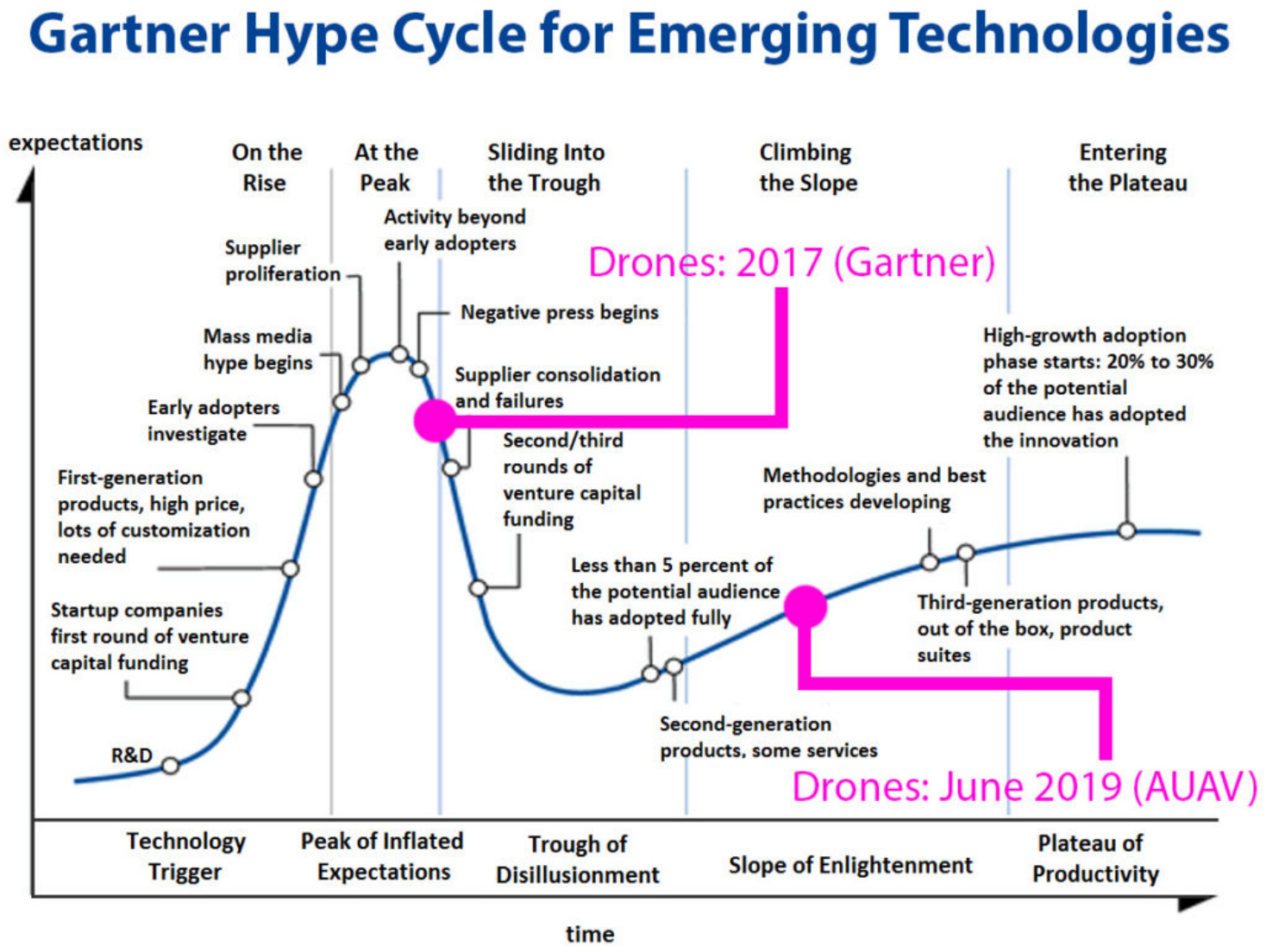
ORUS

Are we getting too late ?



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Did you talk to a drone operator lately?

Is the operation commercially viable?

- ***Takes too long to get permissions.***
- ***Too many people on the field: pilot, observers, safety…***
- ***VLOS makes operations inefficient.***
- ***Access to restricted airspace.***

- **Companies losing business opportunities that go back to traditional aviation.**
- **Moving business elsewhere (South America, Asia….)**

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under European Union's Horizon 2020 research and innovation programme.

Just an example.

How complex is to access airspace?

- ***Rural location inside Barcelona's CTR.***
- ***Agro inspection.***

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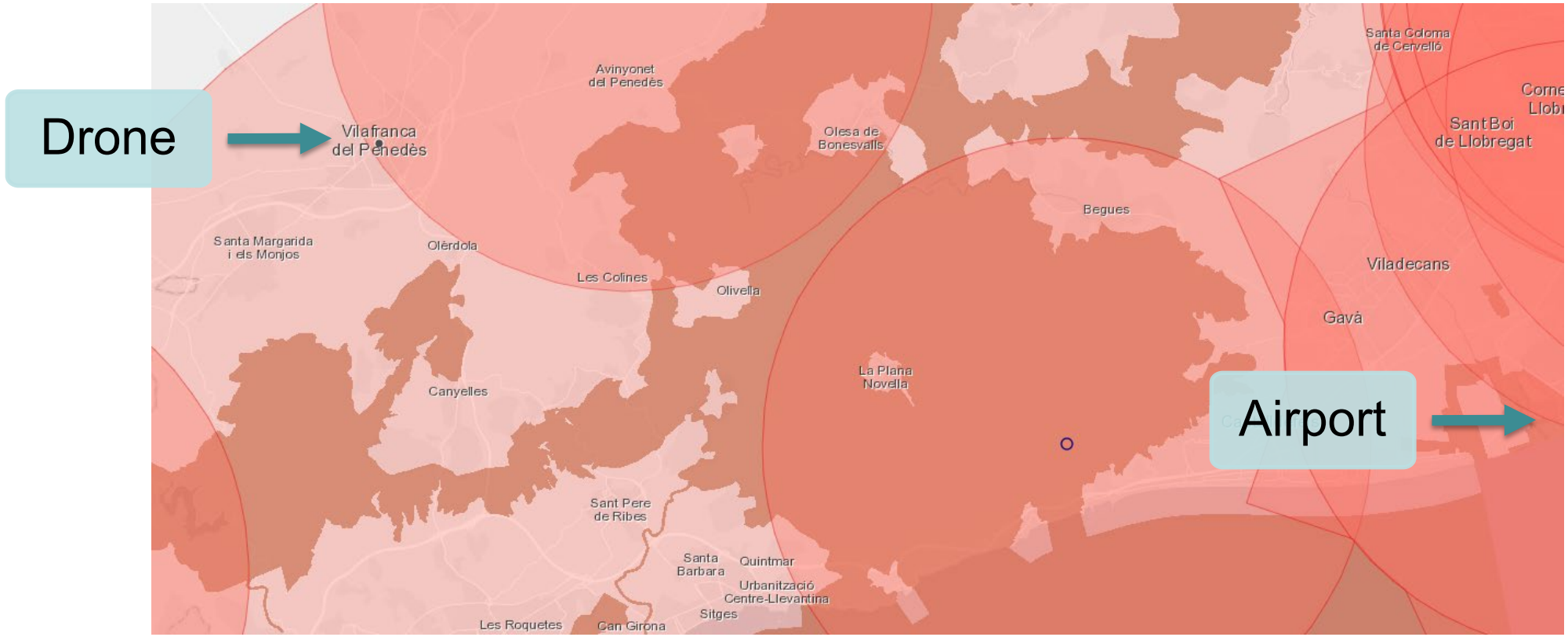
under European Union's Horizon 2020 research and innovation programme.

Just an example.



- **Are we really addressing the needs of operators?**

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under European Union's Horizon 2020 research and innovation programme.

Just an example.

How complex is to access airspace?

- ***Location inside Barcelona's CTR.***
- ***Mountain range 3000ft high 10 km into airport direction.***
- ***Still 20 additional km to reach airport.***
- ***Minimum altitude in that area 4000/5000ft.***

- **Still they need a complex permission request (SORA, etc).**
- **Coordination with airport.**

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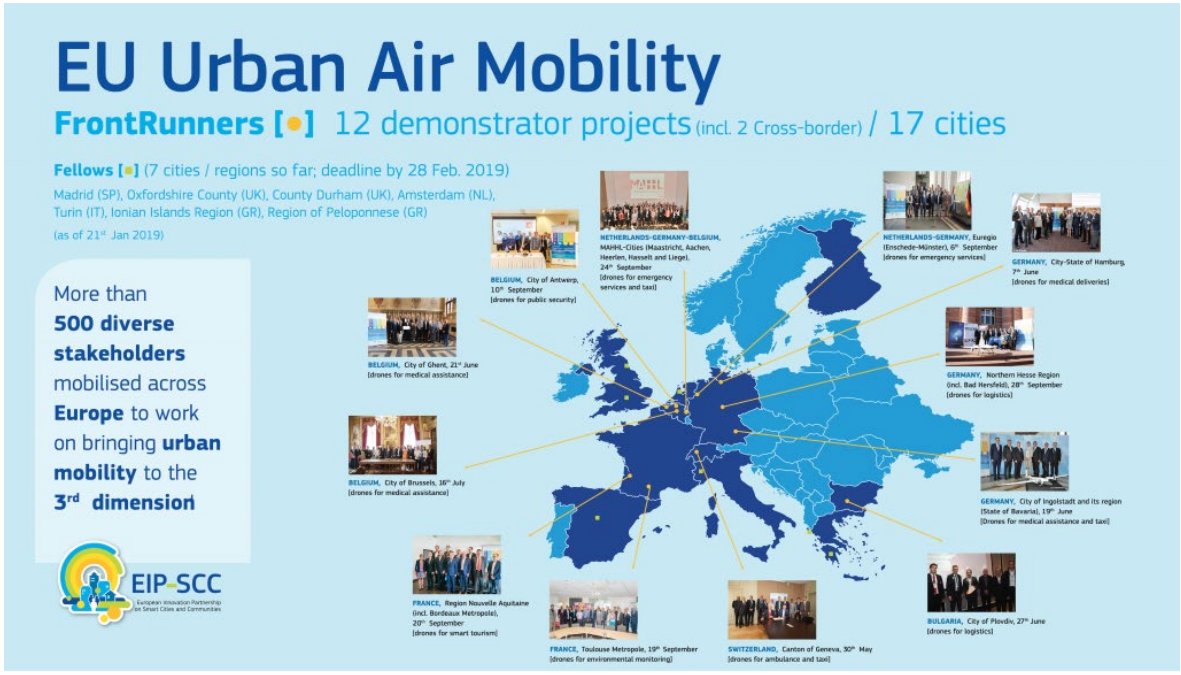
What about cities?

Is *Urban Air Mobility* the main target of U-space?



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What about cities?

City Halls are demanding various types of inspections:

- ***City infrastructure: buildings, gardens, roads, etc.***
- ***Emergencies: medical reaction, blood transfer, etc.***
- ***Safety on beaches.***

- **Are we focusing enough on a business that is already here?**

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Conclusions

We need U-space for multiple reasons.

- ***Safe integration is the main one.***

We must keep in mind that there are already consumers and users that are expecting:

- ***Increased flexibility, BVLOS, automation.***
- ***Access to airspace and cities.***
- ***A reasonable amount of effort on their side to adapt.***
- ***A solution in a reasonable time.***

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U-space Conference
U-Space services – a brief tour

30 September, 2019

Koen Williame
Unifly

Services and capabilities

- Capability
  - What?
- Service
  - How?

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An example: capability

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Audience should stay awake during this presentation

An example: capability

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Services to fulfil the capability

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Serve coffee before the presentation

Services to fulfil the capability

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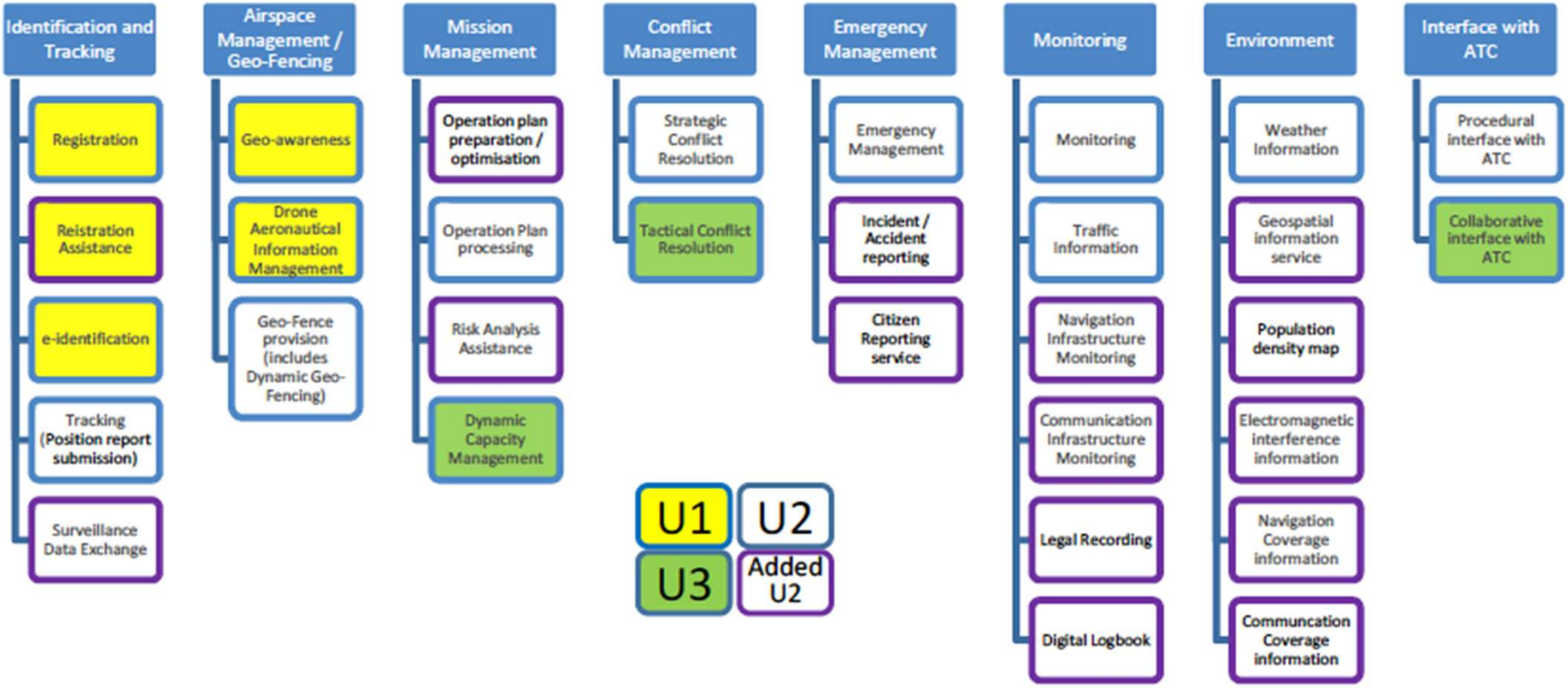
Services (capabilities)

30 September, 2019

Overview



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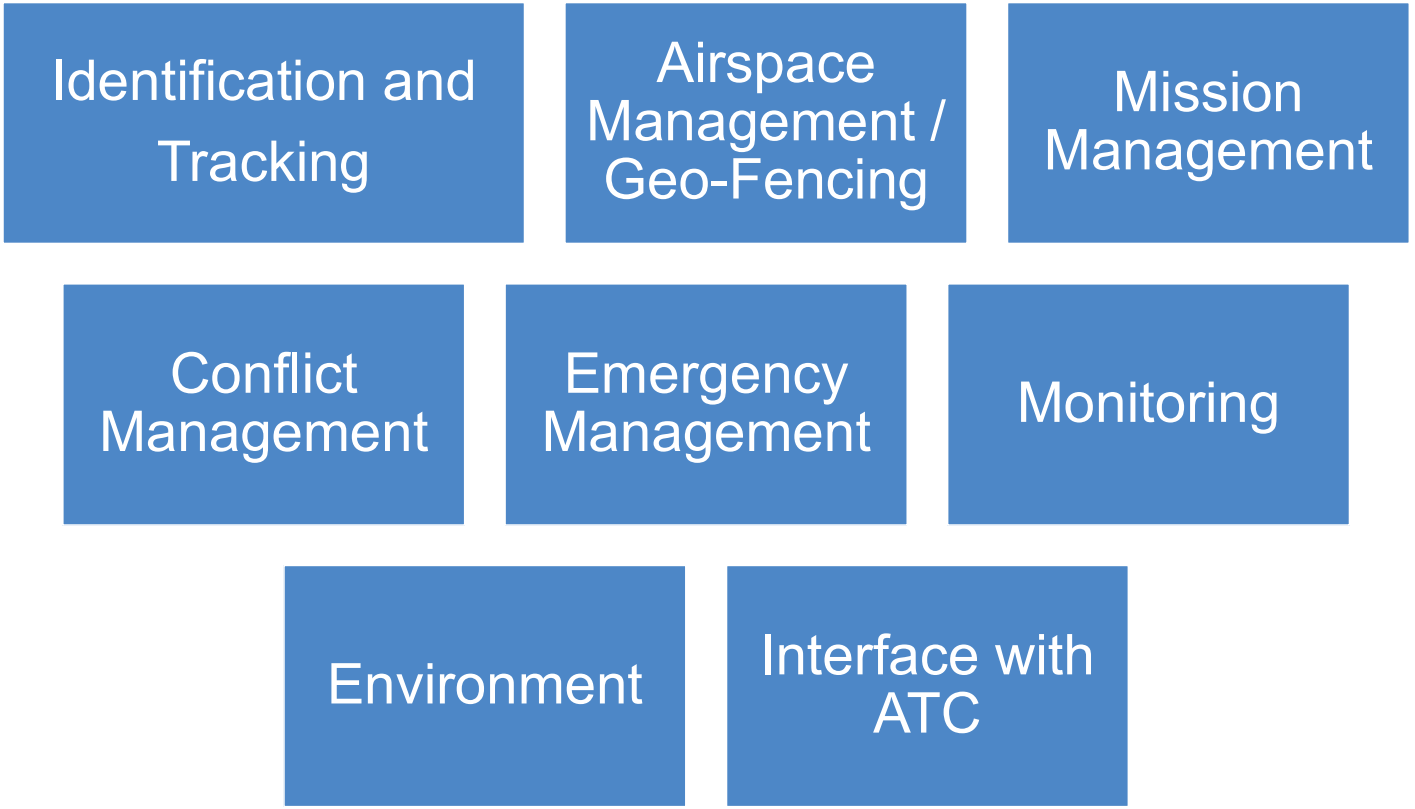
8 U-space services highlighted



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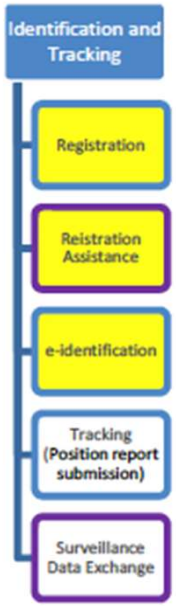
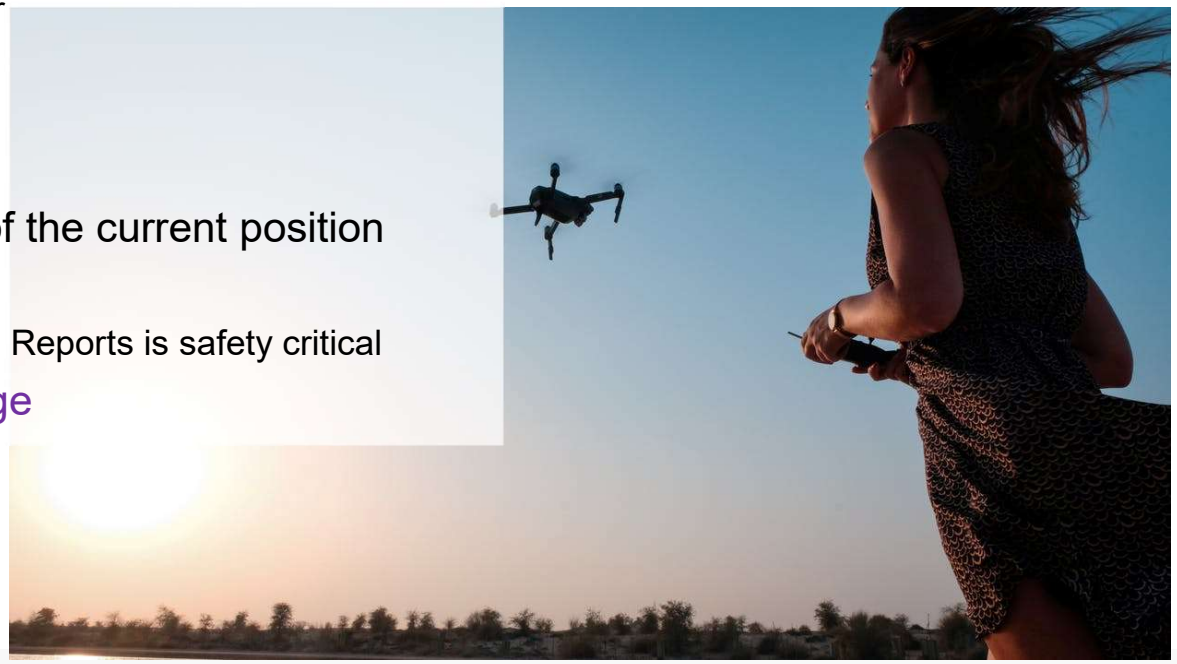
Identification and Tracking



- Registration: Ares(2018)5119803
  - Drone operator representative
  - Drone owner representative
  - Accredited registry reader
  - Accredited registry updater
  - Drone pilot
  - Registrar
- Registration assistance
- e-Identification: emission of the current position
- Tracking
  - The information in Position Reports is safety critical
- Surveillance Data Exchange



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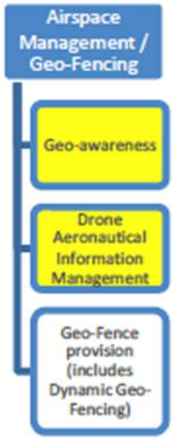
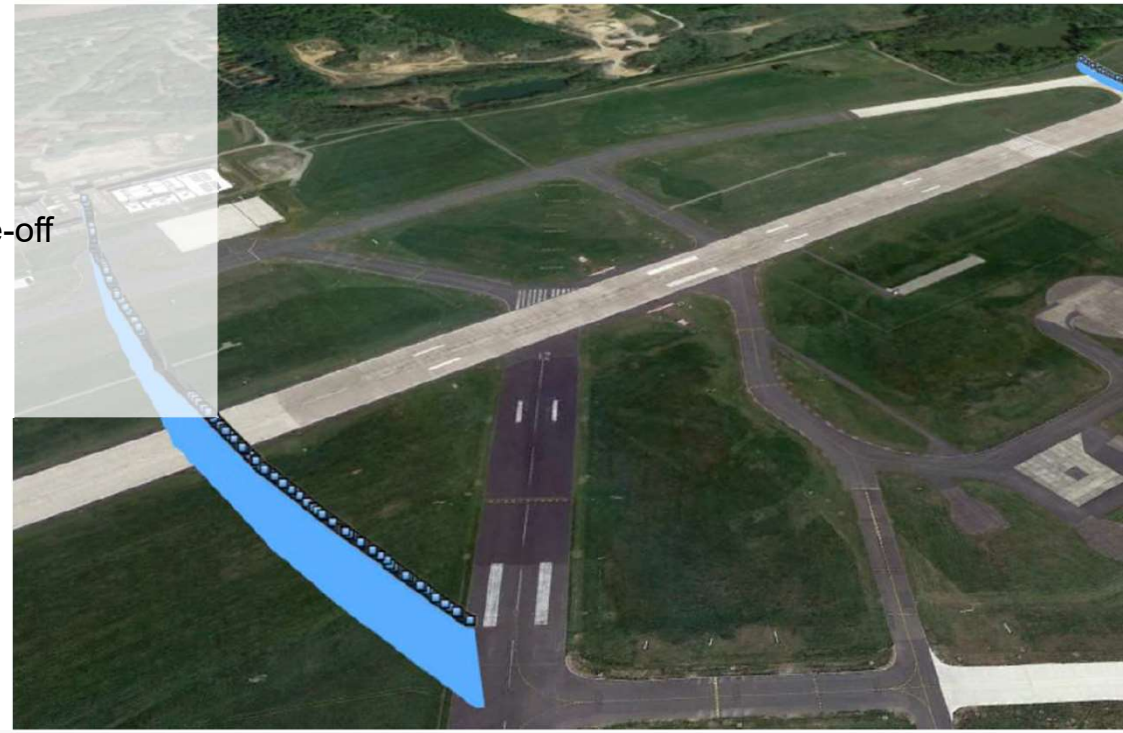
Airspace Management / Geo-Fencing



- Geo-awareness
- Drone AIM
- Geo-Fence provision
  - Geo-fence
  - other flight restriction
  - up to the moment of take-off



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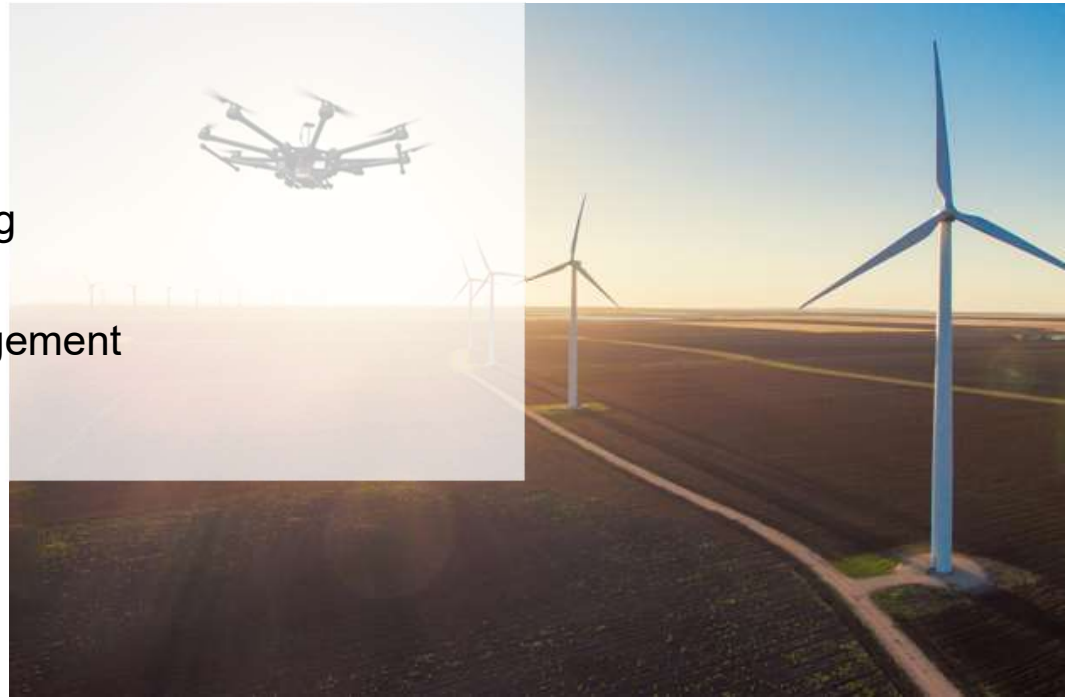
Mission Management

- Operation plan preparation / optimization
  - Prepare and submit
  - Display result
  - Check on the status
  - Cancel or update
- Operation plan processing
- Risk Analysis Assistance
- Dynamic Capacity Management
  - propose delay for flights
  - propose rerouting



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Conflict Management

- Strategic Conflict Resolution
  - Before flight
  - detects conflicts, then it proposes solutions
- Tactical Conflict Resolution
  - during the flight
  - changing the flight
  - advisory service or giving instructions

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Emergency Management

- Emergency management
  - assistance to a drone pilot
  - communication to interested
- Incident accident reporting
- Citizen reporting service

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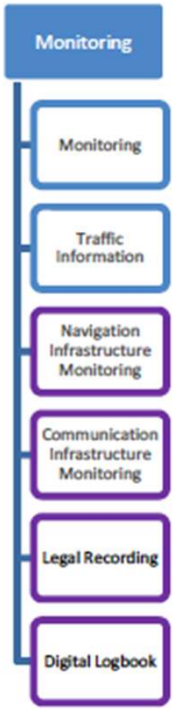
Monitoring



- Monitoring
  - Operation plan conformance monitoring
  - Weather limit compliance monitoring
  - Ground risk compliance monitoring
  - Electromagnetic risk monitoring
- Traffic Information
  - Traffic which have some risk
  - may be restricted
- Navigation Infrastructure Monitoring
- Communication Infrastructure Monitoring
- Legal Recording
  - support accident and incident investigation
- Digital Logbook
  - give access to own information

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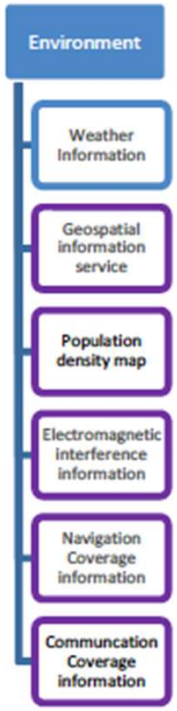
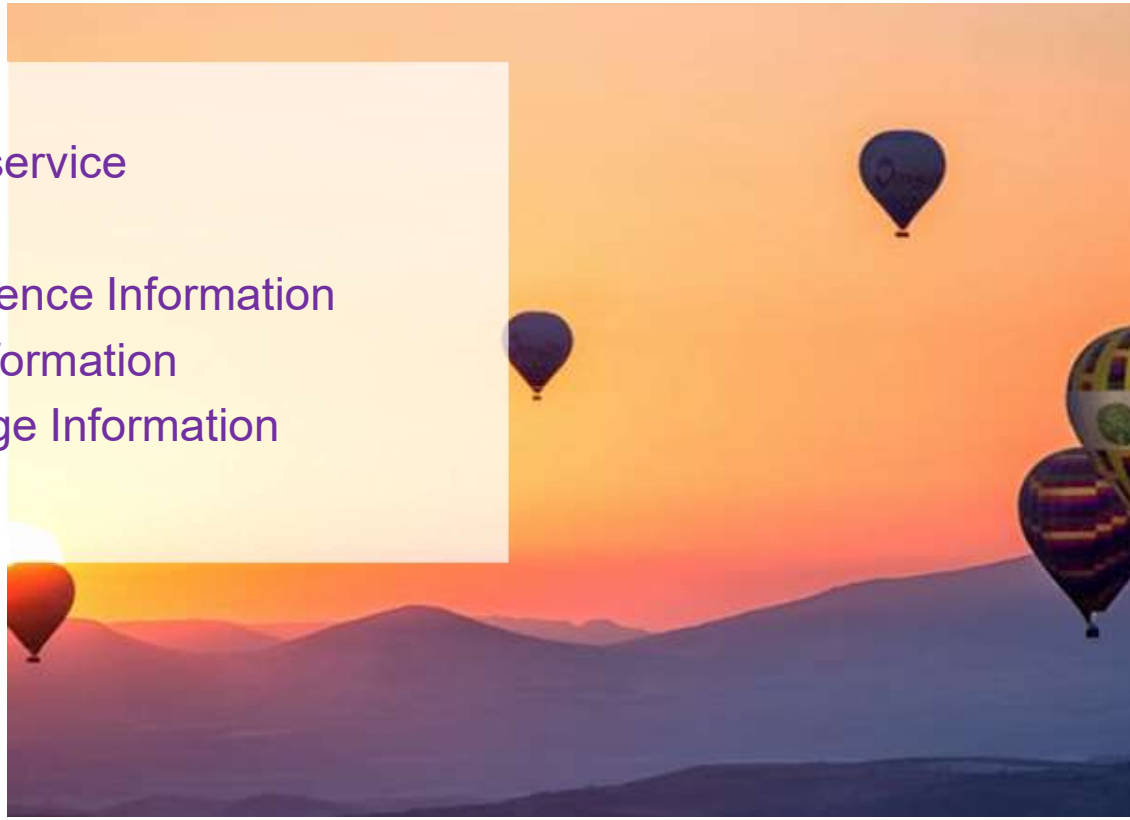
Environment



- Weather Information
- Geospatial Information service
- Population density map
- Electromagnetic Interference Information
- Navigation Coverage Information
- Communication Coverage Information



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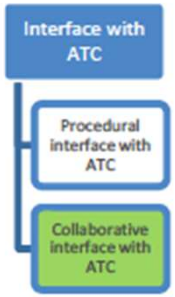
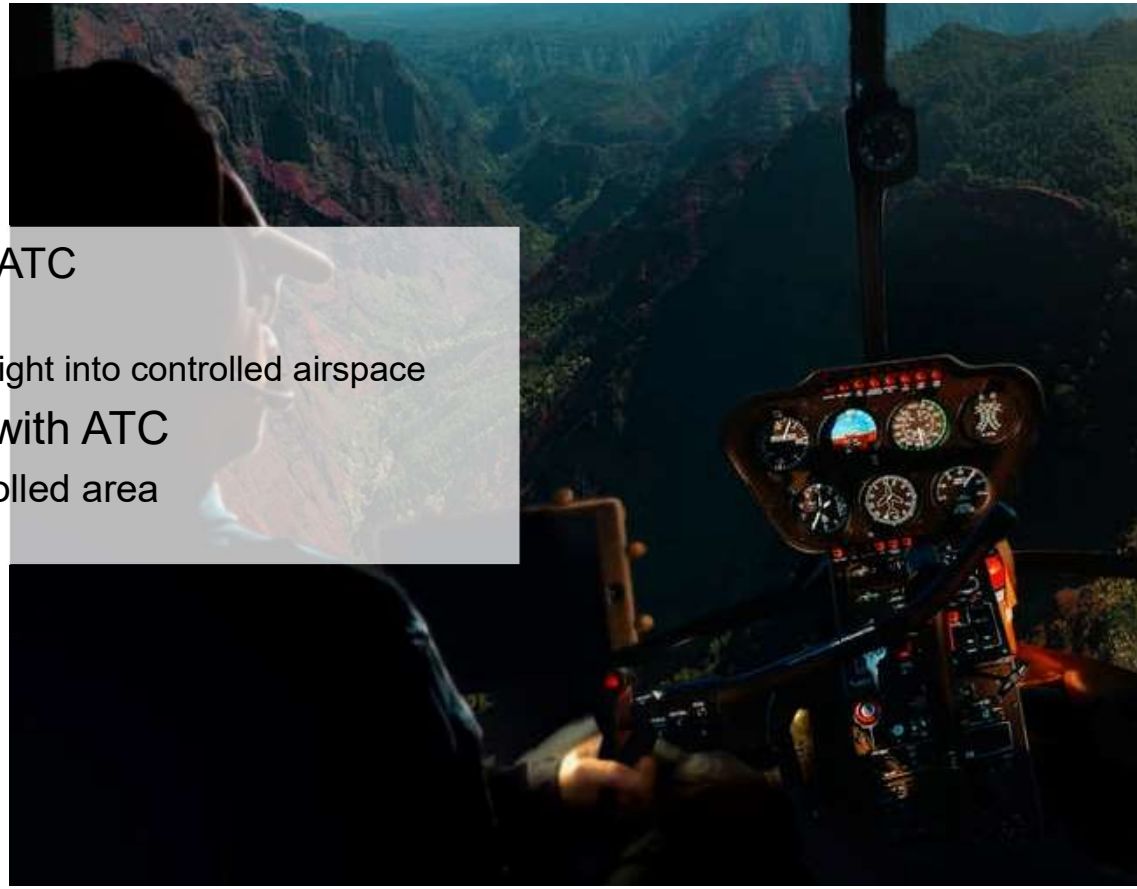
Interface with ATC



- Procedural Interface with ATC
  - Before flight
  - coordinate an entry of a flight into controlled airspace
- Collaborative Interface with ATC
  - When drone is in controlled area
  - Offers communication



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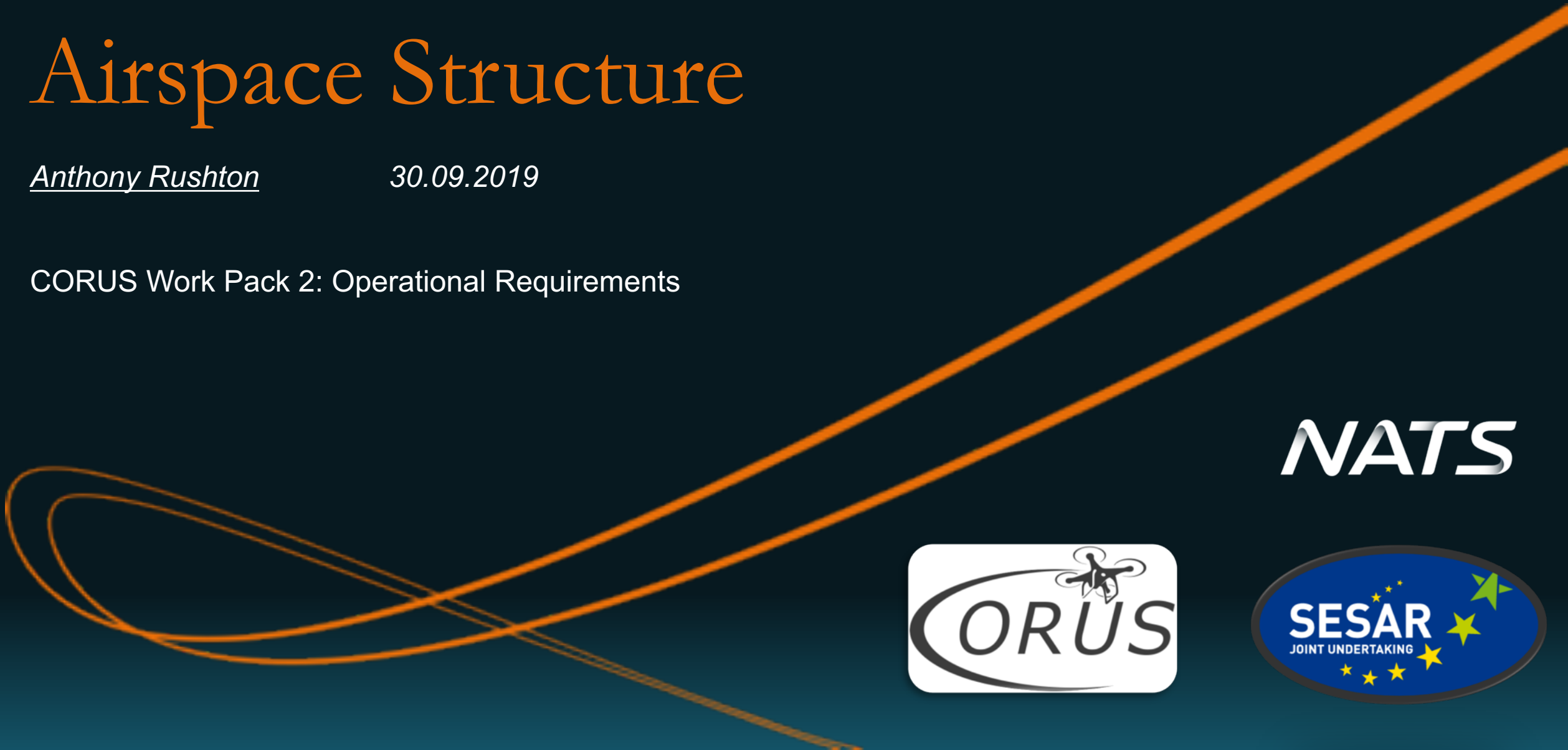
Airspace Structure

Anthony Rushton *30.09.2019*

CORUS Work Pack 2: Operational Requirements



Research Objectives

- *Why would we need a U-space structure?*
- *What are the U-Space Volume structures?*
- *How could the Airspace be structured?*
- *Where would U-Space operate?*

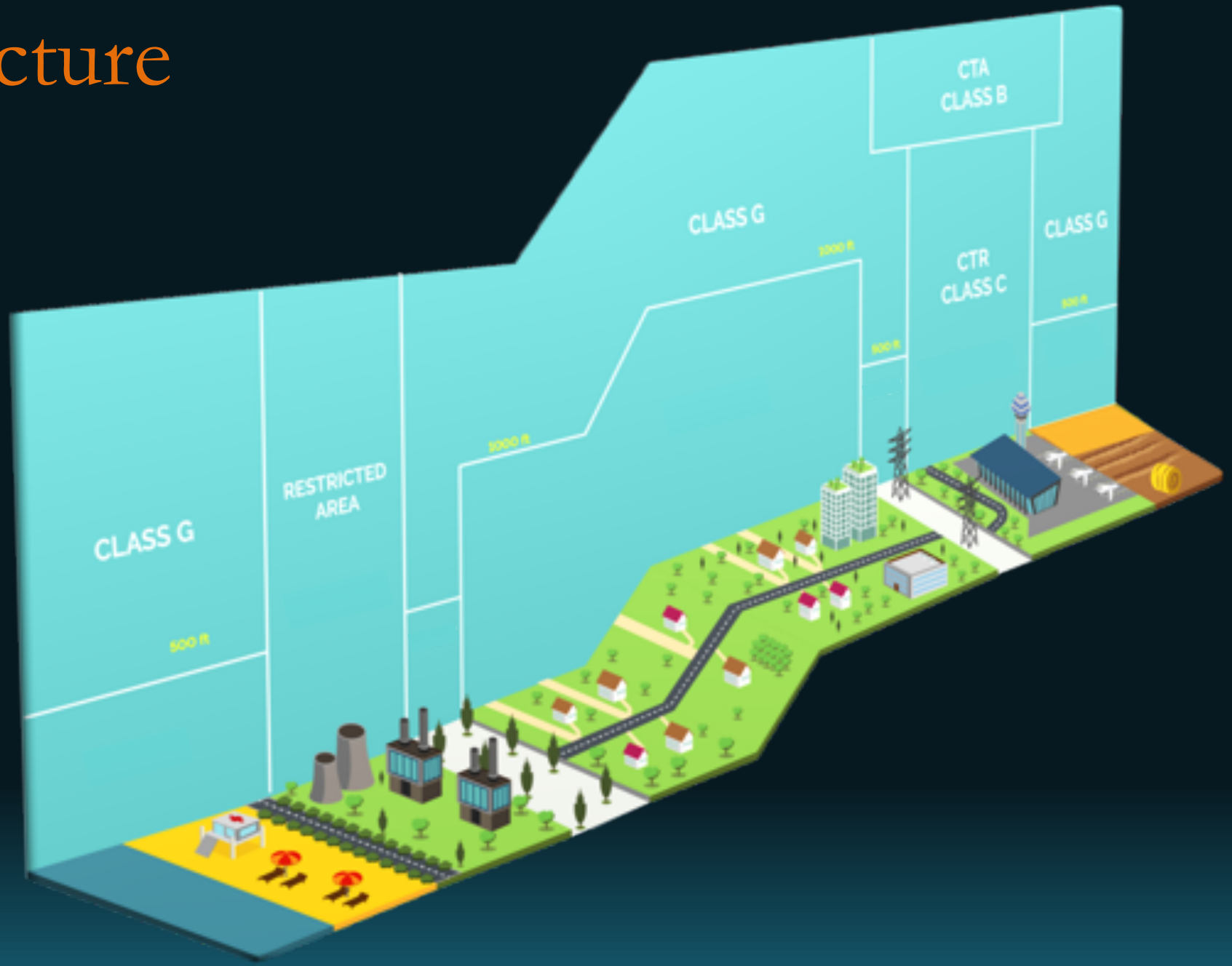
Research Objectives

- *Why would we need a U-space structure?*

Airspace Structure

for U-Space

- *Gives access control*
- *Links the air risk to the ground risk*
- *Sets the minimum standards*



U-Space Volumes

Operational UTM Requirements

ORUS	X	Y	Z
Minimum Description	Conforming	Collaborating	Coordinating
Example Area	Non-restricted UAS airspace	Surrounding controlled airspace	Aerodrome Traffic Zone (ATZ)
Operational Emphasis	Free flight	UTM Trajectory based operations	U-Space capacity management
Typical Operating Height	Below 400-500 ft (120-150 metres)	Specific agreement with regional authorities*	Above 0ft of ATZ or above "VLL"

* Operations above VLL TBD

Research Objectives

- *What are U-Space Volumes?*

TYPE X

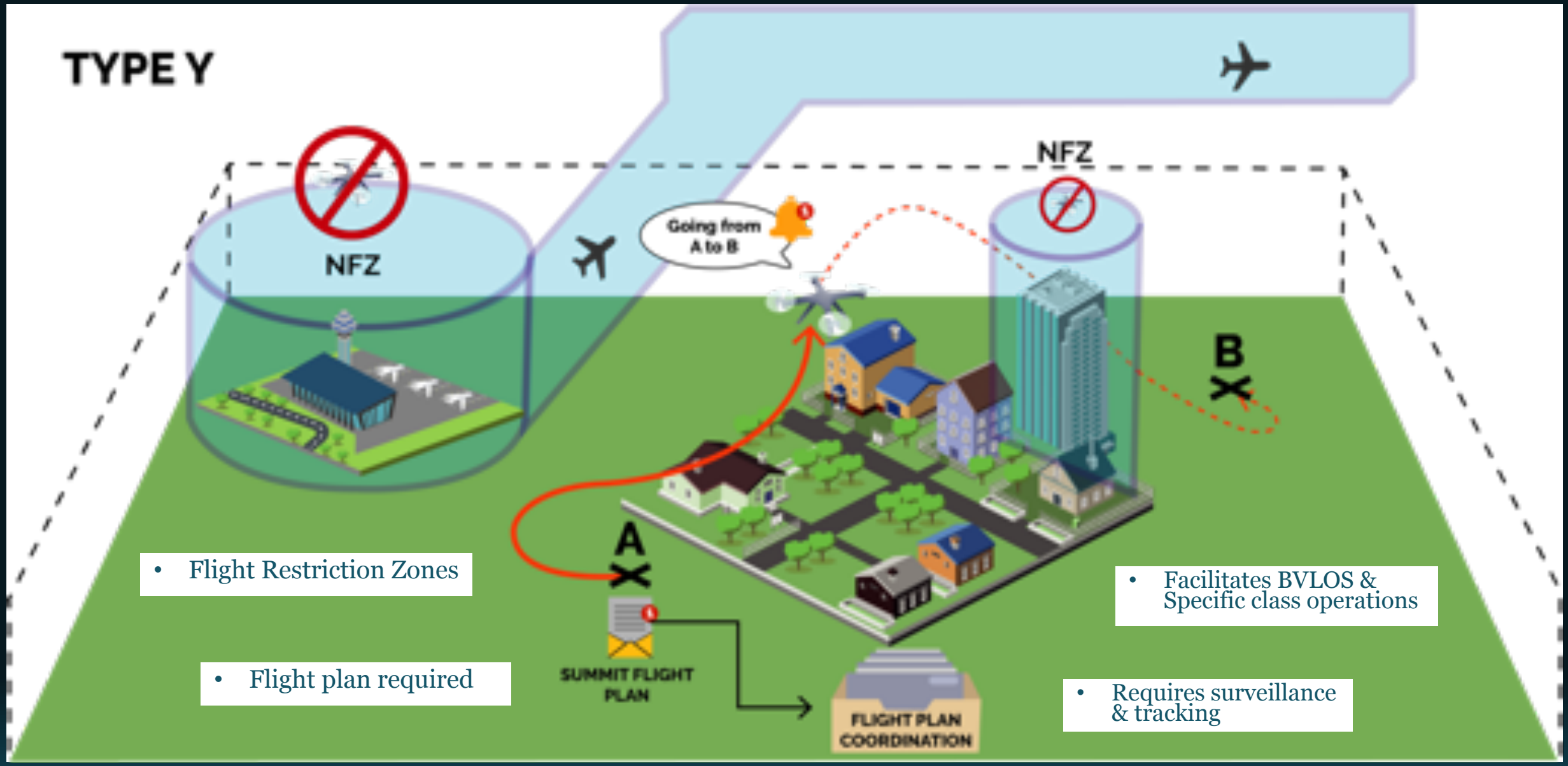
- Be aware of other airspace users

- No operation plan needed

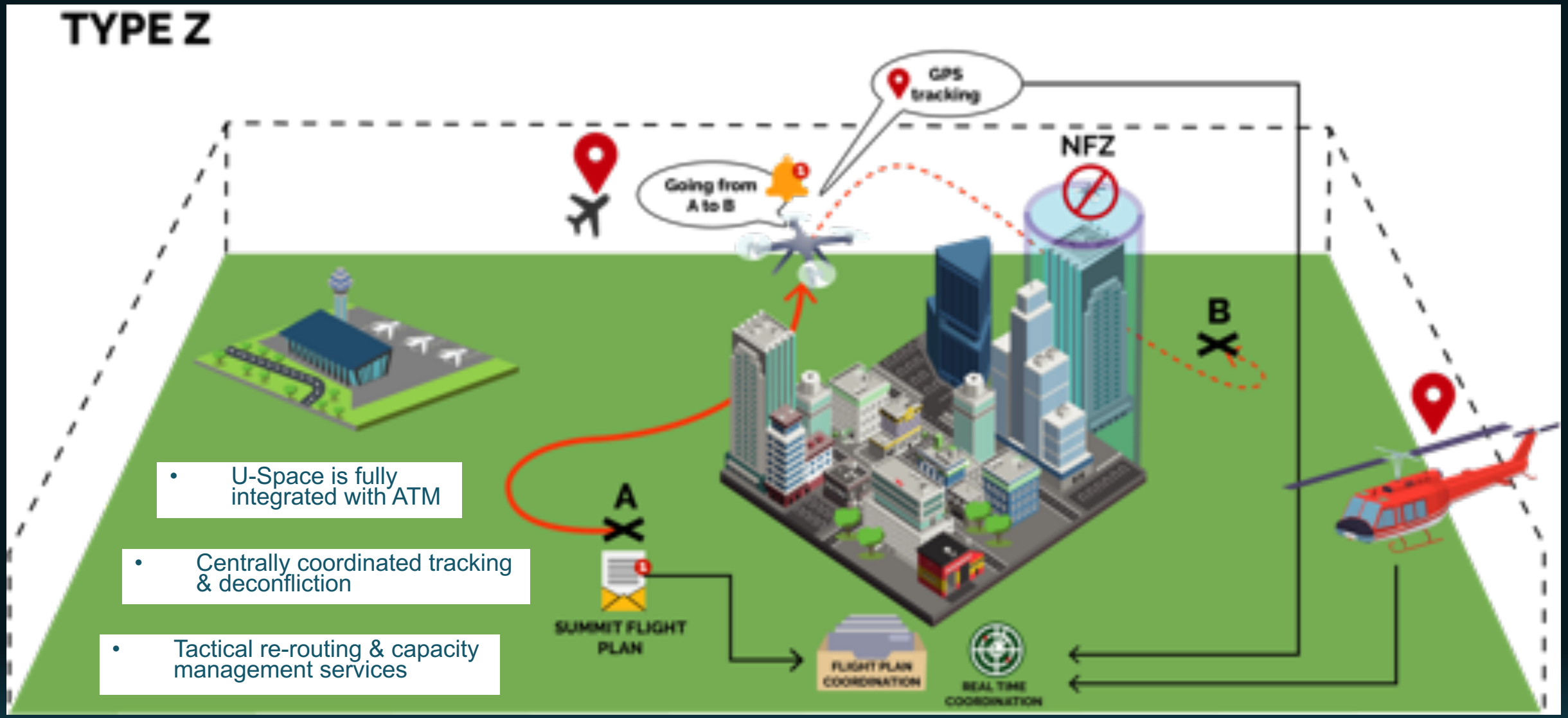
VLOS

- Responsibility for separation is with the remote pilot

- BVLOS or Autonomous flight need significant risk mitigation

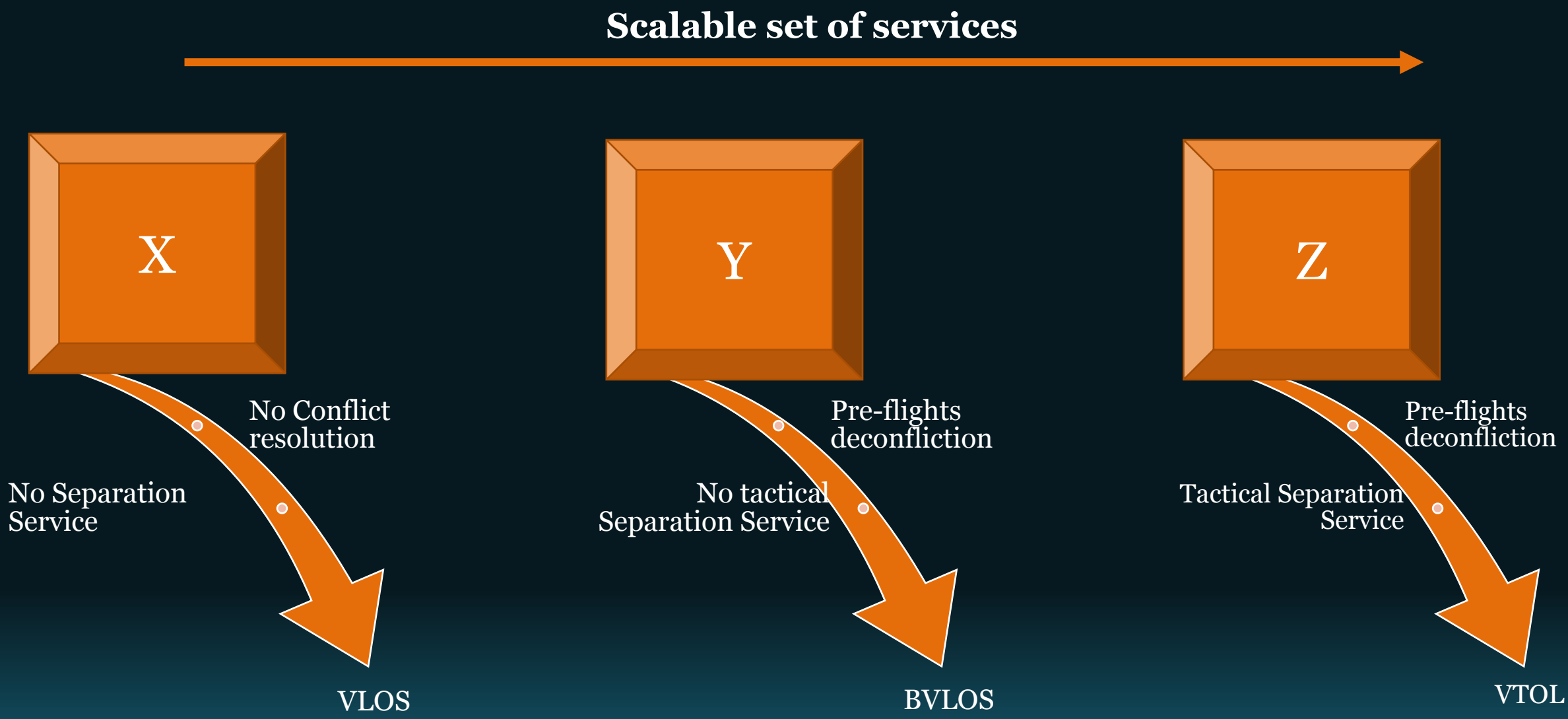

TYPE Y
NFZ
NFZ
Going from A to B
A
B
SUMMIT FLIGHT PLAN
FLIGHT PLAN COORDINATION
• Flight Restriction Zones
• Flight plan required
• Facilitates BVLOS & Specific class operations
• Requires surveillance & tracking

TYPE Z



- U-Space is fully integrated with ATM
- Centrally coordinated tracking & deconfliction
- Tactical re-routing & capacity management services

U-Space Volume types



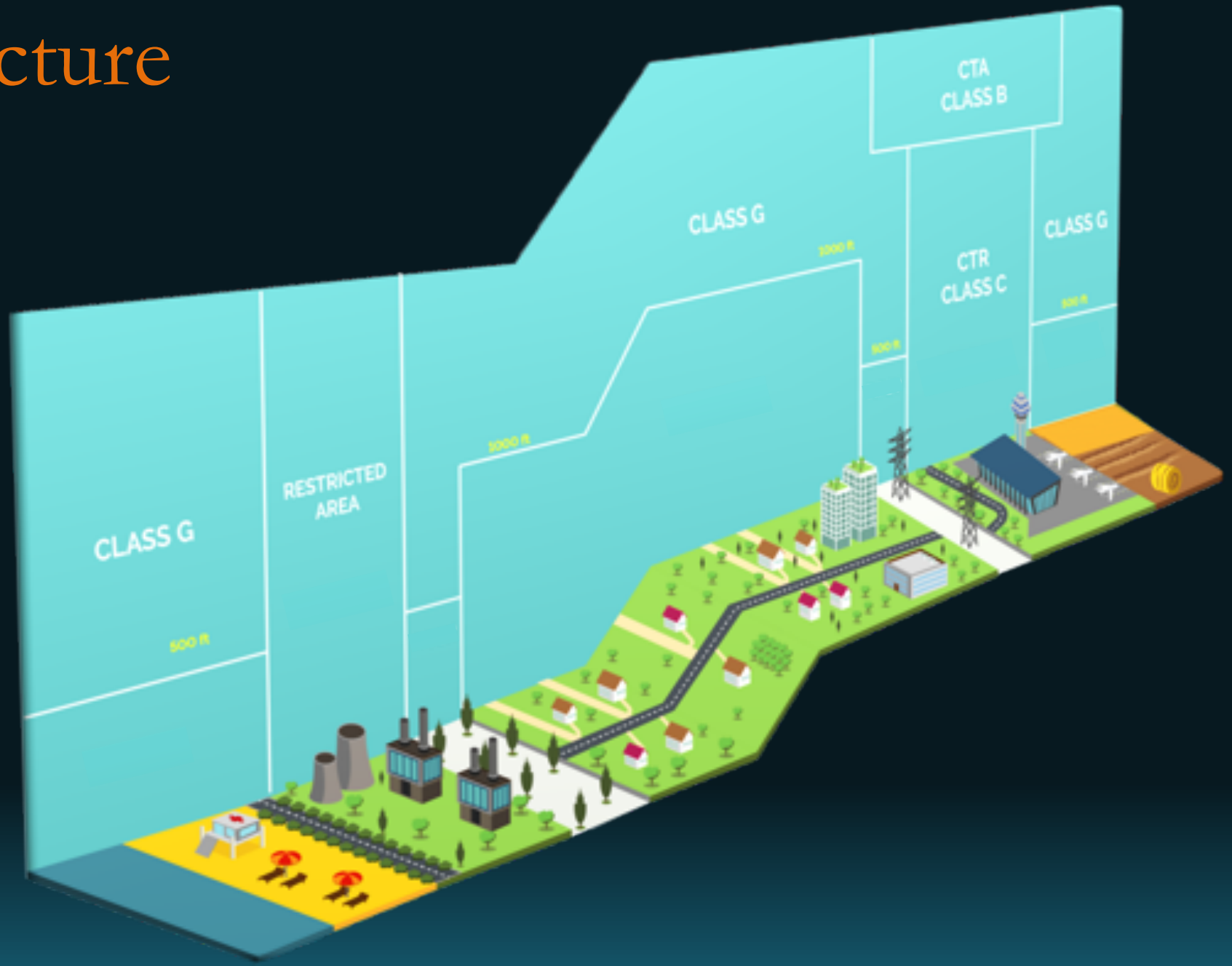
Research Objectives

- *How could the Airspace be structured?*

Airspace Structure

for U-Space

- *Gives access control*
- *Links the air risk to the ground risk*
- *Sets the minimum standards*



Airspace Structure

for U-Space

- *Gives access control*
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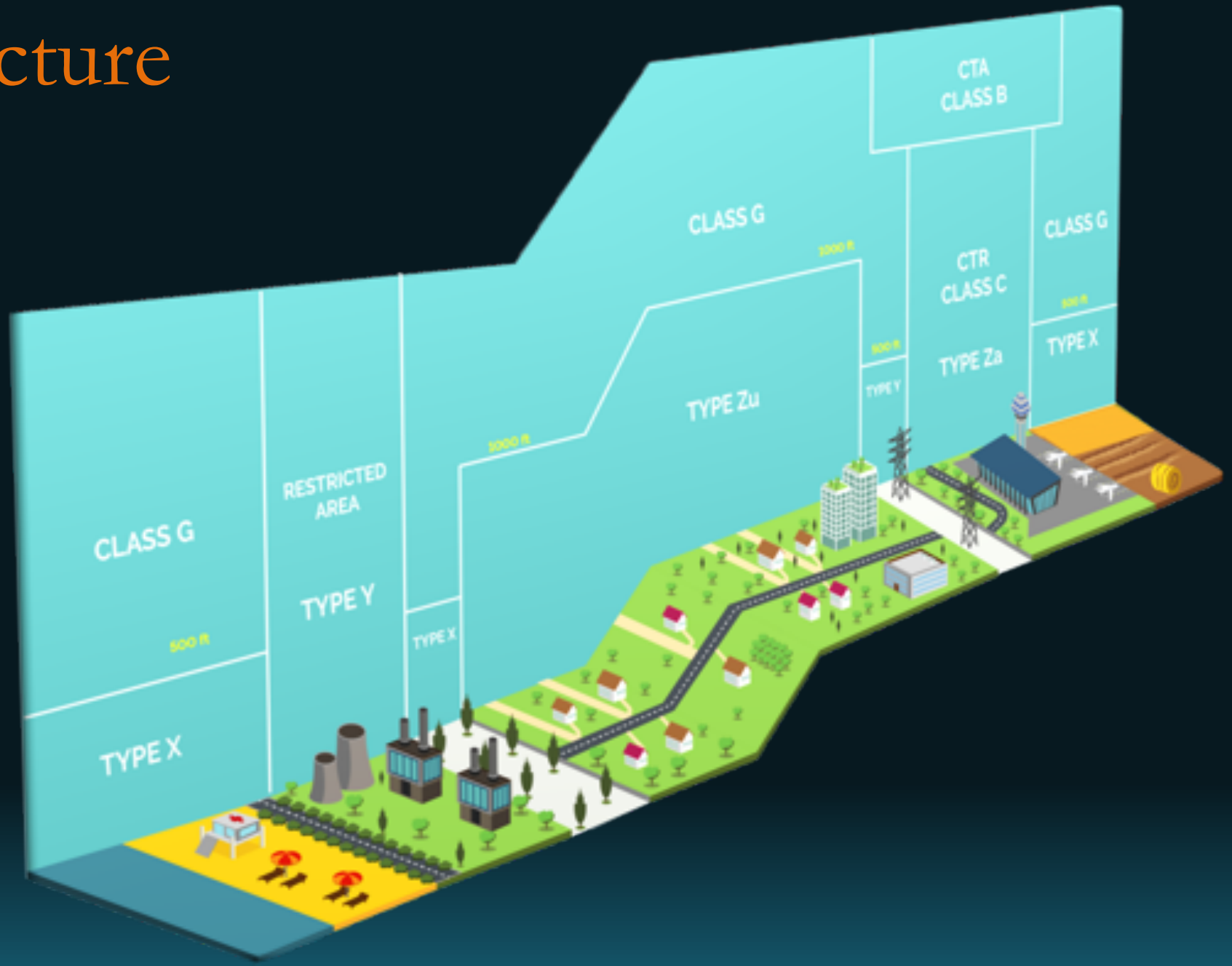


Identification, Tracking & Airspace Requirements – X Volumes

- Registration / CAA
- e-ID / Remote ID
- Flight Restriction Zones

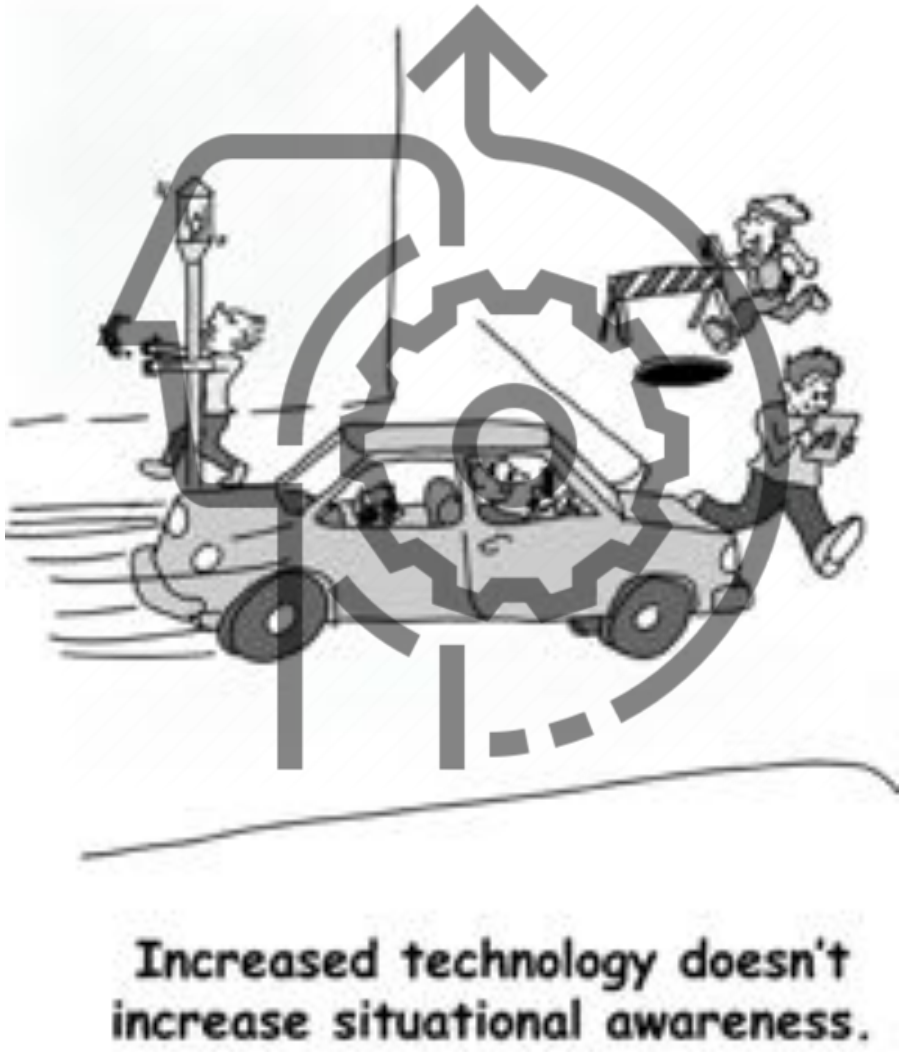
UK example of Flight Restriction Zone (FRZ)

Identification, Tracking & Airspace Requirements – Y Volumes

- Drone operator will be responsible for ensuring position reports are sent on request
- Reports may be derived from Remote ID
- Many surveillance sources, may not be certified
- Tracking of data, but might be of limited value unless fused with cooperative metadata

Identification, Tracking & Airspace Requirements – Z Volumes

- Certified surveillance where required (e.g. ATZ)
- Centralised tracking to protect manned aviation
- Optimal traffic management by top down coordination



Research Objectives

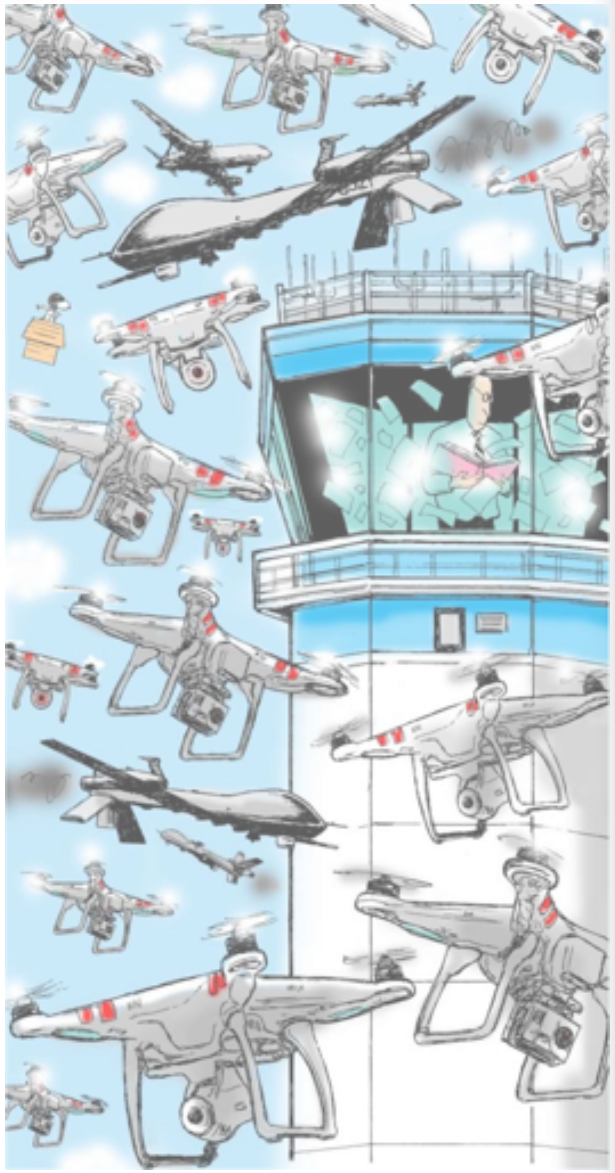
- *Where would U-Space operate?*

U-Space interface with ATC

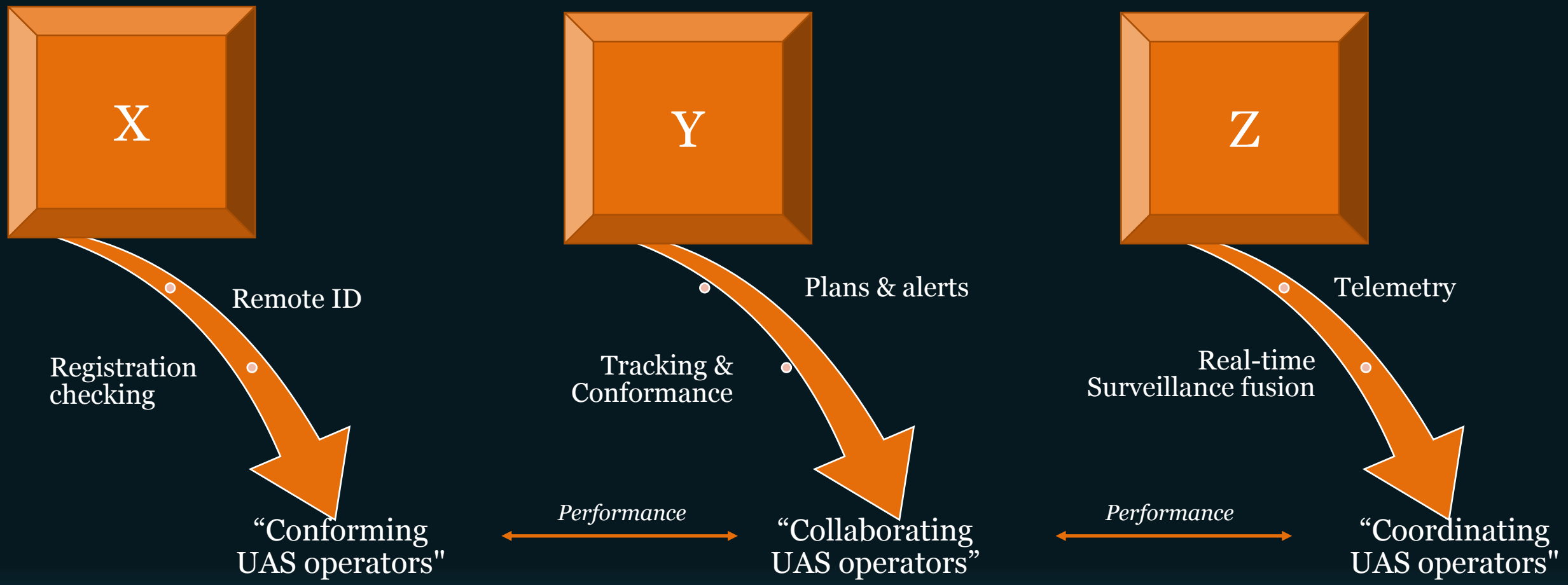
Two possible types of U-Space Z volume foreseen:

- Za – Within the ATC control zone an interface is required between U-Space <-> ATC
  - Procedural interface allow planned entry of a UAS flight into restricted controlled airspace.
  - Collaborative interface allowing (near) real-time communication between UAS and ATC.

- Zu - Outside of aerodromes
  - U-Space Service for safety of air traffic
  - U-Space services that help coordinate the UAS traffic
  - Separation could be either in-the-loop controlled service or on-the-loop advisory



U-Space Volumes – Performance based



Thank you

NATS

U-Space Volumes

Operational UTM Requirements

ORUS	X	Y	Z
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* Operations above VLL TBD

ORUS

SESAR JOINT UNDERTAKING

Legal aspects & Social Impact

Dissemination Workshop

Brussels 30th Sep 2019

Cristina BARRADO
UPC BarcelonaTECH

This project has received funding from the SESAR Joint Undertaking under grant agreement 763551
under European Union's Horizon 2020 research and innovation programme.

Outline

WP4

- LEGAL: Vol3 Annex J
  - European current diversity
  - Recently approved EU directive (EASA/JARUS)
- BEST PRACTICES: Vol3 Annex I
  - Current
  - Summary table
- SOCIAL: Vol3 Annex H
  - General rules for social acceptance
  - Previous works and public consultations
  - Social acceptance indicators

(*) Drone is used as a synonym of UAS / UAV / RPAS

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Outline

- **LEGAL**:
  - European current diversity
  - Recently approved EU directive (EASA/JARUS)

- BEST PRACTICES
- SOCIAL

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under European Union's Horizon 2020 research and innovation programme.

LEGAL: Europe current

	Administrative						Additional requirements					
Pays	**Registration**		**Permit to fly, drone pilot license, certificate required**		**Other docs (e.g. flight log, license)**		**Mandatory equipment (e.g. fail- safe)**		**Insurance**		**Age**	
	Rec	**Pro**	**Rec**	**Pro**	**Rec**	**Pro**	**Rec**	**Pro**	**Rec**	**Pro**	**Rec**	**Pro**
Austria	Yes	Yes	Some	Some		Yes			Some	Yes		Yes
Belgium		Some		Some				Yes		Yes		
Czech R.		Some	Yes	Some		Yes	Some	Yes	Yes	Yes		
Denmark	Some	Some			Some	Some			Yes	Yes	Yes	Yes
Finland		Some							Yes	Yes		Yes
France	Some	Some	Some	Some					Yes	Yes		
Germany			Some	Some					Yes			
Ireland	Some	Some								Yes		
Italy		Some		Some		Yes		Yes	Yes	Yes		Yes
Lithuania		Yes		Yes					Yes	Yes		Yes
Malta				Some								
Netherland		Some		Yes						Yes		Yes
Poland		Some	Some	Some		Yes		Yes		Yes		Yes
Portugal										Yes		
Slovenia		Some		Some		Yes			Yes	Yes		Yes
Spain	No	Yes	No	Yes	No	Yes	No	Yes	Some	Yes	Yes	Yes
Sweden		Some		Some				Yes	Some	Yes		
Switzerl.									Some	Yes		
U. K.	Some	Some	Some									
Latvia							Yes	Yes	Some	Yes	Yes	
Greece	Some	Some		Some								
Romania	Some	Some		Some	Some	Some				Yes		
Bulgaria			Some	Some						Yes		
Hungary				Yes						Yes		
Croatia				Some						Yes		
Slovakia	Some	Yes		Some					Yes	Yes		Yes
Estonia	Some	Some		Yes						Yes		
Norway		Some		Yes		Some	Some	Yes		Yes		

See CONOPS Vol 3 Annex J Table 1: Administrative

LEGAL: Europe current

	Operational requirements														Airworthiness	
Pays	VLOS/BVLOS		Max height		Out of cloud		Distance people H/V		Distance airport		Max drone weight		Night flight		Drone ID	
	Rec	Pro	Rec	Pro	Rec	Pro	Rec	Pro	Rec	Pro	Rec	Pro	Rec	Pro	Rec	Pro
Austria	VLOS		150		Yes	Yes										
Belgium	VLOS	VLOS	10	90	Yes		SD/0				1				No	Yes
Czech R.	VLOS	VLOS	300	300					5.5						Yes*	Yes*
Denmark	VLOS	BOTH*	100	100	Yes		50/0		5		7	25	No	No*		Yes
Finland	VLOS		150	150			/0	/*	5		25	25				Yes
France	VLOS	BOTH*	150*	150*			/0	/0			25*	25*	No	No		Yes
Germany	BOTH*	BOTH*	100	100			100/0	100/0	1.5	1.5	5*	5*	No	No		Yes*
Ireland	VLOS	VLOS	120	120			30/0	30/0	5	5						
Italy	VLOS	VLOS	150	150	Yes		/0	/0				25*				Yes
Lithuania	VLOS	VLOS	120	120			50/0	50/0	1.8	1.8	25	25			No	Yes
Malta							/0	/0								
Netherland	VLOS	BOTH*	120				50/0	50	?	?	25		No	No		
Poland	VLOS	BOTH*	No limit	120*			30-100/0	SD	6*	6*	150	150*		Yes		Yes
Portugal	VLOS	BOTH*	120*	120*			30/0	30/0			25*	25*	No	Yes*		
Slovenia	VLOS		150				150		1.5				No		Yes	
Spain	VLOS	VLOS	120	120	Yes	Yes	SD/0	SD/0				25*	No	No		
Sweden	VLOS	BOTH*	120	150			SD/0	SD/0			7*	7*			Yes	Yes
Switzerl.	BOTH*	BOTH*	150	150			100/0	100/0	5	5			No	No		
U. K.	VLOS	BOTH	120				150		1*		20					
Latvia	VLOS	VLOS	120	120			50/0	50/0	?	?			No	No	Yes	Yes
Greece	BOTH*	BOTH*	120	120	Yes	Yes	/0	/0			25	25	No	No	Yes	Yes
Romania	VLOS	VLOS	300	300			?/0	?/0							No	Yes
Bulgaria					Yes	Yes										
Hungary			100	100			SD/0	SD/0					No	No		
Croatia	VLOS	VLOS	300	300	Yes	Yes	30/0	30/0	3	3			No	No	No	Yes
Slovakia	VLOS	VLOS	30	30			50/0	50/0					No	No	No	Yes
Estonia			150	150	Yes	Yes										
Norway	BOTH*	BOTH*	120	120			150/	50/	5	5						

See CONOPS Vol 3 Annex J Table 2: Operational

* Only if authorized, especial permit, license or with exceptions

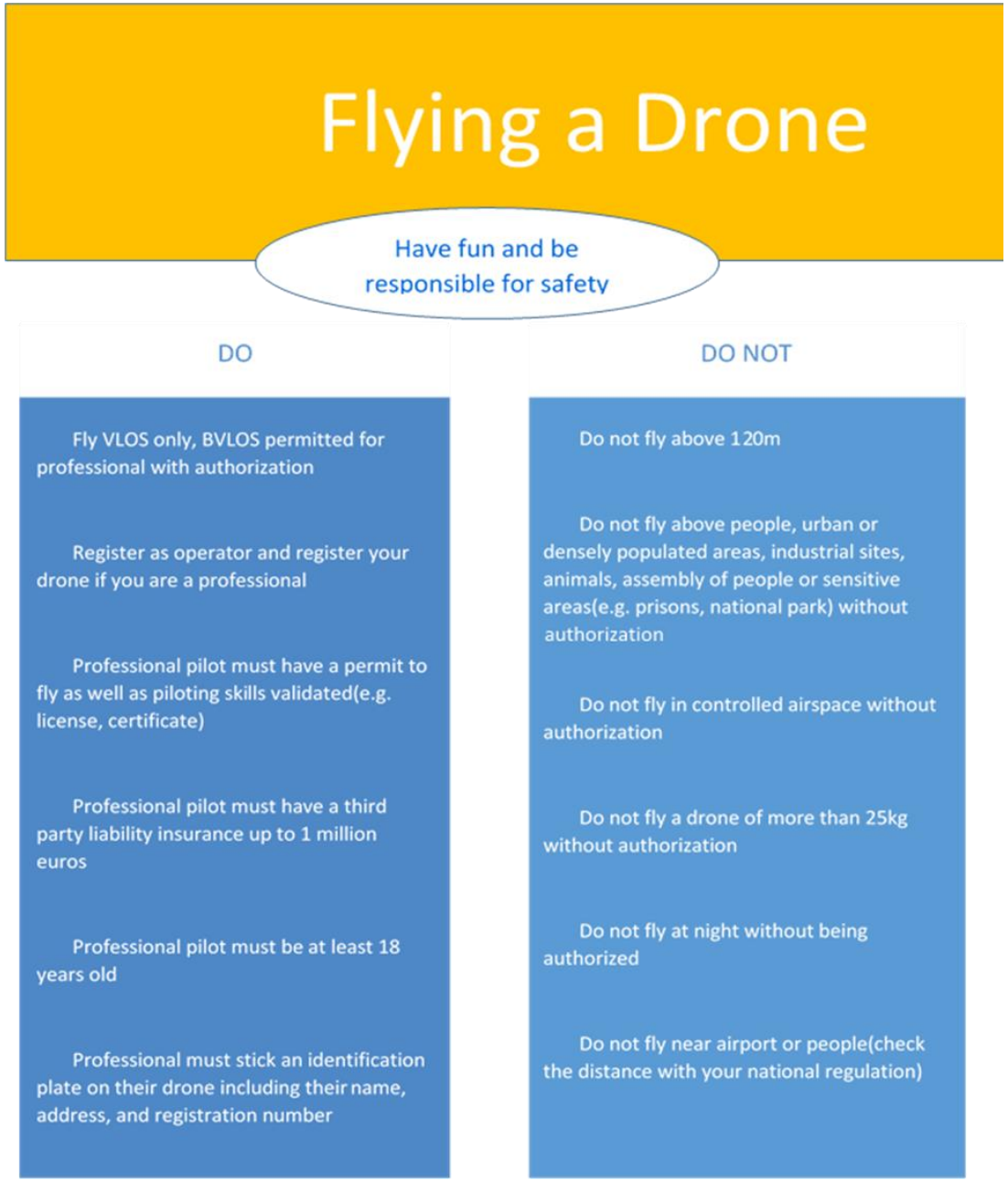
Today Common legal aspects

Good news

- Common important aspects (leaflet)
- In accordance with Commission Reg. and EASA Opinion

Bad News

- Too diverse
- Not always easy to find



This project has received funding from the SESAR Joint Undertaking under grant agreement 763551 under European Union's Horizon 2020 research and innovation programme.

Legal: Recently approved EU directive

- **Delegated Act.** Reg. (EU) 2019/945 & **Implementing** Reg. (EU) 2019/947.
  - Published in EUR-Lex 11th of June 2019
  - Both regulations entered into force on 1st of July 2019 ➔ transitional period
    - Registration, and first Open&Specific operations in Jun 2020
    - National full adoption by 1st of June 2021
- **From EASA, based on JARUS work**
  - Established drone operations according to **risk**
  - Risk = **Air** risk + **Ground** risk
  - Operation **categories** are Open / Specific / Certified

under European Union's Horizon 2020 research and innovation programme.

Legal: Recently approved EU directive

- **Open** category
  - Low risk by operational limitations:
    - max. weight 25 kg
    - VLOS
    - Max height, speed, noise
    - Areas of flight & people
    - Payload, no drop
  - Few administrative tasks
  - On-line pilot training
  - Subcategories (drone classes)
    - A1 (C0, C1) – Hobby
    - A2 (C2) – Theory exam
    - A3 (C3, C4) – RC clubs

- **Specific** category
  - apply to competent authority for operational authorisation
    - SORA
    - Light UAS Operator Certificate (LUC)
    - Standard scenario
- **Certified** category
  - When over people, transport of people, dangerous goods or SORA
  - Type certificate
  - Certificate of airworthiness
  - Noise certificate
  - Licenses
  - Approved operator

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Legal: Recently approved EU directive

- **Articles on**
  - Rules & Procedures for: operations, pilots, risk assessment, airworthiness
  - Cross-border ops
  - Registration of operators and drones
  - Attributions of Member states, Model aircraft clubs, Competent authorities

- **Coming soon** from EASA* / EU:
  - (Oct 2019) Guidance Material (GM), Acceptable Means of Compliance (AMC)
  - (Oct 2019) Pre-defined SORA and standard scenarios
    - Urban VLOS
    - Rural BVLOS
  - (Dec 2019) U-space Opinion

* https://www.easa.europa.eu/easa-and-you/civil-drones-rpas

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Outline

- LEGAL
- **BEST PRACTICES:**
  - Current
  - Summary table
- SOCIAL

(*) Drone is used as a synonym of UAS / UAV / RPAS

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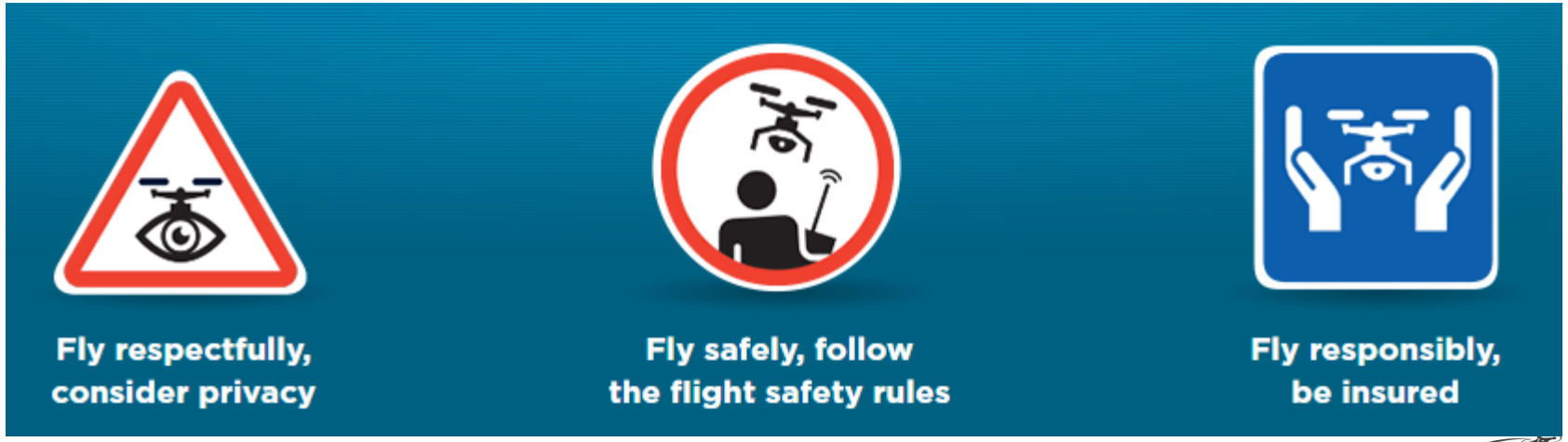
Best practices / Code of Conduct

Best Practice

- Current Best Practices
  - Non-profit association of drone operators and pilots: Prodronepilots, AOPA, ARPAS-UK, ACUAS, DPF, ACUO, AEDRON, UAA …
  - CORUS recommends “UASP Code. Tools to advance UAS safety and professionalism", by Aviators Code Initiative, Jan 2018. Proposes codes in:
    - Pilots responsibilities
    - Manned aircraft & people on the surface
    - Training and proficiency
    - Security and privacy
    - Environmental issues
    - Use of technology
    - Promotion of UAS
  - And … “DroneRules.eu” project & website



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Best practices / Code of Conduct

- Summary table of Code of Conduct (based in AESA GM):

Best Practice

PLATFORM	UAV Setup	Construction
		Initial Setup
		Airworthiness
		Maintenance
OPERATIONS	Before flight	Material checklist & Mission Planning
	During flight	Safety
	After flight	Incident reporting
		Data storage

- Embedded into day-to-day processes

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Outline

- LEGAL
- BEST PRACTICE

- **SOCIAL**:
  - General rules for social acceptance
  - Previous works and public consultations
  - Social acceptance indicators

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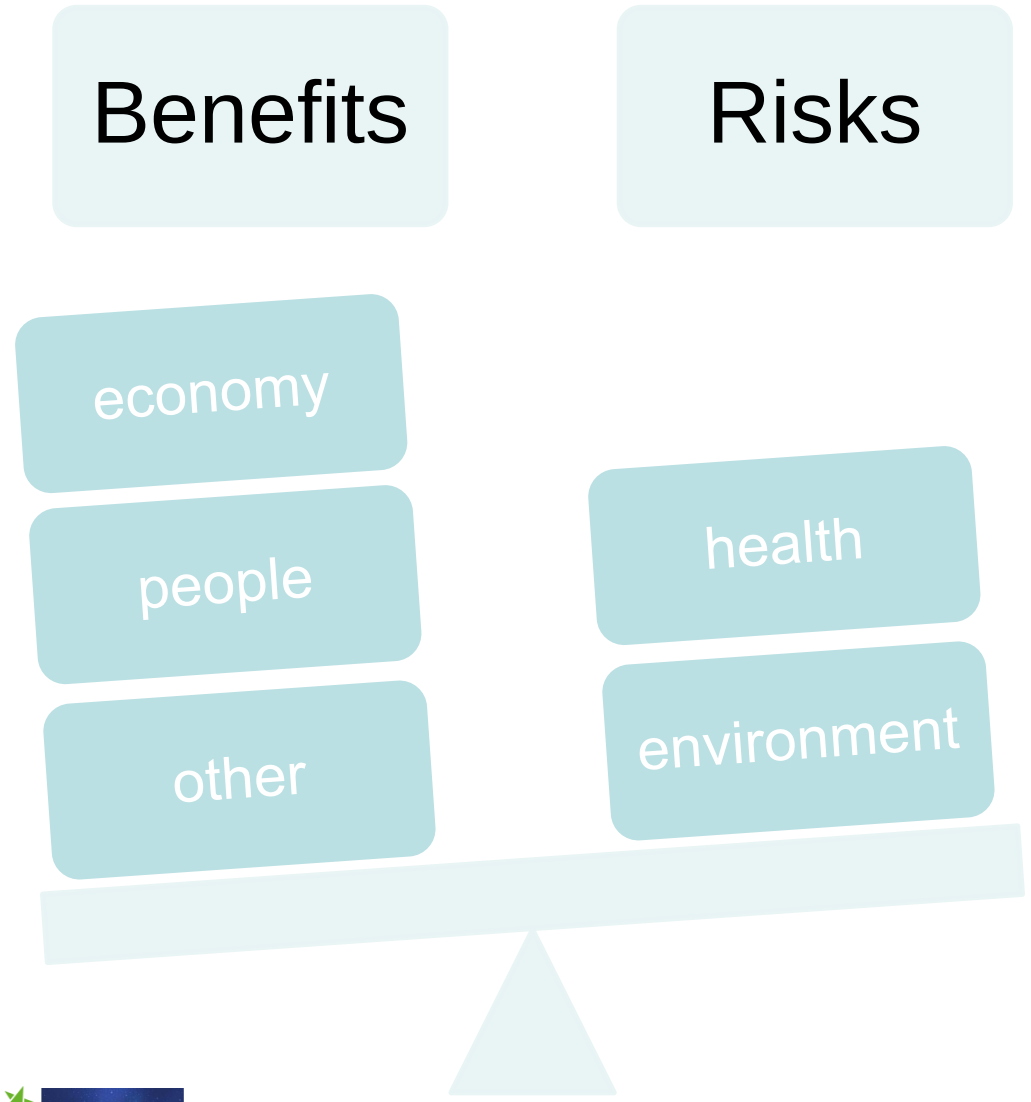
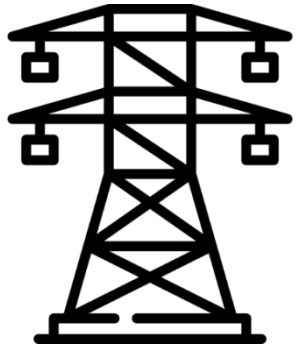
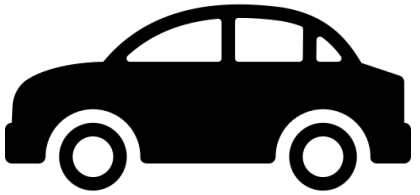
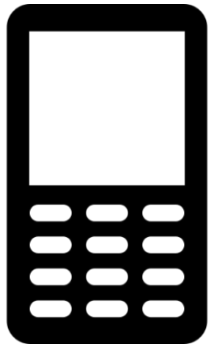
SOCIAL: General rules for social acceptance







EMERGENT TECHNOLOGIES



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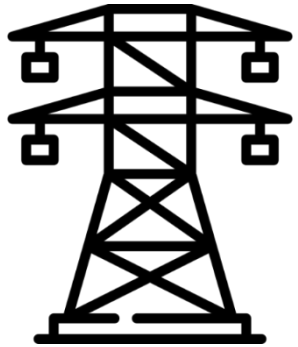
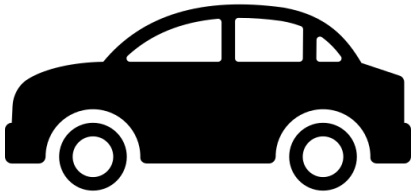
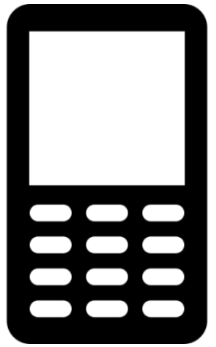
SOCIAL: General rules for social acceptance

Benefits	Risks
economy	UNKNOWN
people	Health
other	environment





EMERGENT TECHNOLOGIES



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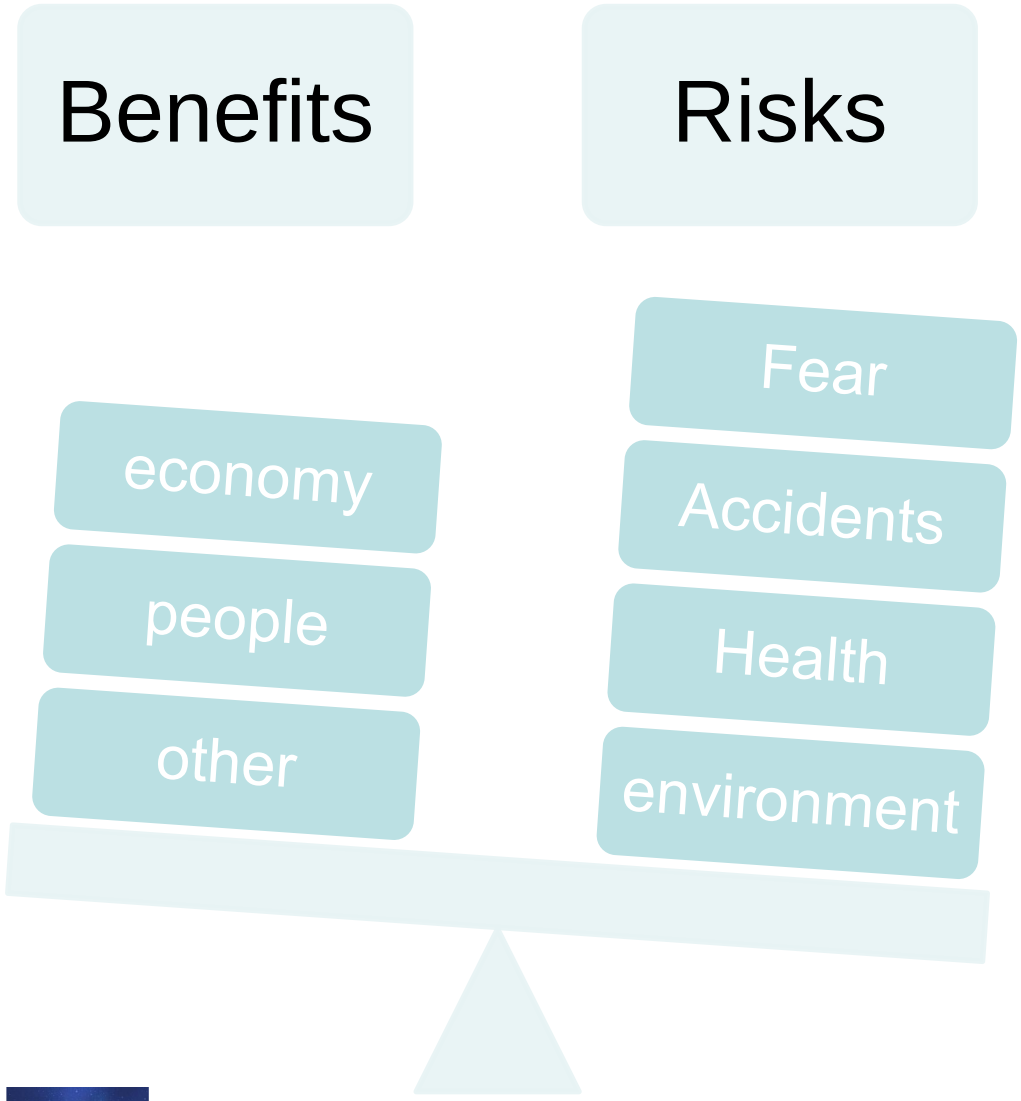
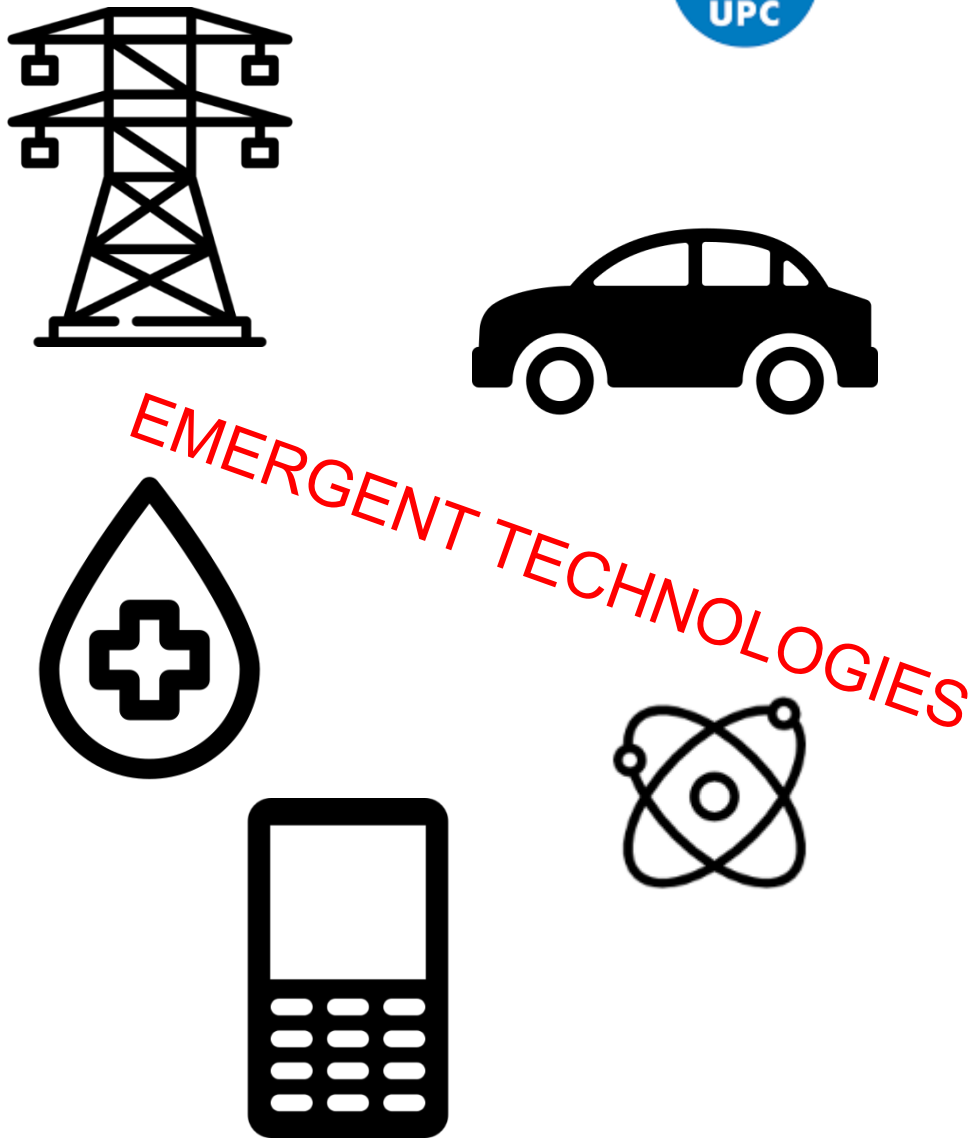
SOCIAL: General rules for social acceptance





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SOCIAL: Principles for acceptance

- Transparency: **COMMUNICATE**
  - Accurate, Complete, Timeliness
  - Understandable language

- Law enforcement: **ACT**

- Inclusiveness: **LISTEN**

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SOCIAL: **DRONES PERCEPTION** & Individual interests

Benefits

Risks

Growth

Employment

Business

Insurance cost

Benefits

Risks

Air Safety

Any?

New costs

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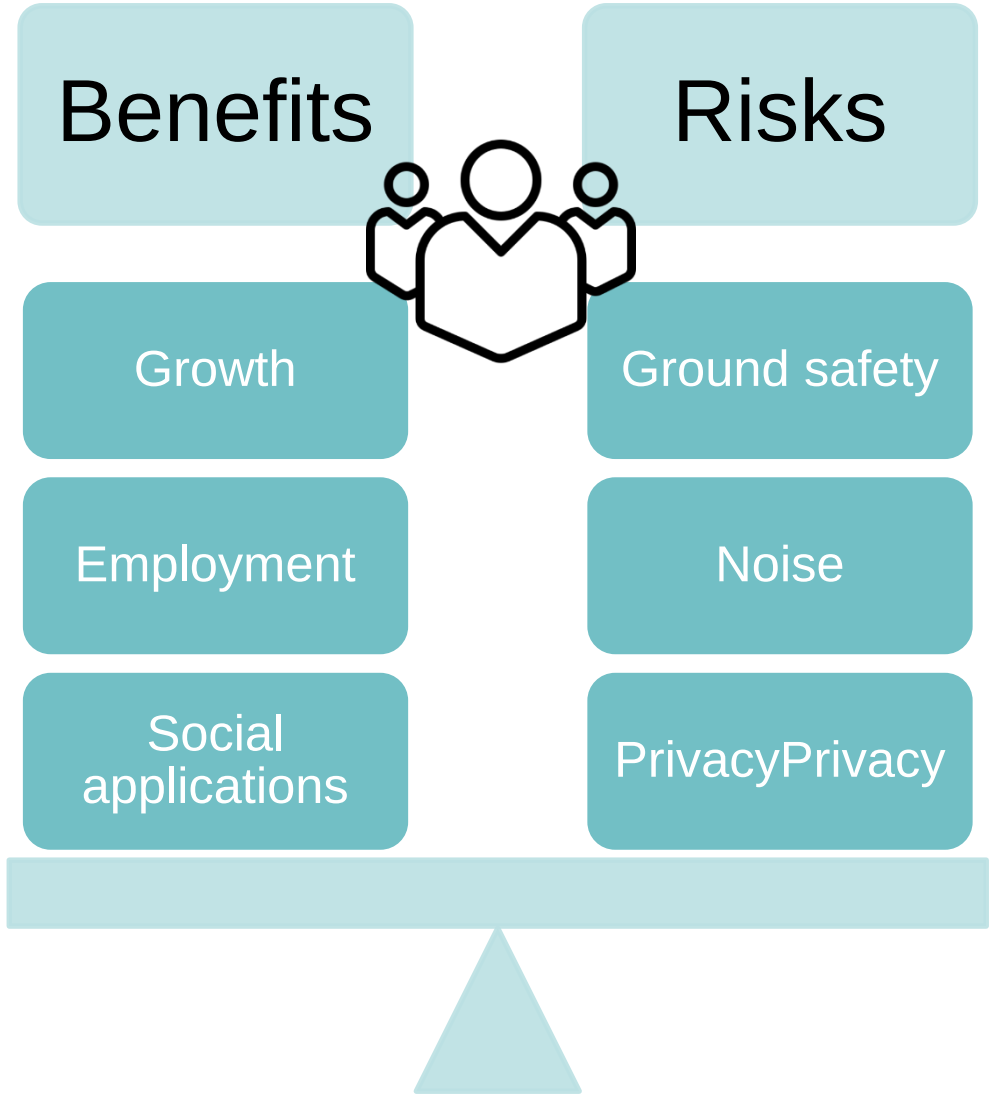
SOCIAL: Public **perception of drones**



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SOCIAL: Public perception

Benefits	Risks
Growth	Safety
Employment	Privacy
Social applications	Noise

- Voluntary
- Capability to respond
- Consequences of failures
- Mass media
- Full control

- Chilling effect
- Dehumanisation
- Function creep

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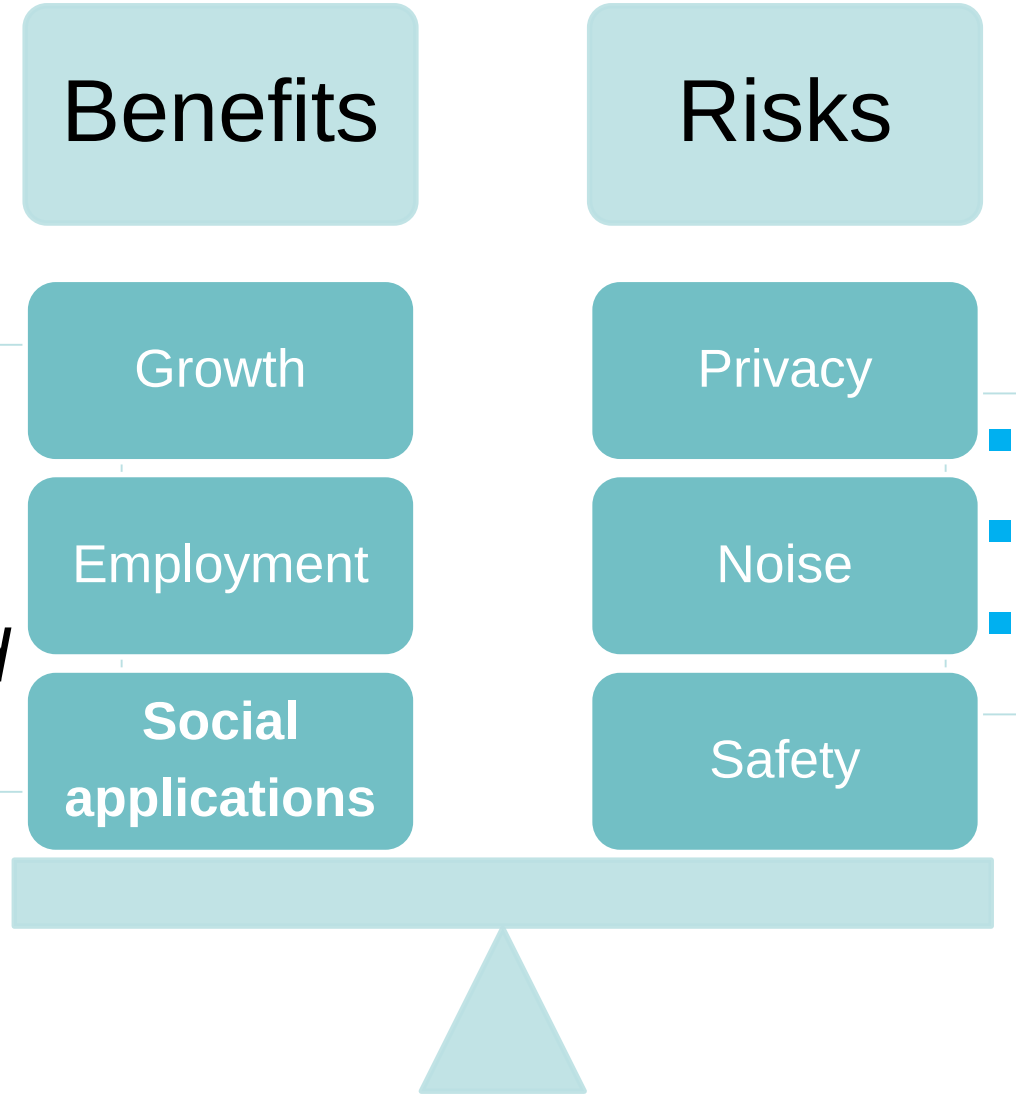
SOCIAL: How to increase positive perception



- Disseminate benefits
- Enforce law
- First for *Good* Civil Causes

- Best practices
- Code of conduct
- Insurance factor

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SOCIAL: Important role in disaster management

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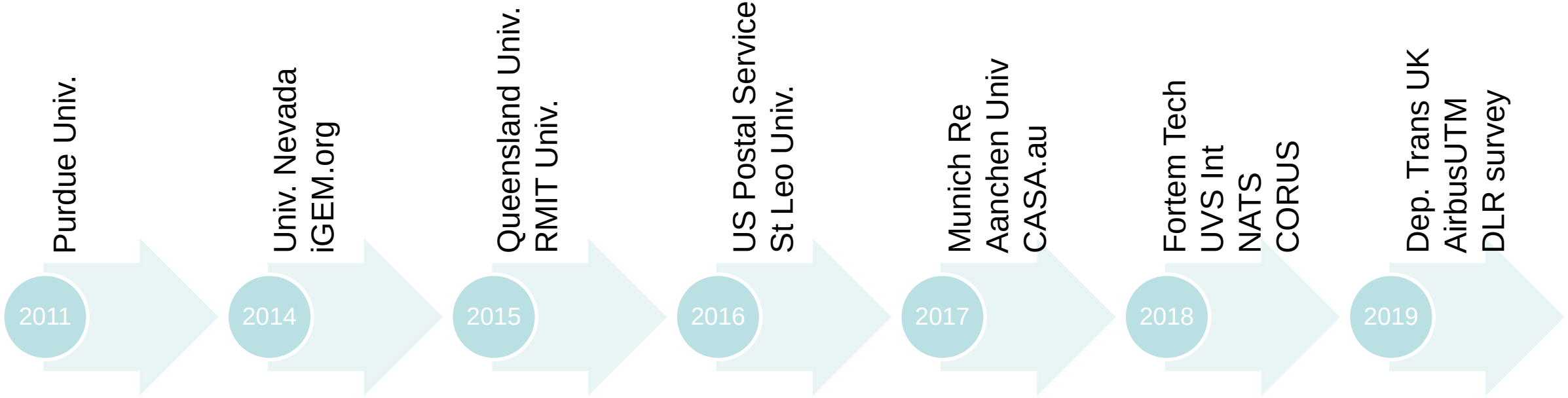
Surveys and public consultations



Public perception
Associate to military

Public perception
+70% privacy at home
Role of Artificial Intell.

Cargo & Passenger
Risk perception

Delivery
Top concern malfunction
Public perception
40% ban in own community

Risks Managers
Public perception
Regulation

Public perception
Favor to social mission
Economy
High growth

Regulation
Urban Air Mob
40%safe vs 55%
Counter-Drone

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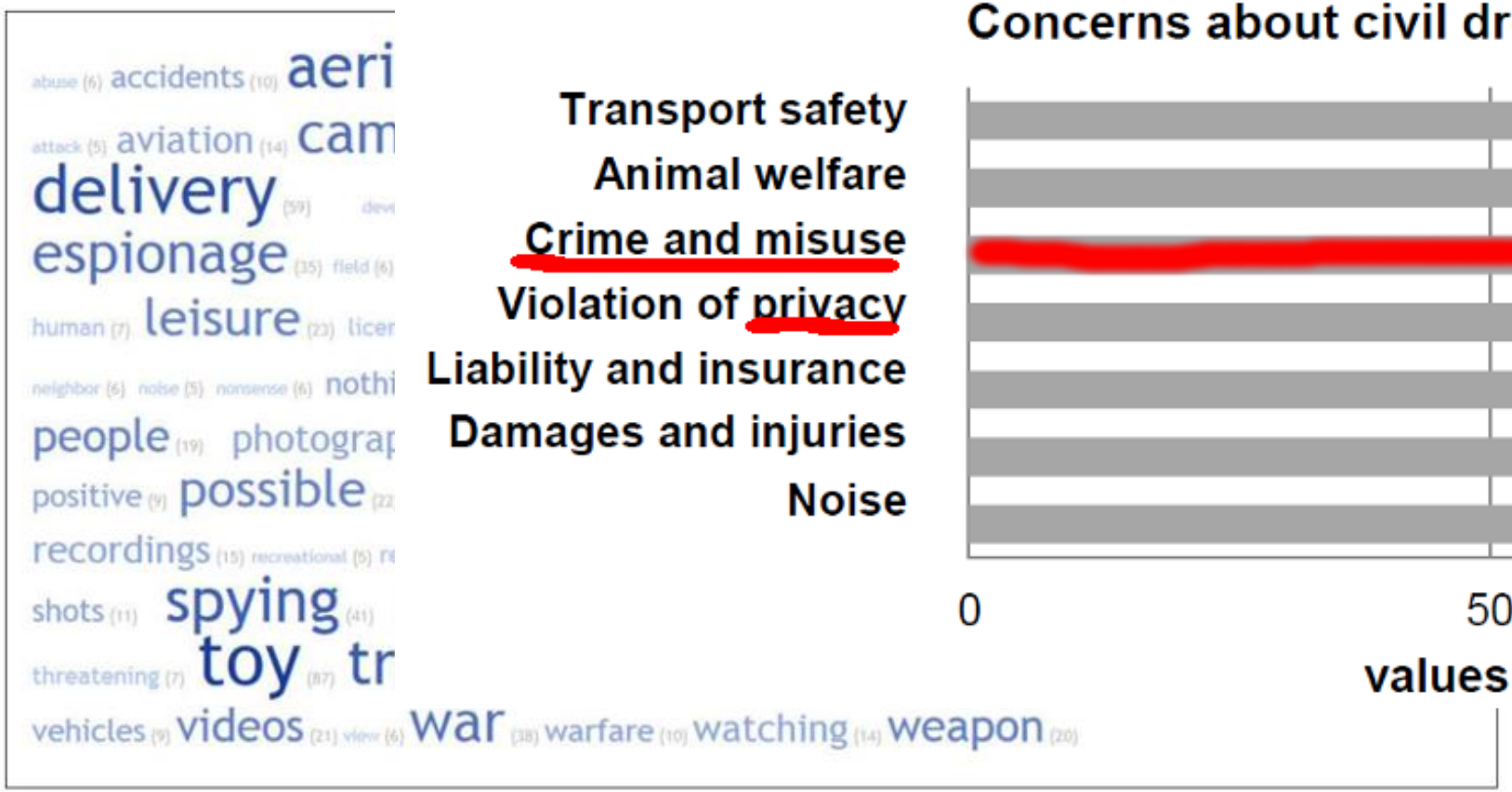
Surveys and public consultations highlights



THE ACCEPTANCE OF CIVIL DRONES IN GERMANY

DLR German Aerospace Center

Outline

- LEGAL
- BEST PRACTICE

- **SOCIAL**:
  - General rules for social acceptance
  - Previous works and public consultations
  - **Social acceptance indicators***

* Social/Stakeholders indicators

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under European Union's Horizon 2020 research and innovation programme.

Social acceptance indicators

- Social acceptance indicators (SAI) **requirements**:
  1) Consider all perspectives of the impact of drones on society, not only economical
  2) Use a feasible methodology to obtain SAI values
  3) SAI values shall be easy to understand
  4) Assessment of results shall be useful for the CONOPS tuning

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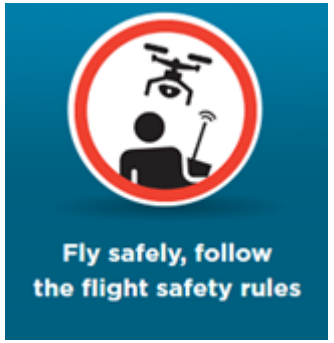
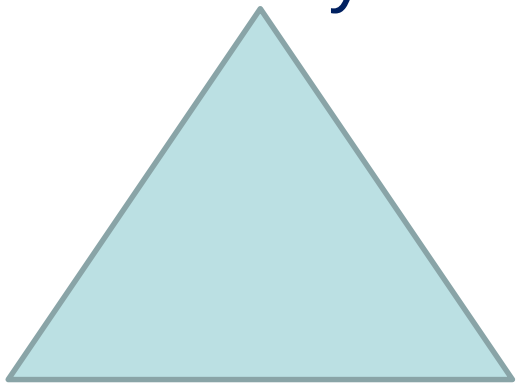
Social acceptance indicators

- Req.1) Consider all perspectives of the impact of drones on society, not only economical

- Propose of three indicators:
  - SAI_SA
  - SAI_EC
  - SAI_PO



Safety



Political

Economy

Figures from DroneRules.eu

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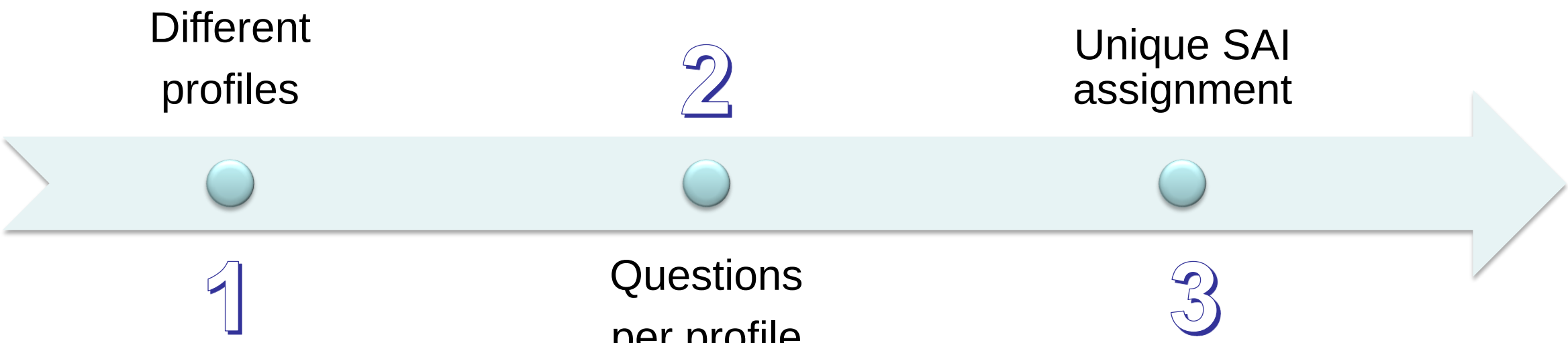
Social / Stakeholders acceptance indicators

- Req.2) Use a feasible methodology to obtain SAI values
  - Follow methodology to obtain data:



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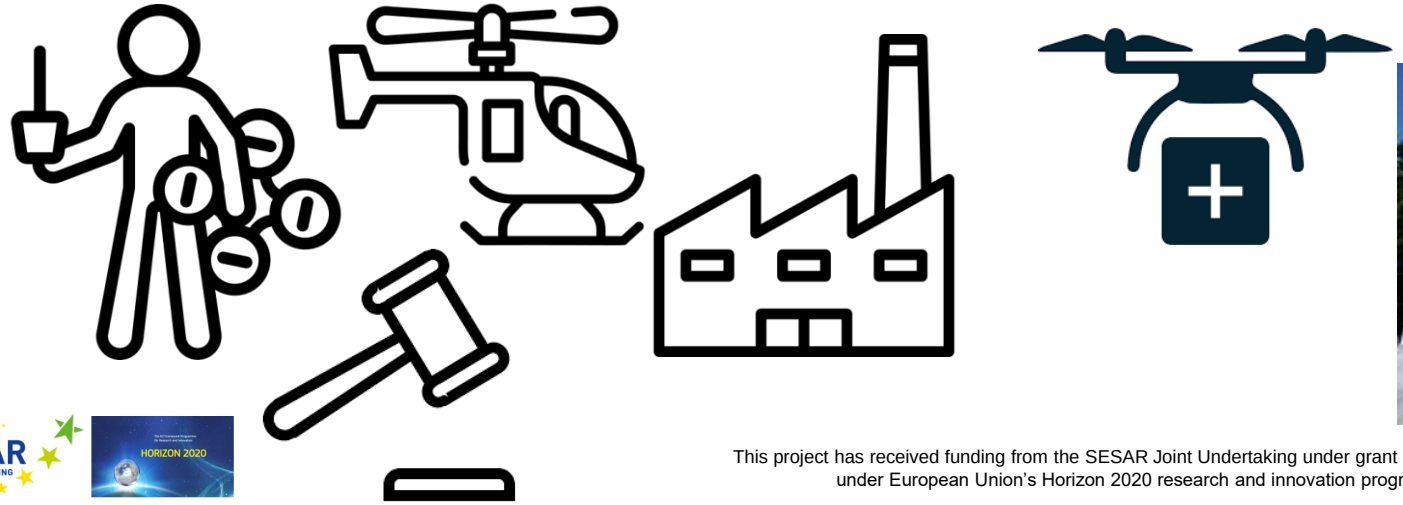
Social acceptance indicators

- **52 questions**. For instance:
  - How flexible is the system to drone operation last minute changes?
  - How cameras on drones are useful or dangerous to citizens?
  - …
- The questions are proposed to have a complete view of society
  - Drone operator, other airspace users, clients of drone operators, supply industry, citizens, environment, emergency respondents, administration, law enforcement, airlines, airports, ANSP, … => **10 profiles**



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Social acceptance indicators

- Each profile is assigned to only one of the 3 areas

ECONOMICAL	Drone operator	Clients of drone ops.	Industry
POLITICAL	Environment	Emergency responders	Government & Agencies
	Citizens		
SAFETY	Airlines	VLL Airspace Users	Airports, ANSP

- Questions are grouped by topic => **22 metrics**: SAI.EC#, SAI_PO# and SAI_SA#
  - Answers using **Likert scale** by
    - Experts, CORUS Partners
    - WS attendants
    - Students

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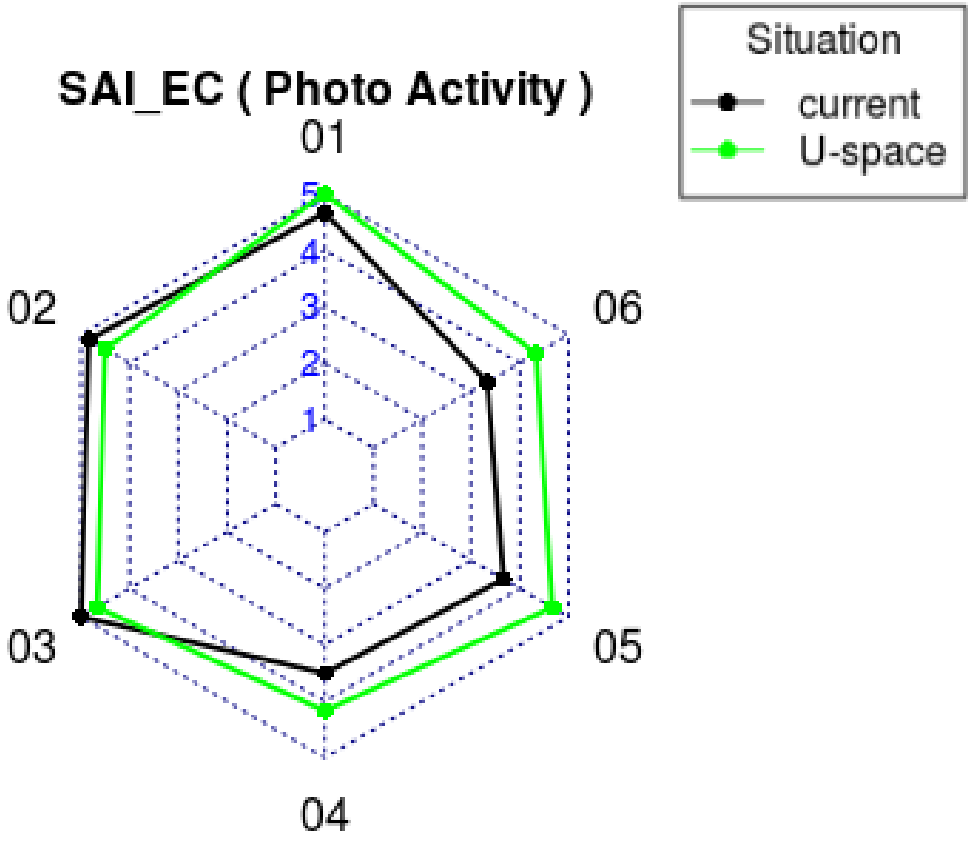
under European Union's Horizon 2020 research and innovation programme.

Social acceptance indicators

Req.3) Make SAI values easy to understand

- The results are plot using radar charts:
  - Easy to compare the balance between the 3 areas
  - Easy to compare between scenarios

Example



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Social acceptance indicators

Req.4) Results useful for the CONOPS tuning

- Used 4 use cases to compare services in Volumes X-Y-Z

✓ Photo activity (X)

✓ Bridge inspection (Y)

✓ Runway inspection (Za)

✓ Police Surveillance (Zu)

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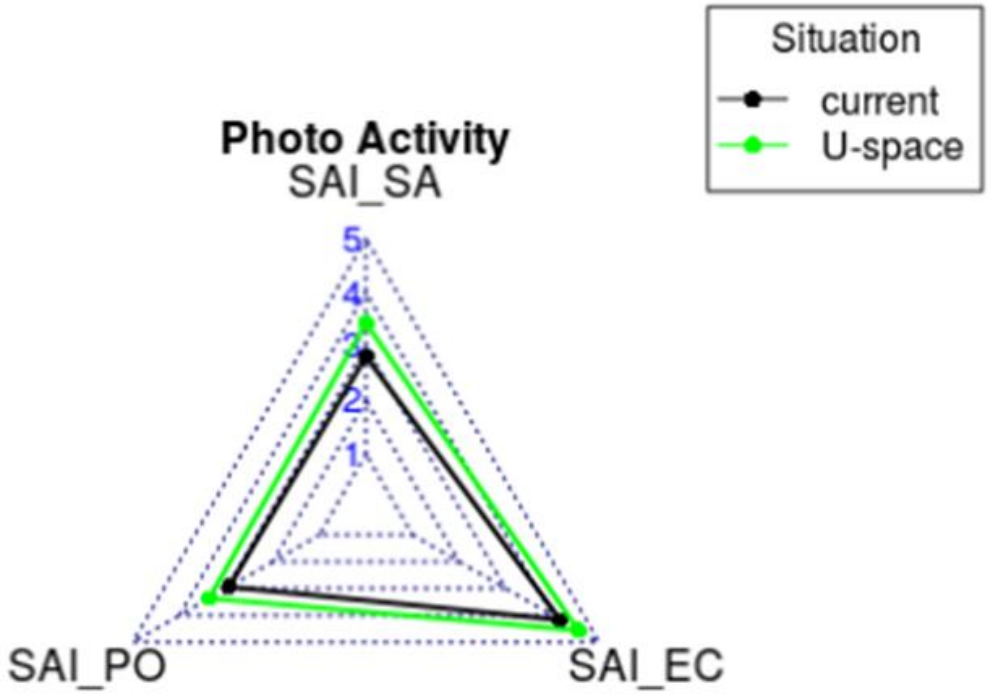
Use case ….in X

- ✓ VLOS, less than 900g: OPEN.
- ✓ Over non-populated area
- ✓ Photo activity



- From good to better, but very similar.
  - Economy stays very good
  - Safety & Political have improvement
- ➢ NO much differences today with volume X, except eID

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Use case … in Y

- ✓ BVLOS, less than 4kg,
- ✓ Bridge inspection.
- ✓ Reference for VFR pilots and leisure drone.
- ✓ SORA confirms operation is in the Specific category.

- Improvement on SAFETY by estrategical deconfliction
- Improvement also EC & PO
- ➢ Need of Y volume for BVLOS

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Use case … in Za

- ✓ BVLOS, less than 4kg, in TMA
- ✓ Runway inspection.
- ✓ The drone flight is under the control of ATC
- ✓ SORA confirms the operation is in the specific category.

- Huge improvement on Economy & Safety
- Good also for Economy
- ➢ Need of Za volume

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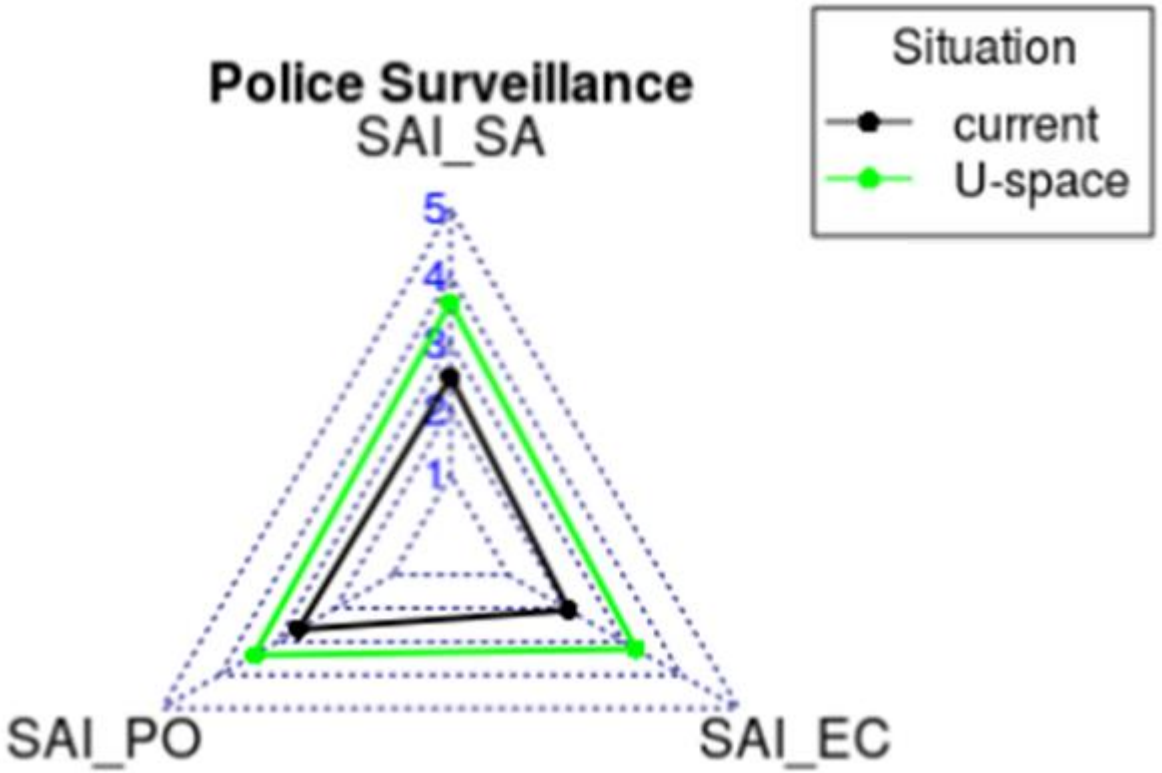
Use case… in Zu

- ✓ BVLOS, more than 25kg, over urban area.
- ✓ Police surveillance.
- ✓ SORA confirms the drone must be certified.



- Good improvements on ALL
- But still low values (ie. EC by cost of certification)
- ➢ Current situation is very bad

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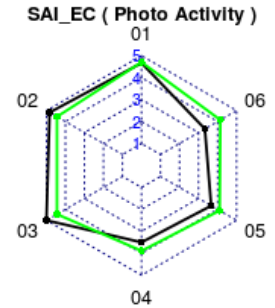
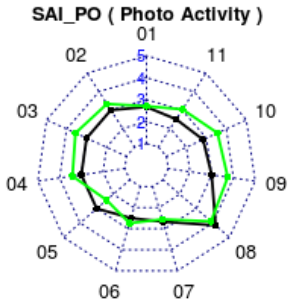
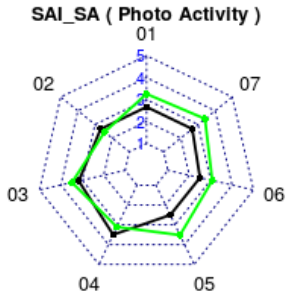
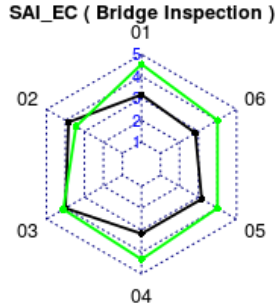
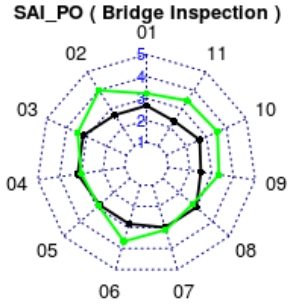
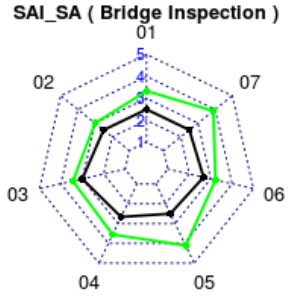
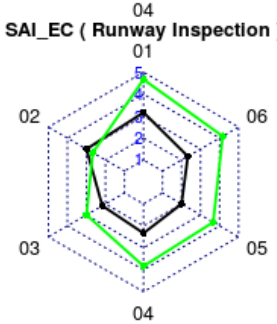
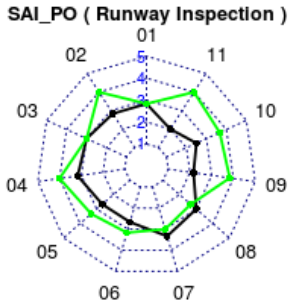
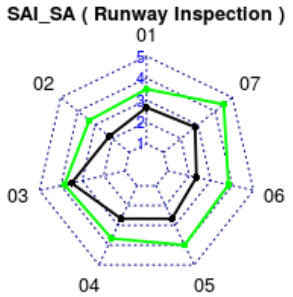
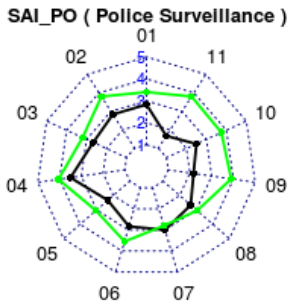
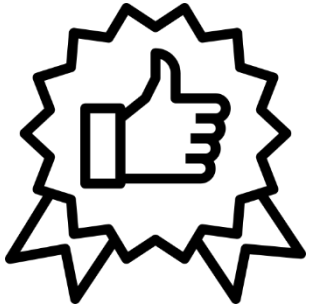
All in one

	EC	PO	SA
Photo Activity			
Bridge inspection			
Runway inspection			
Police surveillance			

under European Union's Horizon 2020 research and innovation programme.

Conclusions

- Legal:
  - Long term: homogenization for EU being addressed by EASA and SESAR
  - Short term: most countries have regulated drones
  - Very important law enforcement capabilities
- Best Practices:
  - Drone operators associations
  - Pilots from RC
  - Extend to industry and suppliers
- Social Acceptance:
  - Needs to communicate, listen and act
  - SAI used to assess the CONOPS (Req.4)



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Legal aspects & Social Impact

Most ICONs from to www.flaticon.com

Cristina BARRADO
UPC BarcelonaTECH

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CORUS Safety Approach

U-space ConOps and Research Dissemination Conference

David Martín Marrero
Safety Specialist at Eurocontrol

30th September 2019

This project has received funding from the SESAR Joint Undertaking under grant agreement 763551
under European Union's Horizon 2020 research and innovation programme.

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- Airspace Safety Assessment Scope
- Safety Assessment Methodology Approach
- Methodology for the U-Space Safety Assessment (MEDUSA)
- Drone operations at airport (Example 1)
- Introduction to parcel delivery flight in Paris region (Example 2)

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Airspace Safety Assessment Scope

Operator's Assessment View

AIRWORTHINESS

Air Operation

GROUND RISK

to mitigate /reduce risk

Airspace Design

ATS provision

U-Space Service provision

+ MET, AIS, etc…….

to mitigate /reduce risk

AIR RISK

Airspace Safety Assessment Scope

This project has received funding from the SESAR Joint Undertaking under grant agreement 763551 under European Union's Horizon 2020 research and innovation programme.

Airspace Safety Assessment Scope (2)

- To address the risk associated to operations supported by the U-Space we have to consider:
  - Different services running and cooperating in real time
  - Different U-Space/UTM service providers might exchange information
  - Coordination with ATM/ATS through dedicated interfaces
  - Multiple drone operations will be conducted simultaneously cohabiting with manned aircraft

- Information required to perform an exhaustive safety assessment difficult to access to operators

- Reasons: privacy issues, security aspects and/or competition with other operators, among others.

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Safety Assessment Methodology Approach

Eurocontrol Safety Reference Material

- The basic principle is to conduct a safety assessment for such operation in accordance with the principle of the EUROCONTROL SRM (Safety Reference Material)

- The safety assessment addresses all the “aviation domains” associated to the operation (ATS, Aerodrome operator, Drone operator,…).

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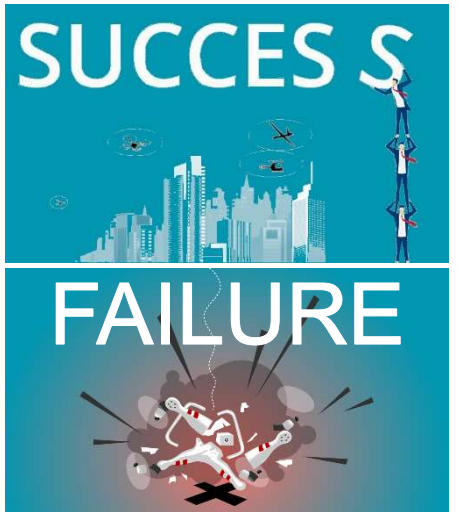
Methodology for the U-Space Safety Assessment (MEDUSA)

- The MEDUSA process provides a **holistic approach** to the U-Space safety assessment:
  - Incorporates different viewpoints:

Airspace Design	Air Operation	U-Space Service provision
ATS provision	Interoperability	+ MET, AIS, etc…….

- Adopts a **broader safety approach** addressing both:
  - Positive contribution of U-Space to aviation safety (Success approach):
    - Assessing how effective U-Space would be when is working as intended.
  - As well as the negative effect of U-Space on the risk of an accident (Failure approach).



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Methodology for the U-Space Safety Assessment (MEDUSA) (2)

- In relation with the risk determination, three areas are proposed to assess the mitigation level provided by U-space services:
  - Level of mitigation of air risk (unmanned-manned / unmanned-unmanned)

  - Level of mitigation of ground risk (prevent fatalities on the ground and damage to critical infrastructure).
    - Including aviation infrastructures like Control towers, Ground Navaids, Comm antenna mast, etc.

  - Level of mitigation of incursion into “no-fly zones” (airspace infringement).

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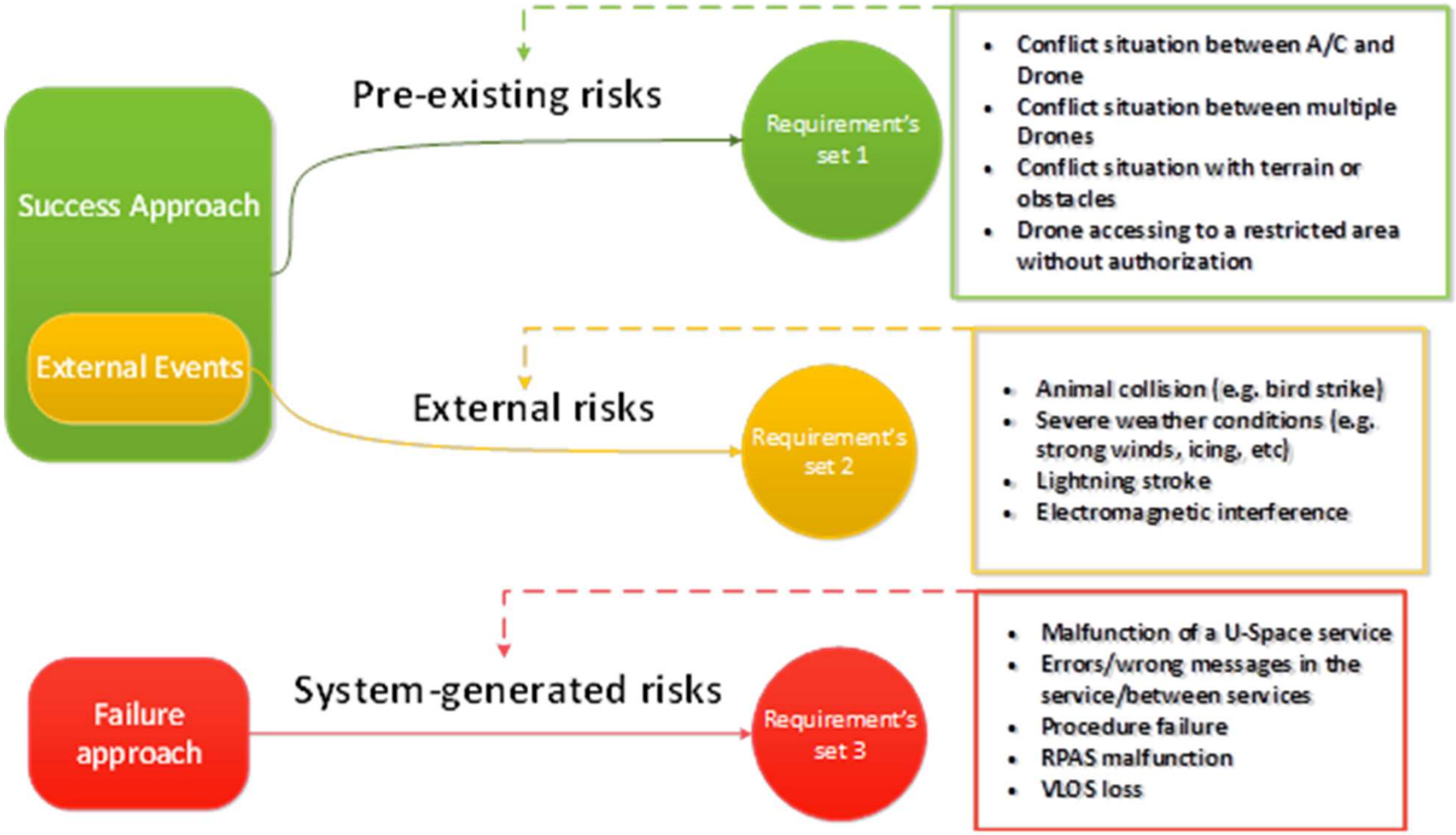
Methodology for the U-Space Safety Assessment (MEDUSA) (3)



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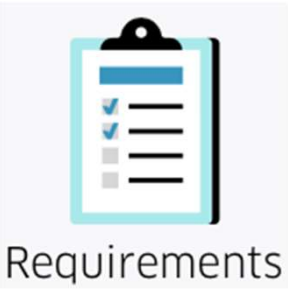
Methodology for the U-Space Safety Assessment (MEDUSA) (4)

- Identification of aviation hazards and definition of safety target (Safety Criteria - SAC).

- Safety Criteria are allocated into Safety Objectives (SOs) to be materialized/achieved through Safety Requirements (SRs).



- The assessment is initially carried out in normal conditions (fault-free conditions) considering the planned drone operation.

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Methodology for the U-Space Safety Assessment (MEDUSA) (5)

- The assessment shall then consider abnormal conditions which will/might be encountered.
- Finally the assessment shall considered faulted conditions associated to “System-generated” hazards.
- The derived requirements/mitigations for normal, abnormal and faulted conditions will be directly allocated to USSPs, drone operators, ATSP or aerodrome operator
- It should be shown that this set of safety requirements is sufficient to satisfy the Safety Criteria

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Example 1 – Drone operations at airport

- Drone operations conducted at a controlled aerodrome during day or night conditions.

- Cover the different lifecycle of the drone operations from definition to the actual operation implementation.

- To identify the list of safety requirements for implementation addressing normal, abnormal and failure conditions.

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Example 1 – Drone operations at airport

- Possible use cases considered :
  - Runway and Taxiway pavement inspection
  - FOD detection
  - Lightning inspection
  - ……

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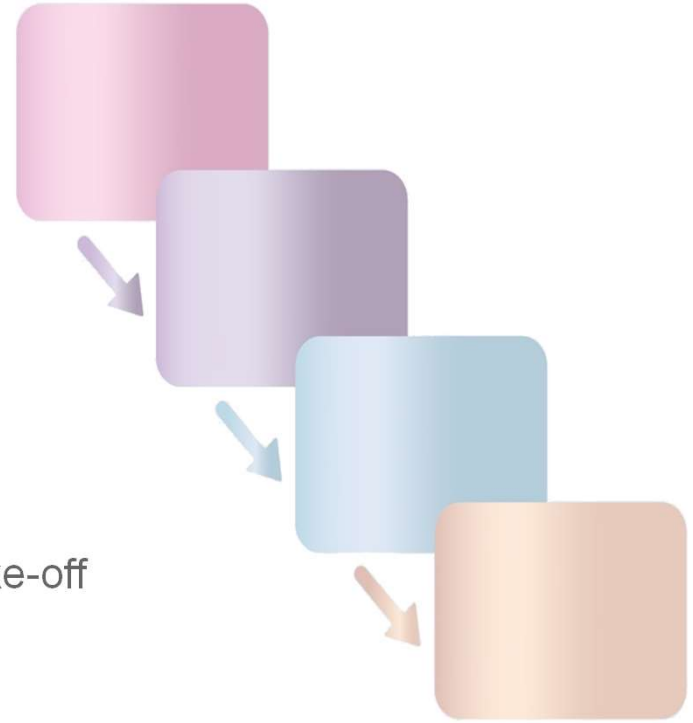
Example 1 – Drone operations at airport

Steps nominal flow

1. Aerodrome Operator initiates drone inspection.
2. The drone pilot is briefed about operational constraints/procedures
3. Drone pilot request permission
4. ATC provides permission
5. Drone pilot launches the drone at a pre-designated take-off location for the operational Volume
6. Drone pilot verifies that data to be monitored/inspected is being captured properly



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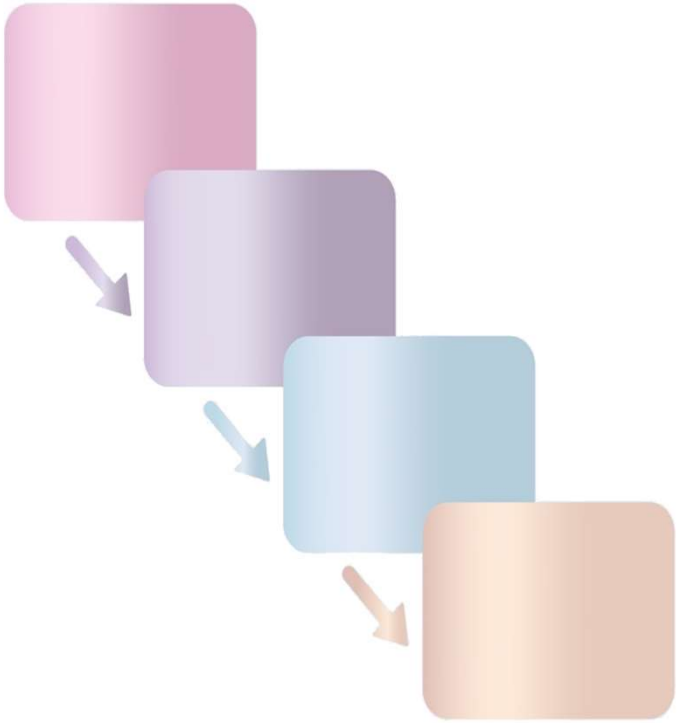
Example 1 – Drone operations at airport

Steps nominal flow (continuation)

7. Drone pilot flies the drone in the relevant operational volume in VLOS or BVLOS
8. Drone pilot finishes the flight and drone returns to the pre-designated landing location
9. The drone is secured
10. Drone pilot reports operational volume vacated to ATC
11. ATC acknowledges the relevant operational volume is vacated.



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Example 1 – Drone operations at airport

Aviation hazards relevant for drone operations at the aerodrome:

The intended trajectories of drone and manned aircraft are in conflict in the air (air-risk)

Safety Criteria define the acceptable level of safety to be achieved

SAC#1: No more number of drone runway incursions per drone movement compared to manned aircraft runway incursion per movement at this aerodrome

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Example 1 – Drone operations at airport

Definition of Safety Objectives in normal conditions:

The following safety objectives are formulated in order for drone operations to meet the SAC in normal operating conditions (fault-free conditions).

SO ID	Achieved by/ Success Case Safety Objective	Ref. SAC
SO#005	ATC shall manage and monitor safely the drone operation on the runway	SAC #1
SO#010	ATC shall prevent conflict on the runway between manned aircraft/vehicle and drone	SAC #1

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Example 1 – Drone operations at airport

Safety Objectives in abnormal conditions

The following abnormal conditions have been identified:

Abnormal scenarios	GNSS interference	#1
	Radio Interference (C2 link, …)	#6

These abnormal scenarios have been assessed for potential risk, then mitigations are derived in the form of Safety Objectives:

SO ID	Description	Ab. Cond.	Ref. SAC
SO#105	Absence of GNSS and/or radio interference at the aerodrome affecting drone operation shall be verified	#1; #6	SAC# 1
SO#115	Drone operation at the aerodrome shall be stopped immediately when abnormal conditions are encountered during the flight	#1; #6; other	SAC# 1

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Example 1 – Drone operations at airport

Safety Objectives in faulted condition

Operational hazards are identified assessing their consequences :

ID	Hazard description	Operational effects
Hz_01	Drone during the monitoring/inspection deviates from its trajectory towards a landing/Taking-Off aircraft	Drone might collide with the landing or taking off aircraft

SO ref	Safety Objectives (integrity/reliability)
SO#1000	The likelihood of a drone deviating from its trajectory toward a landing or taking off A/C during an inspection shall be improbable*

*Improbable: Such an effect is not expected to happen throughout the system lifetime (Severity classification in a qualitative manner)

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Example 1 – Drone operations at airport

* According to the Functional System high-level design representation

SR description	Responsible actor*	Ref. SO ID
Tower Controller shall always be aware that a drone runway monitoring/inspection is ongoing	Drone pilot → ATCO	SO#010
The drone shall be equipped with a C2 link loss function (e.g.: return to home)	Drone	Hz_01
The aerodrome operator shall check that there is no interference which might impact the drone operation in the monitoring/inspection volumes in particular interferences affecting GNSS and/or C2 link	A.O.	SO#105 Hz_01
Drone shall be equipped with a geo-caging system for aerial safety	Drone	Hz_01

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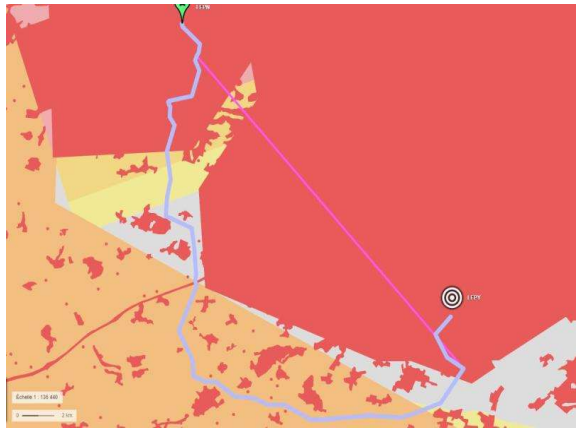
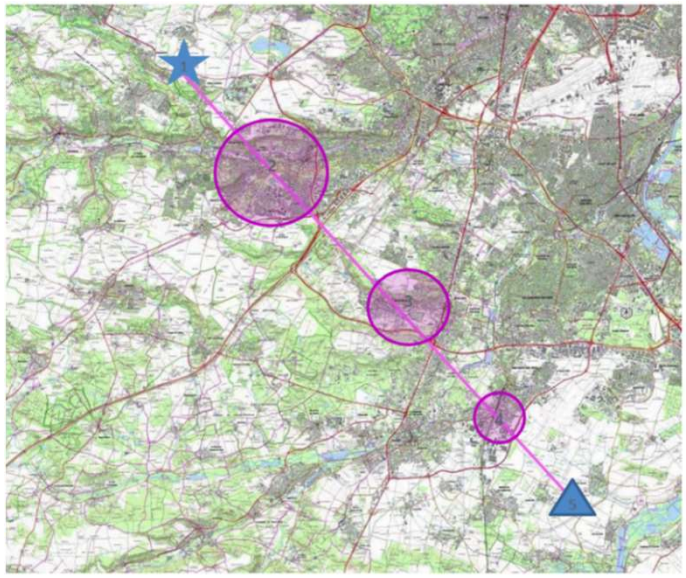
Example 2 – Parcel delivery flight in Paris Region

- Flight between LFPN (Toussus-le-Noble) to LFPY (Bretigny sur Orge)
- 24 km on direct route, 49 km on alternative route.
- VTOL, 3,5 m wingspan, 18 m/s cruise speed, MTOW 13,5 kg, Payload 2 kg
- Automated flight and beyond visual line-of sight (BVLOS).





ConOps Annexes D2 & D3

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Contingency

CORUS Dissemination Day

Andreas Volkert
WP3 leader
30th September 2019

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Contingency vs. Emergency

Conclusion from Workshops

- **Contingency Plan:**
  - Plan B (Alternative)
  - Situation is under control
  - Attempt to maintain the level of operation
  - Different levels of contingencies, depending on event severity

- **Emergency Plan:**
  - Situation is out of (safe) control
  - Triggered after catastrophic event that leads to an unsafe situation
  - Sudden event:
    - Normal operation → Emergency situation
  - Deteriorating event:
    - Normal operation → degraded mode of operation → Emergency situation

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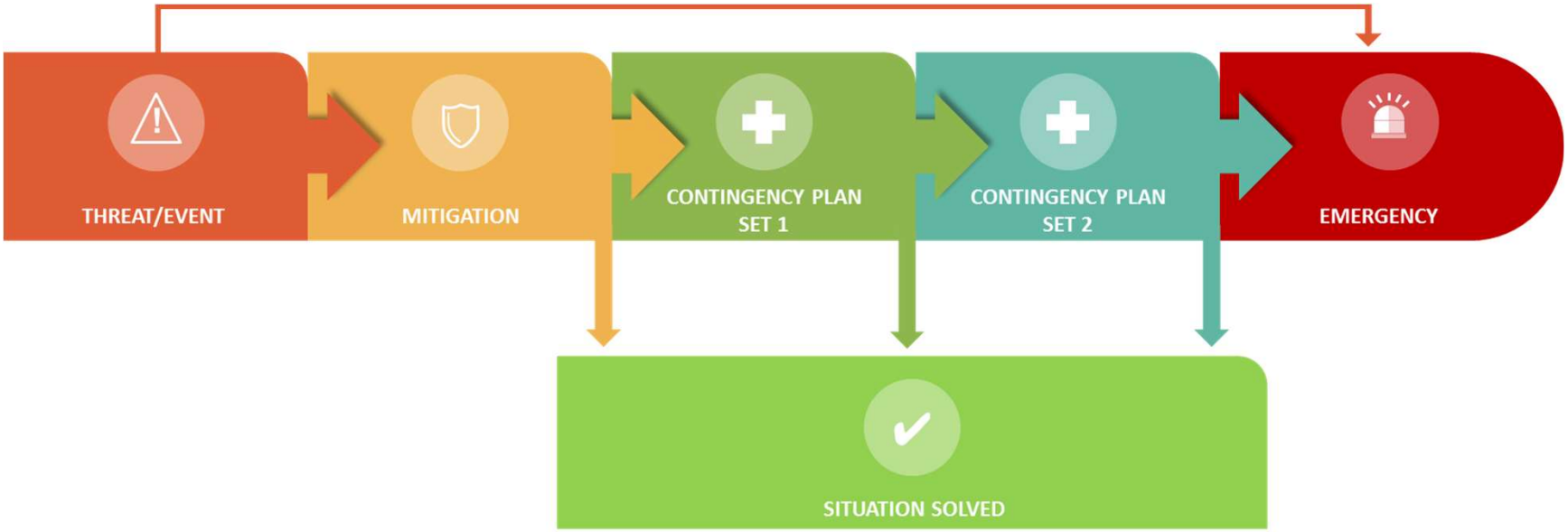
Contingency vs. Emergency



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Presentation of Contingency Plan examples

- Presented Contingency Plans are proposals only
- Drone operators are responsible for Contingency Plans/Sets
- U-Space Service providers are responsible for Contingency Plans/Sets

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Contingency Example #1

- Runway Inspection with Multicopter (BVLOS)
- **Event**: Electromagnetic interference (e.g. antennas, solar storms)
- **Symptoms**: wrong compass indication and a misleading GPS signal

- **Contingency Set #1:**
  - The drone must either return to home/launch or land at a dedicated landing area, either by pilot command or automatically
  - Pilot/drone has to send weather information to the weather information service

    Note: The weather information is also responsible for Kp-values (solar storms) and permanent sources of electromagnetic interferences (buildings, antennas, etc.)
- **Contingency Set #2** (drone flight without GPS and compass support):
  - If VLOS → chance of manually flying back to launch/home
  - If BVLOS → emergency plan (depends on drone capabilities, e.g. (super) simpel mode by Arducopter)

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Emergency Example (very generic)

- The drone must activate the emergency landing protocol (immediately) and appropriate emergency equipment has to be activated (e.g. parachute, flash lights to be seen at night and sound a signal to be heard on ground)
- Either the drone or the pilot has to send an emergency signal immediately to/via the emergency management service

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Contingency Example #4

- **Service:** Emergency Management
- **Event:** Datalink loss to/from drone operator/pilot
- **Symptoms:** Emergency messages cannot be reported (to/from drone)

- **Contingency #1.1** (Service → drone operator/pilot):
  - Drone operator/pilot must be contacted by phone
    (This demands a requirement for all drone operators/pilots to be on call)
- **Contingency #1.2** (Drone operator/pilot → service):
  - Drone operator/pilot has to contact service provider via hotline/emergency phone

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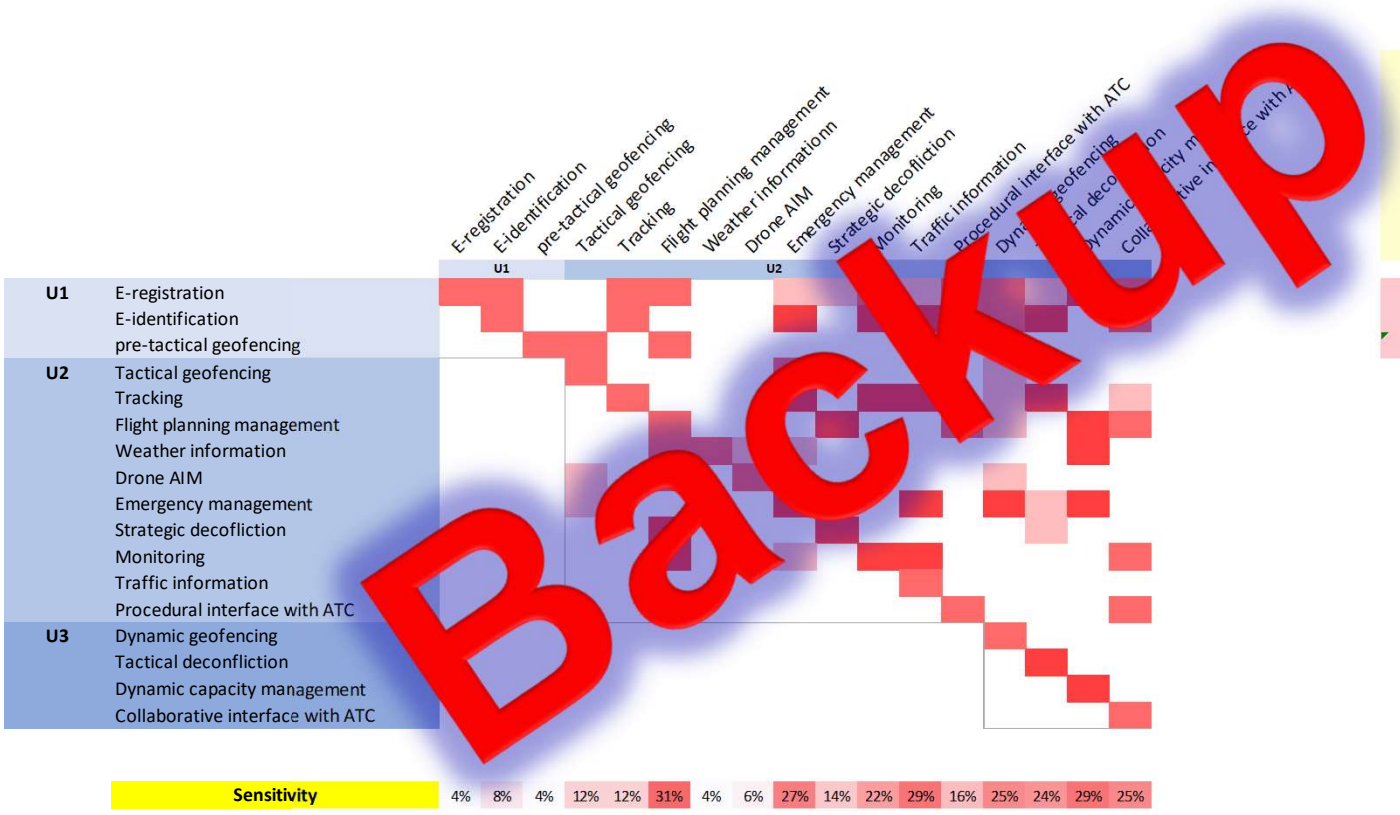
Impact of system-generated risks on U-Space Services

Which U-Space services are affected if another service fails?



	U1	U2 (U1+U2)	U3 (U1+U2+U3)
E-registration	44%	38%	45%
E-identification	22%	38%	43%
pre-tactical geofencing	22%	15%	12%
Tactical geofencing		10%	10%
Tracking		28%	31%
Flight planning management		18%	25%
Weather information		15%	18%
Drone AIM		13%	12%
Emergency management		18%	27%
Strategic decofliction		15%	14%
Monitoring		26%	24%
Traffic information		5%	4%
Procedural interface with ATC		5%	8%
Dynamic geofencing			4%
Tactical deconfliction			6%
Dynamic capacity management			6%
Collaborative interface with ATC			4%

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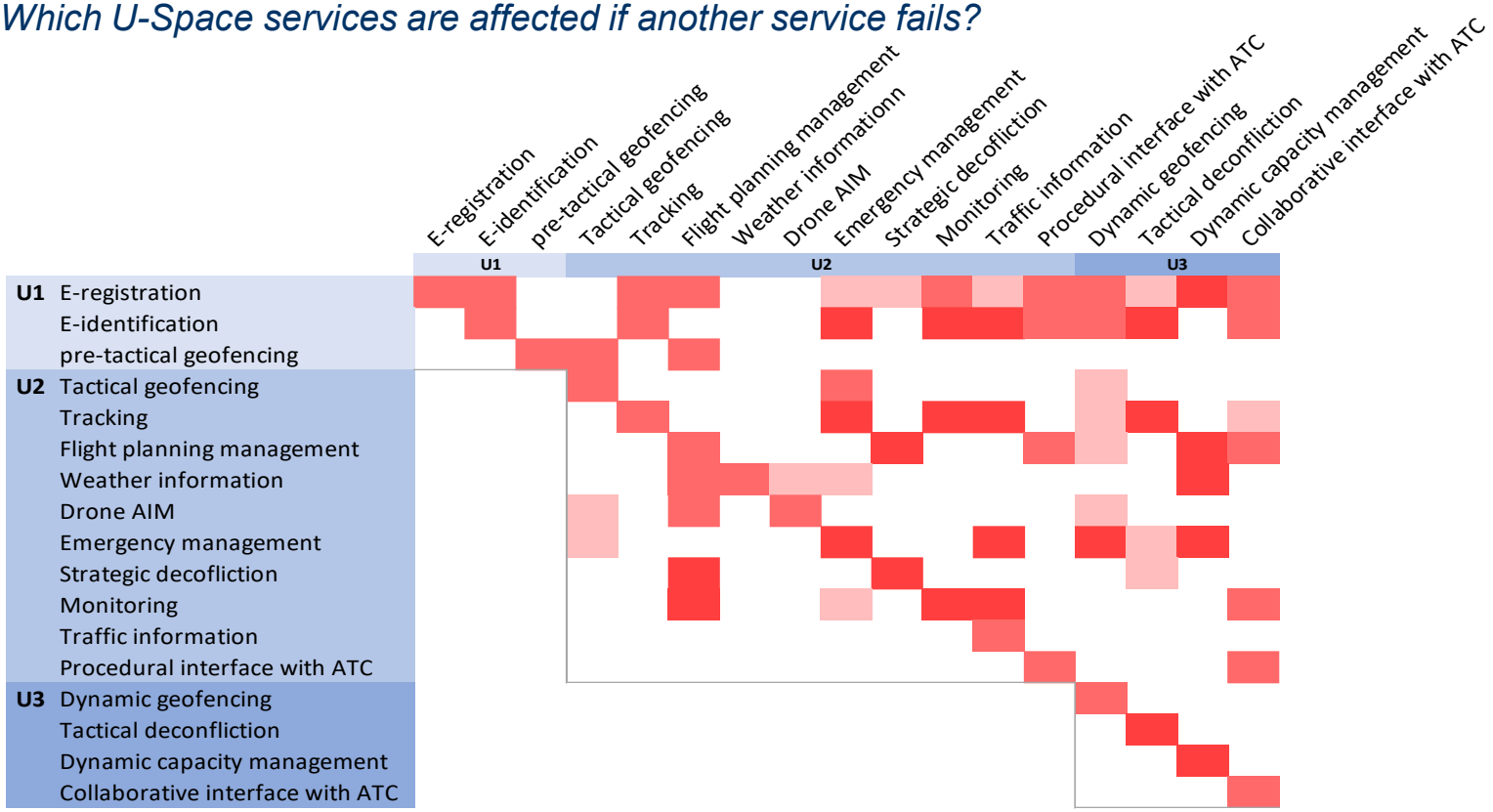
Impact of system-generated risks on U-Space Services

Which U-Space services are affected if another service fails?



	None	It doesn't affect. No relation. Independent services.
	Low	It affects partially or indirectly. It does not affect the continuity of the service but it may affect the quality or precision.
	Medium	It affects directly. Affects the expected service continuity in an operation. The safety of the operation may have been compromised.
	High	It affects the whole system or other users. The safety of other operations, other users or third parties may have been compromised.

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Impact of system-generated risks on U-Space Services

Dependency and Influence of other U-Space Services

		Dependency (U3)	Influence U1	Influence U2	Influence U3
U1	E-registration	4%	44%	38%	45%
	E-identification	8%	22%	38%	43%
	pre-tactical geofencing	4%	22%	15%	12%
U2	Tactical geofencing	12%		10%	10%
	Tracking	12%		28%	31%
	Flight planning management	31%		18%	25%
	Weather information	4%		15%	18%
	Drone AIM	6%		13%	12%
	Emergency management	27%		18%	27%
	Strategic decofliction	14%		15%	14%
	Monitoring	22%		26%	24%
	Traffic information	29%		5%	4%
	Procedural interface with ATC	16%		5%	8%
U3	Dynamic geofencing	25%			4%
	Tactical deconfliction	24%			6%
	Dynamic capacity management	29%			6%
	Collaborative interface with ATC	25%			4%

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ConOps: What is our contribution?

- Safety approach
- SORA integration
- Definition of Contingency and Emergency
- Proposals of Contingency Plans for drones & U-Space Services
- Proposals for Accident/Incident Reporting

Backup

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Accident and Incident Reporting

CORUS Dissemination Day

Davide Del Vecchio (ENAV)
presented by Andreas Volkert (DLR)
30th September 2019

Presentation Items

- Existing Accident/Incident Reporting Regulatory Framework
- Example and Open Items
- On-going Accident/Incident Reporting Regulatory Framework

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CORUS objective for U-space Accident/Incident Reporting

Recommendations and modifications

Extend the manned aviation procedures and current practice

Tailored for **drones operations** (VLL in particular)

Extend the system to allow reporting of possible incidents/accidents
between drones (pairs or multiple),
between drones and other airspace users and
between drones and infrastructures

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Existing Regulatory Framework

- **ICAO Annex 13** — puts requirements on States to establish and operate a *mandatory aviation incident reporting system* to collect information about actual or potential safety hazards
- **ICAO Doc 9859** — illustrates *examples* of the reporting procedure for mandatory occurrences

- **EU Regulation 376/2014** — addresses *reporting, analysis and follow-up* of occurrences in civil aviation
- **EC Implementing Rule 2015/1018** — provides a *list of occurrences* in civil aviation to be *mandatorily reported* (for manned and unmanned)

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Example

EC Implementing Rule 2015/1018 – Annex I, Section 5

- Occurrences Related to the Operations of the Aircraft
  - External Environment and Meteorology
    - Firearms, fireworks, flying kites, laser illumination, high powered lights, lasers, *Remotely Piloted Aircraft Systems*, model aircraft or by similar means

- Occurrences Related to Air Navigation Services and Facilities
  - Other Occurrences
    - Interference with an aircraft, an ATS unit or a radio communication transmission including by firearms, fireworks, flying kites, laser illumination, high powered lights, lasers, *Remotely Piloted Aircraft Systems*, model aircraft or by similar means

Only appearance and related to ***Aircraft vs. Drones*** occurrences only

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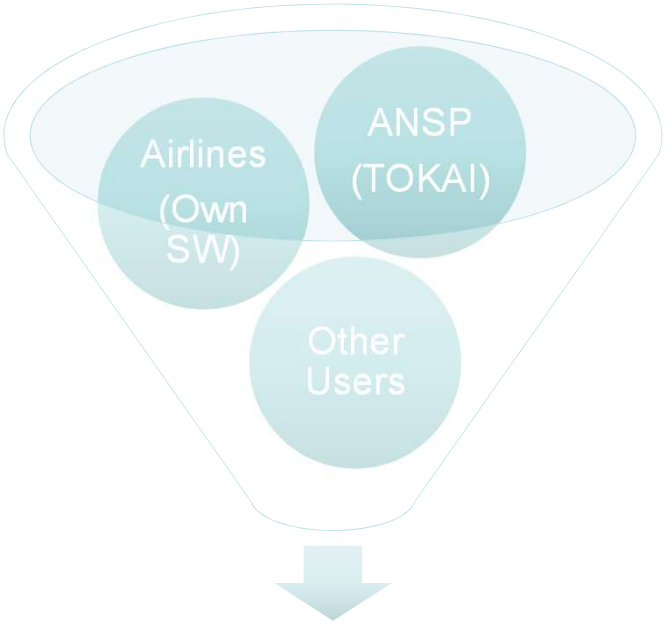
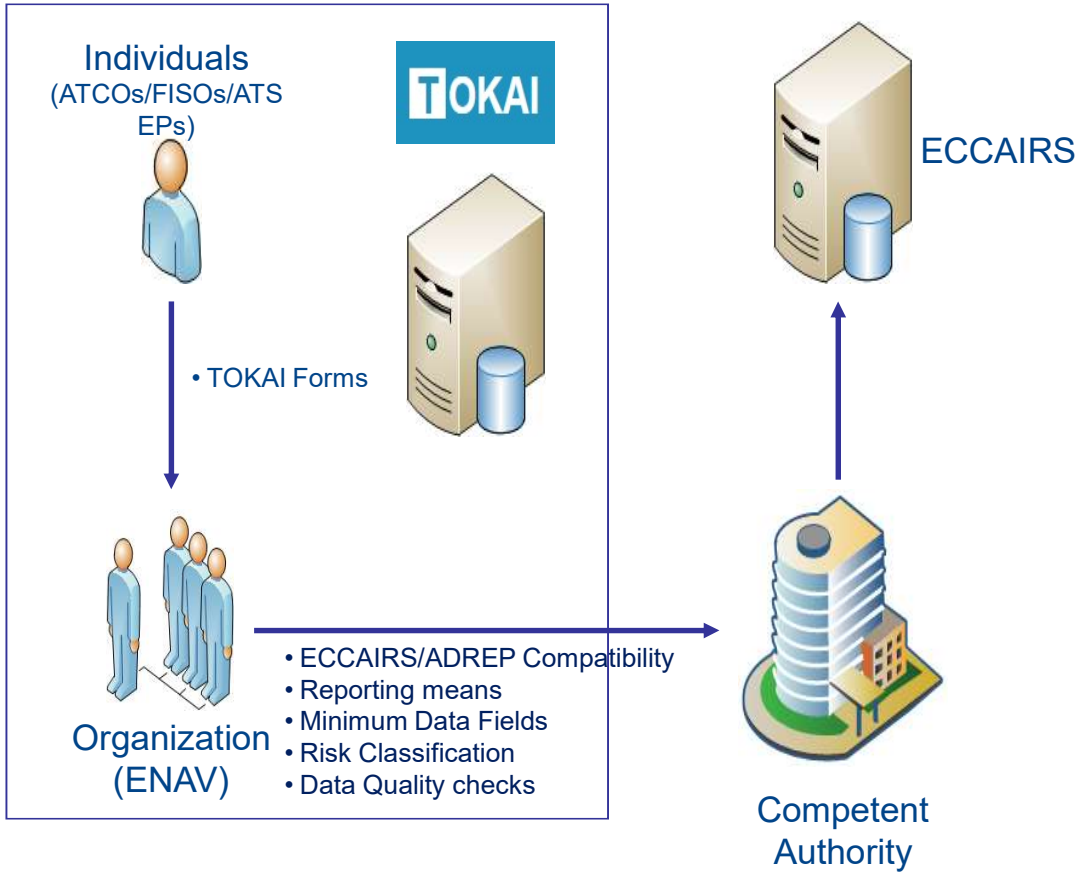
Occurrences Reporting Tool – ECCAIRS

European existing system for manned aviation



ECCAIRS

http://eccairsportal.jrc.ec.europa.eu/index.php?id=2



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Time-constraints and procedures for Reporting

Currently in Manned Aviation

	Notification to the CAA and/or the accident investigation authority	Mandatory Report (Form XYZ) submission to the CAA and/or the accident investigation authority	Investigation Report to the CAA
Accident	Immediate/ASAP	Within 24 hours	90 days
Serious Incident	Immediate/ASAP	Within 48 hours	60 days
Incident	N/A	Within 72 hours	30 days (where required)

Note: Regulations also promotes a ‘safety culture’ so that occurrences are spontaneously reported **by witnesses**

→ EU Reg. 2018/1139

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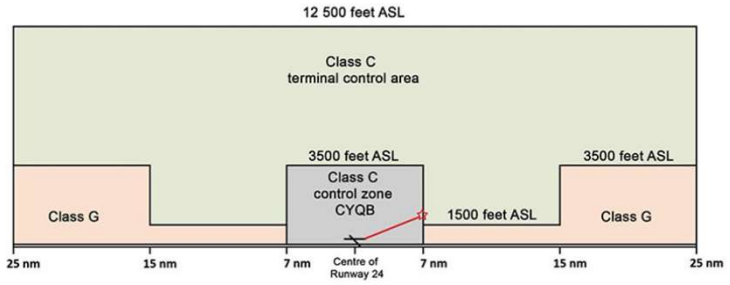
Example – Drone Incident Report 1/3

A Beechcraft King Air A100 was on an instrument flight rules flight from Rouyn-Noranda Airport (CYUY) (Quebec) to Québec/Jean-Lesage International Airport (CYQB) (Quebec) with 2 pilots and 6 passengers on board.

As the aircraft approached CYQB, the aircraft was cleared for a visual approach to Runway 24. On final approach, the **flight crew observed a drone**, about the size of a dinner plate, in front of the left wing. The pilot had no time to take evasive action. The **impact was unavoidable**, and the drone disintegrated.

The collision took place at 1802 Eastern Daylight Time,1 at an altitude of 2500 feet above sea level (ASL),2 and approximately 7 nautical miles from the midpoint of Runway 24.

At 1804, the **crew declared an emergency**, then completed the landing without further incident. There were no injuries.



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Example – Drone Incident Report 2/3

Today

ACTOR	ATC	A/C Pilot	Drone Pilot
Subject to MOR?	YES	YES	NO
What	Interference	Interference	Collision
To whom	MOR to CA	MOR to CA	VOR to CA
Within	72 h	72 h	n.a.

MOR = mandatory occurrence reports
VOR = voluntary occurrence reports
CA = Competent authority

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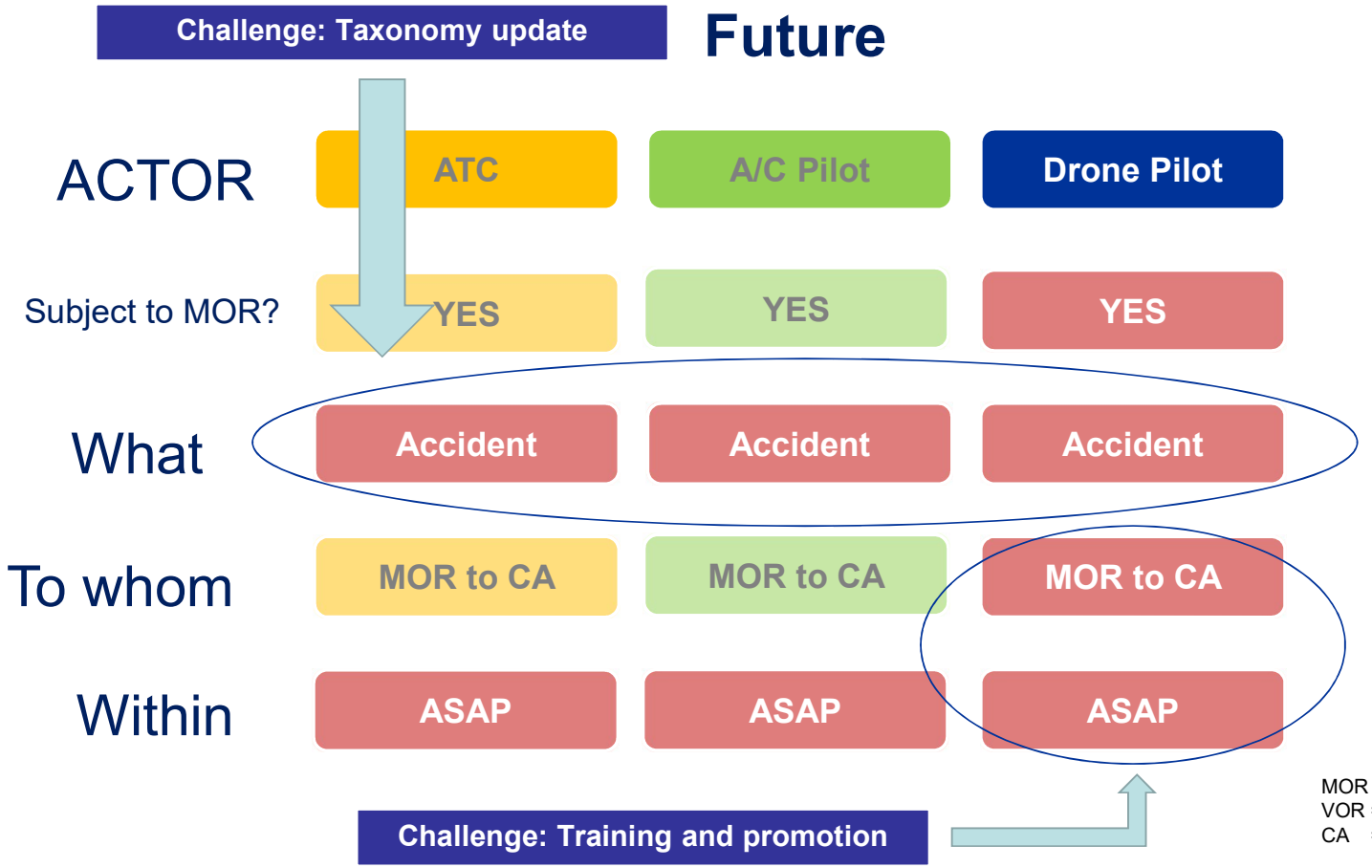
Example – Drone Incident Report 3/3



Interference reported by U-Space Service; Accidents reported by pilots

MOR = mandatory occurrence reports
VOR = voluntary occurrence reports
CA = Competent authority

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Summary of Open Items - Gaps

1. **Limited number of occurrences involving drones identified in the existing regulations**
   - Define the additional occurrences to be reported
2. **Identify who has to report the event**
   - Does he need training? Does he have access to tools for reporting?
3. **Reporting Tool** (ECCAIRS interface for drones occurrences?)
   - Need to modify taxonomy to report occurrence
4. **Are existing Time-constraints and Procedures relevant for drone occurrences?**
5. **Data Coherency and Analysis** performed at National Level mainly
   - Need to identify Severity Classification Scheme to assess effects*
   - Need to clarify role and associated responsibilities of a trans-national investigation authorities

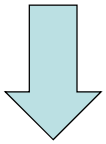
** Not every incident can be investigated, but should be collected anyway for statistical reasons.*

The CORUS project has received funding from the SESAR Joint Undertaking under grant agreement 763551 of the European Union's Horizon 2020 research and innovation programme.

New European Rules on Drones

- On 11th June 2019 common European rules on drones have been published to ensure safe and secure drone operations across Europe:

  - ✓ **Commission Delegated Regulation (EU) 2019/945**
  - ✓ **Commission Implementing Regulation (EU) 2019/947**



OPEN, **SPECIFIC** and **CERTIFIED** categories of Operations

UAS classification from C0 to C4 for **OPEN** Operations

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2019-947-IR **Open Category operations**

MTOW < 25 kg

Alt. < 100 m

VLOS, EVLOS

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2019-947-IR **Specific & Certified Category Operations**

Specific:

- Trained pilots
- (mostly) Commercial drone flights (Organisation)
- Safety Assessment required

LUC (Light UAS Operator Certificate) holder shall establish a safety management system, including **safety reporting and internal investigations**
(EC Regulation 2019/947, UAS.LUC.030)

Certified:

- Even better trained pilots
- UAS & Operator certification

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2019-947 Article 19 – Occurrence Reporting

Implementing Rules

- The competent authorities of the Member States and market surveillance and control authorities referred to in Article 36 of Delegated Regulation (EU) 2019/945 shall cooperate on safety matters and ***establish procedures for the efficient exchange of safety information***
- Each UAS ***operator shall report to the competent authority*** on any safety-related occurrence and exchange information regarding its UAS in compliance with Regulation (EU) No 376/2014
- The ***EASA and the competent authorities shall collect, analyse and publish safety information*** concerning UAS operations in their territory in accordance with Article 119 of Regulation (EU) 2018/1139 and its implementing acts
- Upon receiving any of the information referred above, EASA and the competent authority shall take the necessary measures to address any safety issues on the best available evidence and analysis, taking into account interdependencies between the different domains of aviation safety, and between aviation safety, cyber security and other technical domains of aviation regulation
- Where the competent authority or EASA takes measures, it shall immediately notify all relevant interested parties and organizations that need to comply with those measures in accordance with Regulation (EU) 2018/1139 and its implementing acts

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Main Next Steps 1/2

October 2019

Publication of Guidance Material (GM), Acceptable Means of Compliance (AMC) and first pre-defined risk assessments by EASA

- a revised version of the draft AMC and GM that were published with Opinion 01/2018
- the description of the risk assessment methodology called SORA that is required in the “specific category”
- the first pre-defined risk assessment to assist operators when applying for an authorisation in the specific category for an operation: Over Sparsely Populated Areas, In Uncontrolled Airspace, At Very Low Levels. BVLOS with Visual Air Risk Mitigation, Using UA up to 3m characteristic dimension;

June 2020

Registration of UAS operators & certified drones becomes mandatory

- all drone operators shall register themselves before using a drone:
- in the ‘Open’ category, with a weight more than 250g or less then 250g when it is not a toy and it is equipped with a sensor able to capture personal data
- in the ‘specific’ category .
- All certified drones (operated in high risk operations) shall be registered as well. The registration number needs to be displayed on the drone.

June 2020

Operations in ‘Specific’ category may be conducted after the authorisation given by the National Aviation Authority.

- Based on the risk assessment and procedures defined by the EU Regulation
- Based on pre-defined risk assessment published by EASA as an AMC

Source:https://www.easa.europa.eu/easa-and-you/civil-drones-rpas

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Main Next Steps 2/2

June 2020

Drone user can start operating in limited ‘Open’ category. Between June 2020 till June 2022

- Drones with a weight less than 500 g may be operated in an area where reasonably it is expected that no uninvolved person is overflown
- Drones with weight up to 2 kg may be operated up to 50 m horizontal distance from people
- Drones with weight up to 25 kg may be operated at 150 m horizontal distance of residential, recreational and industrial areas, in a range where reasonably it is expected that no uninvolved person is overflown during the entire time of the operation

June 2021

National authorisations, certificates, declarations are fully converted to the new EU system

June 2022

All model clubs and associations should receive an authorisation by the National Aviation Authority

Source:https://www.easa.europa.eu/easa-and-you/civil-drones-rpas

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U-space Conference Architecture

30 September, 2019

Mario Boyero Pérez
EUROCONTROL

Luigi Brucculeri
ENAV

Ralf Heidger
DFS

Summary

Introduction

- Architecture approach
- Drivers/principles
- Architecture framework
- Architecture publishing

U-space Architecture description

- Capabilities
- Operations
- Services
- Systems

Architecture Portal (eATM Portal)

A DFS Implementation Example

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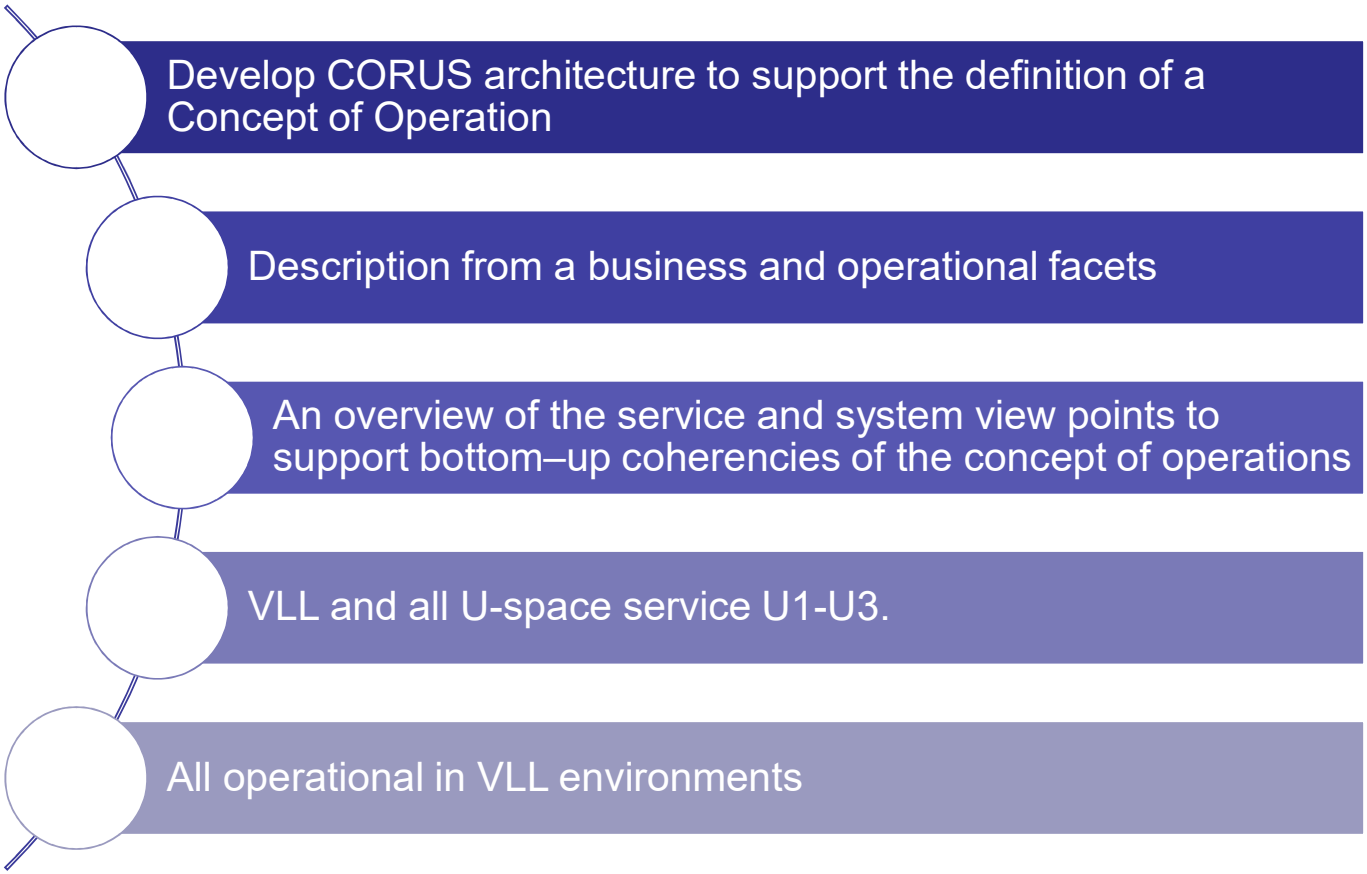
U-space Architecture Introduction

30 September, 2019

Architecture Development Scope and Objectives



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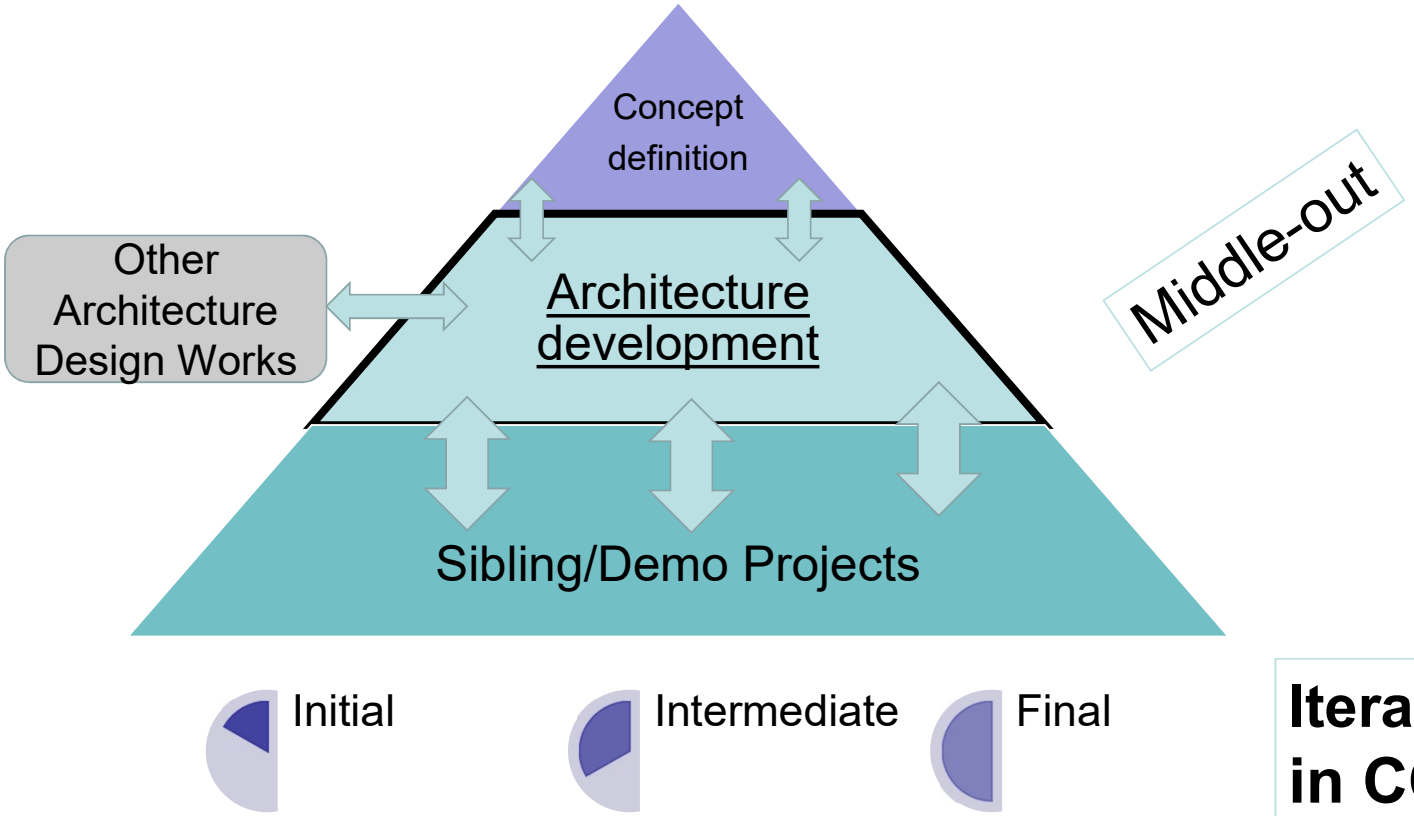
Architecture Development Approach



Iterative work in CORUS

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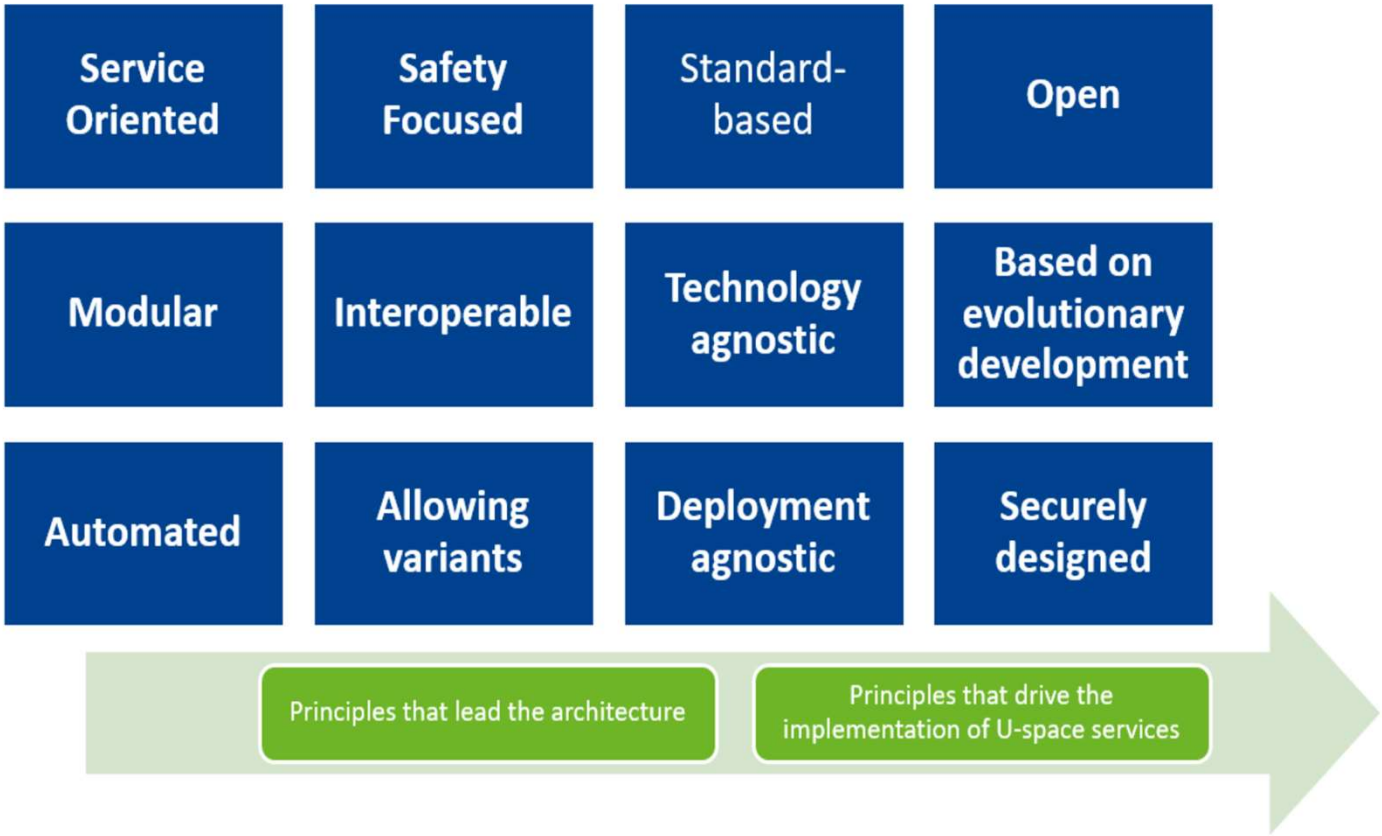
Architecture Principles



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Architecture Framework

- Based on **EATMA** (European ATM Architecture) framework
- CORUS mainly focuses on: Capability (Business), Operational, Service and System

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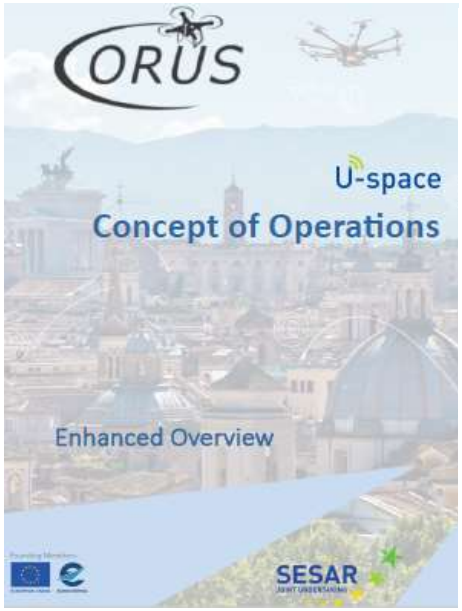
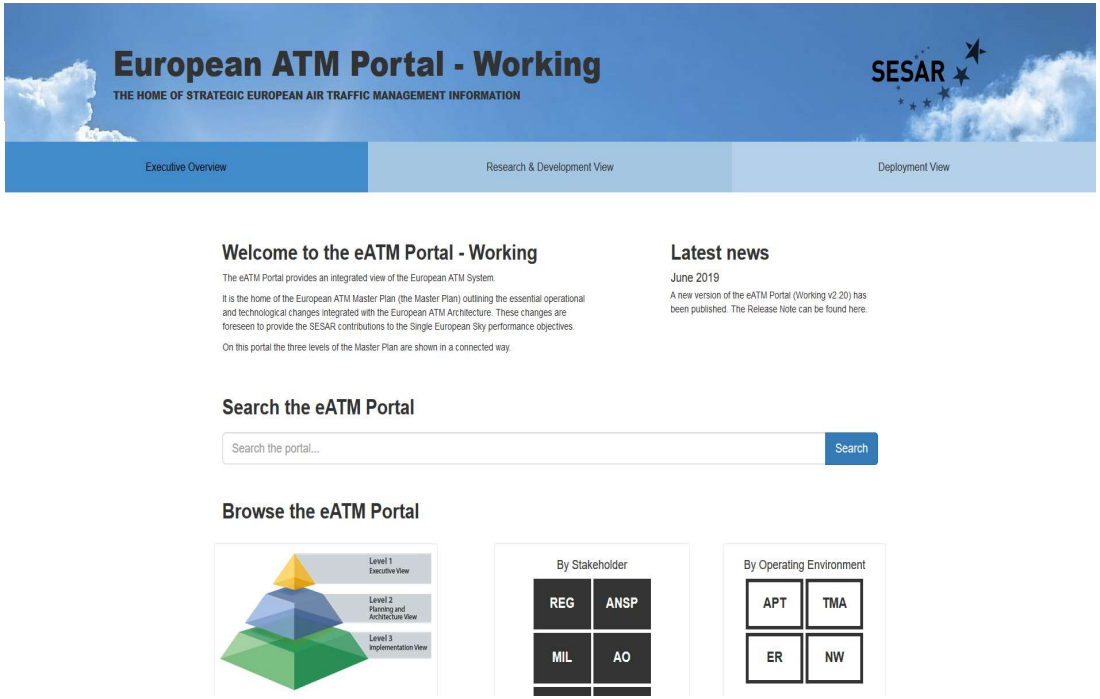
Architecture Publishing





Management overview

Technical overview

eATM Portal (U-space)

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U-space Capabilities

30 September, 2019

Capability Architecture

- The **capability/business layer** describes the U-space's abilities. It can be understood as the strategic layer
- **Capability** is the **ability** of one or more of the enterprise's resources to deliver a specified type of effect or a specified course of action to the enterprise stakeholders.
- A Capability represents a **high-level specification** of the enterprise's ability. As such, the whole enterprise can be described via the set of Capabilities that it has.
- A Capability is a statement of **"what"** is to be carried out and **does not refer to "how" or "by whom"** they are carried out.
- Consequently, capabilities are **free from** considerations of **physical organisation** or specific choices of **technology**.

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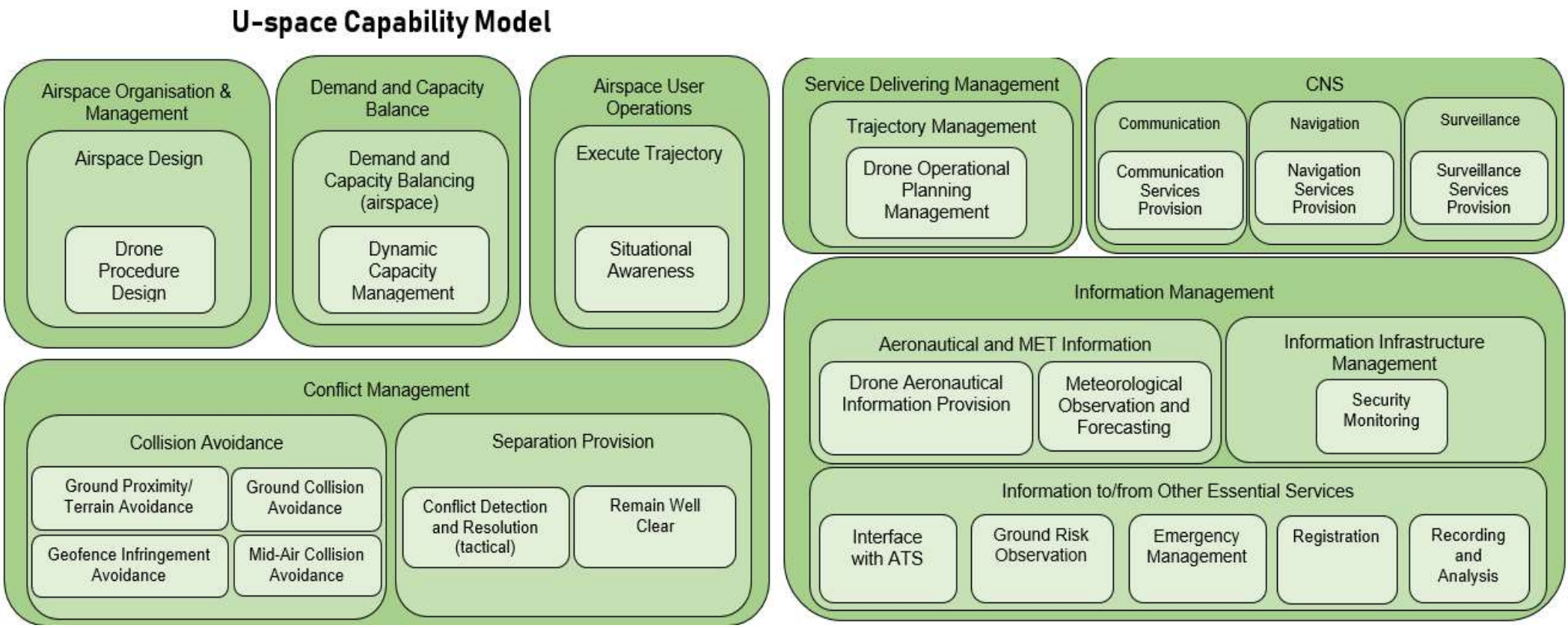
Capability Model



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U-space Operational Processes

30 September, 2019

Operational Architecture

- Concept Development activities
  - Definition and refinement of operational concept.
  - How U-space actors collaborate.

- A **Node** is a logical entity that performs **Activities.**
- An **Information Exchange** highlights the collection of **information elements** that are exchanged between two nodes.
- An **Information Element** is a formalised representation of information. Is carried by one or more Information Exchanges (between Nodes).
- **Activities** represent **WHAT** has to be done to complete a Capability. They are specified independently of how the process is carried out.
- An **Information Flow** represents the flow of information from one Activity to another.

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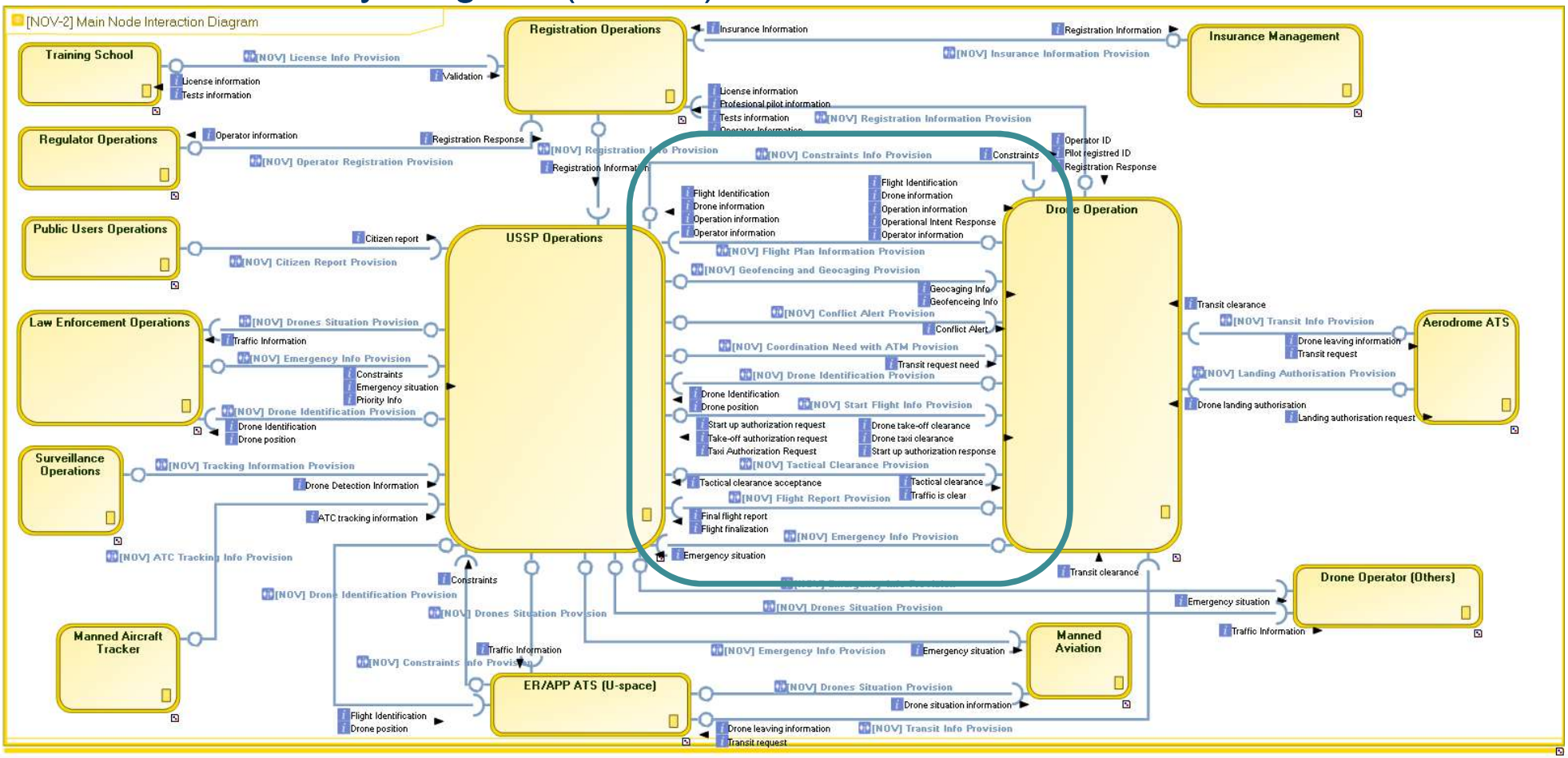
Node Connectivity Diagram (NOV-2)



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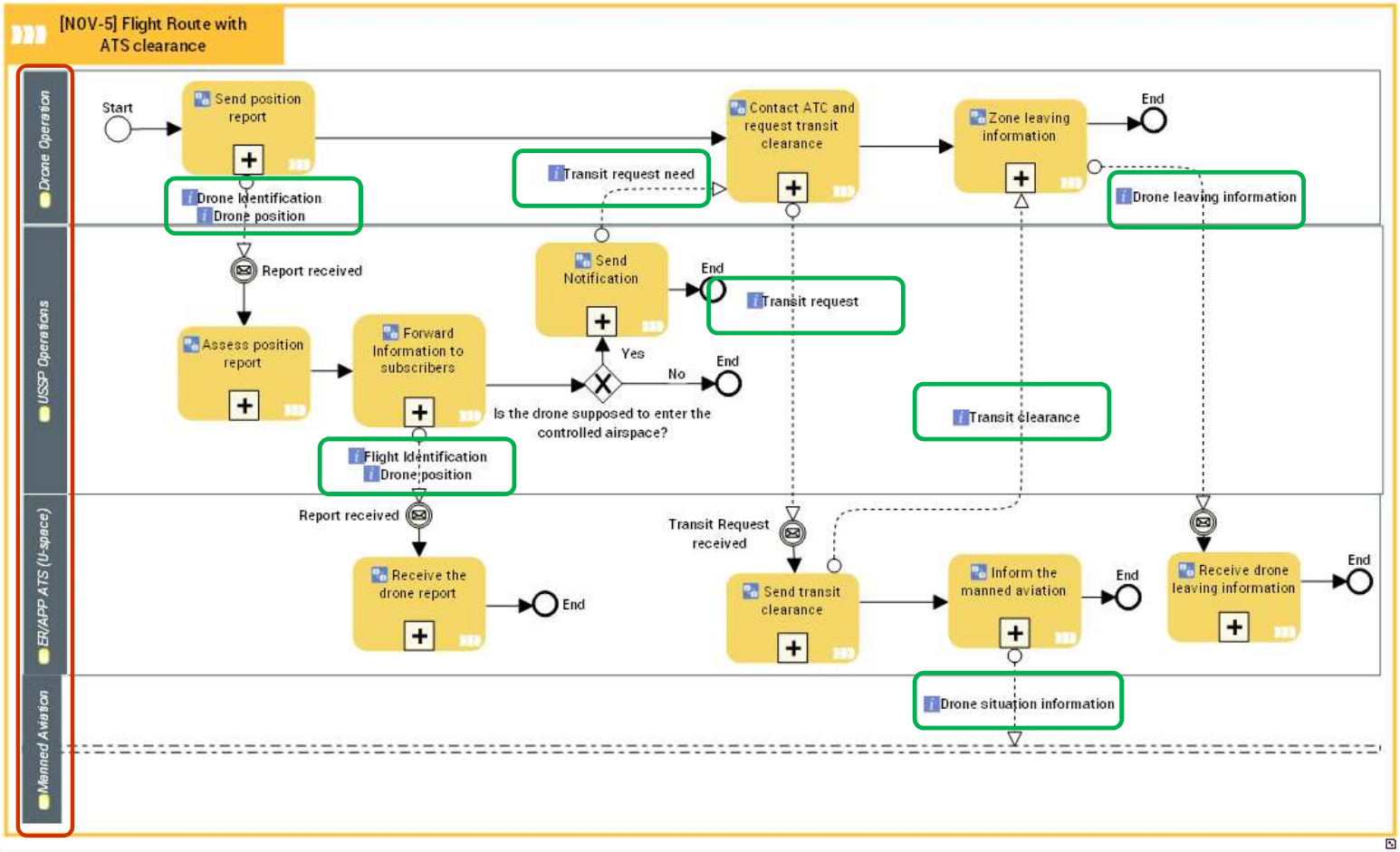
Use Case (NOV-5)



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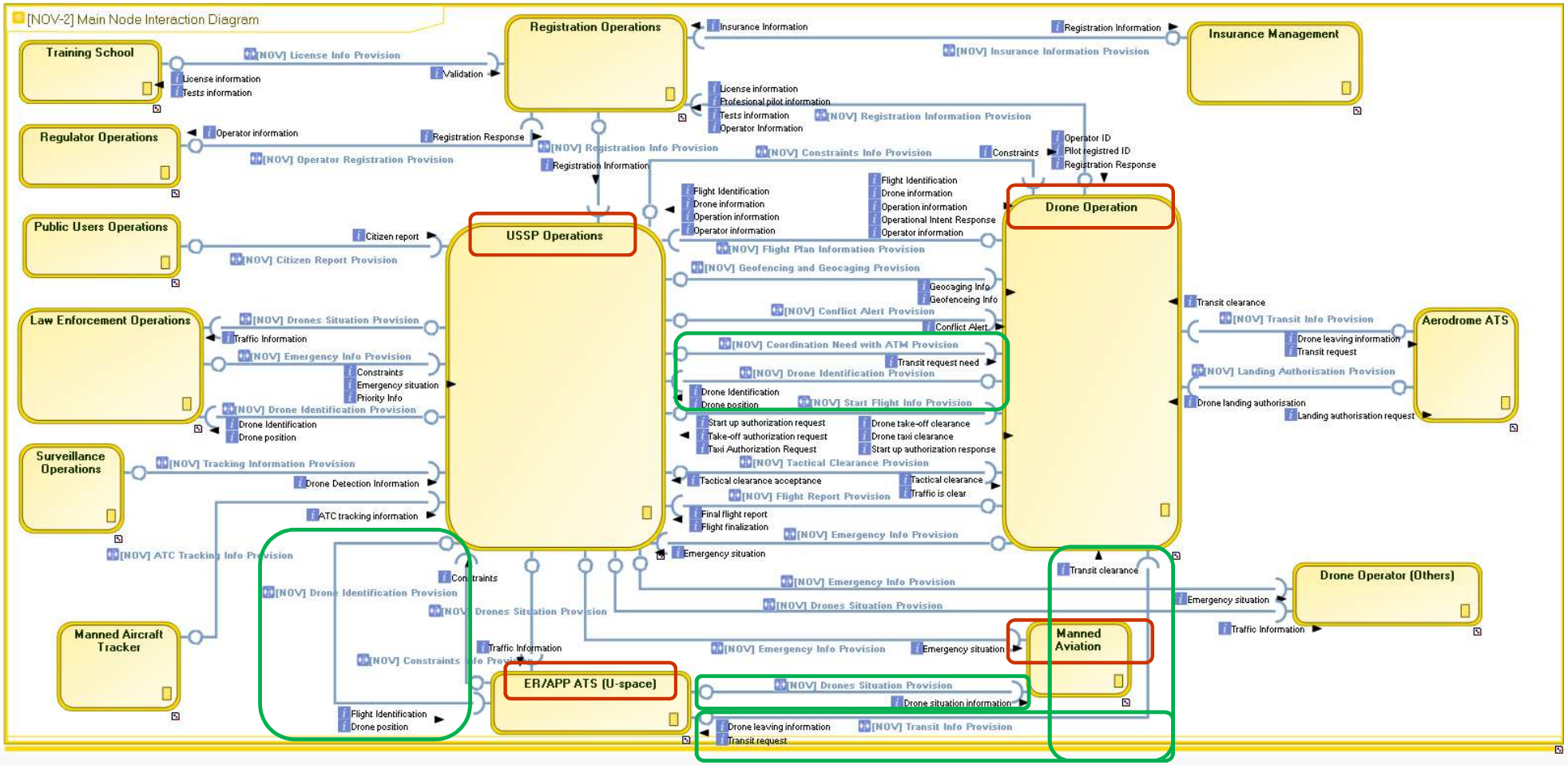
From the Use Case towards the Services



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U-space Services

30 September, 2019

Service Layer

- The service layer provides a link between the operational need and technical solution by describing services.
- Definition and refinement of the description of the U-space services.

- **Service** is the contractual provision of something (a non-physical object), by one, for the use of one or more others. Services involve interactions between providers and consumers, which may be performed in a digital form (data exchanges) or through voice communication or written processes and procedures.

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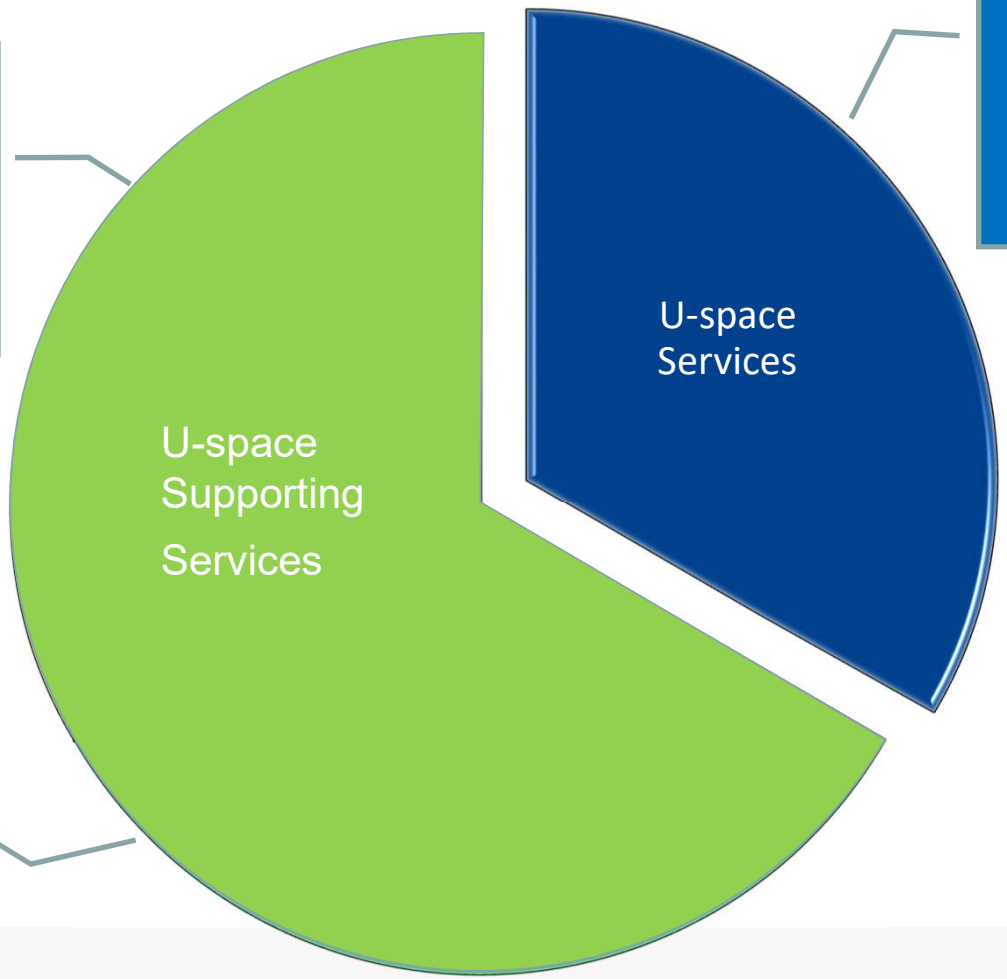
Service Porfolio - Classification

Services which provides supplemental data for U-space (e.g. terrain, obstacles, weather, …)



Services strongly linked to U-space domain

Services linked to CNS supporting infrastructures for U-space

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Services

Supplemental Data Services
Weather information
Geospatial information service • Terrain map • Buildings Obstacles
Population density Information
Electromagnetic information

Infrastructure Services
Navigation Coverage information
Navigation Infrastructure Monitoring
Communication Coverage information
Communication Infrastructure Monitoring
Surveillance Data

U-space Service
Registration (Drone Registration, Drone Pilot Registration, Drone Owner Registration, Drone Operator Registration)
e-Identification
Tracking
Drone Aeronautical Information Publication
Geo-Awareness
Geo-Fencing provision
Drone operational plan processing
Strategic Conflict Management
Tactical Conflict Management
Monitoring
Traffic Information
Interface with ATC
Emergency Management
Legal Recording
Dynamic Capacity Management
Registration Assistance
Drone operational plan preparation assistance
Risk analysis assistance
Accident / Incident reporting
Citizen reporting
Digital Logbook

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U-space Systems

30 September, 2019

System Layer

- The system layer describes **all human and technical resources** of a U-space system including its internal functional breakdown and its interactions with the surrounding systems.

- **Stakeholder**. A stakeholder is an **individual, team, or organization** (or classes thereof) with interest in, or concerns relative to, an enterprise [e.g. the U-space].
- **Role.** An aspect of a **person** or organisation that enables them to fulfil a particular function.
- **Capability Configuration**. A Capability Configuration is a combination of **Roles and Technical Systems** configured to provide a Capability derived from operational and/or business need(s) of a stakeholder type.
- **Technical System**. A collection of **Functional Blocks** or Functions.
- **Functional Block**. A logical and cohesive grouping of automated Functions in a Technical System.

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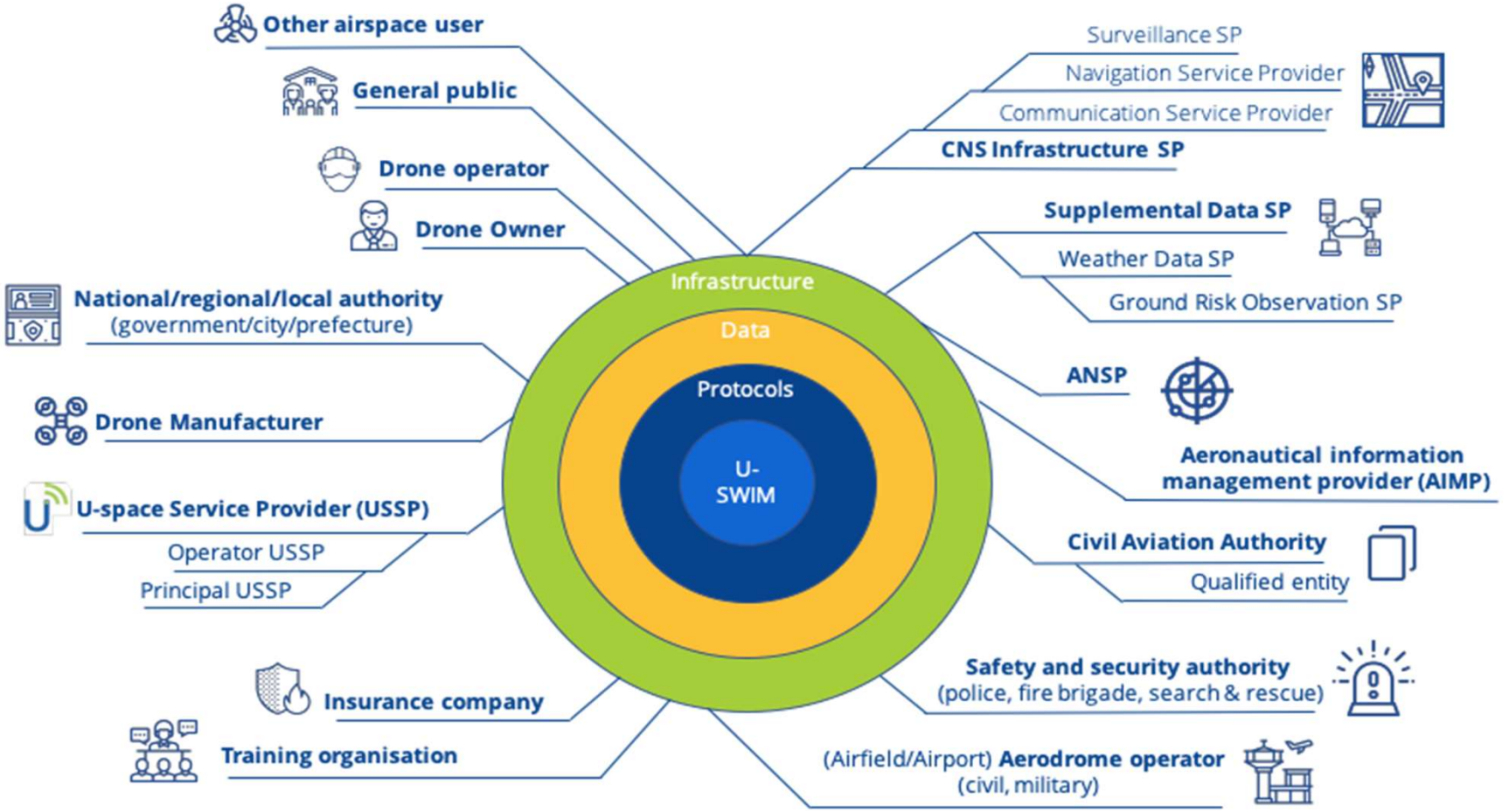
U-space Stakeholders



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U-space Roles

- Drone pilot, Drone crew, Drone operator representative
- Drone owner representative
- ATS Operator
- Police or security agent
- Pilot
- Citizen
- Registrar, Accredited registry updater, Accredited registry reader
- Drone Aeronautical Information Manager, Drone specific aeronautical information originator
- Authorised viewer of air situation
- USSP Supervisor, Authorization Workflow Representative
- Capacity Authority
- Drone Manufacturer Representative
- Airport Operator Representative

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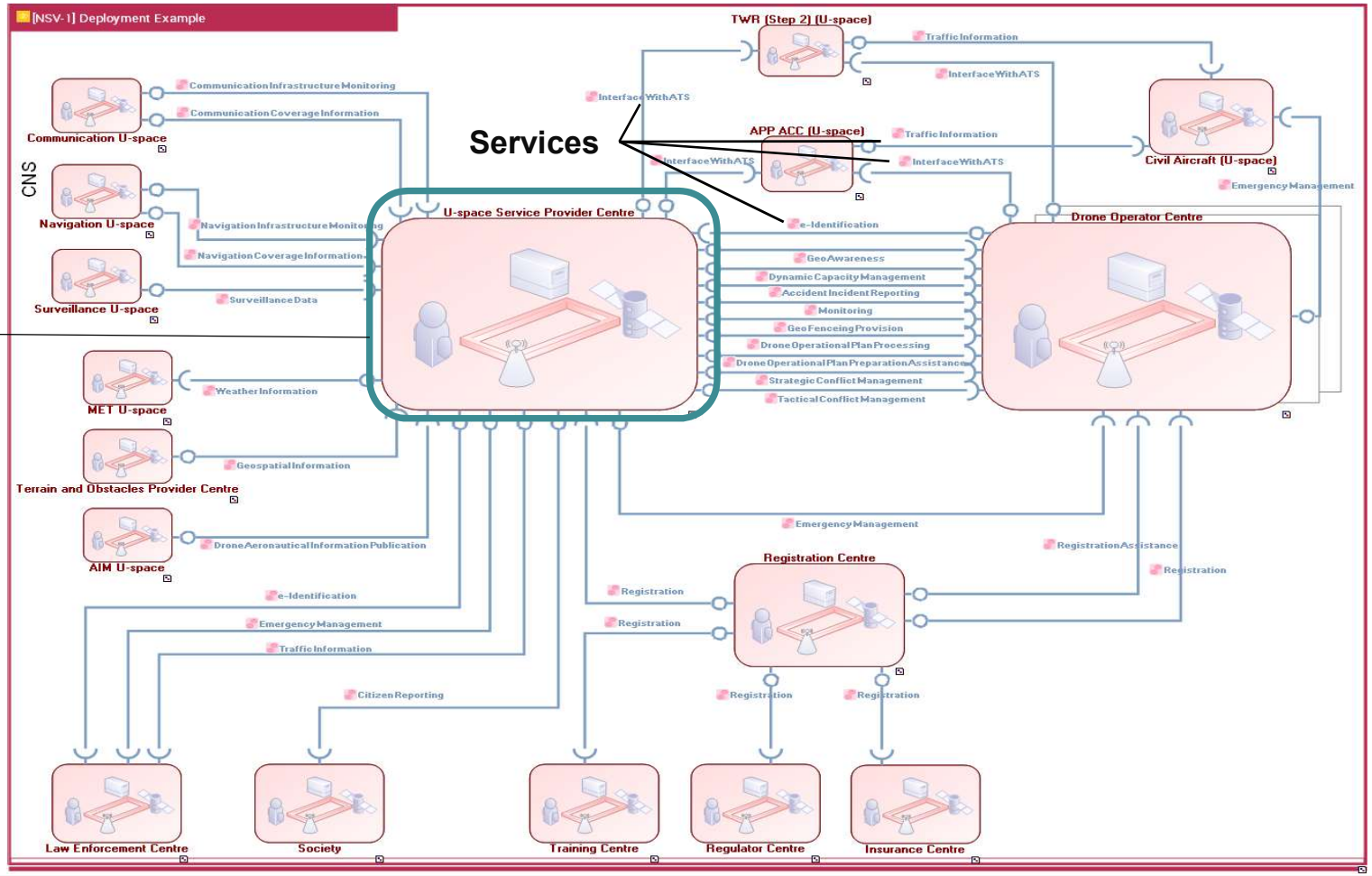
Possible Deployment Option (NSV-1)

Capability Configuration



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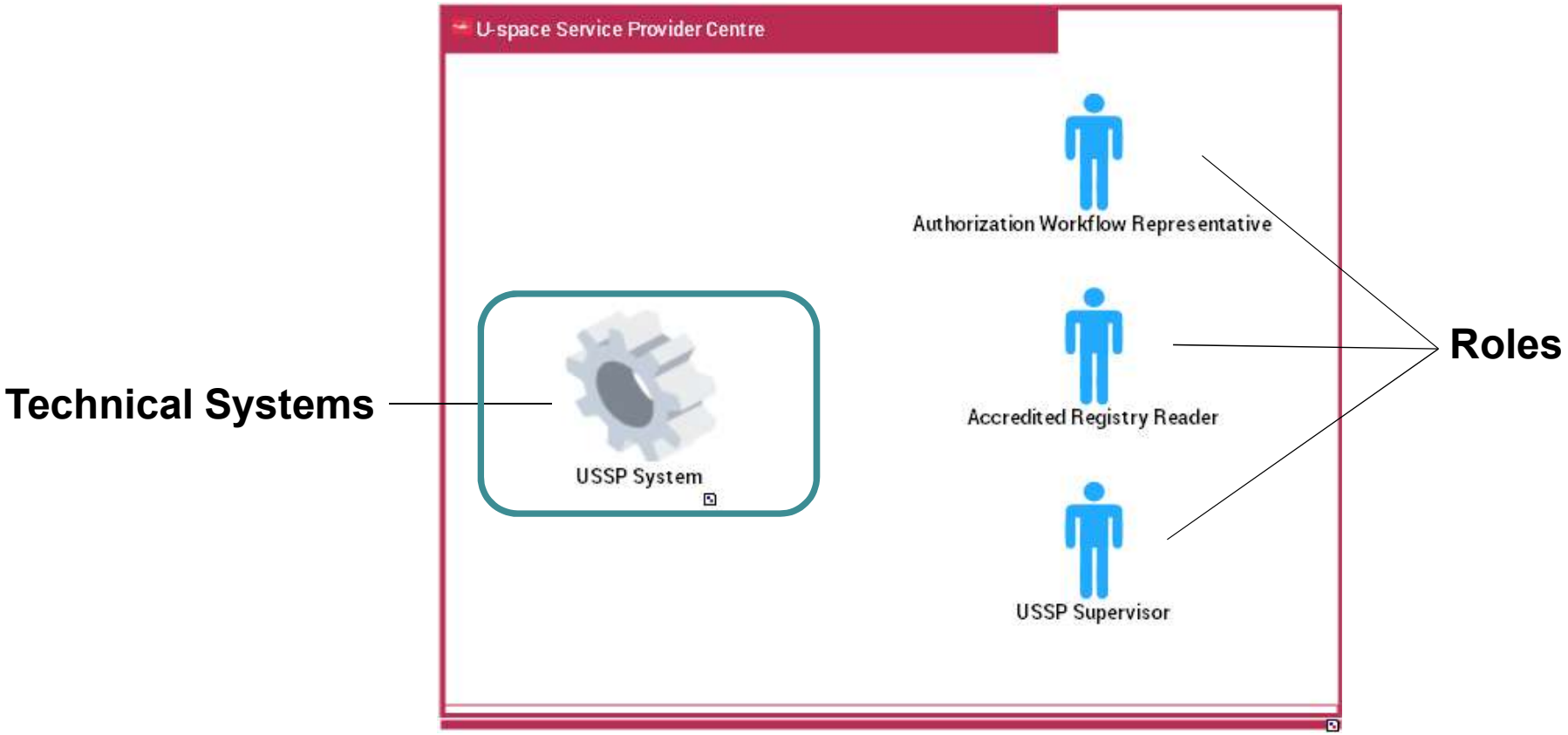
Possible U-space Service Provider Centre breakdown



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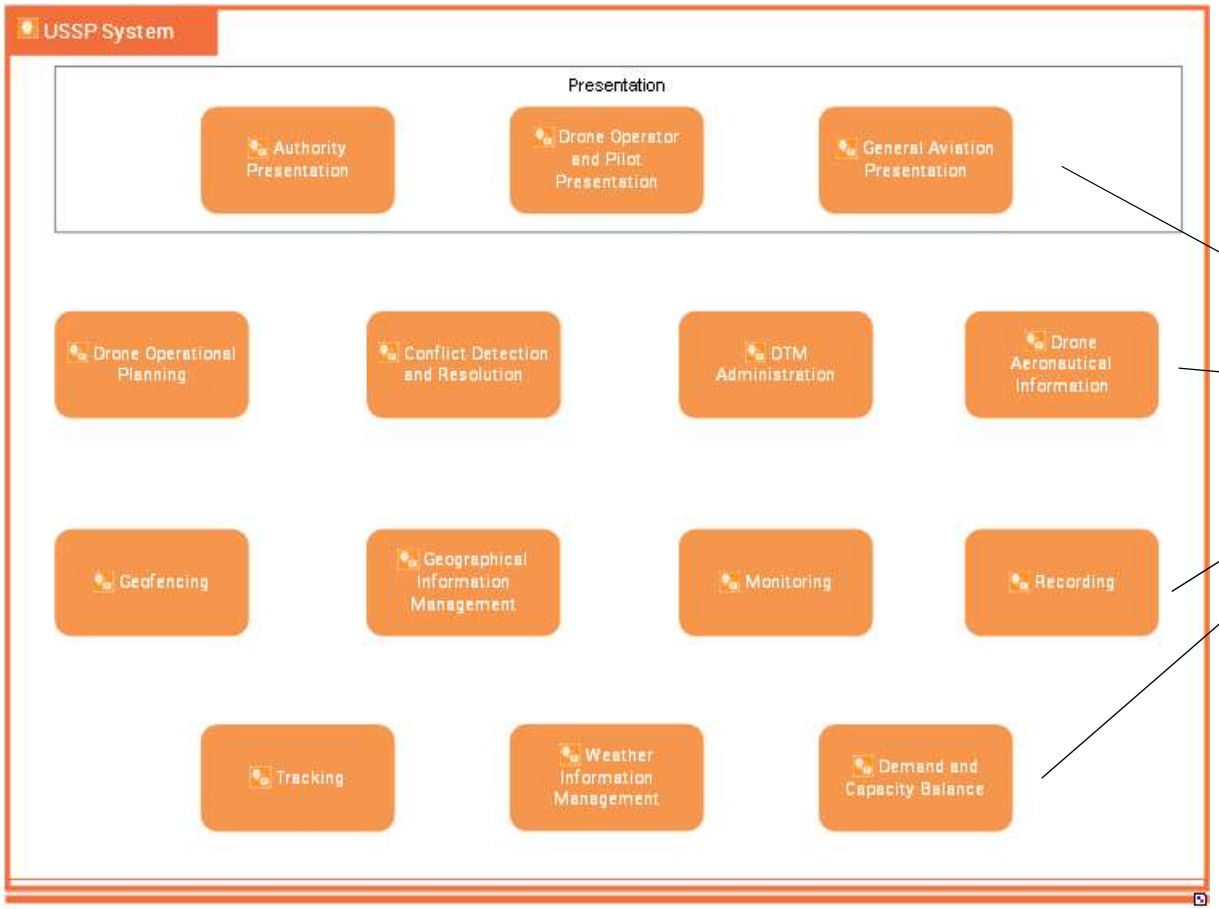
Possible USSP System Breakdown



Functional Blocks

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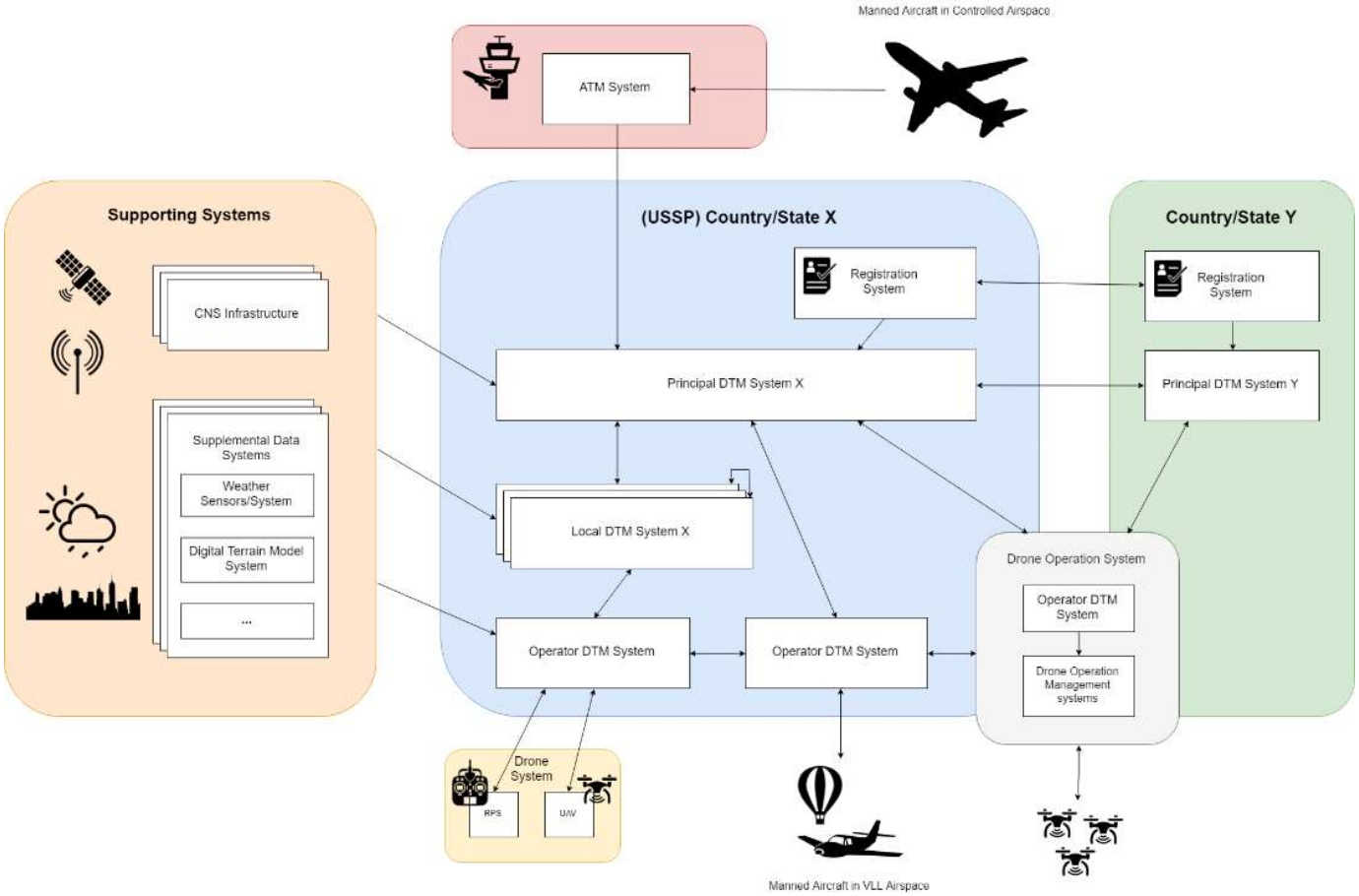
Other Possible Deployment Option



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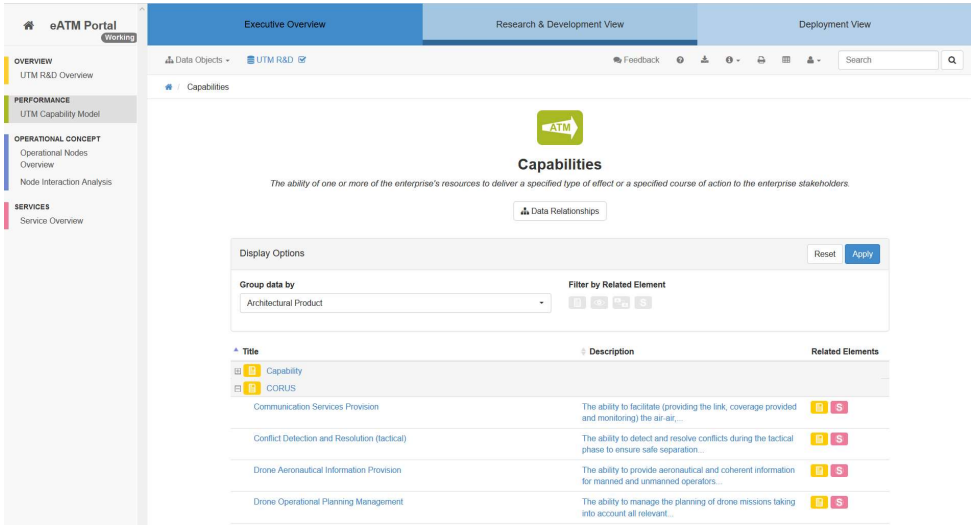
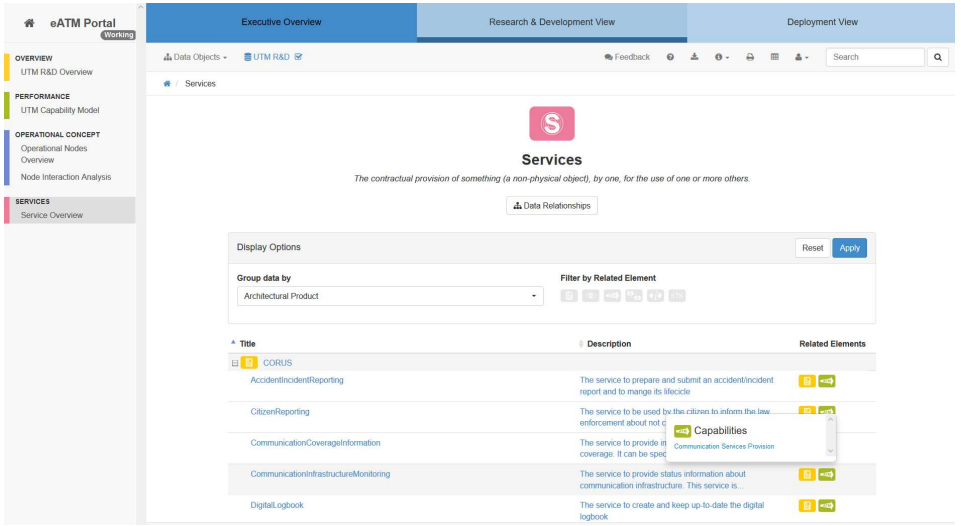
U-space Architecture Portal

30 September, 2019

U-space Architecture Portal

- https://www.eatmportal.eu/working/signin
- What do you need to access?
  - One Sky account





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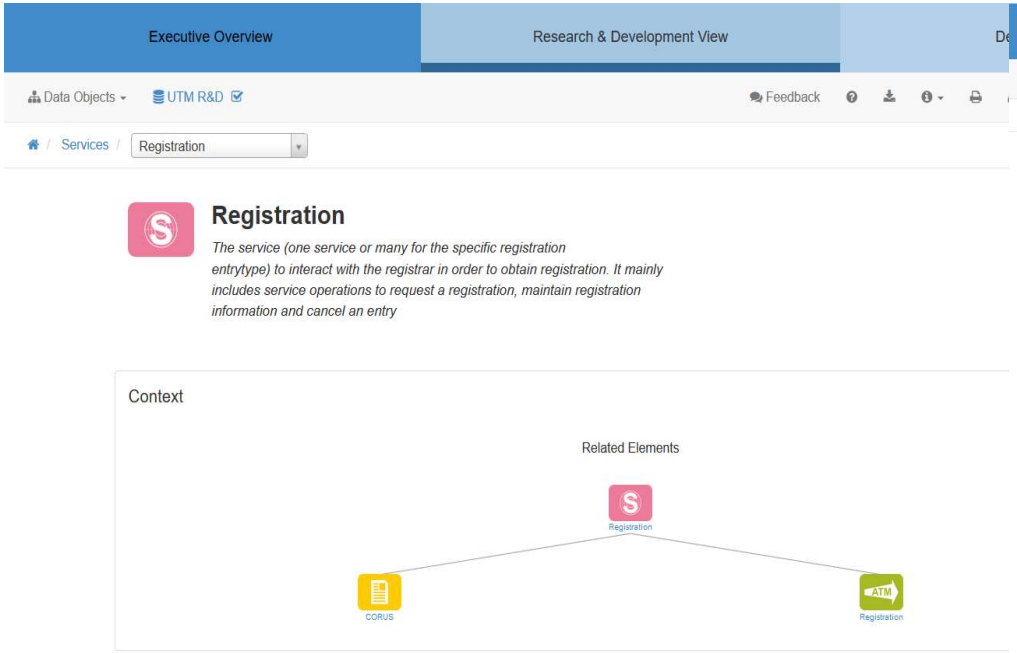
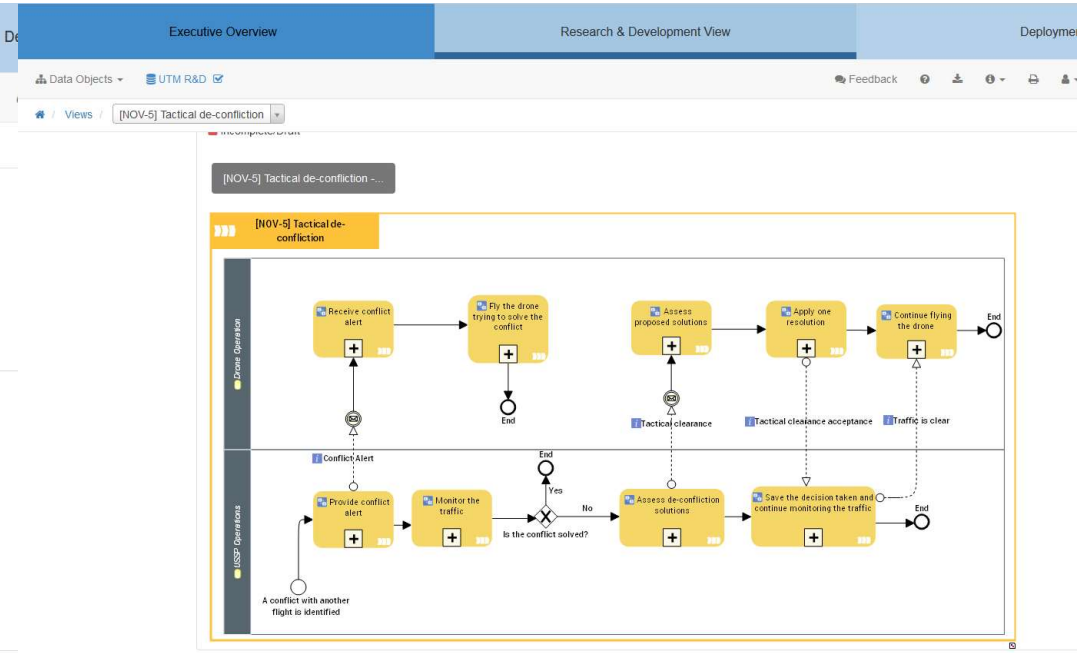
Elements with description and links between elements and Views





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A DFS Implementation Example

30 September, 2019

Ralf Heidger
DFS

The DTM/UTM* system architecture at the DFS and its evolving links to ATM and DDS

CORUS Dissemination Workshop, Brussels 30.9.-1.10.2019

Ralf Heidger

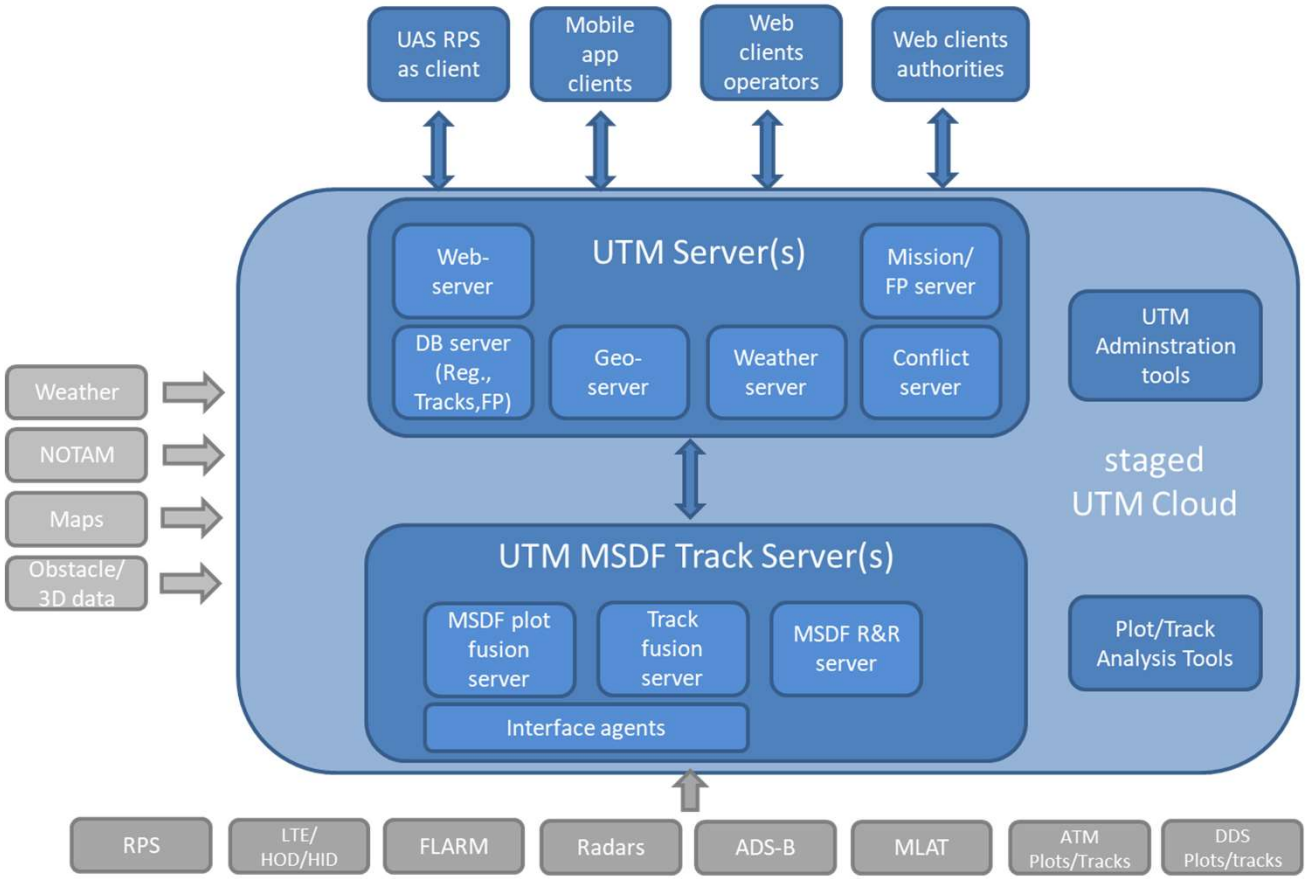
Program Management UTM Development, SH

DFS Deutsche Flugsicherung GmbH

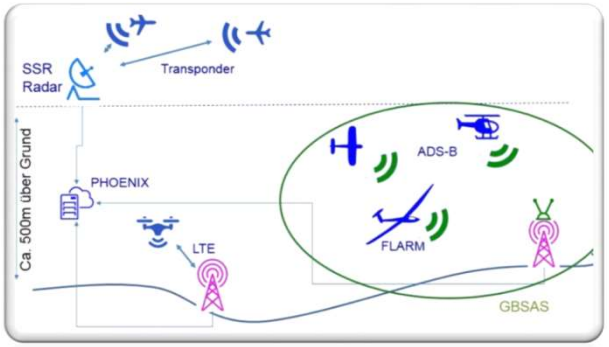
member of FABEC

DFS Deutsche Flugsicherung

A DFS DTM/UTM* reference architecture is developed in line with the CORUS definitions and work at European level



UTM needs to see UAS and manned aviation in VLL:



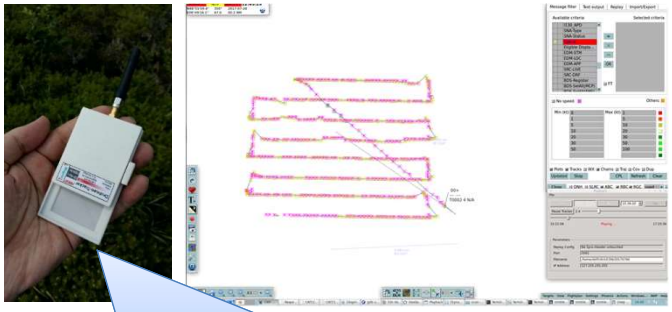
Ground Based Situational Awareness System (GBSAS)

UTM side effect:
UAS activities accelerate manned aviation surveillance in VLL (FLARM, ADS-B ...)

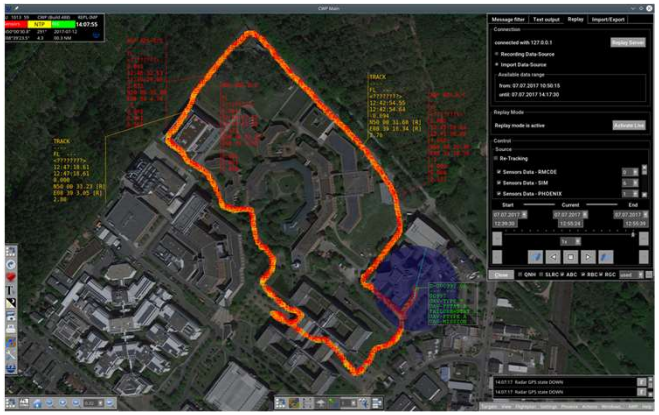
*) UTM = UAS Traffic Management, here synonymous to = DTM = Drone Traffic Management

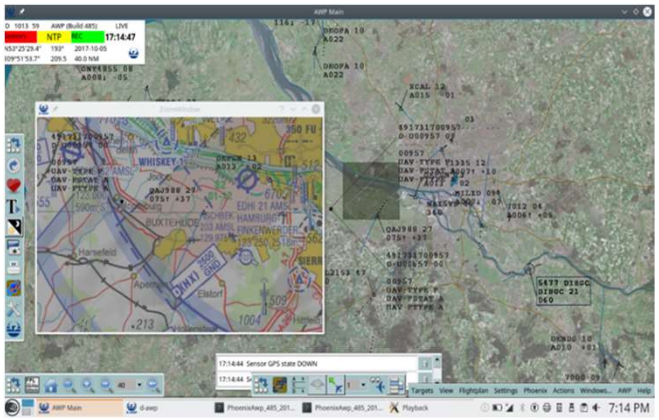
DFS Deutsche Flugsicherung

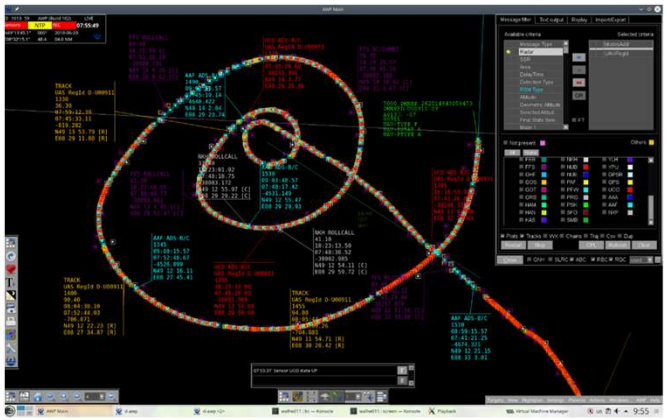
Feasibility of drone tracking (here PHOENIX AWP screenshots) using mobile telecom & HOD is proven since 7/2017ff



1. Generation Hook-on-device (HOD), has been evolved to a 2. generation HOD, integrating LTE, FLARM and ADS-B



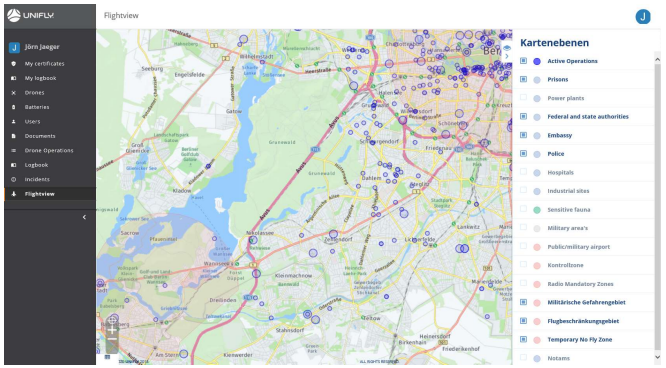




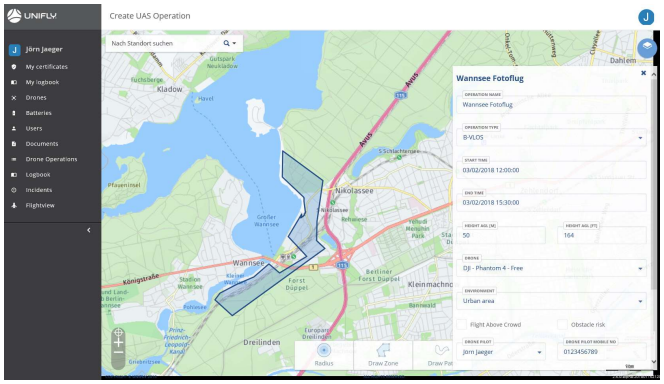
DFS Deutsche Flugsicherung

The available UTM prototype provides a comprehensive set of functionalities

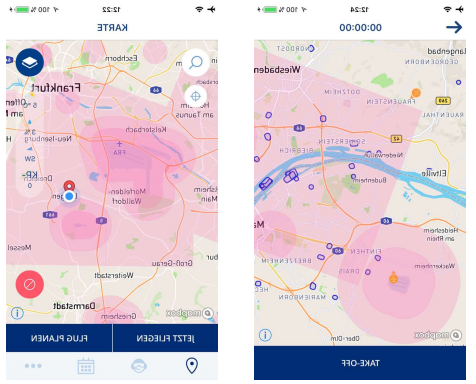
Preflight Situational Awareness



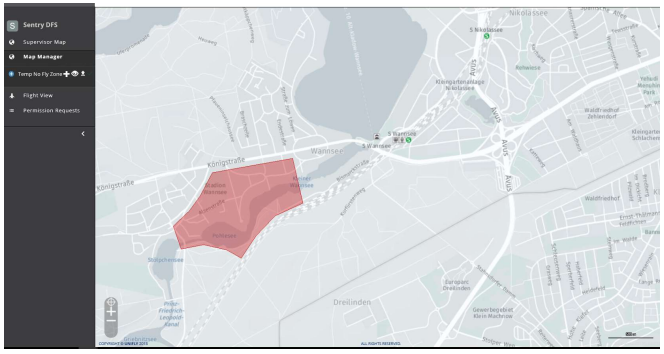
Mission planning for UAS Operators



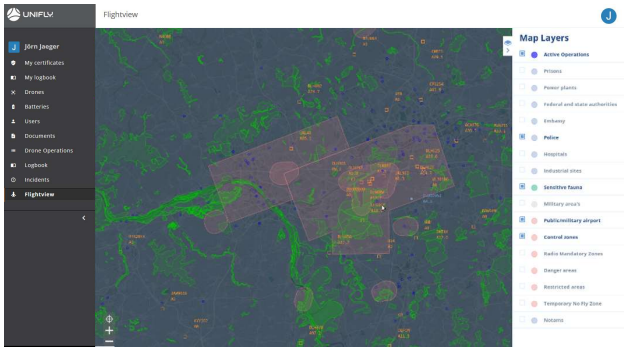
Mobile Apps for Pilots in the Field

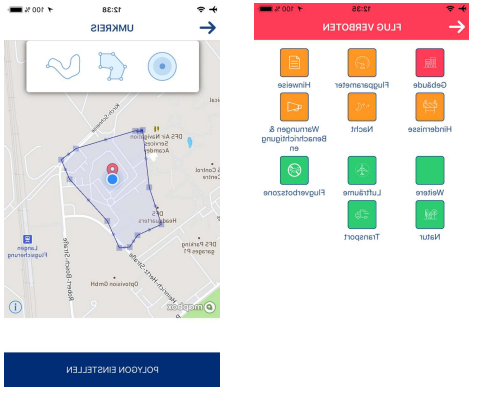


Static and dynamic Airspace Management



Inflight Integrated Situational Awareness Displays





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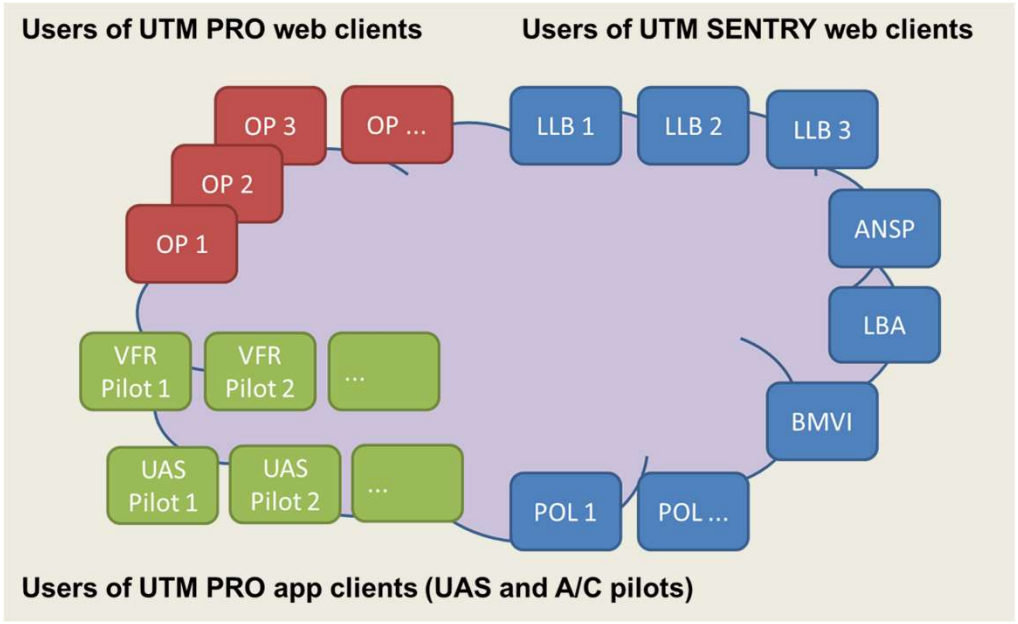
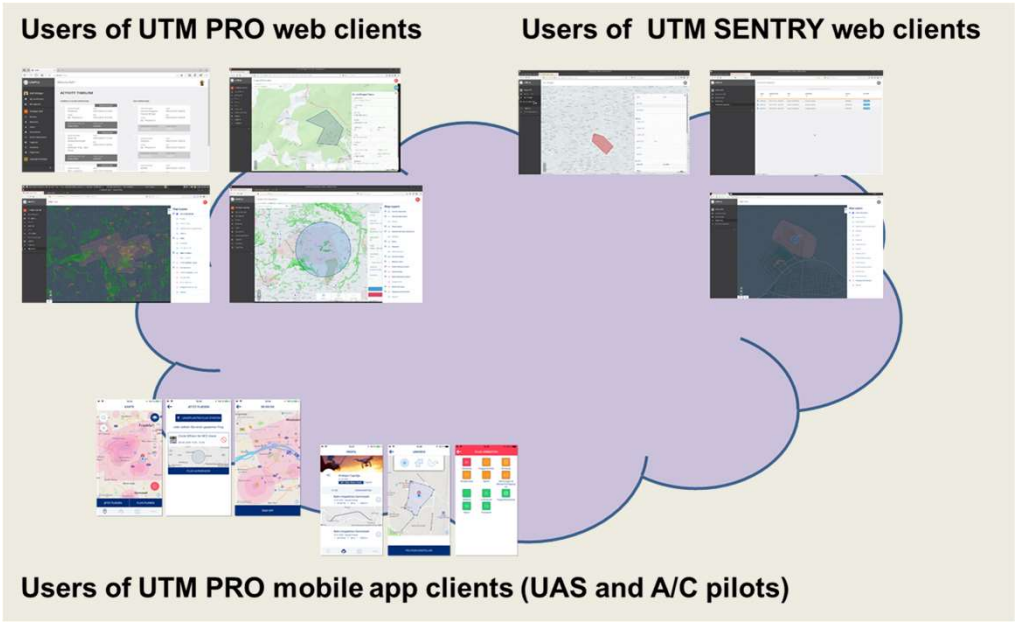
UTM will be an internet-based public network with a variety of participant classes using browsers and URL access





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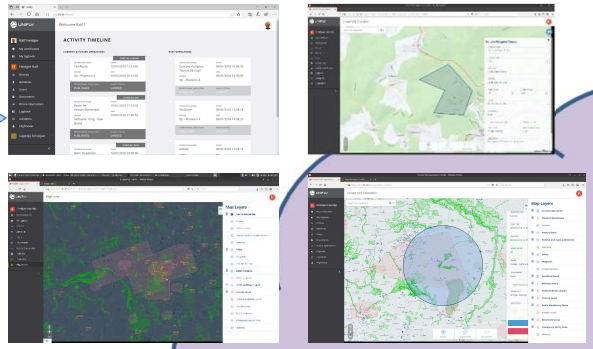
The UTM framework consists of 2 types of web applications (PRO, SENTRY) and one mobile app

Clients for all DRONIQ use case customers

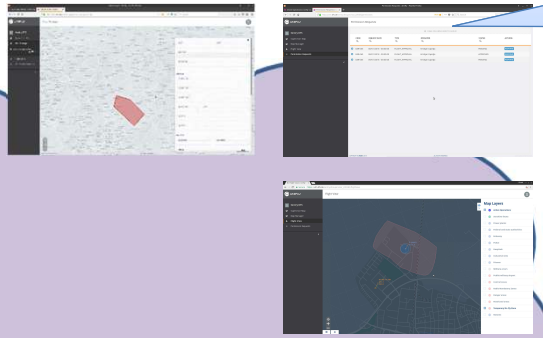
Mobile clients for VFR

Mobile clients for all DRONIQ use case customers' pilots

Users of UTM PRO web clients



Users of UTM SENTRY web clients



Clients for all 24+ federal CAA instances in Germany

Clients for all relevant ANSP instances in Germany

Clients for all relevant police and BOS in Germany

Users of UTM PRO mobile app clients (UAS and A/C pilots)

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Work sequences in UTM:
PRO for operators, SENTRY for authorities

Typical sequence in UTM PRO

Register, create profiles and fill database
- Definition of companies or operators
- Definition of pilots
- Definition of drones to be used
- Definition of documents for means of compliance

Planning of mission
- Planning of mission
- Validation against rules, NFZ, other missions
- Adaptation of planning
- Publication and submission for approval
- Evtl. modification on request

Mission execution
- Activation with mobile app (TakeOff)
- Activation by flight, detection, and tracking
- execution of flight, use of situation display
- Validation against NFZs, changes, and evtl. temp. NFZs
- Check of collission risk

Mission termination
- Report
- Logbook maintenance
- Battery management
- Incident management

Typical sequence in UTM SENTRY

Permissions
- Process permission requests
- Manage permissions

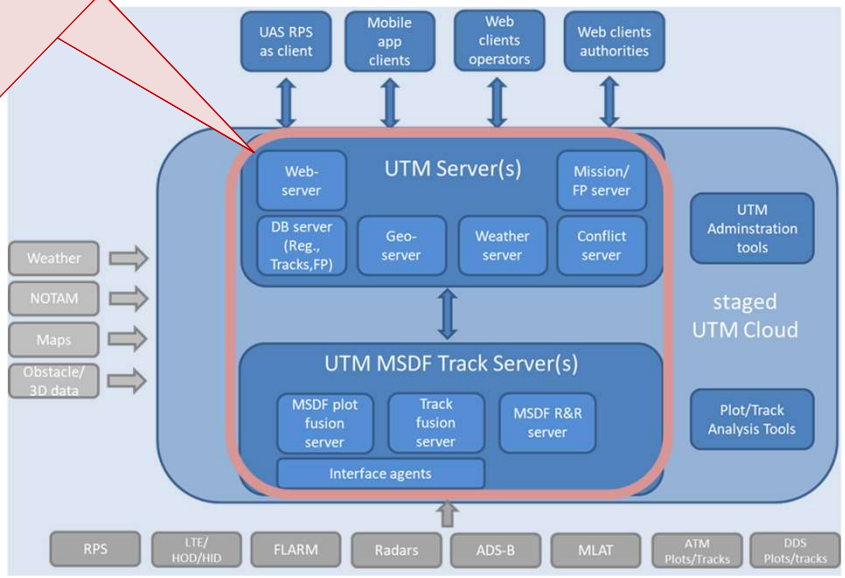
NFZ Workflow
- No Fly Zone creation
- No Fly Zone deletion
- No Fly Zone editing
- No Fly Zone management

Situation display
- Supervision
- Zoom / Decenter / Layer selection

Collaboration concept of UTM and ATM:
Track and flightplan data provision, ATC clearance request & delivery exchange

Service layer of UAS tracks, id, registration and flightplan provision

Tower Flightplan	Tower Air Situation Display
TFDPS TWR Cluster **Berlin** (TXL, SXF, LEJ, DRS, ERF)	PHX TWR Cluster **Berlin** (TXL, SXF, LEJ, DRS, ERF)
TFDPS TWR Clus. **Langen** (FRA, SCN, HAM, HAJ, CGN, DUS, FMO, BRE)	PHX TWR Cluster **Langen** (FRA, SCN, HAM, HAJ, CGN, DUS, FMO, BRE)
TFDPS TWR Cluster **München** (MUC, NUE, STR)	PHX TWR Cluster **München** (MUC, NUE, STR)



UTM -> FIS: UTM Tracks (UAS and VFR)
UTM -> FIS: UTM „Flightplans“,
UTM -> FIS: UTM Warnings & Alerts

FIS (PHOENIX TFDPS)

UTM -> BNL: UTM „Flightplans“
UTM -> BNL: ATC clearance requests
BNL -> UTM: ATC clearances

BNL

UTM -> ATM (PHX TWR): UTM Tracks (UAS and VFR, incl. correlation)
UTM -> ATM (TFDPS): UTM „Flightplans“,)
UTM -> ATM (PHX TWR, TFDPS): UTM Warnings & Alerts
UTM -> ATM (TFDPS): ATC clearance requests
ATM (TFDPS) -> UTM: ATC clearances

LIZ

UTM->LIZ: UTM Tracks (UAS and VFR)
UTM->LIZ: UTM „Flightplans“,
UTM->LIZ: UTM Warnings & Alerts

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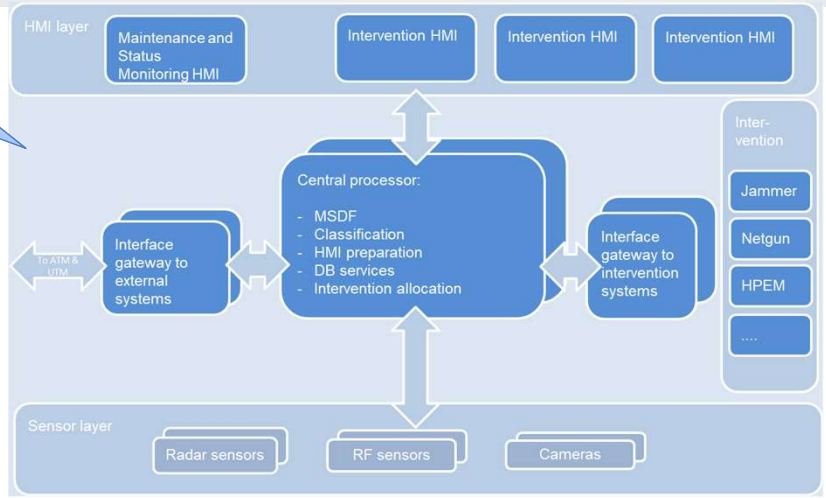
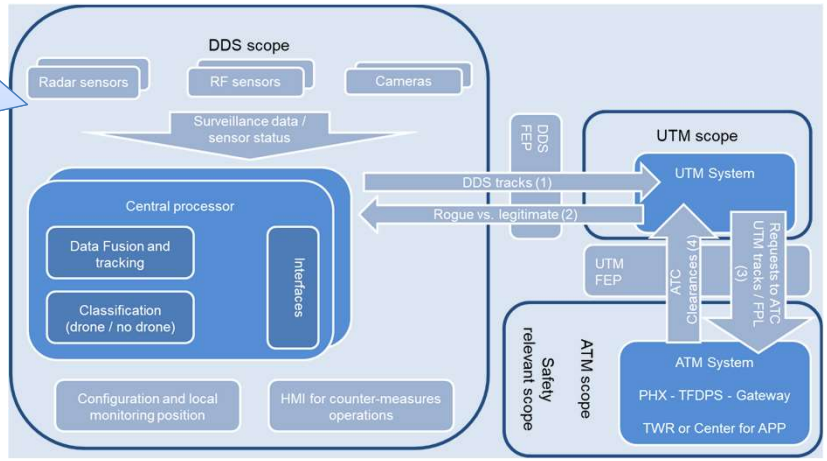
Collaboration concept of UTM and DDS: Primary tracks from DDS, and verification by UTM

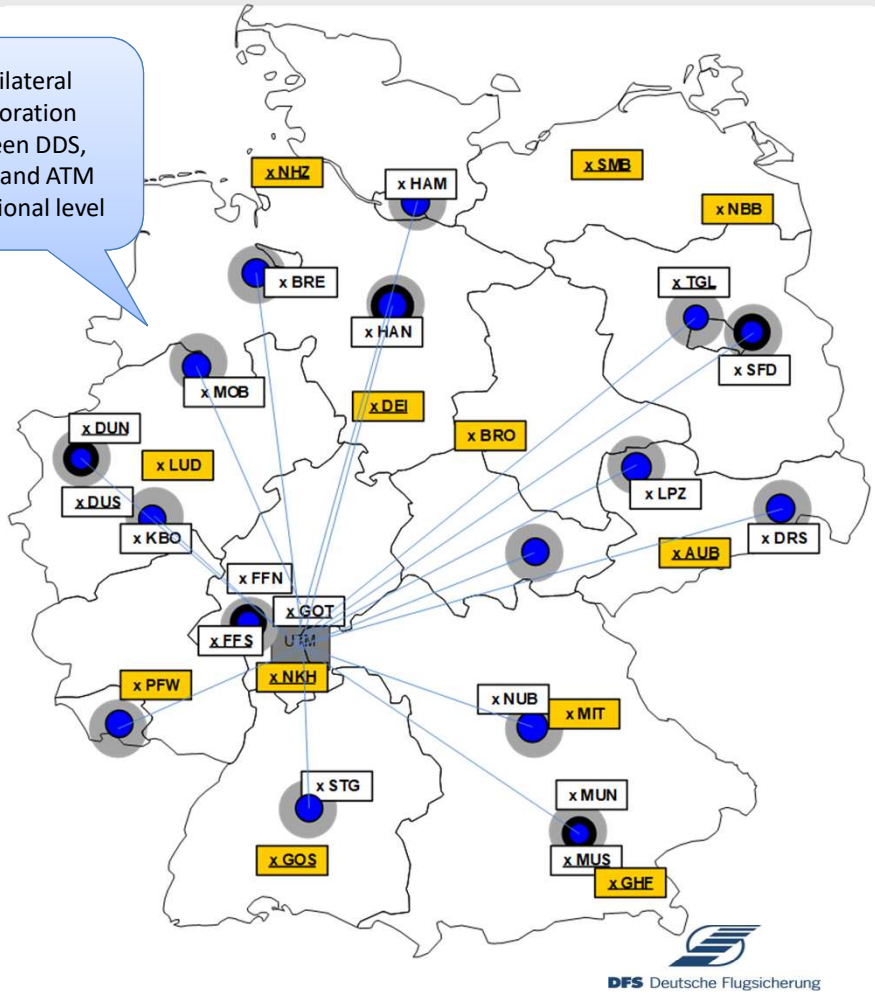
A local DDS



The logical collabo-ration between local DDS, local ATM and UTM



The trilateral collaboration between DDS, UTM, and ATM at national level

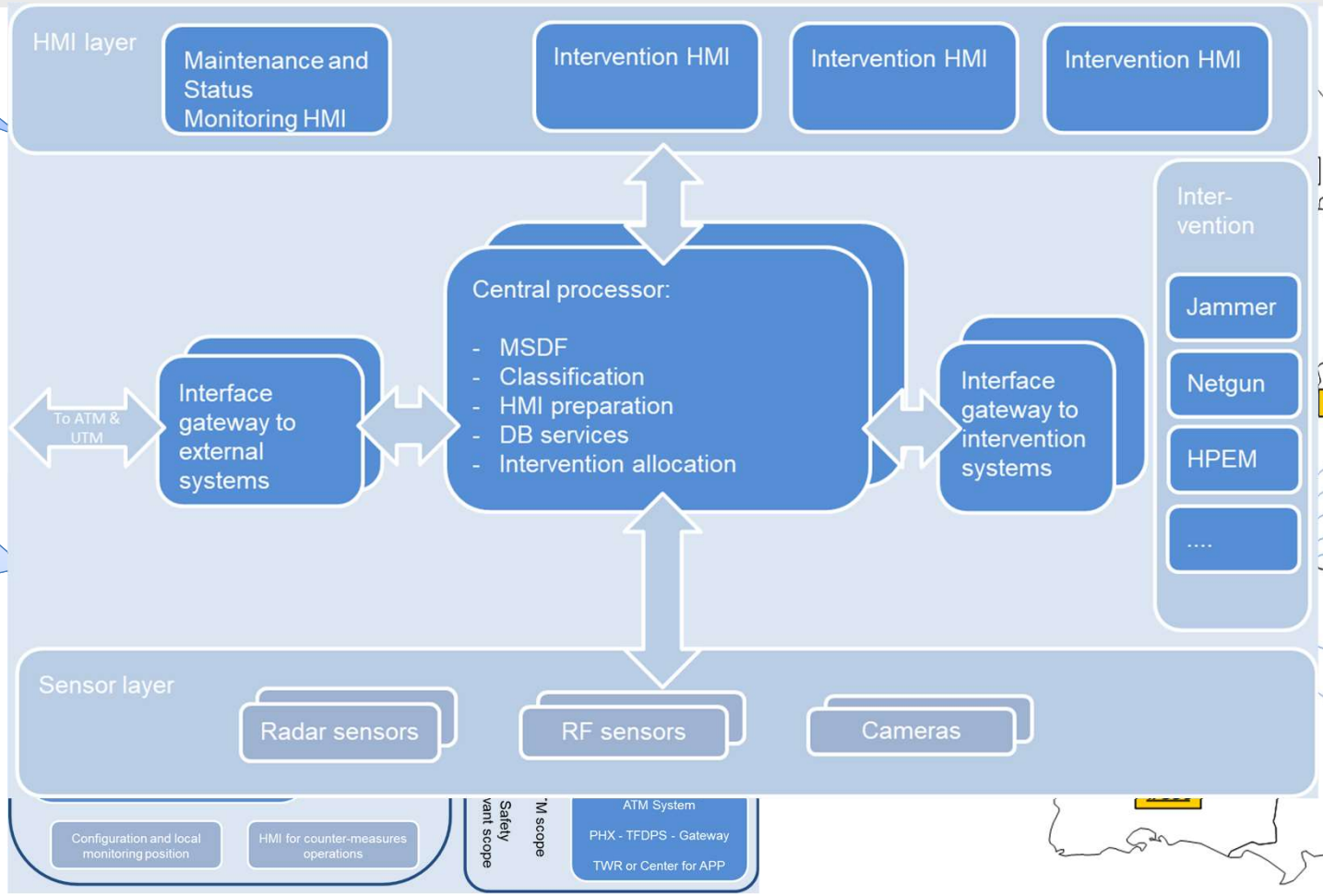


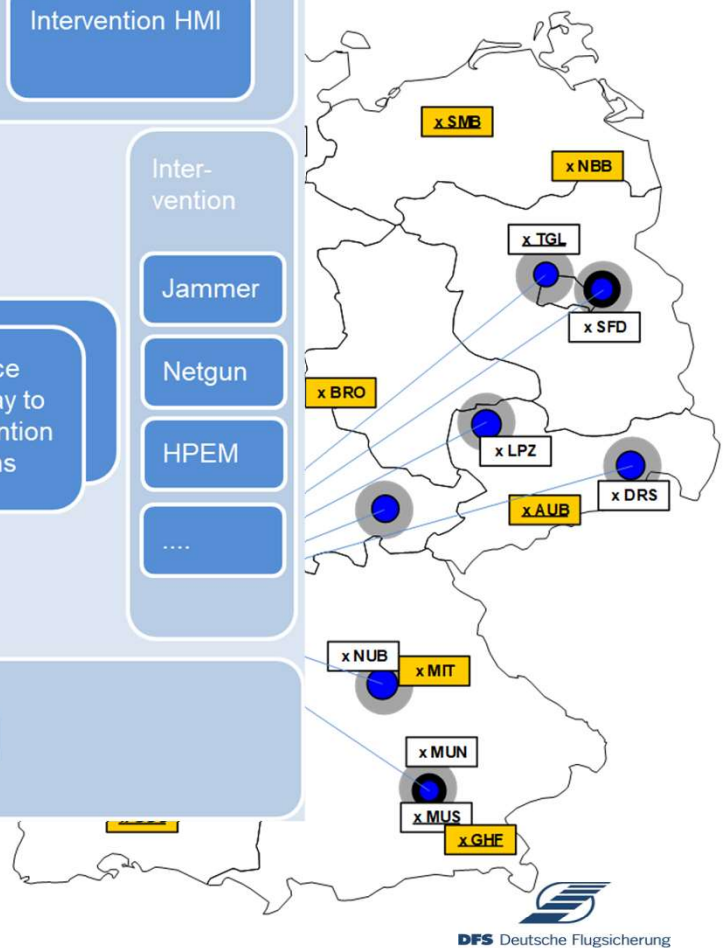
DFS Deutsche Flugsicherung

Collaboration concept of UTM and DDS: Primary tracks from DDS, and verification by UTM

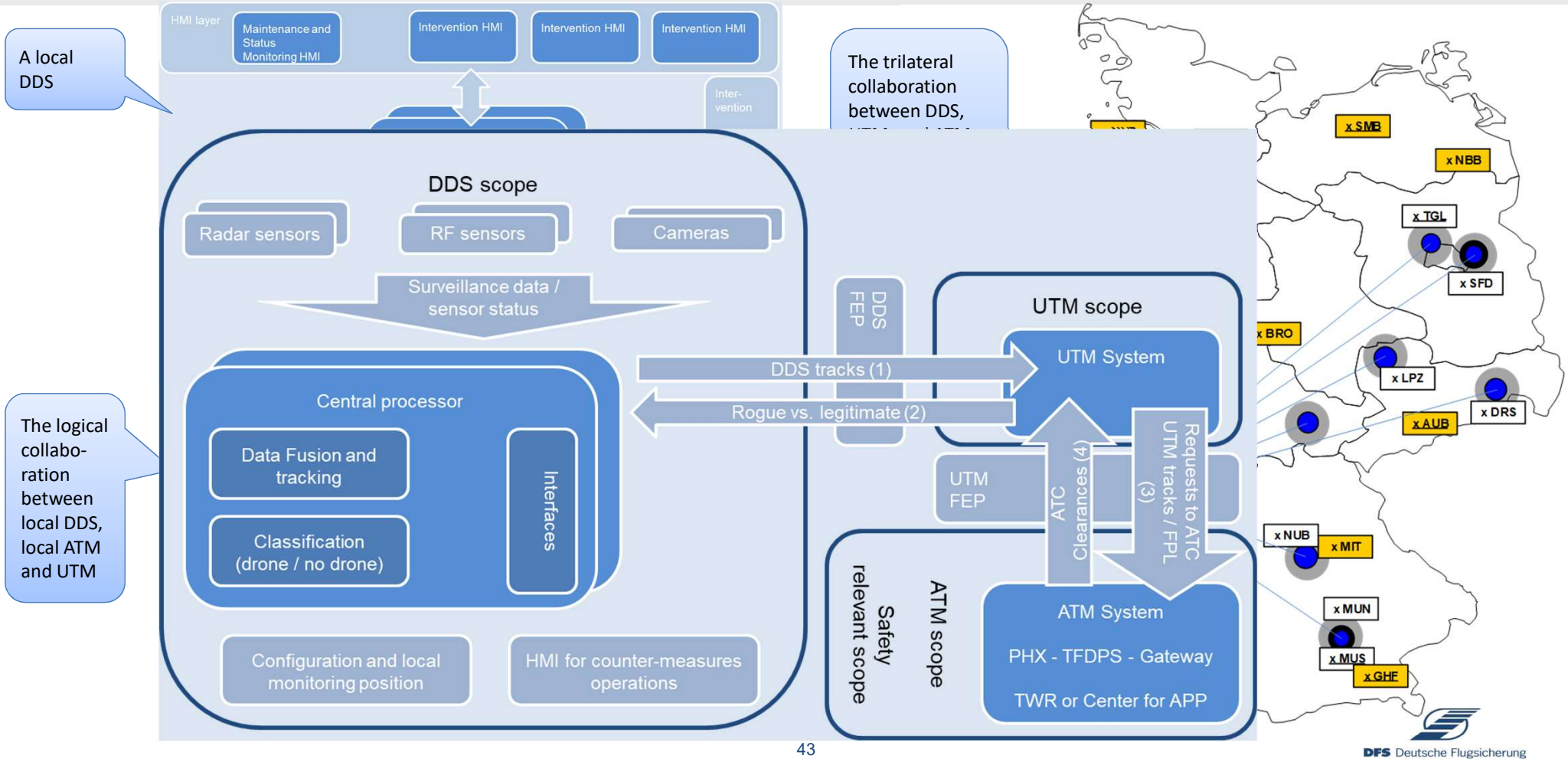
A local DDS

The logical collaboration between local DDS, local ATM and UTM



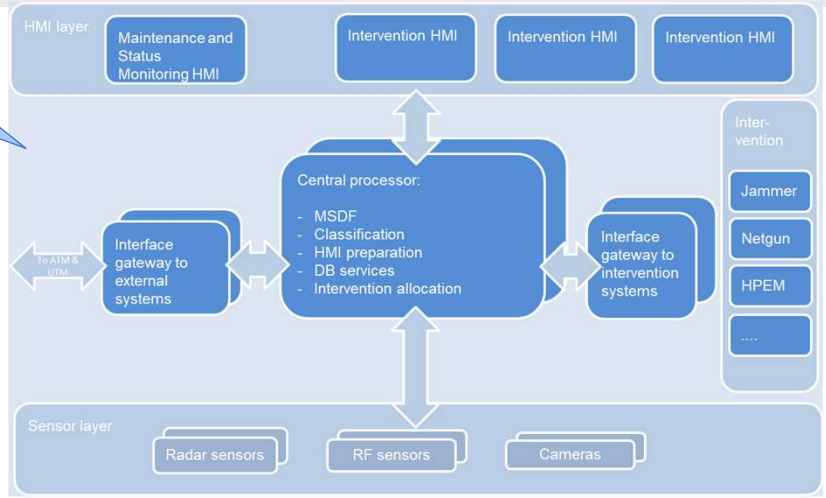


Collaboration concept of UTM and DDS: Primary tracks from DDS, and verification by UTM

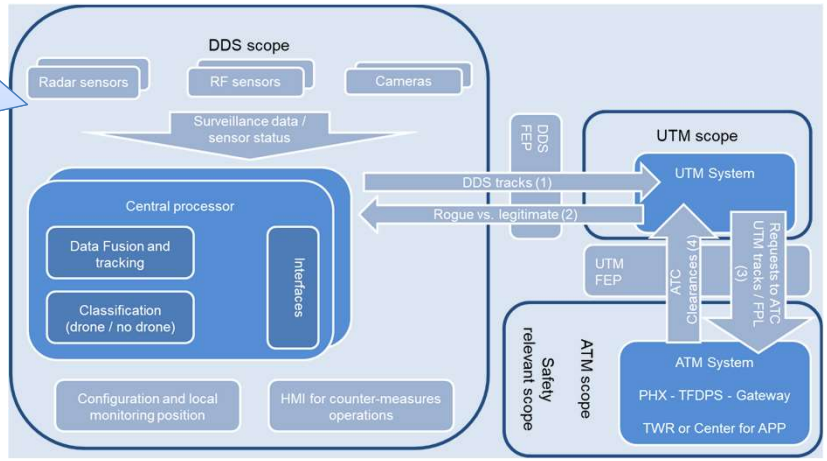


Collaboration concept of UTM and DDS: Primary tracks from DDS, and verification by UTM

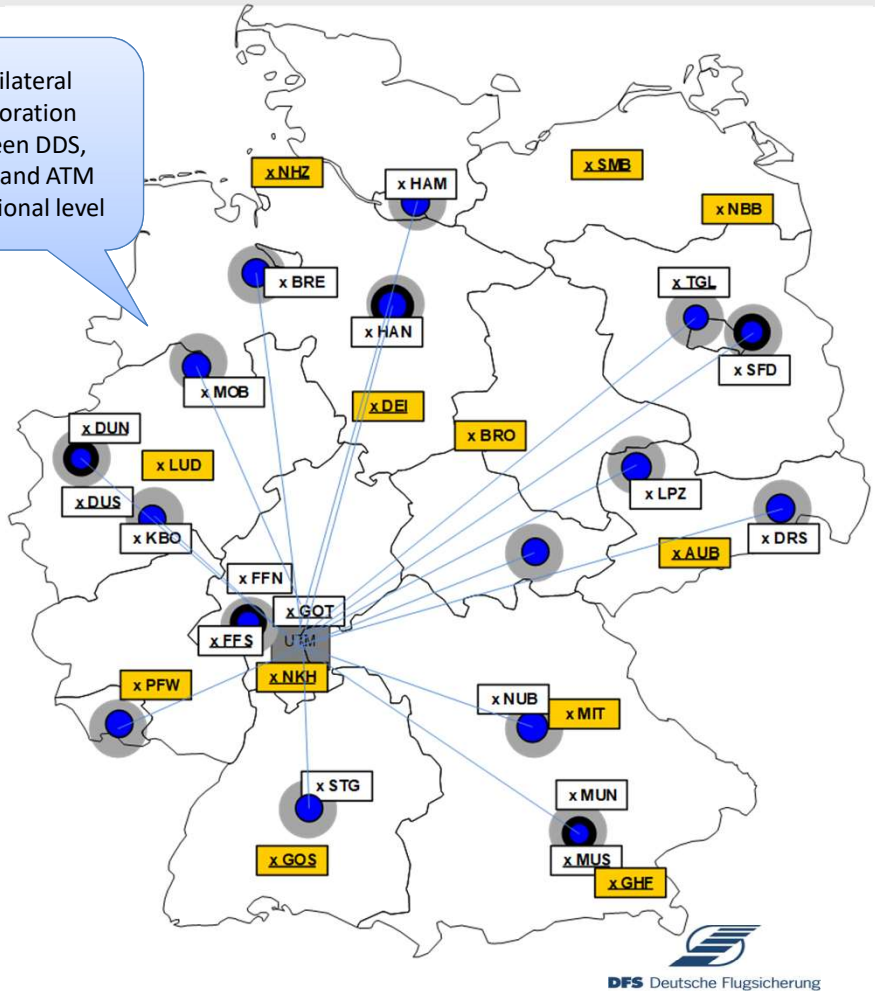
A local DDS



The logical collabo-ration between local DDS, local ATM and UTM



The trilateral collaboration between DDS, UTM, and ATM at national level



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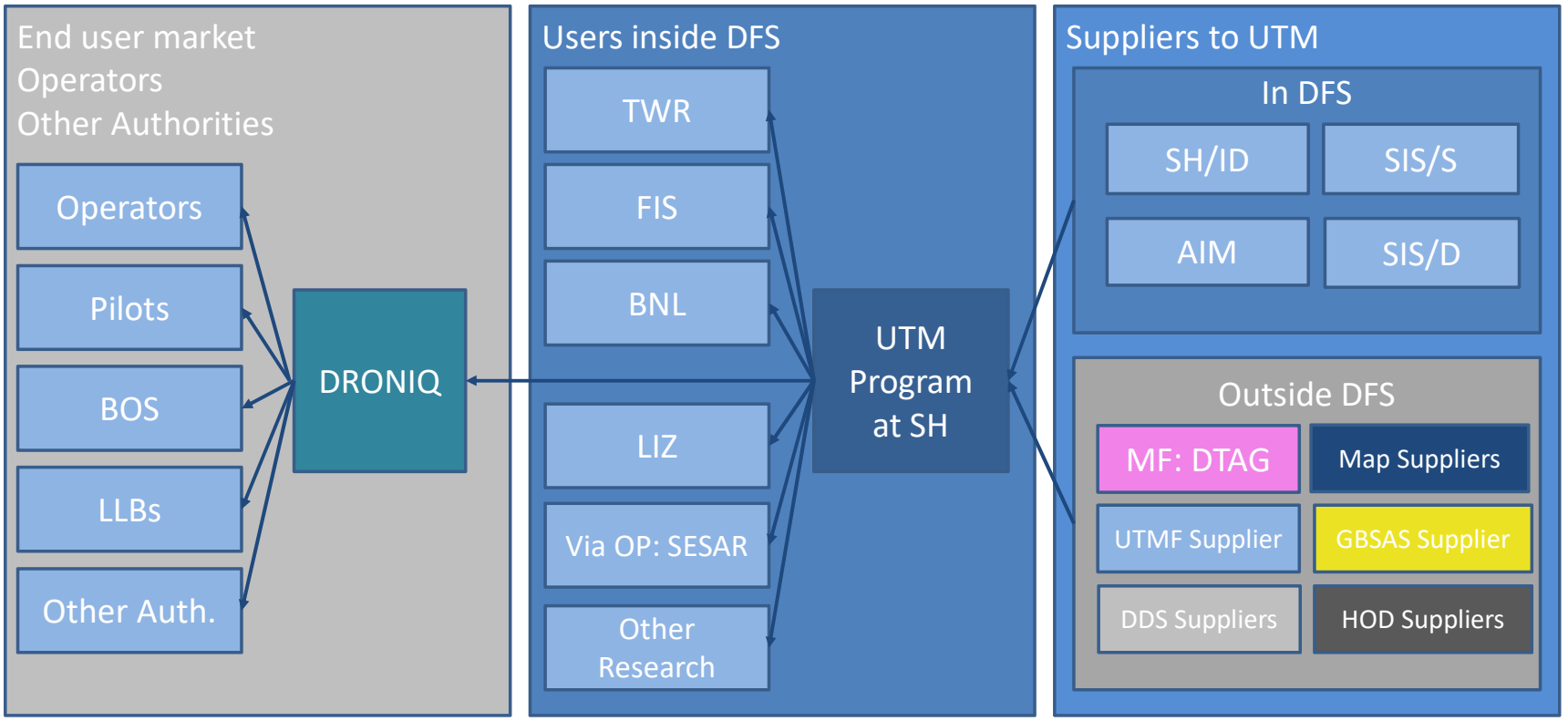
The UTM Service Delivery Chain

- Overall service delivery becomes complex and today consists of:



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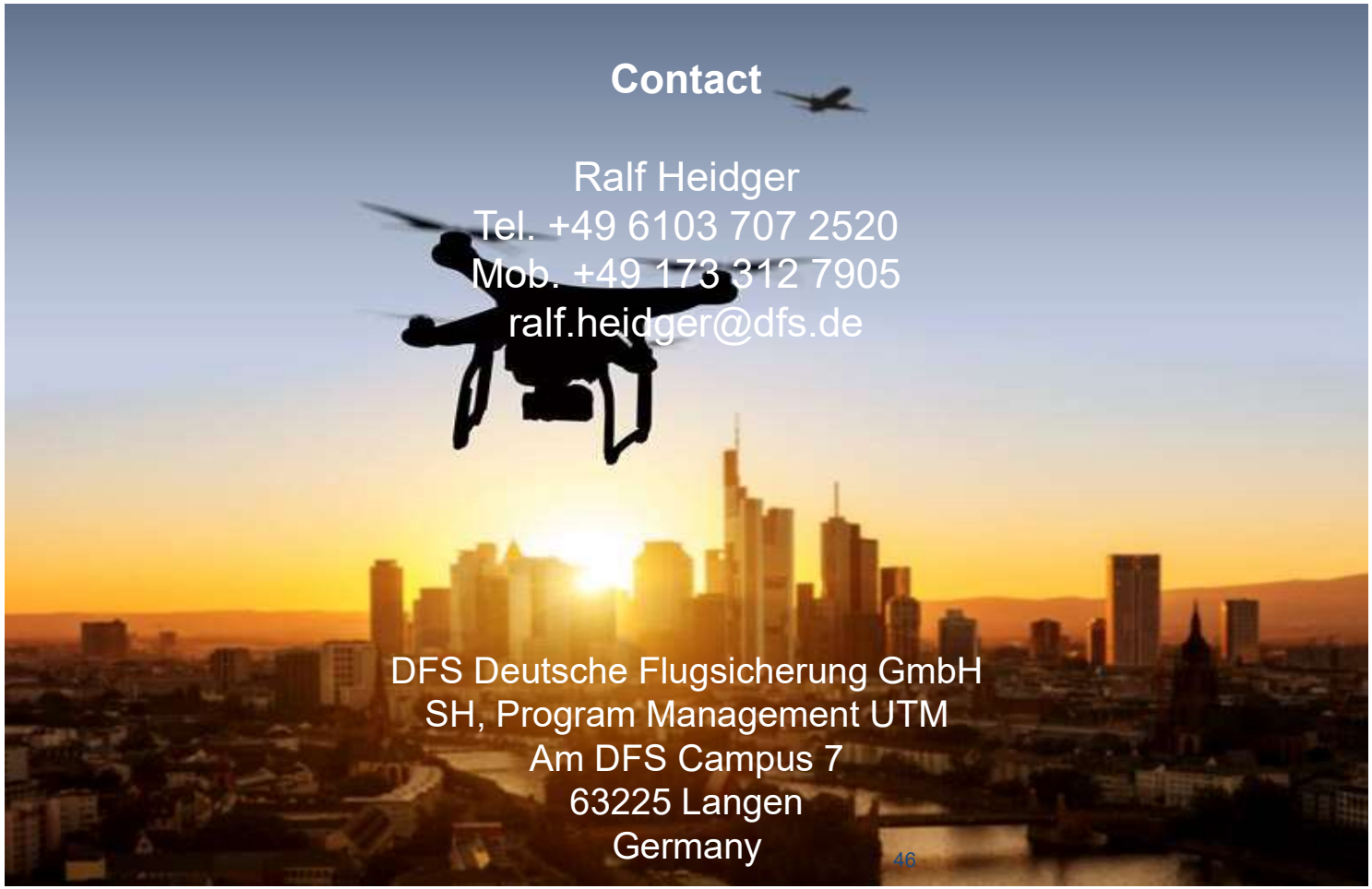
Thank you for your attention



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U-space Services Evolution & Outlook

CORUS dissemination

30th September, 2019

Giancarlo FERRARA
DECMA/INNOVATION
EUROCONTROL

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under European Union's Horizon 2020 research and innovation programme.

UAS/UAM: Emerging Low Altitude Airspace Users

- Over the last century, the aviation industry has fundamentally changed the way we live and it has never ceased to innovate.
- With the advent of UAS and eVTOL/UAM operations in urban areas, aviation is, once again, taking a significant step forward unlocking new opportunities.

Unmanned Aircraft Systems (UAS)

- Hobbyist and commercial use
- Typically < 25 kg
- Potentially 4 million by 2021*
- Remotely piloted or fully automated

Urban Air Mobility (UAM)

- Passenger carrying operations in a metropolitan area
- Potentially 27,000 operations per deployed city by 2025**
- Human piloted, remotely piloted, or fully automated

- *** FAA aerospace forecast: 2017-2037**
- **** Uber Elevate: eVTOL Urban Mobility**

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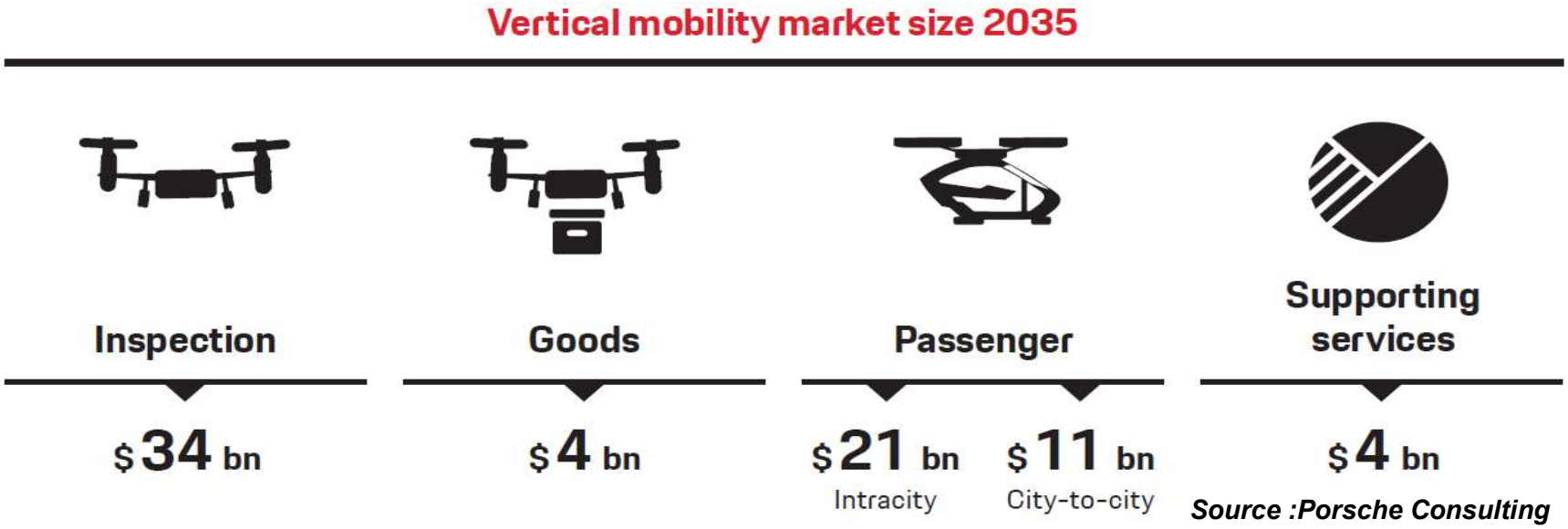
Integrating UAS/UAM into the future aviation system

- UAS it is expected to grow and move towards urban scenarios while UAM operations will take off soon (~2025) requiring more advanced U-space services and operational/regulatory solutions to ensure safe and efficient manned and unmanned flight operations not limited to VLL.
- Opening the sky to these new airspace users is an EU political and economic imperative considering their potential for growth and the benefits they could bring to the quality of urban living.
- The combined UAS/UAM market is projected to be roughly $74 billion in 2035.



Source :Porsche Consulting

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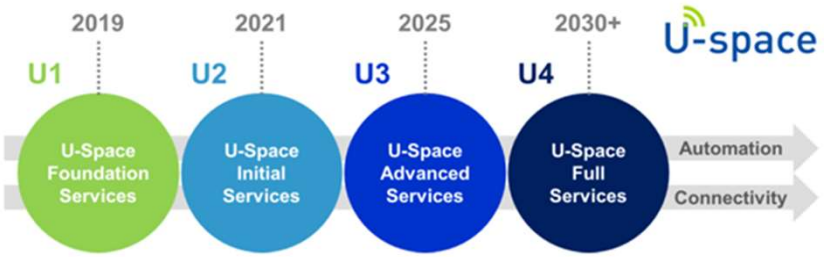
U-space Full Services: opening the evolving skies..

- Safe and equitable integration of current and future UAS/UAM operations is essential, especially in the urban airspace and close to airports.
- U-space services and air traffic management solutions will be a key enabler for achieving the required level of integration for UAS/UAM operations not limited to VLL.
- The most critical success factor for the UAS/UAM operations will be the ability to develop advanced U-space U3/U4 services and solutions that allow airspace users (unmanned and already existing manned such as General Aviation) to safely, sustainably and efficiently operate.



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Urban U-space: managing a system of systems

- The new U-space ecosystem shall have the potential to enable and create a smarter and more integrated network of air mobility across the urban and inter-city skies.
- Small drones operations should not only be limited to VLL airspace.
- UAM/eVTOL operations performed from VLL up to higher altitudes where some classes of “prioritized” users are already operating (e.g. Helicopters, General Aviation etc.)

Source :Embraer X

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U-space main challenges from UAS/UAM Ops

UAS/UAM urban/sub-urban operations will heavily challenge the U-space operations due to the:

- Increased number of flight operations in urban/sub-urban/airport areas
- Increased density of operations requiring digitalisation and automation of U-space functions
- Lower altitude urban operations challenges on CNS systems and infrastructures
- Heterogeneity in terms of pilots training/certification, level of automation and aircraft performances/levels of equipage

Source :Airbus

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U-space Services future R&D requirements

To move forward and get UAS/UAM urban operations deployed, further U-space R&D activities are required to properly address some pending issues and challenges:

- Identification of the most promising operational/regulatory U-space services and tech/ops solutions to support the UAS/UAM urban airspace requirements for fully manned/unmanned aircraft integrated operations.
- Effective solutions for the interoperability among U-space Service Providers (USP) and a proper interface with ATM operations.
- Urban airspace/separation management solutions to cope with the expected UAS/UAM demand.
- Demand/Capacity Balancing operations managed by U-space to avoid safety and/or efficiency impacts.
- UAS/UAM and GA regulatory challenges and non-aviation aspects that offers solutions for easing social acceptance.

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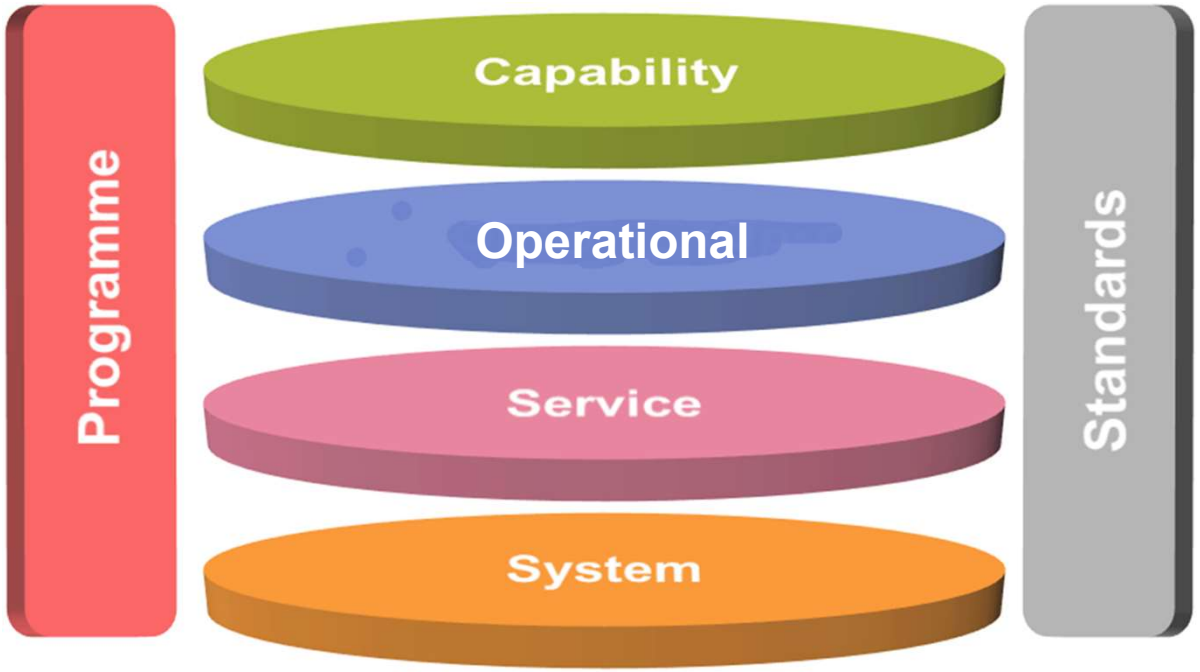
U-space Concept of Operations

Closing remarks

Andrew Hately
CORUS technical coordinator
30th September 2019

Thanks for coming today!

Now for the test.



- The missing layer is:
- Business
- Functional
- Information
- Operational

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The ConOps is available for download today

https://ext.eurocontrol.int/ftp/?t=9f70966d18dc4e21097c7f0a033164e3

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Don’t forget to come back tomorrow!

08:30 Direct shuttle from Gare Centrale
08:45 Direct shuttle from Schuman

09:30 Welcome

10:00 Introduction: …

The CORUS project has received funding from the SESAR Joint Undertaking under grant agreement 763551 of the European Union’s Horizon 2020 research and innovation programme.

And now…

Networking reception

Don’t forget:
18:45 Direct shuttle to Gare Centrale
19:00 Direct shuttle to Schuman

By Ralf Roletschek - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=43686103

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