



The U-space ConOps

4th Edition

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Founding Members



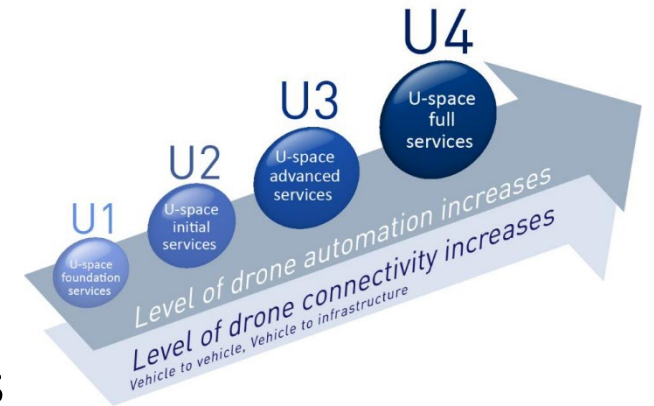
A U-space ConOps?

What is U-space?

- U-space is defined as a set of services

What is the Purpose of the ConOps?

- To explain how the services are used, how U-space works



Why do we need a new ConOps? CORUS delivered edition 3 in 2019.

- Increased scope: meeting the needs of Urban Air Mobility
- Alignment with recent EU regulations
- Integrating the work of recent research and standards
- *We felt we could make the ConOps easier to read*

What will be presented in this session?

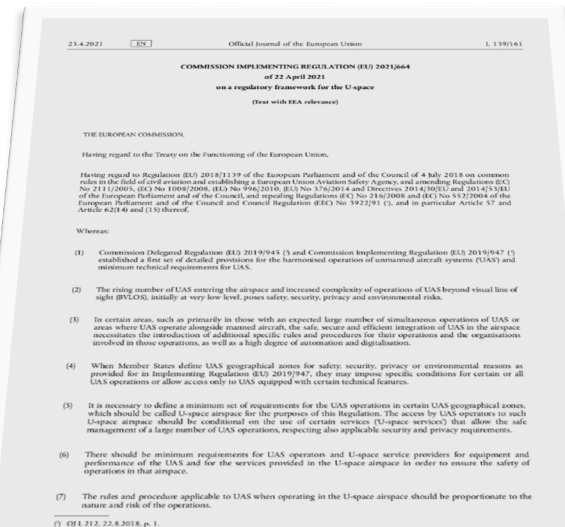
The U-space Conops Edition 3 in 1 minute.

The main areas of change in edition 4, with reasons for each change:

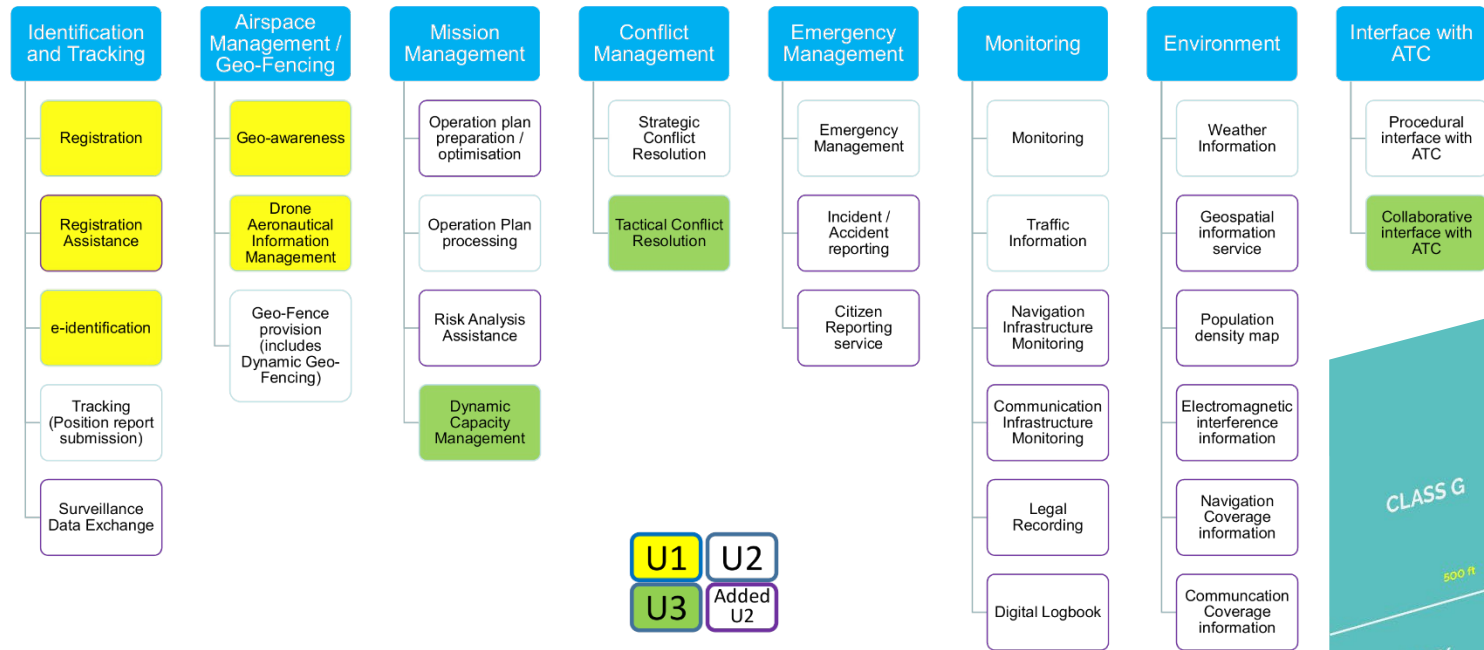
The U-space regulation

The needs of Urban Air Mobility

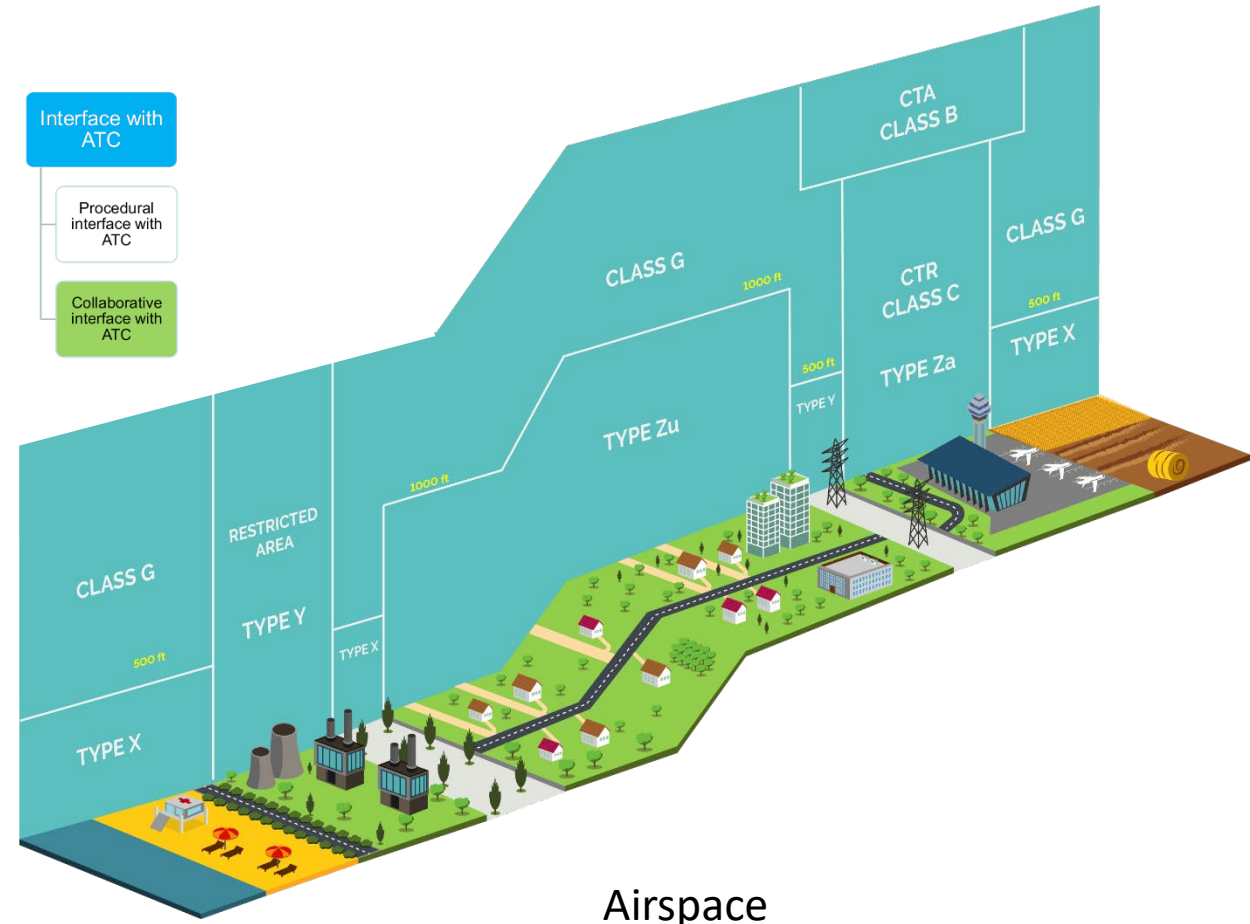
Incorporating progress in the field, research, standards, ...



Where left off



Services



The essence of the U-space ConOps Edition 3

Three levels of U-space services are defined, a fourth is anticipated

U1: *The foundations*

- Geo-awareness. *Where can UAS fly, under what circumstances*
- Registration. *Who is flying.*

U2: *Enabling low density BVLOS flight with minimal CNS*

- Many services are defined to enable flight with strategic conflict resolution.

U3: *Facilitating higher density & higher risk operations*

- Tactical conflict resolution, protected by dynamic capacity management

U4: *Integration with manned traffic*

- *Not covered in edition 3: Flight rule(s) for UAS.*

Ed3: Airspace Volumes and Conflict Resolution

X:

- No conflict resolution service
- 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
 - e.g. National park

Z:

- Conflict resolution before flight and in flight
- Requires tracking
- Separation minima in function of system performance

Za *subset of Z*

- ATC controlled airspace, e.g. airport
- U-space provides
 - Situational awareness to ATC
 - Communication tools
 - Standard ways of working

Zu *subset of Z*

- U-space (software) provides conflict resolution during flight, from the ground

Δ Ed4 vs Ed3. Operating environments

Initial U-space implementation

- The U-space regulations come into force in 2023

Traffic rises

- Uncrewed flight is relatively common in the some airspaces
- A new flight rule accommodates integration of uncrewed flight with crewed aircraft in U-space airspace
- Tactical processes are commonly used.

Widespread U-space

- U-space is widely implemented
- Uncrewed flight is very common, including passenger carrying
- U-space services are commonly used by being used by crewed flights

Full U-space

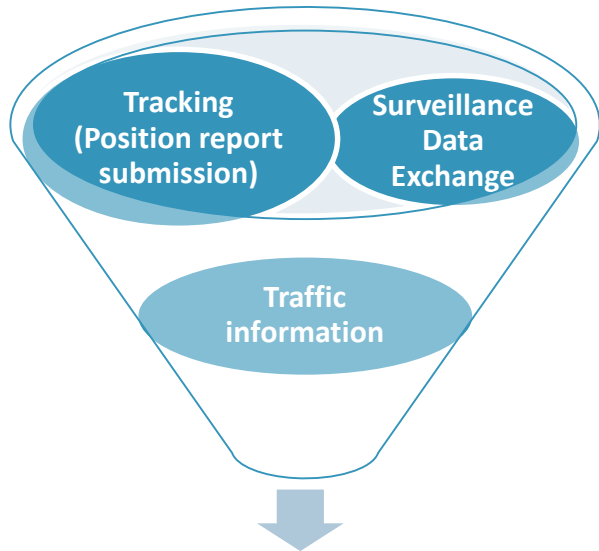
- The majority of flights are uncrewed

The U-space regulations vs Ed3

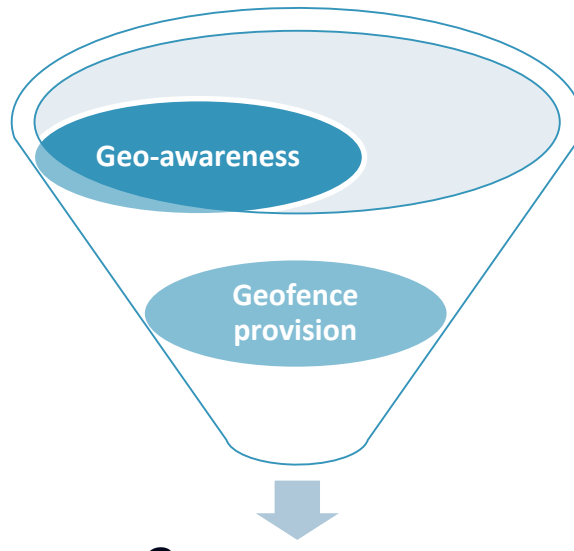
- CORUS described a complete set of services extending to U3
 - Scope extends to high density & tactical separation
- EU IR 2019/947 established U1
- EU IR 2021/664 builds on 2019/947 and regulates the minimum services for initial U2
 - Strategic conflict resolution only
- The EU regulations don't map cleanly onto Edition 3
 - The distribution of functions among the services are not the same
 - Airspace use differs
 - Terminology differs

- **According to Commission Implementing Regulation (EU) 2021/664**

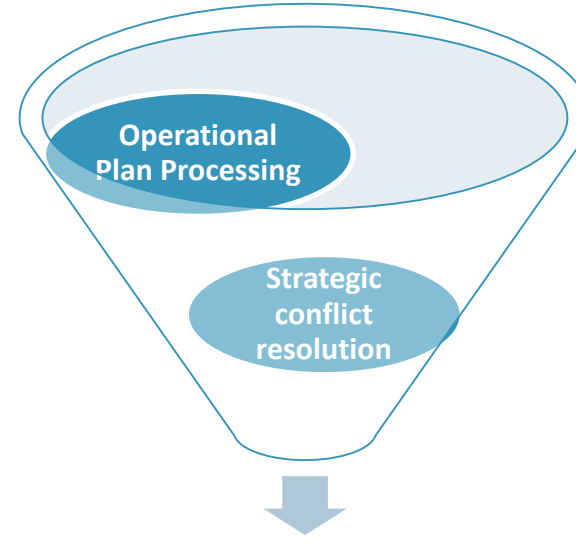
- **4 MANDATORY services:**



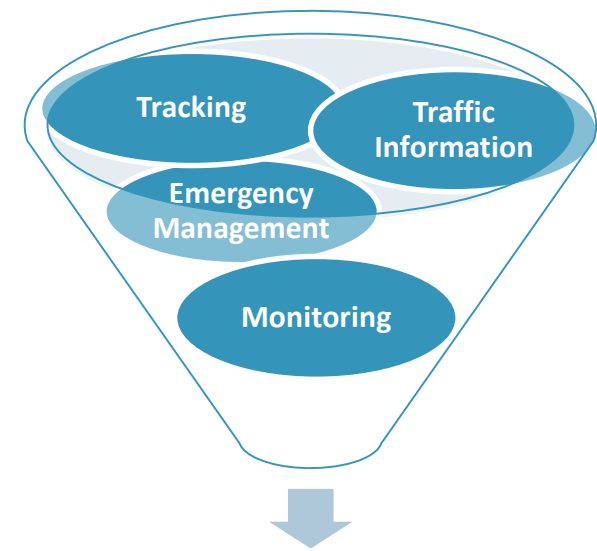
Network identification service



Geo-awareness service



UAS flight authorization service



Traffic Information service

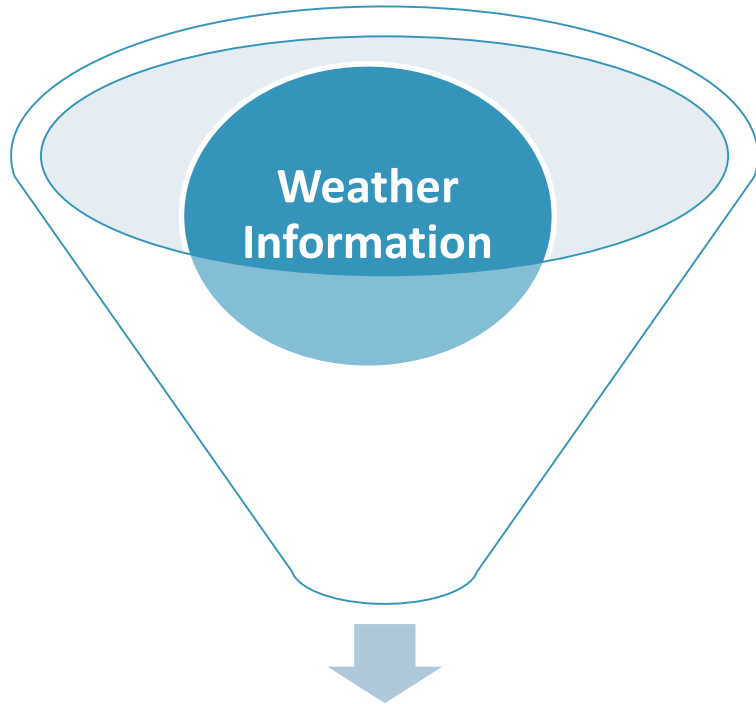
- **CONOPS Ed.3 services don't cover:**
Point (e): *The geographical position of the remote pilot or, if not available, the take-off point*

- Close fit on CONOPS Ed.3 Geo-awareness and Geofence provision services characteristics

- **CONOPS Ed.3 services don't cover:**
Some Annex IV points about UAS flight authorisation request such as *identification technology, expected connectivity methods, endurance, emergency procedures in case of C2 link loss*

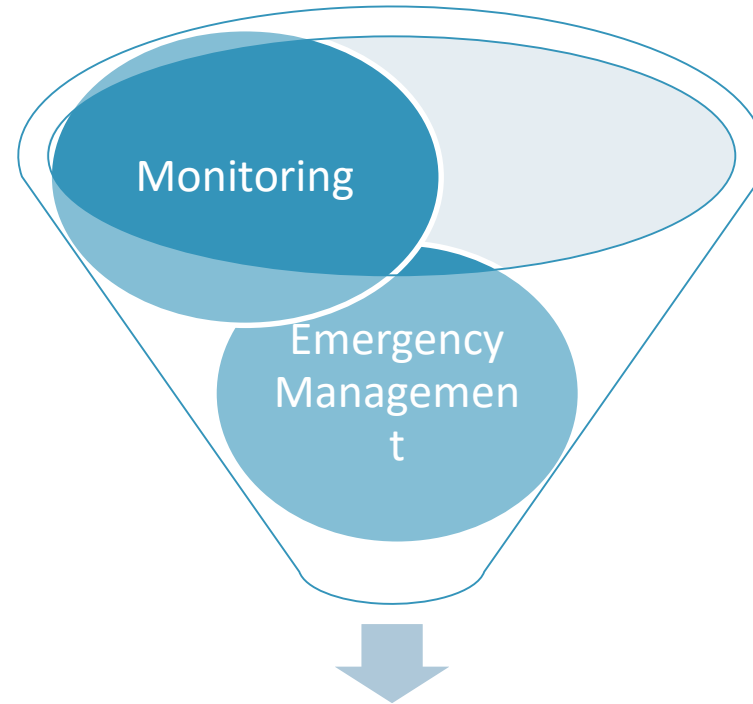
- In CONOPS Ed.3 the information of nearby (for traffic information) comes from the monitoring service

- **According to Commission Implementing Regulation (EU) 2021/664**
- 2 services could be mandatory (depending from member state):



Weather information service

- Good match with CONOPS Ed.3 Weather Information service



Conformance monitoring service

- Combination between the two CONOPS Ed.3 Monitoring and Emergency Management services

Aligning with the EU regulations in Edition 4

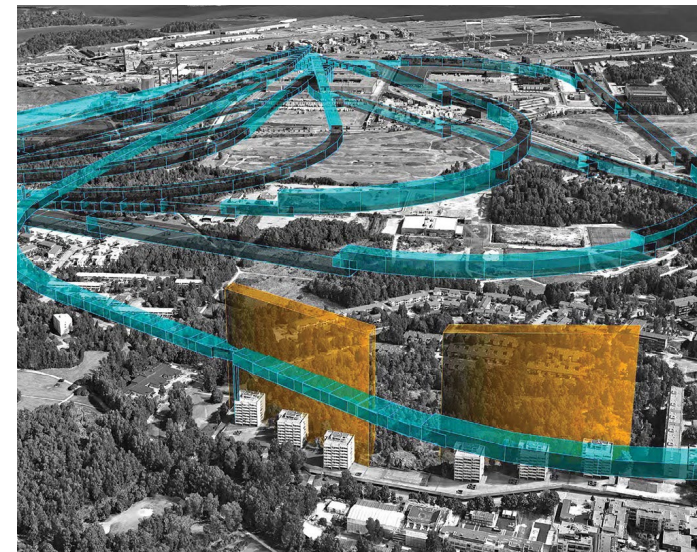
- Service names from EU regulations can be used in Edition 4
 - There are many more services in Edition 4 due to its scope beyond U2
- More work is needed in a few cases:
- Operation plan processing including strategic conflict detection and resolution vs 664 “flight authorisation request”
 - EU regulation scope is only strategic deconfliction inside one U-space airspace
- 2021/664 identifies the **activation** of a flight.
 - Missing from Edition 3
- Airspaces
 - Edition 3 has some ambiguity

Operation plan processing

Operation plan processing in our ConOps includes

- Verification of airspace access permission
 - A scheme of access tokens is needed.
- Strategic Conflict Resolution and/or Dynamic Capacity Management
- Coordination with ATC if needed
- Coordination with Vertiports if needed

- The ConOps will retain its larger scope and identify the subset covered by EU regulations
- But will add any missing elements, like activation.



Differences in strategic conflict detection & resolution

Detection

- ConOps Edition 3 proposed we considers the probability of intersection. Conflicts must exceed some minimum probability before they need to be resolved
- The U-space regulation considers and any intersection as a conflict
 - For the level of traffic the regulation aims at the result is a much easier implementation
 - At a cost to the efficient use of airspace

Resolution

- The regulation prioritises first to file the plan.
- Edition 3 identified prioritising first to file as unfair.
 - Edition 3 proposed “RTTA.”
Concept is not mature - detailed research needed

RTTA & Demand Capacity Balancing

- Dynamic Capacity Management balances the capacity with the demand
- Plans arrive or are updated potentially at any time before flight
- Hence the complete picture of total demand is only available shortly before flight.
- Hence Dynamic Capacity Management can only take place shortly before flight
- This time is agreed with the participants – the airspace users, the USSP.
- It is “Reasonable Time to Act” (RTTA)
 - Equivalent to NM’s slot issue time in European manned aviation

RTTA & Strategic Conflict Resolution

- EU regulation prioritises first to file
- First to file reserves the airspace has three disadvantages
 - Business that fly “on demand” are systematically disadvantaged
 - There is an incentive to plan early and hence when there is a lot of uncertainty hence plans will maximise use of capacity to allow a margin
 - The longer ahead planning is made the more likely change and cancellation
- Different schemes have been proposed instead of first to file or modifying first to file.
 - Market based
- Applying RTTA to SCR offers an algorithmic solution
 - Flights not yet at RTTA are ignored
 - Flights at RTTA are deconflicted
 - Flights after RTTA are “frozen” as far as possible.
- This is an ongoing research topic.

Airspaces and Flight rules and the EU regulations

- ICAO airspace classes A to G are defined in terms of flight rules and services.
- UAS in U-space are not currently considered as flying any of VFR, SVFR, IFR. Due to this
 - U-space is a restricted area
 - UAS cannot fly among VFR, SVFR or IFR flights
- In order to have integration, we need to either
 - Fly UAS following an existing flight rule
 - Devise new flight rule for UAS and understand how manned aircraft can fly it or fly with it.
 - *More on this tomorrow*

Y Volumes & the EU regulations



- Edition 3 describes two uses for the “Y” volume
- The Y volume can only be accessed with an authorised plan
 - The main purpose of this is to enable strategic conflict resolution
 - There is a side effect that Y can be used to restrict access.
- By giving a different name to the second use we can have a 1:1 mapping between Y and “U-space Airspace” of 2021/66[456]
- The U-space Airspace is a restricted area.
 - It is not class G airspace, nor ABCDEF.
- The 3rd edition ConOps said this but was not clear enough.

Zu Volumes

- Zu has two definitions in Edition 3. These are to be given distinct names:
 - Zu = Tactical Separation **Instructions** are given
 - Zz = Tactical Separation **Advisory** service is provided.
- Zu implies greater liability for the U-space service provider
- We need to understand how this will work in a collaborative environment

EVTOL

- Short endurance, currently
- Lower noise than helicopter
- Initial operations have pilot on board
- Un-crewed soon

Passenger operations

- Higher risk than cargo
- Passenger operations have uncertain timing
- Tactical processes are needed for efficiency

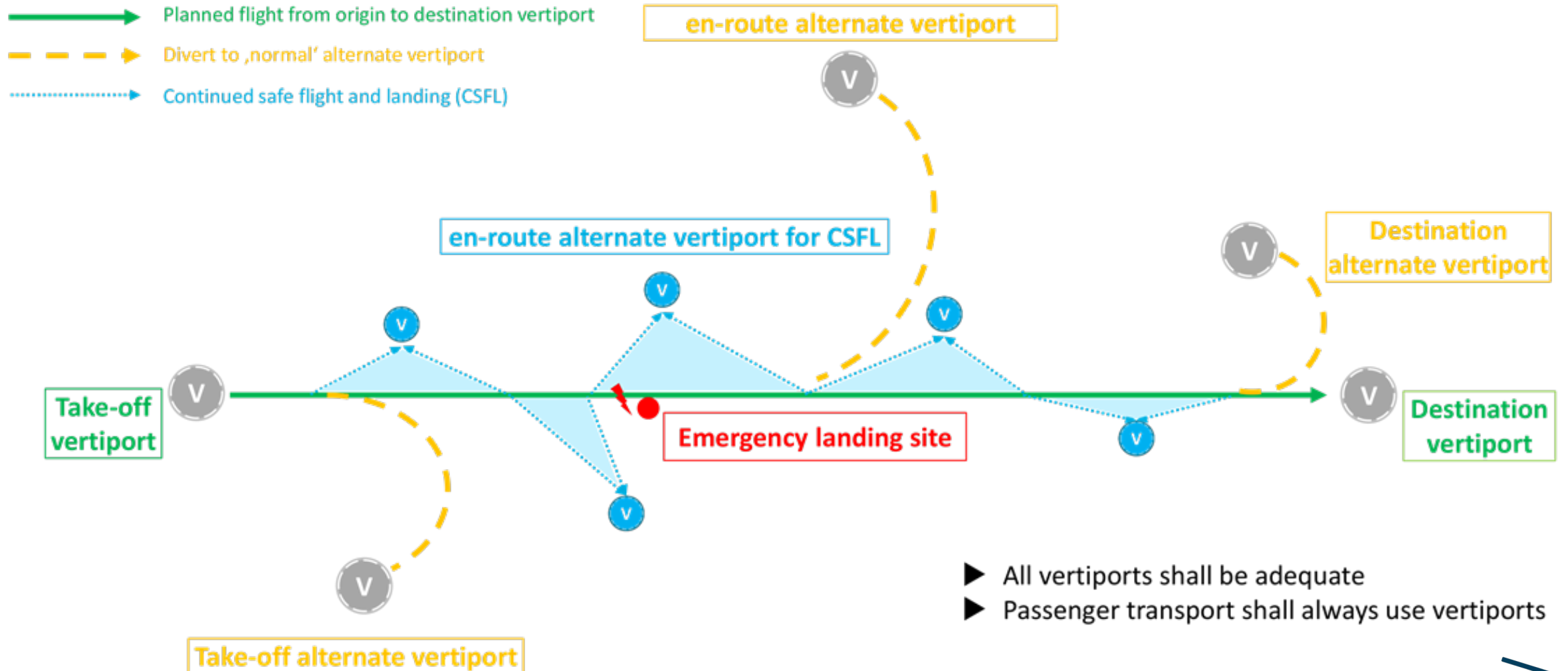
The Vertiport

- Touchdown and Lift-Off area (TLOF) is a critical resource
 - TLOF are alternative landing spots for nearby aircraft
- Vertiport resources are a key element in the planning of flights

Urban environment

- High ground risk
- High sensitivity to noise
- High density of operations

EVTOL flight and alternative landing spots



EVTOL flight and alternative landing points

- Passenger carrying EVTOL will continuously plan the next alternative landing spot
- This implies an expectation to be able to use Vertiports that the flight passes, with probability $\ll 1$
- Attempting to do this using strategic planning leads to either
 - we ignore the problem
 - The planning of this flight depends on flights in the past **and flights in the future**. Planning becomes so interlinked as to be impossible
- Hence tactical conflict resolution is required.
 - Availability of alternative landing points is a demand / capacity problem
- Passenger EVTOL flight requires U3 services

The Vertiport as an alternative landing spot

- The availability of a vertiport FATO is safety critical information
 - any passing EVTOL may consider this vertiport as an alternative landing spot
- Vertiports will need to share their current availability and planning
- This will be used in the
 - Emergency management service
 - Dynamic Capacity Management service
- There may need to be special procedures for passing EVTOL following unplanned vertiport closure

- More on the vertiport tomorrow.

Recent research & standards



Common Altitude Reference System

- ICARUS has developed four services. Two are new for edition 4

ASTM F3548-21 & the Inter-USS

- Offers a more mature explanation of strategic conflict detection than Ed3
- Including a safety case

Coming soon:

DACUS project

- Ed3 had two paragraphs on Dynamic Capacity Management.
- DACUS has spent two years on it. Results expected soon

BUBBLES project

- Bubbles has studied separation processes and performance

And many more. There are 16 ongoing projects coordinating with CORUS-XUAM

The ConOps will integrate their results – either in Edition 4 or Edition 5



Closing

Edition 4 will be available shortly.

Edition 5 will be released at the end of the project. Compared to edition 4 it will explore more on

- Safety & Contingency
- Architecture
- Lessons learned from the demonstration activities.

Tomorrow you will hear about

- Vertiports
- Airspace & Flight rules