MINISTERIO DE FOMENTO

AESA AGENCIA ESTATAL DE SEGURIDAD AÉREA

Use of EGNOS for drone operations: the Spanish regulatory approach

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Organised by the ESSP and the European GNSS Agency (GSA)

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AESA and UAS Division

What is AESA?

Agencia Estatal de Seguridad Aérea
Spanish Aviation Safety and Security Agency

AESA is an Aeronautical Authority

AESA is attached to the State Department for Transport at the Ministerio de Fomento through the General Directorate of Civil Aviation

https://www.seguridadaerea.gob.es/lang_castellano/home.aspx

Oversight, **Inspection**, Planning and Management of Air Transport, Aviation Safety, Air Navigation, and Airport Security

Legal authority to impose **penalties** for breaches of civil aviation standards

Assessing the risks in aviation safety

UAS* Division

18 Technical Inspectors of Civil Aviation
6 Administratives

*Unmanned Aircraft System (drone)

- Instruction of penalties proceedings
- Development of national and **international regulations**
- Development of Acceptable Means of Compliance and **Guidance Material**
- Normative disclosure
- **Authorising UAS operators in Spain**
- Aeronautical inspection
- User Support (email and phone number)

AESA is in close colaboration with International Organizations related with UAS in order to develop requirements for UAS aiming safer operations:

- International Civil Aviation Organization (ICAO)
- Joint Authorities for Rulemaking on Unmanned Systems (JARUS)
- European Aviation Safety Agency (EASA)
- Other projects

In Spain:
4311 UAS Operators
5939 registered aircrafts
6098 pilots

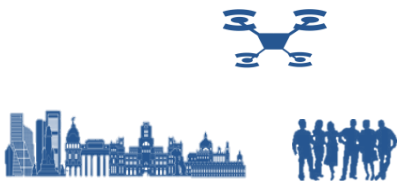
RPAS Advisory Comission:
Authority, airspace providers, manufacturers, operators, spanish RPAS associations

Result:
Creation of Acceptable Means of Compliance and Guidance Material

https://www.seguridadaerea.gob.es/lang_castellano/cias_empresas/trabajos/rpas/material_guia/default.aspx

Scenarios under Authorisation (Spanish Regulation)

GATHERINGS OF PEOPLE AND/OR FACILITIES



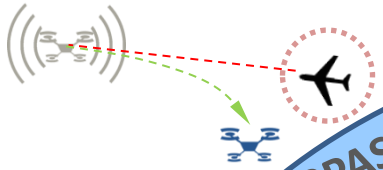
CONTROLLED AIRSPACE

AT NIGHT

AUTHORISED

MTOM > 50 Kg

BVLOS > 2 Kg



RPAS Advisory Comission defined the requirements related to geolocation necessaries to obtain an Authorisation

EASA Regulation

Categories of UAS operations

OPEN:

- Low Risk
- The competent authority is not involved
- Operation with limitations:
  - VLOS
  - Maximum height
  - Distance to airports
  - Airspace restrictions

SPECIFIC:

- Higher Risk
- Approval based on Operation Specific Risk Assessment
- Approval by the aeronautical authority
- Operations Manual mandatory to obtain the approval

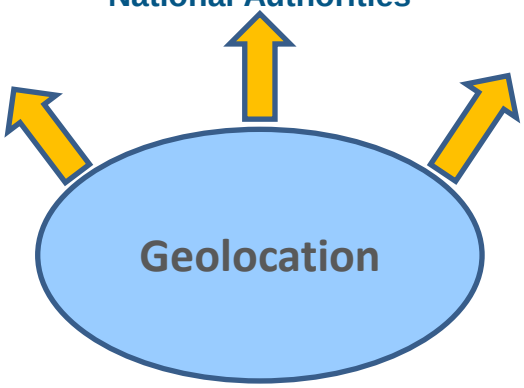
CERTIFIED:

- Regulatory regime similar to manned aviation
- Certified operations to be defined in future regulations
- Pending criteria definition, EASA accepts currently applications
- Some systems (Radio Link, Detect and Avoid,…), may receive an independent approval (eg, ETSO)

Product regulation

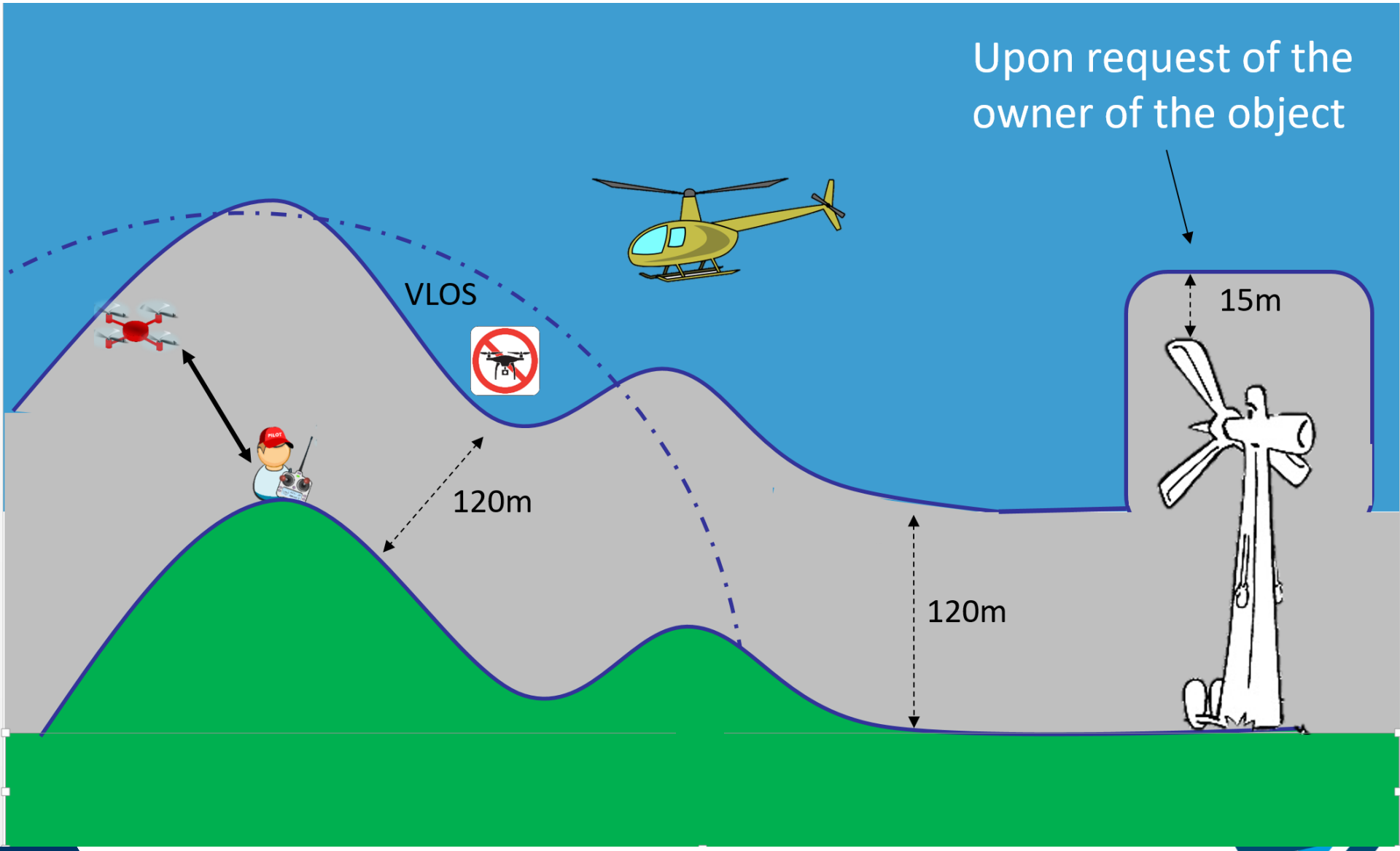
User Manual

National Authorities



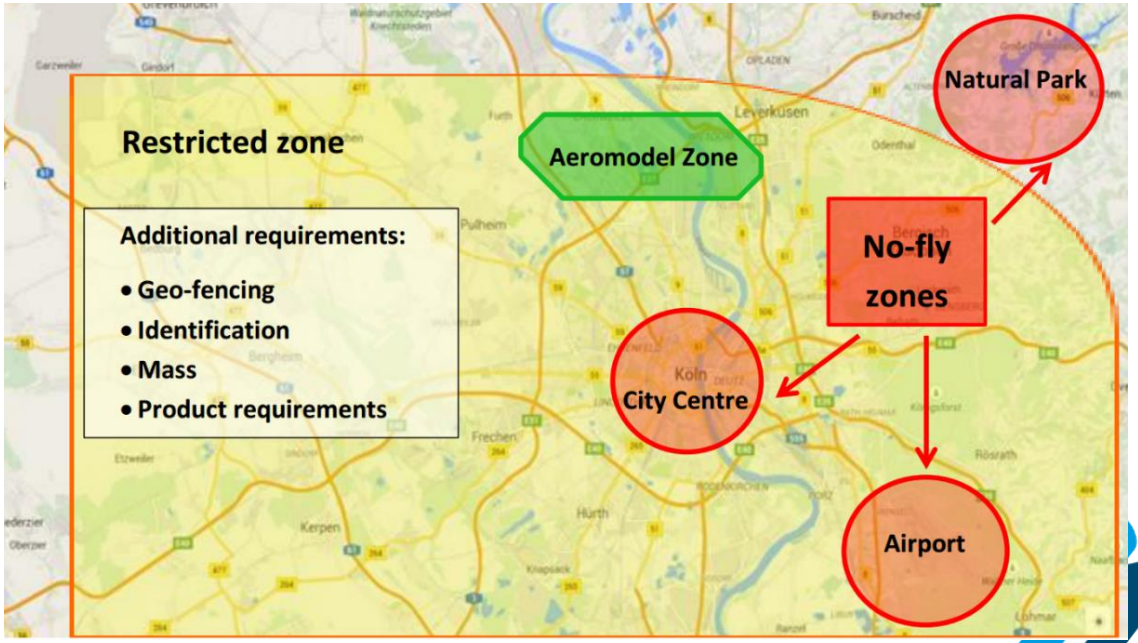
EASA European Aviation Safety Agency

Example of the importance of geolocation



UAS geographical zones

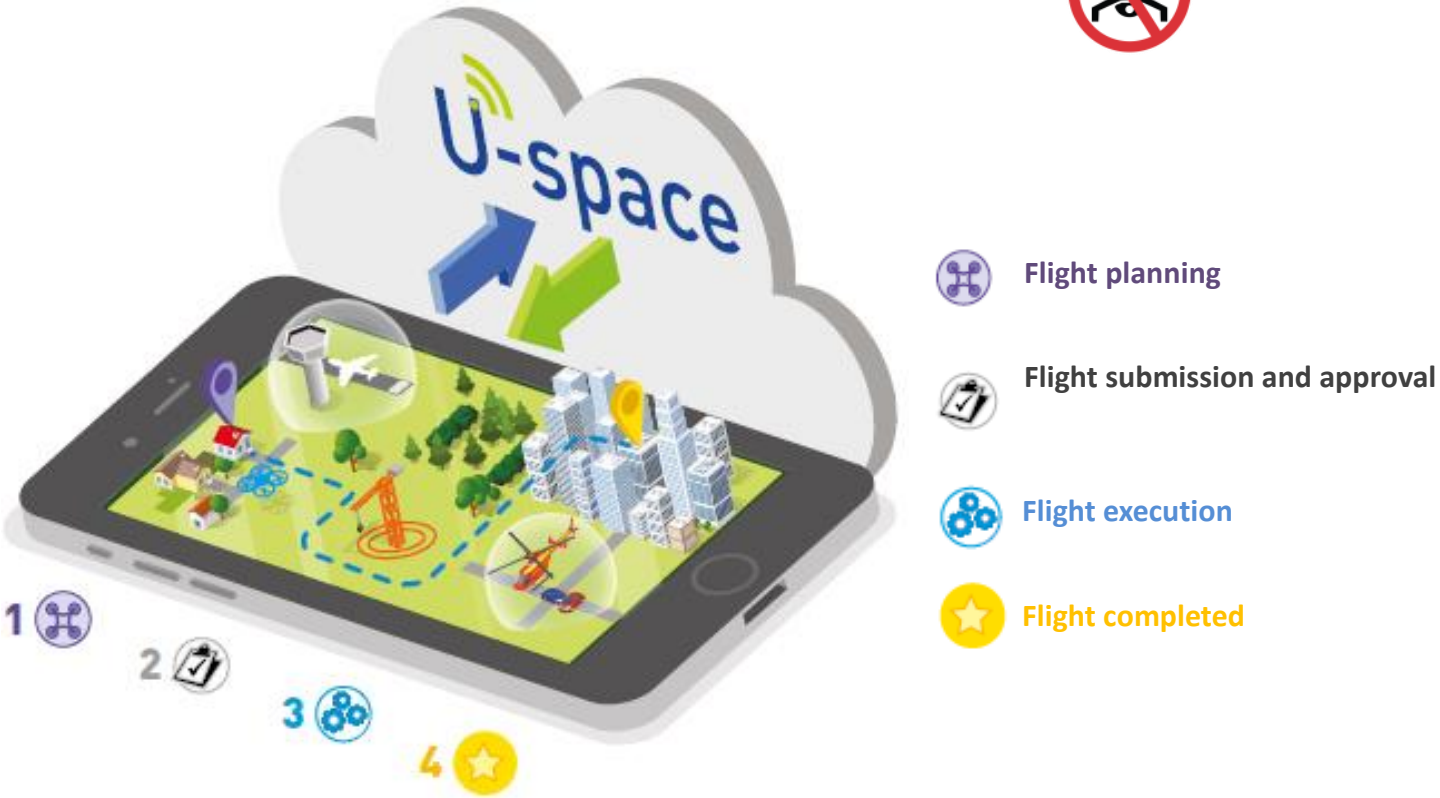
- Portion of airspace established by the competent authority that facilitates, restricts or excludes UAS operations
- In order to address risks pertaining to:
  - → Safety
  - → Protection of personal data
  - → Privacy
  - → The environment



U-Space

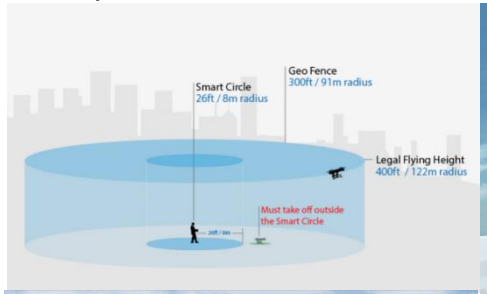
'U-space' (UE Regulation) is a set of **digitalised and automated ATM/ANS functions and services** available in a specific airspace structure to enable **safe, secure, sustainable and efficient manned and unmanned** aircraft operations.

- Set of <u>services</u> that would allow **operations with drones at a very low level** (< 120m)
- Infraestructure fully <u>automated</u> that would provide the remote pilot with:
  - All the <u>information</u> necessary to carry out the operation safely (<u>ATM</u>)
  - Ensuring that no drone accesses to a restriction zone



Geolocation/Geocaging/Geofencing/Geoawareness

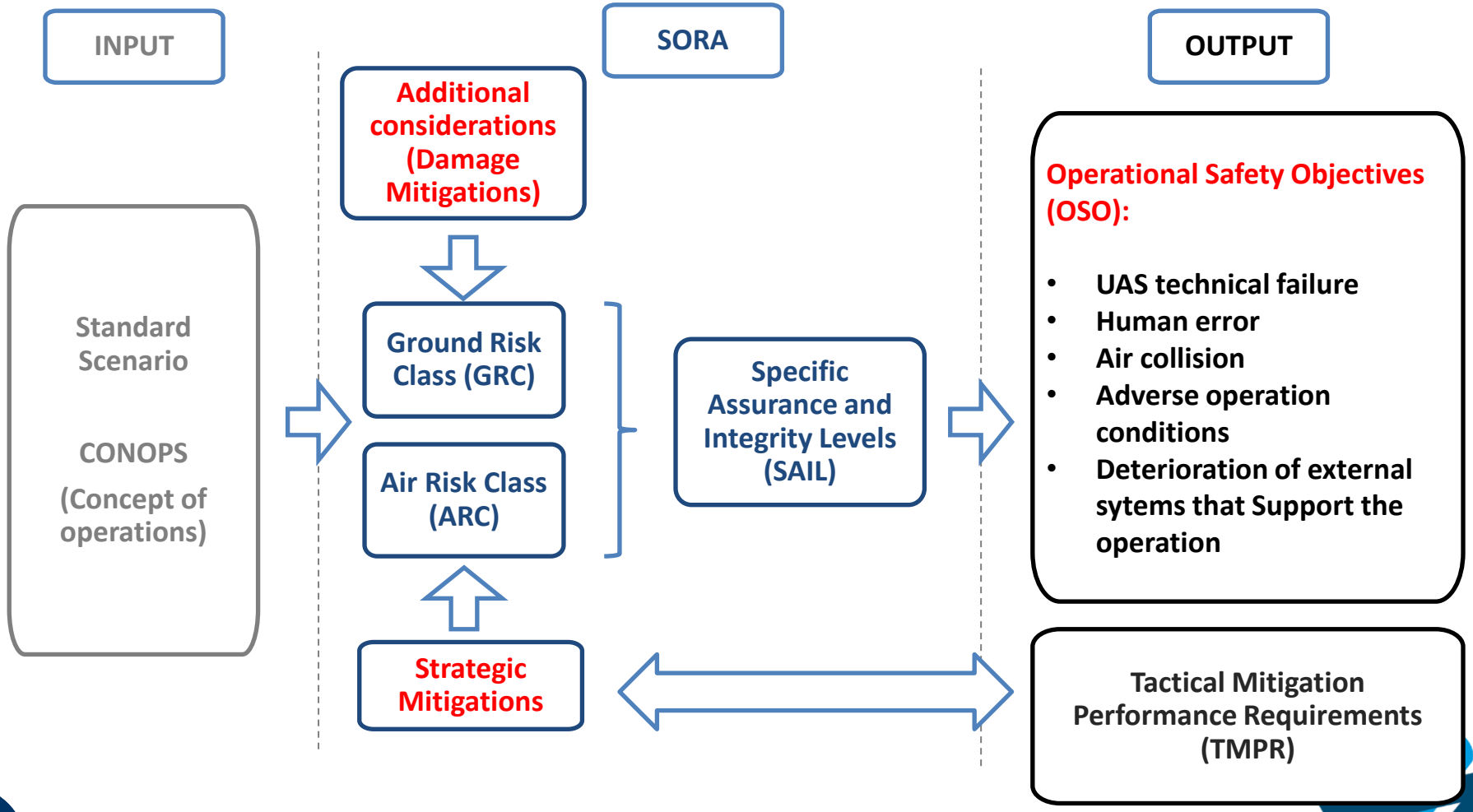
- **Geolocation** is one of the most important aspects to take into consideration on a drone operation. It allows RPAS to **know their exact position** and **perform autonomous operations** as well as providing support to the pilot during the flight.
  - Geofencing: virtual volume/boundary of airspace established by geolocation, within which the UAS **has limited the entry** by software.
  - Geocaging: virtual volume/boundary of airspace established by geolocation, of which the UAS **has prevented the exit** by software.
    - These characteristics are implemented in some comercial UAS.
    - It can be performed manually, although the objetive is to do it automatically and dynamically, depending on temporary limitations or local events**.**
- **Geoawareness** means a function that, based on the data provided by Member States, **detects a potential breach of airspace limitations** and alerts the remote pilots so that they can take immediate and effective action to prevent that breach.




Spanish
Regulatory
Approach

What is SORA?

Specific Operations Risk Assessment developed by JARUS



- Means for the **pilot to know** the **position of the aircraft** during the flight (OSO#13 External services supporting UAS operations are adequate to the operation)

- **Equipments** which guarantee that the aircraft operates within the **planned limitations**, including the airspace volumen in which it is intended that the flight is confined. (M#3, Step#6)

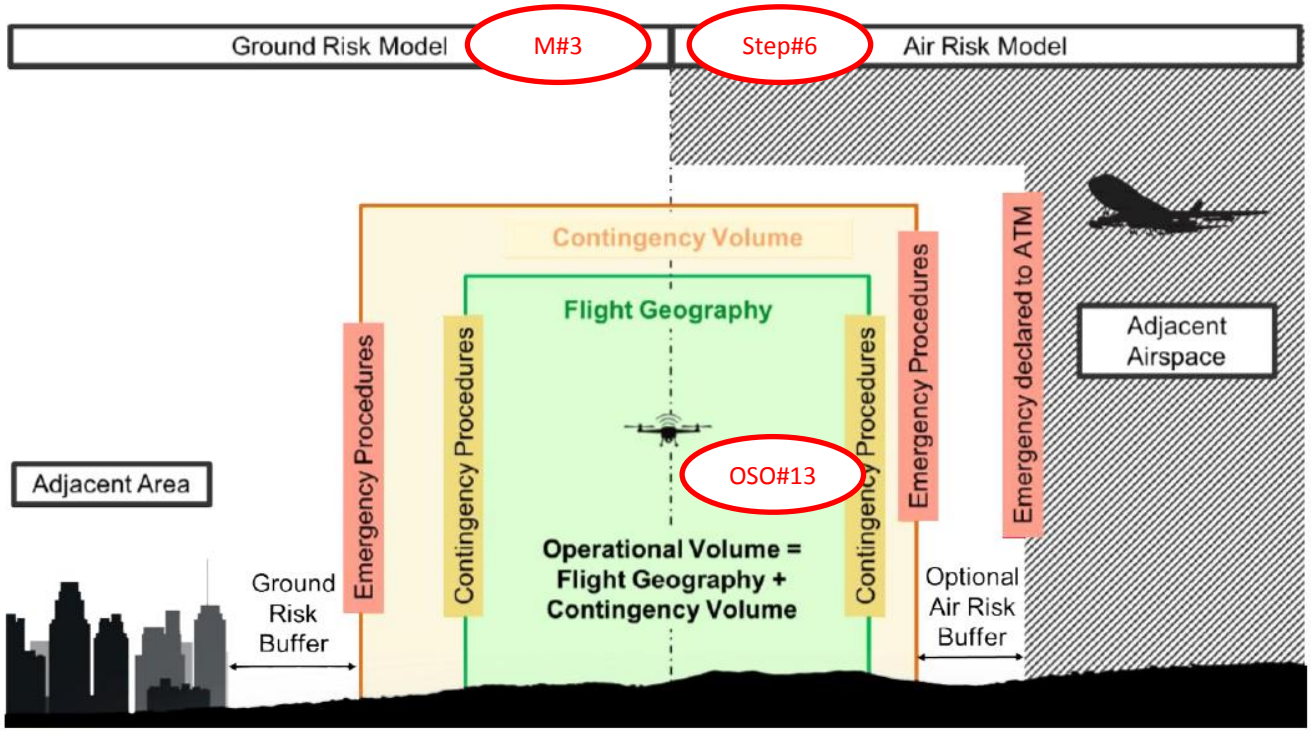


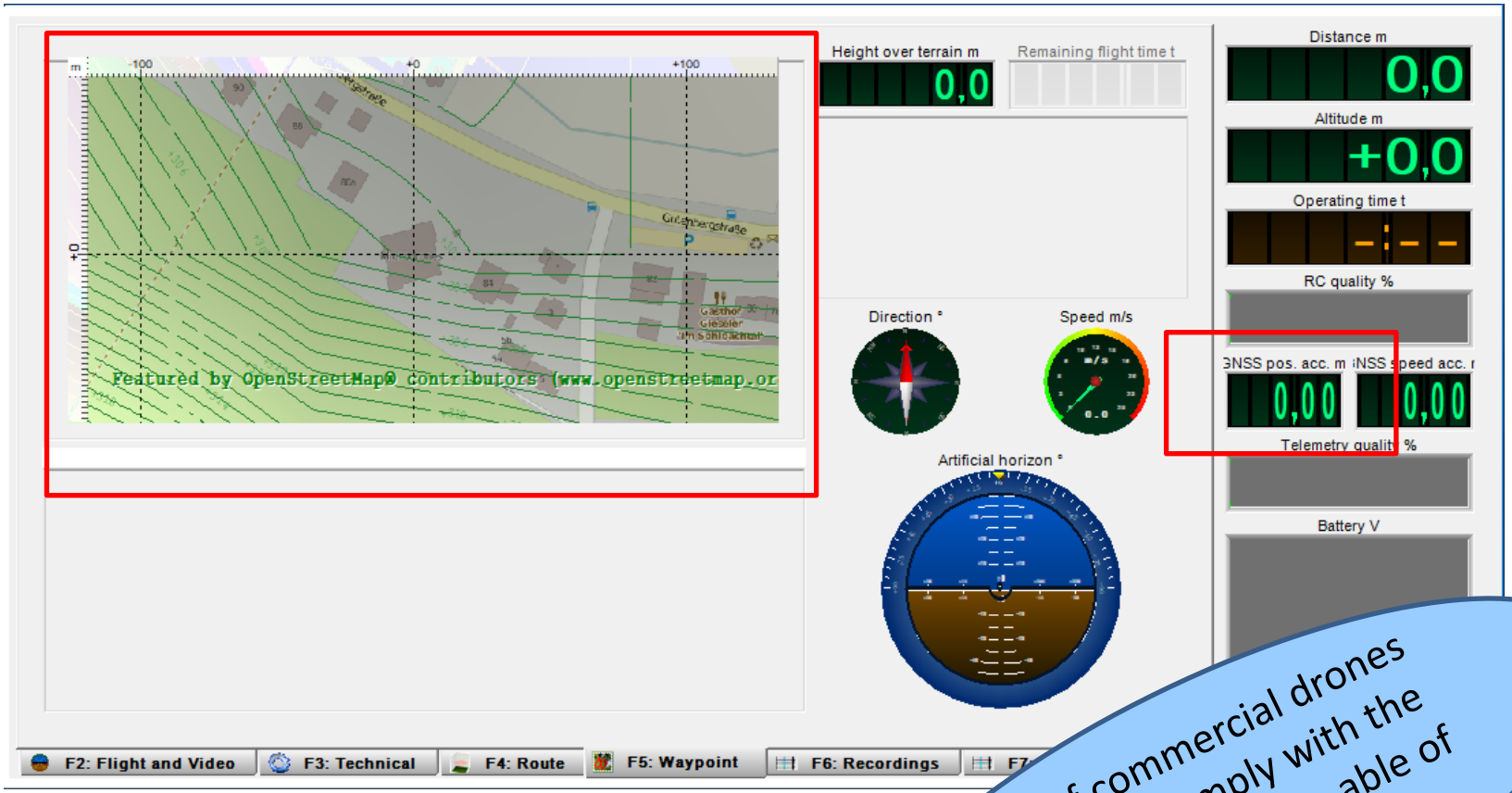
Figure 2 – Graphical Representation of SORA Semantic Model

Low risk (Responsible declaration, SAIL I and II)		
	V L O S	**B V L O S**
Minimum requirements	Altitude measuring equipment with accuracy of 20 metres	GNSS equipment with: - GPS or, - GNSS accurate to 5 m 95% of the time
	Display of the altitude over the take-off point	Display of aircraft's position on a 2D map and altitude. The altitude reference will depend on whether or not it is a VLL flight (see below).
	Display delay of less than 2 seconds	Display delay of less than 2 seconds
		Warning of availability of altitude measurement and GNSS equipment
		For VLL flights: Equipment to measure height above ground that is accurate to 20 metres. If using DEM to calculate height above ground, the cells must be accurate to 100 metres
		For non-VLL flights: barometric altitude measurement system and display of altitude in the reference system based on the intended operation

	Medium risk (SAIL III)	
	V L O S	**B V L O S**
Minimum Requirements	Equipment to measure height above ground that is accurate to 10 metres GNSS equipment with: - GPS or, - GNSS accurate to 5 m 95% of the time	GNSS equipment with: - **GPS plus EGNOS**, or - GNSS accurate to 4m 95% of the time
	Display of height above ground Display of aircraft's position on a 2D map If using DEM to calculate height above ground, the cells must be accurate to 100 metres.	Display of aircraft's position on a 2D map and altitude. The altitude reference will depend on whether or not it is a VLL flight (see below)
	Display delay of less than 1 second	Display delay of less than 0.5 seconds
	Warning, at least visual and with sound, of availability of altitude measurement and GNSS equipment	Warning, at least visual and with sound, of availability of altitude measurement and GNSS equipment
		For VLL flights: equipment to measure height above ground that is accurate to 10 metres, and display of height above ground. For non-VLL flights: barometric altitude measurement system and display of altitude in the reference system based on the intended operation

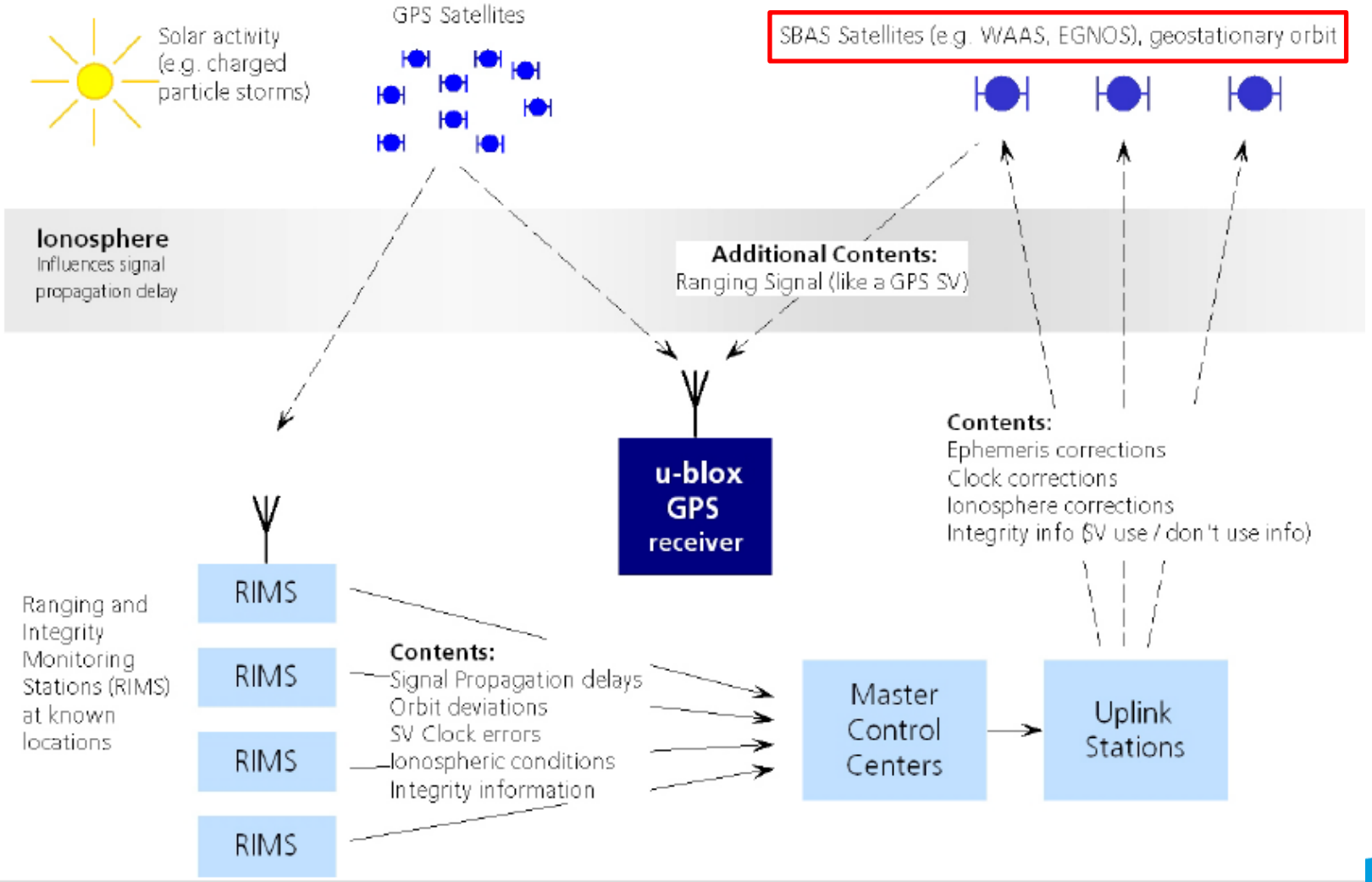
	High risk (SAIL IV, V and VI)	
	V L O S	**B V L O S**
Minimum requirements	Equipment to measure height above ground that is accurate to 5 metres GNSS equipment with: - GPS plus EGNOS, or - GNSS accurate to within 4m 95% of the time	GNSS augmented with INS with: - **GPS plus EGNOS**, or - GNSS accurate to 4m 95% of the time
	Display of height above ground Display of aircraft's position on a 2D map If using DEM to calculate the height above ground, the cells must be accurate to 100 metres.	Display of aircraft's position on a 2D map and altitude in compliance with ISO standard 9241-303 on HMI. The altitude reference will depend on whether or not it is a VLL flight (see below)
	Display delay of less than 0.5 seconds	Display delay of less than 0.25 seconds
	Warning, at least visual and with sound, of availability of altitude measurement and GNSS equipment and in compliance with ISO standard 9241-303 on HMI.	Warning, at least visual and with sound, of availability of altitude measurement and GNSS equipment and in compliance with ISO standard 9241-303 on HMI.
		For VLL flights: equipment to measure height above ground that is accurate to 5 metres, and display of height above ground in compliance with ISO standard 9241-303 on HMI. For non-VLL flights: barometric altitude measurement system and display of altitude in the reference system based on the intended operation in compliance with ISO standard 9241-303 on HMI.

Example of a control station



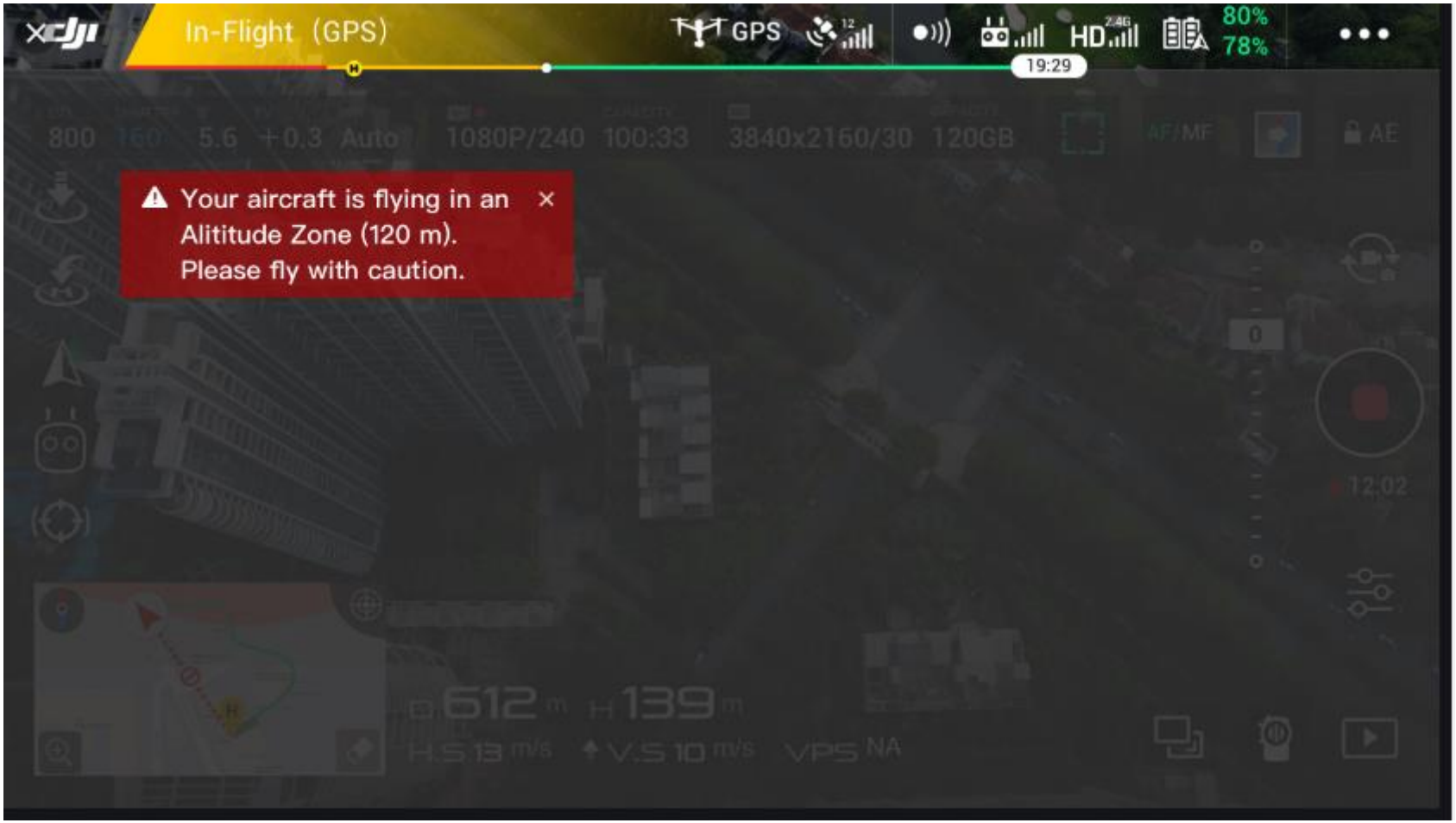
Part of commercial drones ALREADY comply with the requirements to be able of using EGNOS

Example of GPS able to use EGNOS

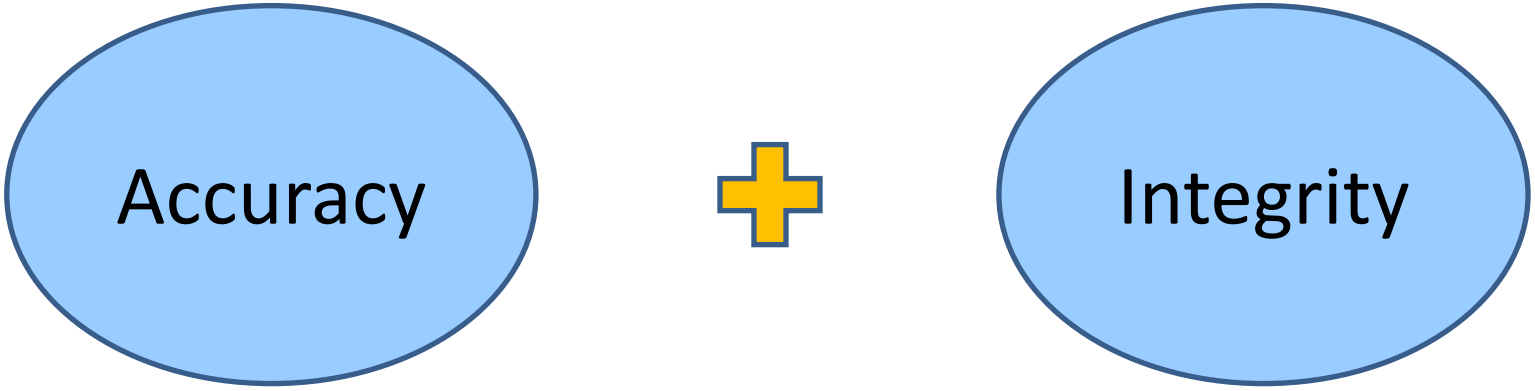


	In all cases. Minimum Requirements (Responsible statement)	Containment Robustness Level: Low Responsible statement)	Containment Robustness Level: High (Present evidences)
Minimum requirements	Minimum requirements "*Means for **the pilot to know the position of the aircraft** during the flight*" depending on the type of operation	Minimum requirements "*Means **for the pilot to know the position of the aircraft** during the flight*" depending on the type of operation	Minimum requirements "***Means for the pilot to know the position of the aircraft** during the flight*" depending on the type of operation
	Warning in case the RPA leaves the planned limitations	Warning, at least **visual and sound**, in case the RPA leaves the planned limitations	Warning, at least visual and sound, in case the RPA leaves the planned limitations and in compliance with ISO standard 9241-303 on HMI
		Activate the approval procedure or the Geoawareness system, in case the RPA leaves the planned limitations	The **Geoawareness system activates the pre-programming maneuvering** in case the UAS gets out of the planned limitations
			Procedures are required to ensure the **software quality**, to be defined by AESA
		A simple failure is not allowed to cause the failure of the Geowareness system	A simple failure is not allowed to cause the failure of the Geowareness system

Example of a visual warning in the control station



EGNOS benefits



- EGNOS improves the accuracy of the position, ensuring more accurate navigation capabilities.

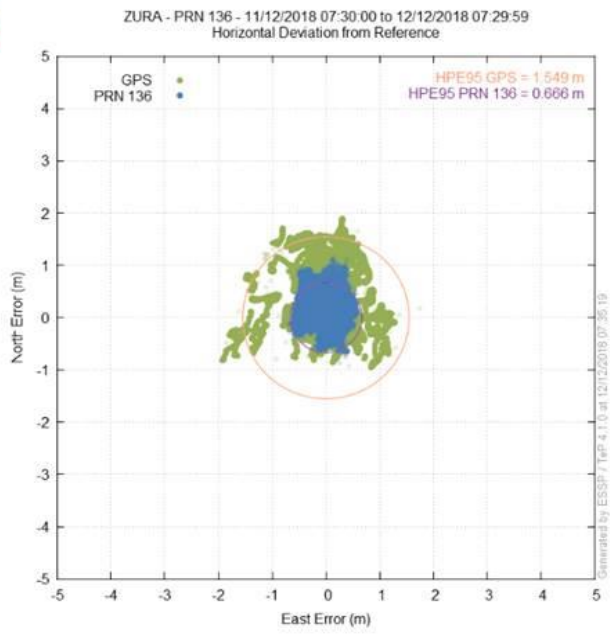
Due to expected high number of drones, relatively small size, and most operations in VLL, having an **accurate navigation** solution is a key requirement for **safe navigation**.

- Moreover EGNOS corrections **could be tailored** in a way **to support robust navigation** of drones and **adapt integrity concept and protection levels to the need of drones**, as it is done in manned aviation.

- EGNOS broadcasts **corrections to GPS satellite clock** and ephemeris data, as well as corrections for the ionospheric delay experienced by a single frequency user.

Horizontal deviation from the reference:

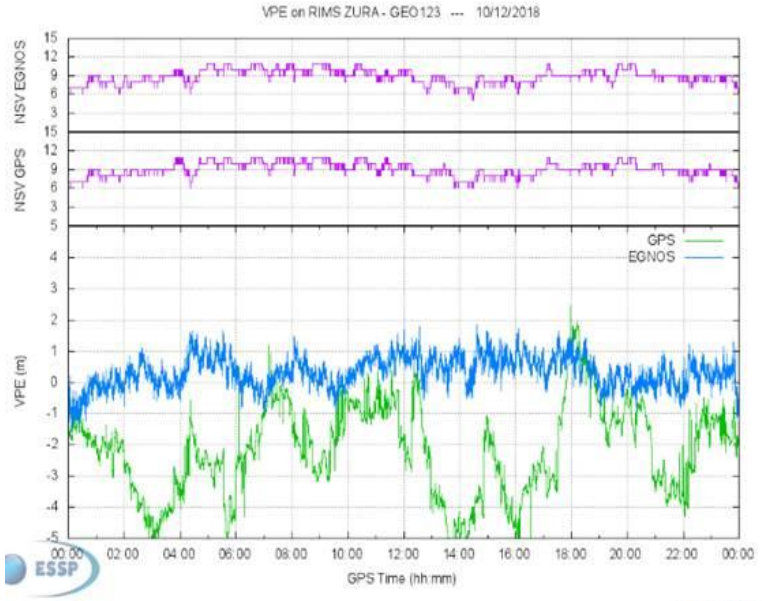
- GPS only. The error grows to 1.55 m
- + EGNOS. The error is 0.66 m



Horizontal Deviation from reference station (RIMS in Zurich), 11th of Dec 2018 with usage of GPS only and GPS+EGNOS

Vertical error measured:

- GPS only. The error is above 5 m,
- + EGNOS. The error stays below 2 meters and in majority of the time is less than 1 m.

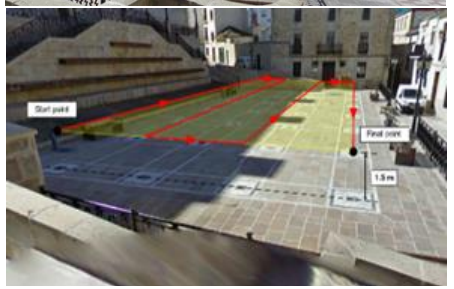


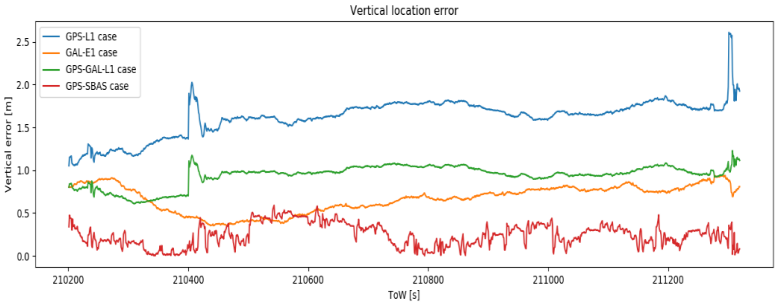
PRN 123

Temporal Comparison of position's vertical error determined with GPS only and GPS+EGNOS (RIMS ZUR, 10th December)

EGNSS4RPAS Project - Main outcomes

- EC launched a contract to provide **support to the standardization actions** for EGNOS & Galileo in drones/RPAS/UAS.
- The **added value of using EGNSS** (Galileo & EGNOS) for drones operations was shown: Added value in segregated airspace (**ATLAS**) & **urban** environments (Villacarrillo, Jaén).
- **Significant improvements** identified during the trials :
  - at **Accuracy** performance level when using Galileo & EGNOS systems
  - at **Availability** level, when using Galileo on top of GPS
  - at **Integrity** performance level, thanks to the integrity provided by EGNOS, key for safety-of-life applications.
  - As a result, EGNSS can be a **key infrastructure** for the drone market in Europe and worldwide, **enabling more complex operations** like Urban Air Mobility or integration in ATM environment, and thus unlocking a panoply of new drone





EGNOS

GALILEO

Significant Improvements identified during Trials:

- **Accuracy**
- **Availability**
- **Integrity**


Thank you
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