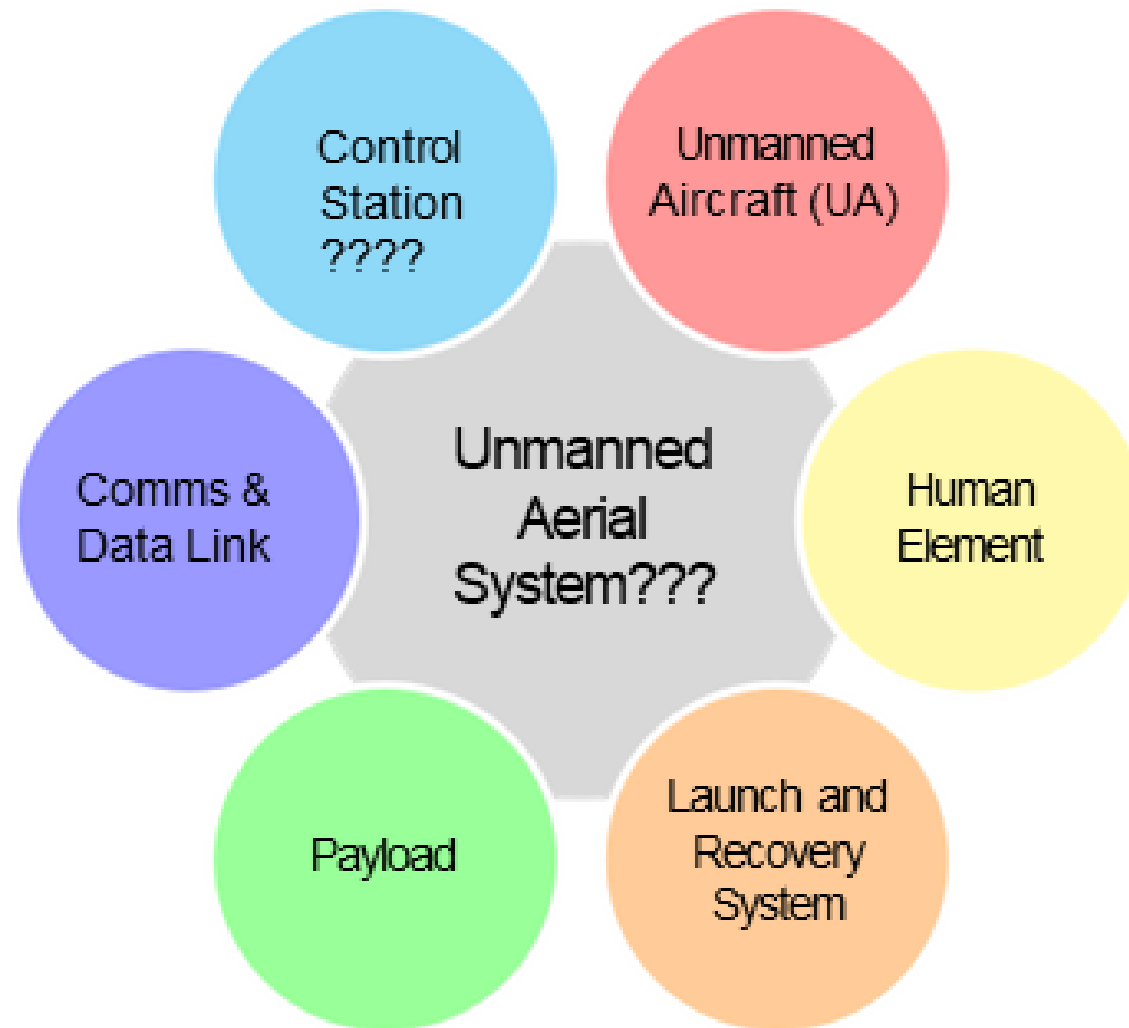


# **GCS**

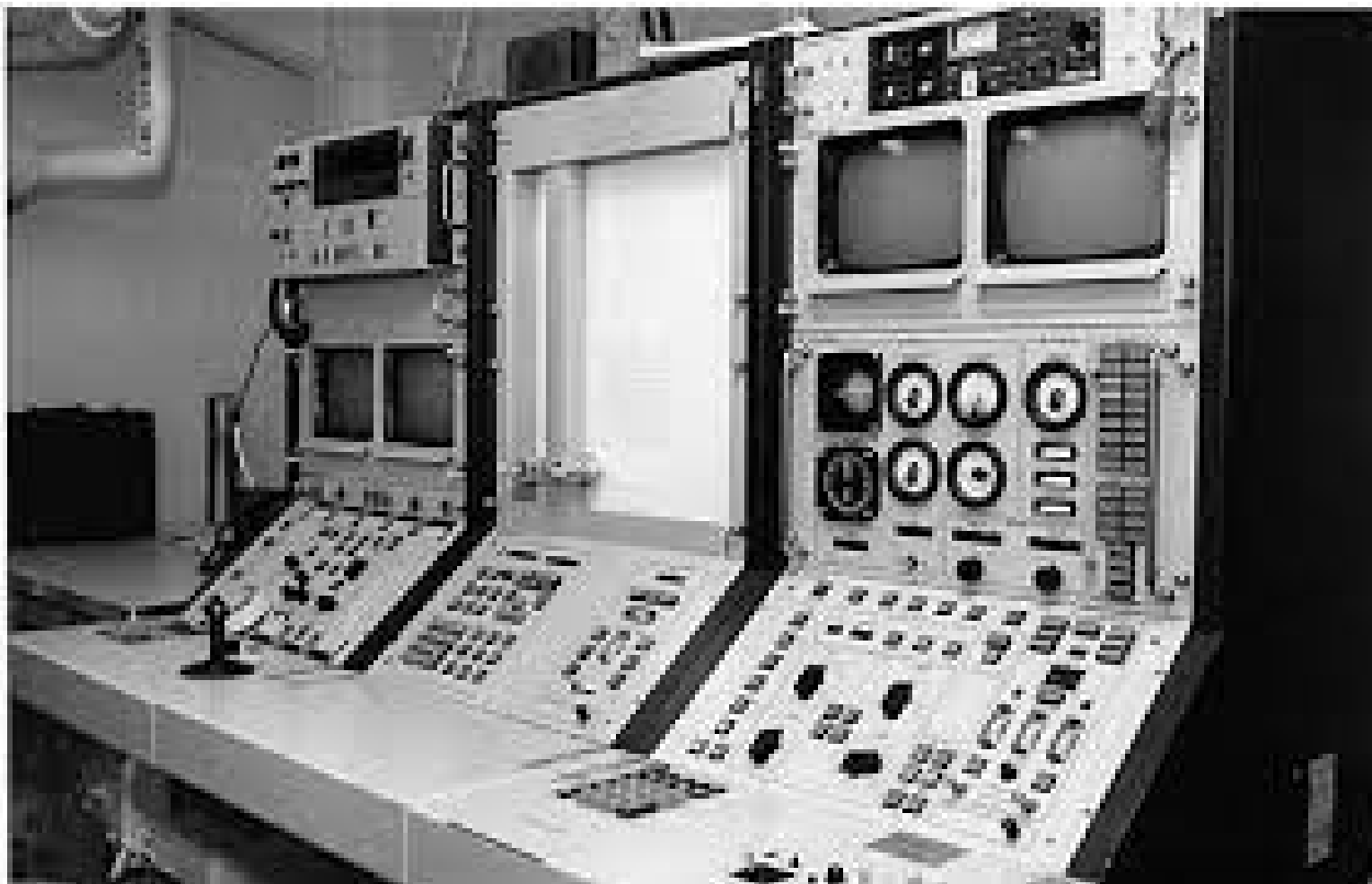
## ***Robótica Aérea***

Xin Chen/Manuel Barriopedro

# Elements of UAS



# Ground Segment - Evolution



Pioneer GCS, 1985

Source: <https://www.globalsecurity.org/intell/systems/pioneer-pics.htm>

# Ground Segment - Evolution



MQ9 Reaper - Source: [www.shefalitayal.com](http://www.shefalitayal.com)

# Ground Segment - Evolution



**Drone Ground Control Stations (GCS)  
& Portable GCS for UAV, Drones & UGV**



# Ground Segment - Evolution



General Atomics GCS - Source: <https://www.ga-asi.com/ground-control-stations/>

# Ground Segment - Evolution



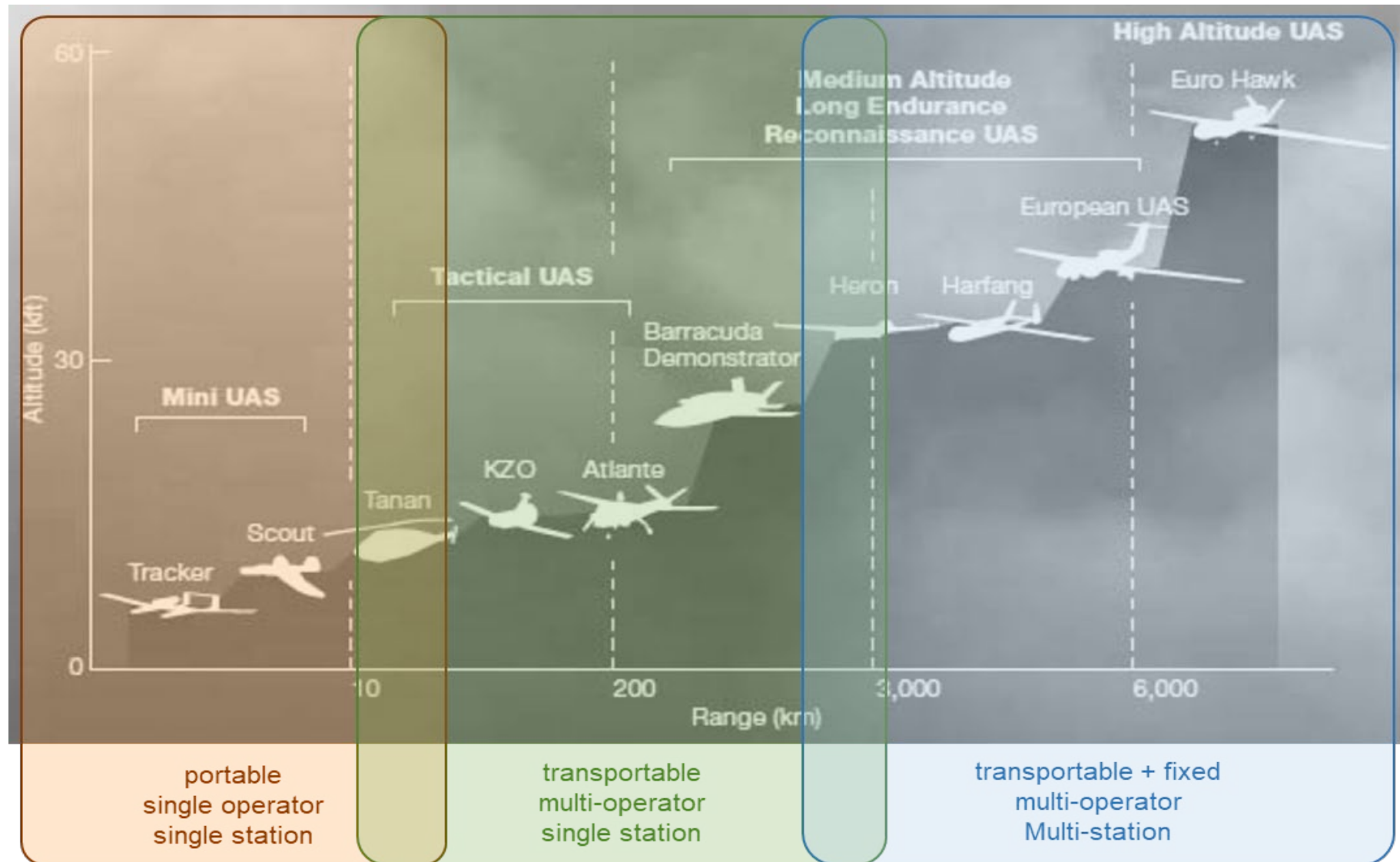
General Atomics GCS - Source: <https://www.ga-asi.com/ground-control-stations/>

# Ground Segment - Classification

- Fixed/Portable
- Single Operator/Multiple Operator
- Single GCS(Multiple GCS)



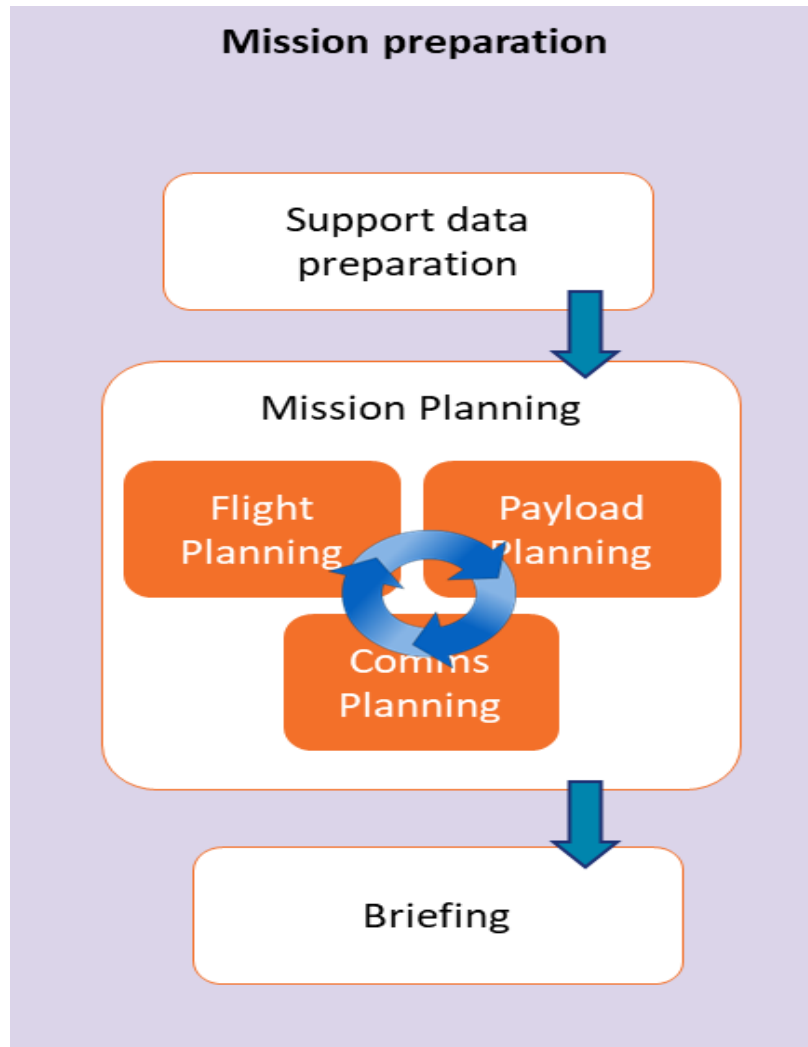
# Ground Segment - Classification



# Ground Segment - Functions

- Mission Preparation
- Mission Execution
- Offline

# Ground Segment – Mission Preparation



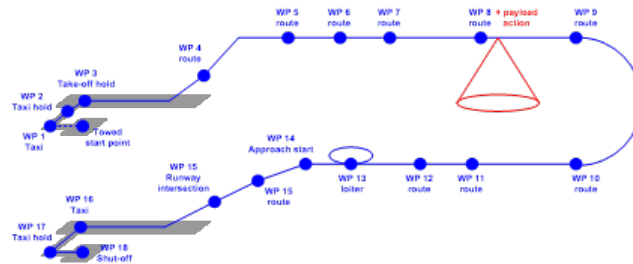
# Ground Segment – Mission Preparation

➤ Mission Preparation is performed taking into account different aspects:

1. With support data as any othe aircraft:

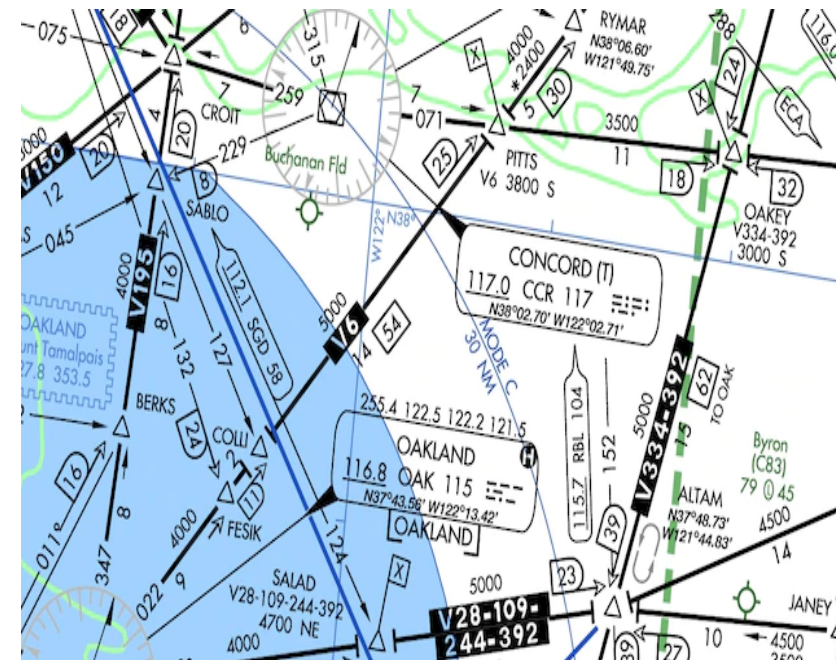
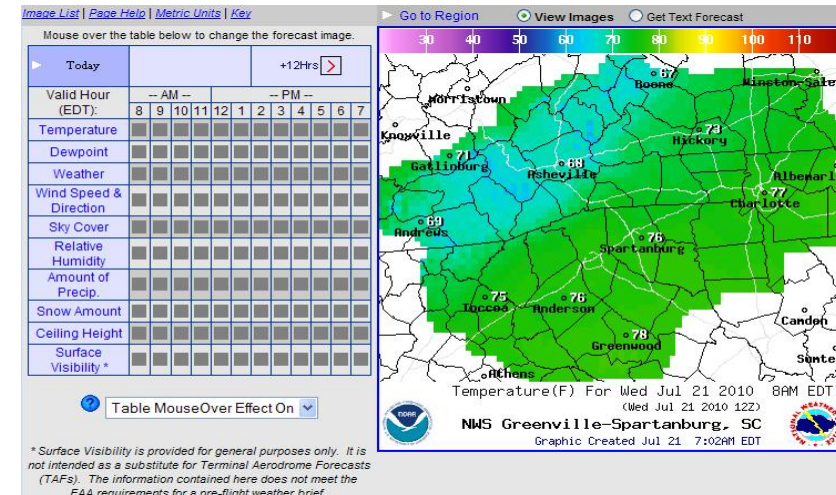
- Cartography
- Meteo
- Traffic information
- Intelligence inforamtion
- Aircraft Configuration
- ...

2. With Flight plan info

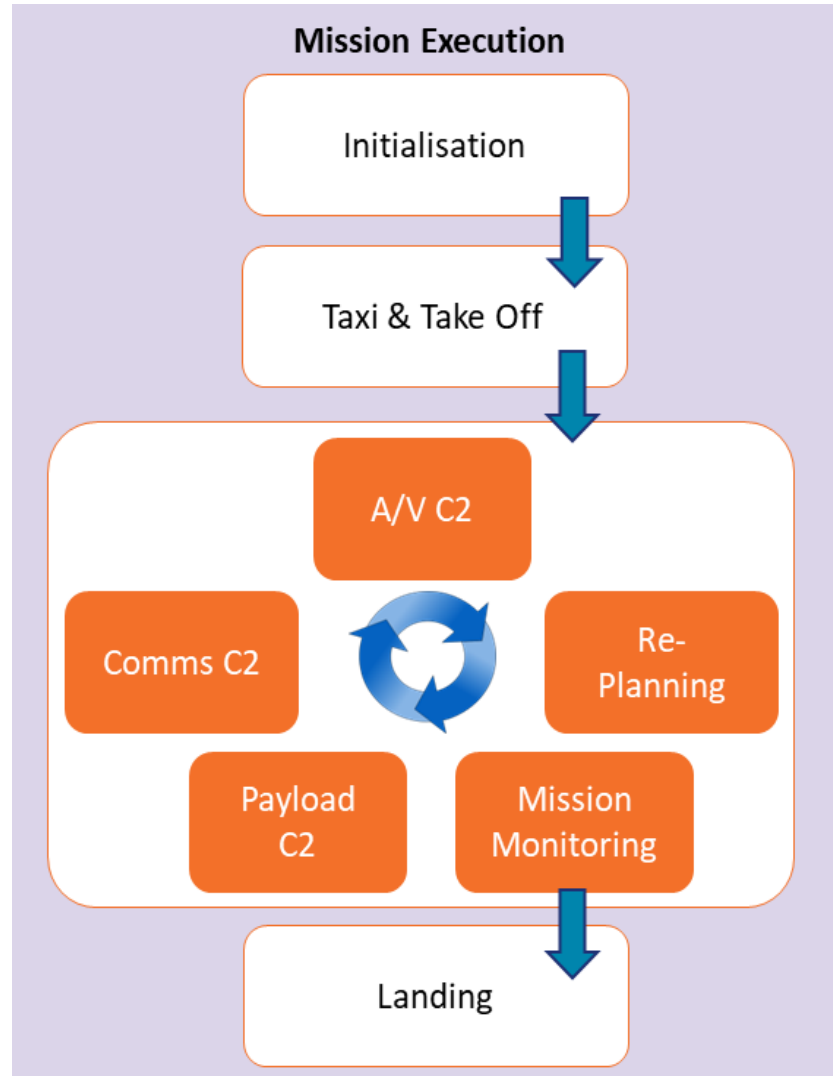


3. With specific required UAS info

- Coverage for Data Links
- ...



# Ground Segment – Mission Execution





# Ground Segment – Mission Execution

- Data prepared during Mission Preparation must be loaded in the System once System is powered on:



Figure: ATLANTE Data Loading  
([Source,](#) → Airbus)

- The the aircrat is ready to take off
  1. After a taxi (automatic or manual)
  2. Using launch equipments (if no runway or take off capability)



Figure: The Rheinmetall KZO UAV  
is launched with a booster rocket  
directly out of its container and  
landed with a parachute ([Source,](#)  
→ Gettyimages)

# Ground Segment – Mission Execution

- It is the moment of continuing the flight. Two main modes:
  1. Automatic: The Air Vehicle is controlling its flight parameters based on the mission plan
  2. Semi-Automatic: “External” commands are sent to the Air Vehicle
    - By the Operator: “Cockpit On Ground”



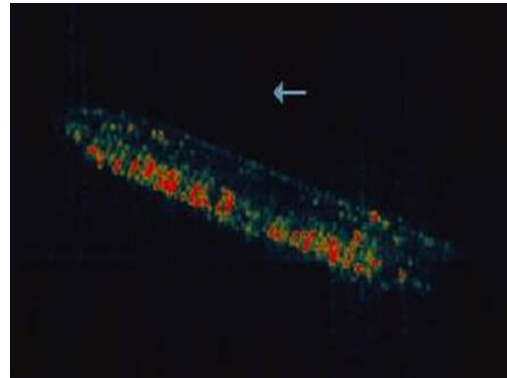
- By the Mission System (see next slide)

# Ground Segment – Mission Execution

➤ UAS is operating to perform a mission, for which Payload is installed...

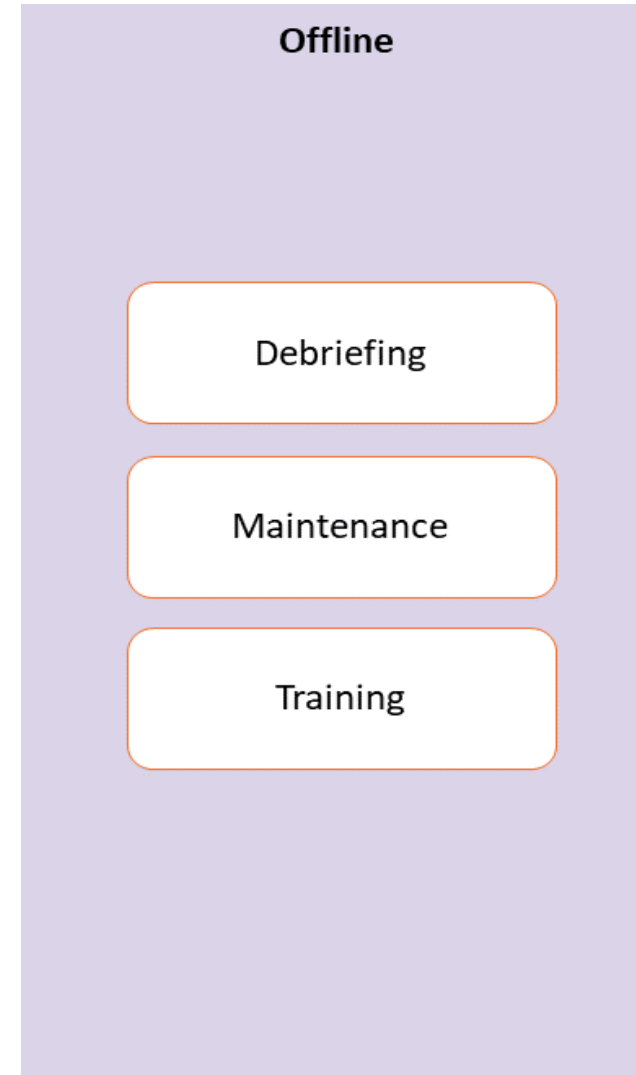
1. RADAR
2. EO/IR Camera
3. COMMunications INTelligence
4. SIGnal INTelligence
5. Antipollution System
6. Acoustic System
7. Automatic and Identification System
8. Weapons...

.....and that is why the Mission System can also “command” the Air Vehicle



# Ground Segment – Offline Functions

- Debriefing: Flight is analyzed
- Maintenance: SW and HW updates
- Training: Pilots and Operator training. Simulation?



# Ground Segment – Operator Roles

- After analyzing the different possibilities of the GCS, it is easy to conclude that different roles can be managed when operating an UAS
  - Flight Operator
  - Mission Commander
  - Payload Operator
- Intelligence Analyst
- Maintenance Operator
- Training Instructor



# Ground Segment – Designing

➤ As always when talking about designing, we need to think about REQUIREMENTS:

1. Functional
2. Operational
3. Certification & Safety: DO-178C (DAL...): Cost & Time
4. Human Factors
  - Workload acceptable (Automation?)
  - Ergonomics
5. Electromagnetic Compatibility and Interference
6. Environmental
7. Electrical
8. Transportability
9. CIBERSECURITY



# Ground Segment – Future

## ➤ Autonomy

- Current situation:
  - Regulation requires one RP for each single RPA.
  - Low level of autonomy and high workload for the RP
- Future situation:
  - More autonomy for both Ground and Air Segment
  - Possibility of controlling several UAVs from a single GCS

## ➤ HMI

- To be able to incorporate technological developments:
  - AI
  - Virtual Reality
  - Speech Recognition
  - Gesture recognition
  - Low level of autonomy and high workload for the RP

## ➤ Portability and operability

- Connected always, from everywhere and in a safety way (from my smartphone?)

# Ground Segment – Future: U - Space

- Unmanned aircraft system traffic management (UTM) is an air traffic management ecosystem under development for autonomously controlled operations of unmanned aerial systems (UAS) by the FAA, NASA, other federal partner agencies, and industry.
- They are collaboratively exploring concepts of operation, data exchange requirements, and a supporting framework to enable multiple UAS operations beyond visual line-of-sight at altitudes under 400 ft above ground level in airspace where FAA air traffic services are not provided.
- UTM is separate from but complementary to the FAA's Air Traffic Management (ATM) system. UTM development will ultimately identify services, roles/responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements for enabling the management of low-altitude uncontrolled UAS operations.
- European Union has developed a vision called U-Space: phased introduction of procedures and services to support safe, efficient and secure access to airspace for large numbers of drones
- These services and procedures rely on a high level of digitalisation and automation of functions, whether they are on board the drone itself, or are part of the ground-based environment.

# Acrónimos

<b>BLOS</b>	Beyond Line Of Sight
<b>GCS</b>	Ground Control Station/System
<b>GNC</b>	Guidance, Navigation, and Control
<b>HALE</b>	High-Altitude, Long-Endurance
<b>HTOL</b>	Horizontal Take-Off and Landing
<b>ISR</b>	Intelligence, Surveillance, and Reconnaissance
<b>LoA</b>	Level of Autonomy
<b>LOS</b>	Line Of Sight
<b>MALE</b>	Medium-Altitude, Long-Endurance
<b>MAV</b>	Micro Air Vehicle
<b>MEMS</b>	MicroElectroMechanicalSystems
<b>MUT</b>	Manned/Unmanned Team
<b>RF</b>	Radio Frequency
<b>RPAS</b>	Remotely Piloted Aerial Systems
<b>UAS/UAV</b>	Unmanned Aerial System/Vehicle
<b>VTOL</b>	Vertical Take-Off and Landing

