# Airbus Defence and Space
# LEO Platforms compliance to SDM
## Clean Space Industrial Days

DEFENCE AND SPACE

Daniel BRIOT/Saturnino VAL SERRA

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# Agenda

- Introduction
- Driving Space Debris Mitigation Requirements
- End of life strategies for LEO platforms
- Identified technologies to comply with SDM requirements
- Priority technologies for Airbus
- Next steps

# Introduction

- Airbus Defence and Space involved in CleanSat initiative since beginning 2015

- Current presentation is the outcome of CleanSat on-going study:
  « *Activities to support the development of LEO platforms compliant with Space Debris Mitigation requirements* »

# Driving Space Debris Mitigation Requirements

- **Casualty risk**
  - Upon re-entry (controlled or uncontrolled), the risk of causing a casualty on ground shall not exceed $10^{-4}$
- **Re-entry in less than 25 years**
  - Satellites shall limit their presence in the LEO protected region to 25 years from the end of the mission.
- **Passivation of energy sources**
  - At the end of mission, a spacecraft or launch vehicle orbital stage shall permanently deplete or make safe all remaining on-board sources of stored energy in a controlled sequence
- **Probability of realisation of the disposal manoeuvres**
  - The probability of successful disposal of a spacecraft or launch vehicle orbital stage shall be at least 0.85/0.90 at the time the disposal manoeuvres are executed (this absolute probability includes de-orbiting and passivation operations).
- **Other topics**
  - Debris release: Spacecraft and launch vehicle orbital stages shall be designed so as not to release space debris into Earth orbit during nominal operations.
  - Accidental break-up: the probability of accidental break-up of a spacecraft or launch vehicle orbital stage shall be no greater than $10^{-3}$ until its end of life.



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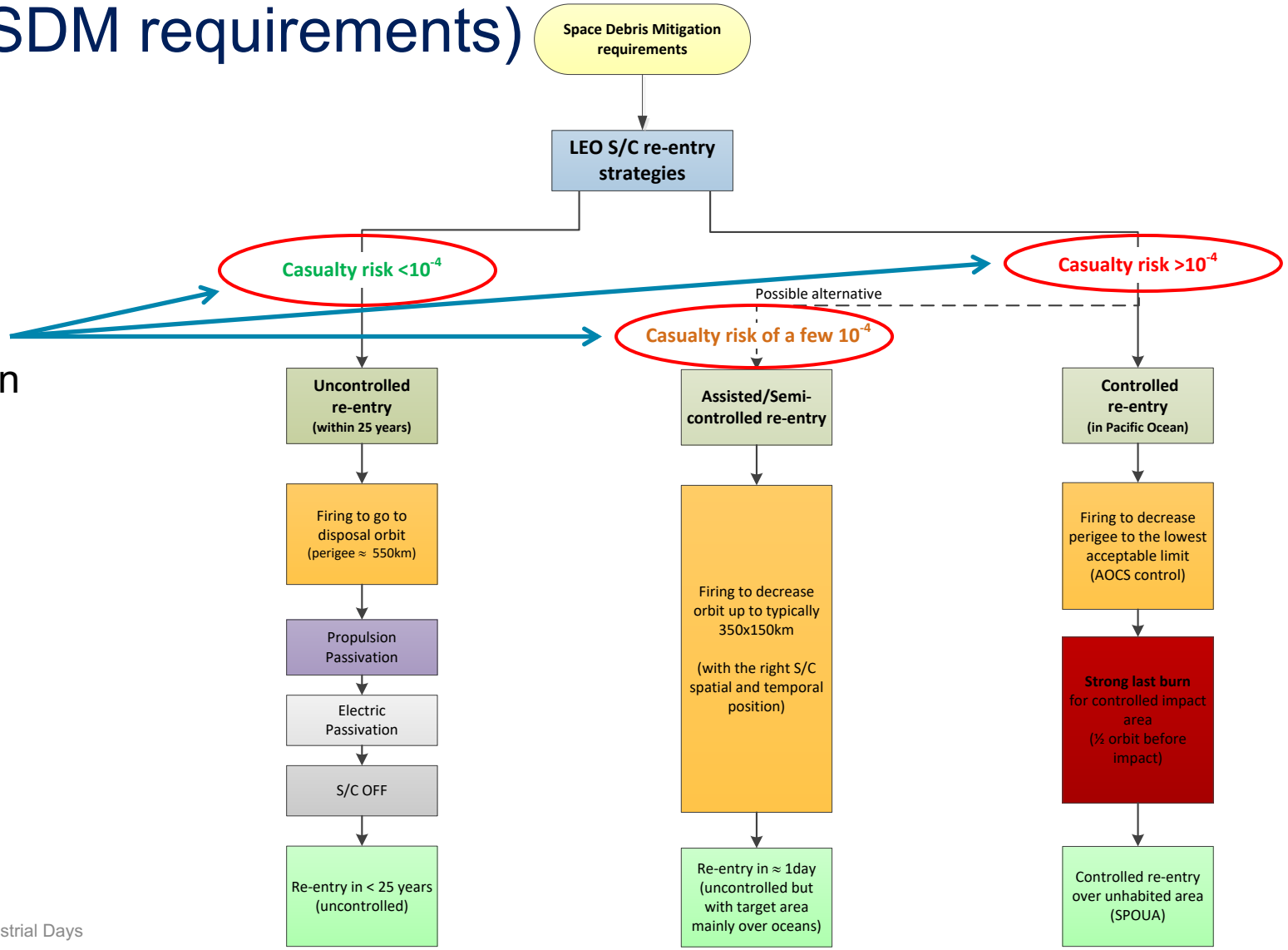
# End of life strategies for LEO platforms (to comply with SDM requirements)

Key requirement for EOL strategy selection



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# Identified technologies to comply with SDM requirements (1/5)

- Five topics have been identified:
  - ➢Technologies relative to design for demise
  - ➢Technologies supporting de-orbiting operations
  - ➢Technologies to comply with the electrical passivation constraint
  - ➢Technologies to comply with the fluidic passivation constraint
  - ➢Technologies to ensure end-of-life reliability

# Identified technologies to comply with SDM requirements (2/5)

- Technologies relative to design for demise

At unit level

- Demisable propellant tanks
- Demisable COPV (Composite Overwrapped Pressure Vessel) tanks
- Demisable reaction wheels
- Demisable magnetorquers
- Demisable Solar Array Drive Mechanism

At satellite level

- Accommodation of critical units
- Platform opening or early breakup

# Identified technologies to comply with SDM requirements (3/5)

- Technologies supporting de-orbiting operations

  - Repressurisation module
  - Pressure regulator
  - De-orbit engine
  - HET (Hall-Effect Thruster) deorbit system
  - Arcjet deorbit system

# Identified technologies to comply with SDM requirements (4/5)

- Technologies to comply with the electrical passivation constraint

  - Power Conditioning and Distribution Unit
  - Battery bypass

- Technologies to comply with the fluidic passivation constraint

  - Shape Memory Alloy valve
  - Micro-perforator
  - Pyro-valve

# Identified technologies to comply with SDM requirements (5/5)

- Technologies to ensure end-of-life reliability

  - Satellite architecture
  - Components selection
  - Software architecture/FDIR
  - Reliability calculation methodology

# Priority technologies for Airbus (1/4)

- Update of the priorities identified during the previous CleanSat phase (Concurrent Engineering phase) which was completed beginning 2017

- Drivers to determine priority technologies:
  - Availability of the needed technologies
  - Amount of concerned platforms
  - Amount of concerned missions

# Priority technologies for Airbus (2/4)

- Update w.r.t. CleanSat Concurrent Engineering phase:

| Building block | Priority |
|---|---|
| Demisable aluminium tanks | High |
| Fluidic passivation device | High |
| Repressurisation module | Medium |
| Demisable wheels | Medium |
| Demisable Aluminium lined COPV | Medium |
| Demisable MTQ | Medium |
| Arcjets (400-500W) | Medium (Long Term) |
| HET thruster 500W | Medium (Long Term) |
| Early break-up mechanisms | Medium (Very Long Term) |

Note: demisability of payload not addressed here but of prime importance !

# Priority technologies for Airbus (3/4)

- **Demisable propellant tank**
  - Tanks are a systematic PF contributor to the casualty risk area
  - Interesting for existing and future platforms using uncontrolled re-entry
- **Fluidic passivation devices**
  - Interesting for all missions involving an uncontrolled re-entry.
- **Repressurisation module**
  - Needed for large platforms requiring a controlled re-entry.
- **Demisable reaction wheels**
  - Interesting for platforms using large wheels and performing an uncontrolled re-entry.
- **Demisable COPV tanks**
  - Interesting for platforms based on electric propulsion for which an uncontrolled re-entry or semi-controlled re-entry are foreseen.

# Priority technologies for Airbus (4/4)

- **Demisable magnetorquers**
  - Interesting on platforms applying an uncontrolled re-entry as EOL strategy and using large magnetorquers.

- **Arcjet de-orbit engine**
  - Interesting for de-orbiting but also deploying platforms using chemical propulsion (because of the high ISP and provided that the thrust level of the thrusters is sufficient).
  - Interest of an ITAR-free solution

- **HET thruster**
  - Interesting for de-orbiting platforms using electrical propulsion (provided that the thrust level of the thrusters is sufficient).

- **Early break-up mechanisms**
  - Promising for future applications on platforms implementing uncontrolled re-entry.

# Next steps

- Start of task 2 of CleanSat study: « *Platform systems and Building Block requirements definition and refinement* »
  - ➢Objective:
    - Define and iteratively update the necessary requirements for the development of the Building Blocks (identified at the end of Task 1 and integrating funding constraints)
    - Perform analyses and simulations to be able to derive the main system and subsystem level specifications
    - Perform the flow down of requirements from platform to the building block level
    - Analyse the integration of the Building Blocks in the respective platforms (in particular assess the impacts on the avionics architecture)
    - Go through a harmonisation exercise following a concurrent engineering approach where the contractors' proposed requirements will be harmonised with the suppliers and the Agency




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