Clean Space

Presentation to UNISEC-Global

02/12/2017
Clean Space
Why EcoDesign

### WE SHOULD

Environment’s protection is a value which is being integrated in public/private life from Companies and Universities to Research Group’s level.

### WE WILL HAVE TO

The evolution of Environmental regulations is leading an increasing number of countries to demand for increasing environmental reporting.

### THERE ARE ALSO BENEFITS

Supply chain knowledge mitigates obsolescence risk and cost savings, due to a more efficient use of energy and resources.
27.3 States and international intergovernmental Organizations should promote the development of technologies that minimize the environmental impact of manufacturing, launching space assets and that maximize the use of renewable resources and the reusability or repurposing of space assets to enhance the long-term sustainability of those activities.
Life Cycle Assessment
To quantitatively assess the potential environmental impacts of a product or service

Multi-steps

Consumption of non-energy natural resources → Emissions to air
Energy consumption → Emissions to water

Utilisation → Emissions to soil → Waste

Multi-criteria

Mineral resource depletion → Global Warming
Fossil resource depletion → Air acidification

Emissions to air → Ozone Depletion
EcoDesign, where are we now?

LCA Launch Segment
LCA Space Segment
LCA Ground Segment

Additional Studies
- Materials and processes LCA
- Ozone atmospheric impact
- Space debris LCA indicator
- REACH into LCA
- Impact of demise
- Deep sea impact
- GreenSat
- Materials and processes devs

LCA Database
EcoDesign CDF Tool
ESA LCA Handbook

9 Green Technologies

9 ESA Projects

Sustainable Space Industry, Activities and projects

Already underway in Ariane 6
Space Debris Mitigation Requirements

| PASSIVATION | - At the end of life the satellite shall permanently deplete or make safe all **stored energy**. The two main causes of break-ups due to stored energy are from the **propulsion** and **power** subsystems. |
| EOL DISPOSAL MANOEUVRES | - Satellites in LEO shall limit their presence in the **protected region** (up to 2000km) to **25 years** from the end of the mission. |
| CASUALTY RISK | - Upon re-entry, the risk of causing **casualty on ground** shall not exceed $10^4$ for controlled and uncontrolled re-entry. |
| RELEASE OF PARTICLES | - Pyrotechnic devices and propulsion systems should not release **solid particles** greater than **1mm**. |

**Mission Related Objects:** Pieces of debris released as part of the normal mission operations such as lens covers, tethers, etc. shall be limited to:
- **ONE**, for the launch of a single S/C
- **TWO**, for the launch of multiple S/C

-> Space Debris Mitigation requirements comport an **evolution of the LEO platforms**.
Space Debris Mitigation (SDM) is being adopted worldwide and is currently the main driver for the evolution LEO platforms.

Need to move fast!

- All new ESA missions shall be fully compliant
- Lois d’Operation Spatiales: sunset date in 2020

A coordinated approach is the best way forward to have competitive European LEO platforms.
Where are we now?

Evolution of European LEO Platforms

2017 - 2020

Future LEO missions e.g. EOP

Space Debris Mitigation Requirements

DEORBITING

Passive deorbit systems

Active deorbit systems

Design for Demise

CASUALTY RISK

Autonomous deorbit systems

Propulsion systems

RELIABILITY

Power systems

PASSIVATION

Demisable TANK

Demisable RWs

Demisable MTQ

Electric passivation in PCDU

Fluidic Passivation Valve

Propulsion upgrade for controlled reentry

Etc. etc. …

Study and Selection of the higher level and most critical priorities

2012

Conc.Eng.
Phase

2013-2014

Evolved LEO P/F

2015

Project Phase

Currently here

2016

Prep. Phase

2020

Req.
Active Debris Removal

4000+ inactive satellites in LEO

to stabilize debris growth: remove 5 large objects per year*

* Stability of the Future LEO Environment (Int. Advisory Debris Committee -12-08, Rev. 1, January 2013)
### Mission Challenges

1. Synchronised Flight
2. Collaborative Control of Robotics/GNC
3. Uncooperative Capture
4. Safety (Comms vs. Autonomy)
5. Stack Control and Disposal

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#### Mission Timeline

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Jan 2024</strong></td>
<td><strong>Launch Vega-C</strong></td>
</tr>
<tr>
<td><strong>Feb 2024</strong></td>
<td><strong>Commissioning at 300 km Circular Orbit</strong></td>
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<tr>
<td><strong>Jan 2024</strong></td>
<td><strong>Transfer and Phasing to Target Orbit</strong></td>
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<tr>
<td><strong>Feb 2024</strong></td>
<td><strong>Rendezvous and Target Inspection</strong></td>
</tr>
<tr>
<td><strong>Mar 2024</strong></td>
<td><strong>Synchronisation &amp; Target Capture</strong></td>
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<tr>
<td><strong>Mar 2024</strong></td>
<td><strong>Stabilisation</strong></td>
</tr>
<tr>
<td><strong>Apr 2024</strong></td>
<td><strong>Disposal</strong></td>
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#### Mission Phase Status

<table>
<thead>
<tr>
<th>Phase</th>
<th>Status</th>
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<tbody>
<tr>
<td>Phase 0</td>
<td>completed</td>
</tr>
<tr>
<td>Phase A</td>
<td>completed</td>
</tr>
<tr>
<td>Phase B1</td>
<td>completed</td>
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<tr>
<td>Consolidation Phase</td>
<td>Kick-off in October</td>
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<tr>
<td>Phase B2</td>
<td>planned at the beginning of 2018</td>
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<tr>
<td>Phase C/D</td>
<td>TBD</td>
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<tr>
<td>Phase E</td>
<td>TBD</td>
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What have we done so-far? System Level

9 e.Deorbit Phase A

3 consortia led by:

1. Flexible deorbit
2. Rigid deorbit
3. Reorbit

Options:

9 e.Deorbit Phase B1

Kicked-off: 2015

System Requirement Review (end of B1): 2017
From e.deorbit to Space Tug

e.Deorbit will led to development and implementation of cutting edge technologies in the following areas:

- Non-cooperative **rendezvous** and **formation flight**

- **Capture** and **control** of large non-cooperative objects

- Adaptive **guidance, navigation and control (GNC)**

  **What is it?**

  **Upper stages** of Space Rockets or dedicated **satellites** will be implemented to absolve this purposes

  **Utilisation:**

  - In-orbit servicing;
  - Cargo and satellites **delivery/tugging** (moving S/C from one region to another such as from from LEO to GEO);
  - In-orbit assembly (e.g. assembly of large telescopes or attaching an antenna onto a S/C in-orbit);

  **Come backs:**

  - Creation of a huge **market**, highly sustainable by local and major **Industries** and exploitable by every **public/private** Organisation, Association and Institution.
Conclusion

9 INNOVATION
Clean Space foster technology developments through a “think different” approach.

9 COMPETITIVENESS
Giving European industry a competitive edge in green technologies, application of space debris regulations and new markets such as space tugs.

9 EUROPEAN COOPERATION
Bringing together ESA, system integrators, suppliers, universities, R&D groups and organisations to open the prospect of shared supply chains and optimized costs.
Let’s keep in touch

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Clean Space Blog

http://blogs.esa.int/cleanspace/

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