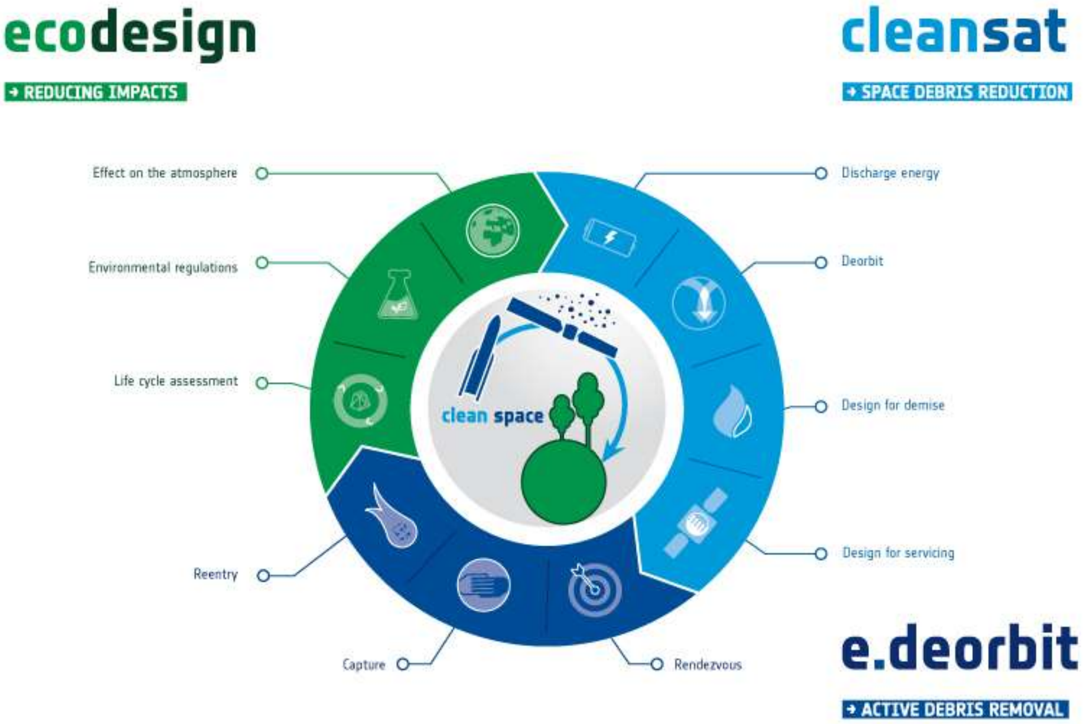
Clean Space

Presentation to UNISEC-Global

02/12/2017

Clean Space


ecodesign
→ REDUCING IMPACTS
cleansat
→ SPACE DEBRIS REDUCTION
Effect on the atmosphere
Environmental regulations
Life cycle assessment
Reentry
Capture
Rendezvous
Design for servicing
Design for demise
Deorbit
Discharge energy
clean space
e.deorbit
→ ACTIVE DEBRIS REMOVAL

Why EcoDesign

⑨ 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.

⑨ WE WILL HAVE TO

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

⑨ THERE ARE ALSO BENEFITS

Supply chain knowledge mitigates ***obsolescence*** risk and ***cost*** savings, due to a more efficient use of energy and resources.

Why EcoDesign

esa

United Nations

General Assembly

Committee on the Peaceful Uses of Outer Space
Scientific and Technical Subcommittee
Fifty-fourth session
Vienna, 30 January-10 February 2017

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.

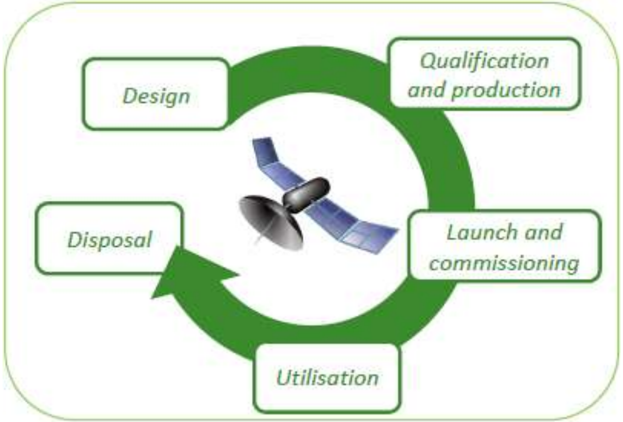
Life Cycle Assessment

To quantitatively assess the potential environmental impacts of a product or service

Multi-steps

Consumption of non-energy natural resources

Energy consumption



Emissions to air

Emissions to water

Emissions to soil

Waste

Multicriteria

Mineral resource depletion

Fossil resource depletion

Global Warming

Air acidification

Ozone Depletion

EcoDesign, where are we now?

LCA

LCA Launch Segment

LCA Space Segment

LCA Ground Segment

Building the framework

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

Currently here

Application

➒ Green Technologies

➒ 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 MANOUVERS	**-**	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**.

CleanSat – Main Messages

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?

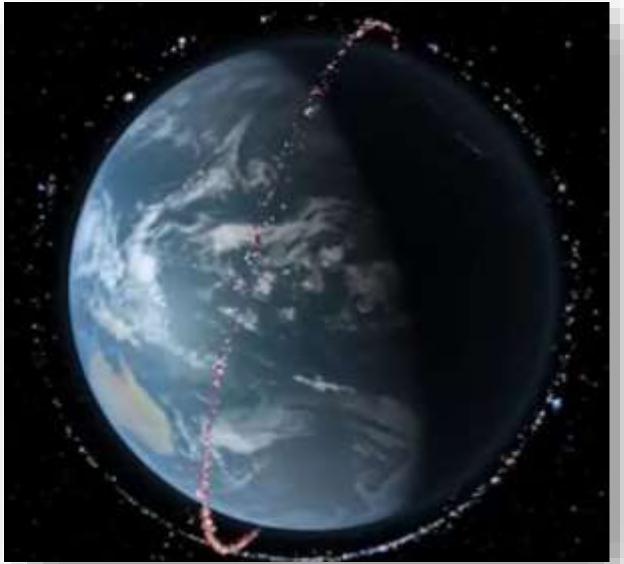
Space Debris Mitigation Requirements

Req.	2012	**DEORBITING** · **CASUALTY RISK** · **RELIABILITY** · **PASSIVATION**
Prep. Phase	2013-2014	Passive deorbit systems · Active deorbit systems · Design for Demise · Autonomous deorbit systems · Propulsion systems · Power systems
Conc.Eng. Phase	2015	**Study and Selection of the higher level and most critical priorities**
	2016	**Building Block Design** — UNI'S, LSIs, Suppliers, ESA TEC, PA, Users: EOP, TIA

Currently here

Project Phase	2017-2020	**Evolution of European LEO Platforms**: Demisable **TANK** · Demisable **RWs** · Demisable **MTQ** · **Electric passivation** in PCDU · **Fluidic Passivation** Valve · Propulsion upgrade for controlled reentry · Etc. etc. …
Evolved LEO P/F	2020	**Future LEO missions e.g. EOP**

Active Debris Removal



➔4000+ inactive satellites in LEO

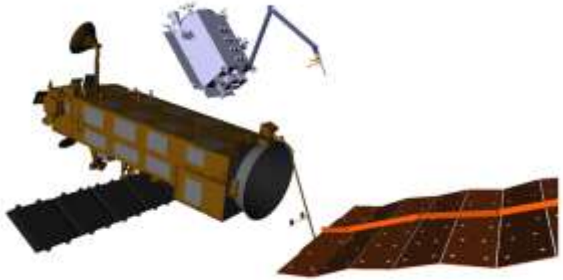
➔to **stabilize** debris growth: **remove 5 large objects per year***

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

e.deorbit

FEB 2024
RENDEZVOUS AND TARGET INSPECTION

MAR 2024
SYNCHRONISATION & TARGET CAPTURE



JAN 2024
TRANSFER AND PHASING TO TARGET ORBIT

MAR 2024
STABILISATION

JAN 2024
COMMISSIONING AT 300 KM CIRCULAR ORBIT

JAN 2024
LAUNCH VEGA-C

APR 2024
DISPOSAL

Mission Challenges

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

Mission Phase	Phase 0	Phase A	Phase B1	Consolidation Phase	phase B2	Phase C/D	phase E
	Pre-conceptual design, Mission analysis and identification	**Feasibility, preliminary analysis** and design	Mission preliminary **design**, high level **requirements** acquisition and **schedule** definition	Requirements analysis in order to **maximise synergies** between e.Deorbit and space tug operations; maximising the **reuse** of those technologies developed for e.Deorbit	**Maturation** and **Development** phase; Requirements detailed editing	**Detailed** study of phase B solution; qualification setup; **Production**/ground qualification testing, end of system development; design and operational **qualification**	Launch campaign, **Launch** and in-flight acceptance of space elements. operation and maintenance of the system; feedback
STATUS	*completed*	*completed*	*completed*	*Kick-off in October*	planned at the beginning of 2018	TBD	TBD

What have we done so-far? System Level

❾ e.Deorbit Phase A

3 consortia led by:

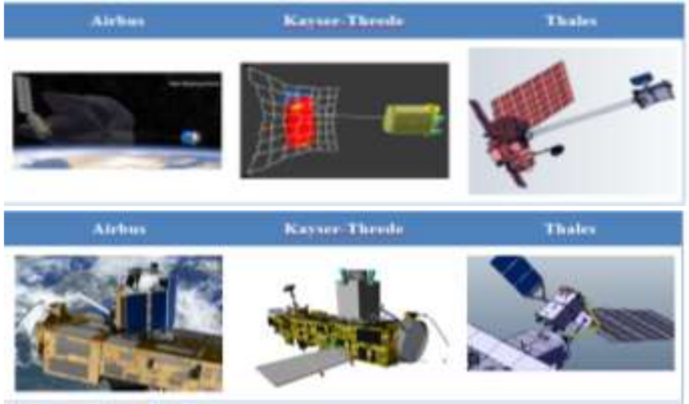
AIRBUS DEFENCE & SPACE

KAYSER-THREDE

ThalesAlenia Space

Options:

1. **Flexible deorbit**
2. **Rigid deorbit**
3. **Reorbit**



❾ e.Deorbit Phase B1

Kicked-off: **2015**

AIRBUS DEFENCE & SPACE — QuinetiQ Space nv (BE), DLR (DE), SENER (PL), GMVIS (PT), GMV (PL), MDA (CA)

System Requirement Review (end of B1): **2017**

OHB — OHB Munchen (DE), OHB Sweden (SE), TAS-I (IT), DLR (DE), MDA (CA) and CBK PAN (PL).

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)

Standardised features (grips, handles ..) enabling future **ADR** missions

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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❾ Clean Space Blog

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