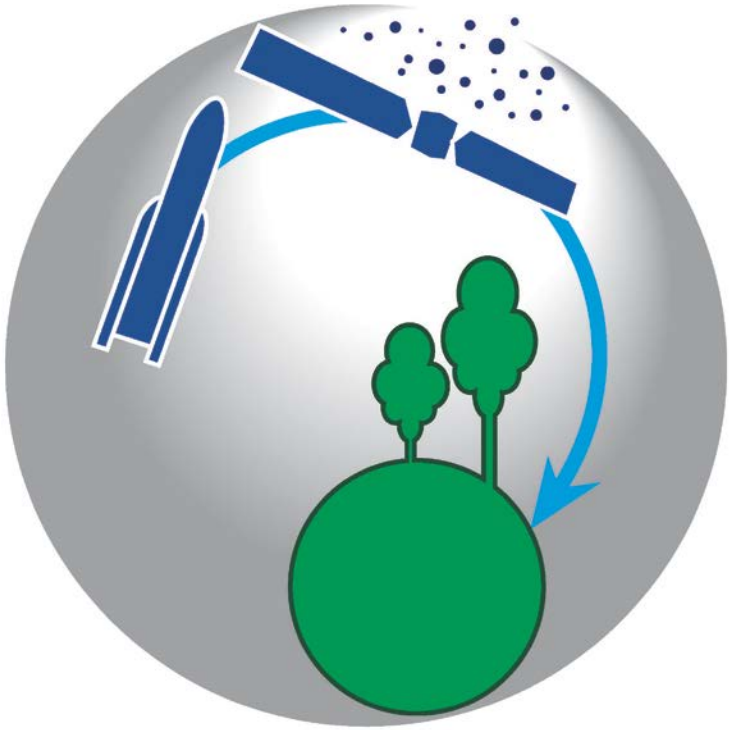

Clean Space

A new cross-cutting initiative of ESA

The Clean Space Team
15/04/2013

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Introduction

Environmental concerns lead to:

- New legislations (REACH, RoHS, LOS)
- Competitive advantage due to green technologies
- Pressure on the space industry (risk of supply chain disruptions; requests from customers, operator clients, employees)

Concerns on the sustainability of the **exploitation of space**:

- Risk due to space debris
- News headlines worldwide (impact on the image of the space sector as a whole)

ESA, with the Clean Space initiative, will give a pro-active answer to the environmental challenges both on ground and in space, including its own operations as well as operations performed by European space industry in the frame of ESA programmes

ACTION IS NECESSARY TO TRANSFORM THREATS INTO OPPORTUNITIES

Clean Space

Clean Technologies

"contribute to the reduction of the environmental impact of space programmes,

taking into account the overall life-cycle

and the management of residual waste

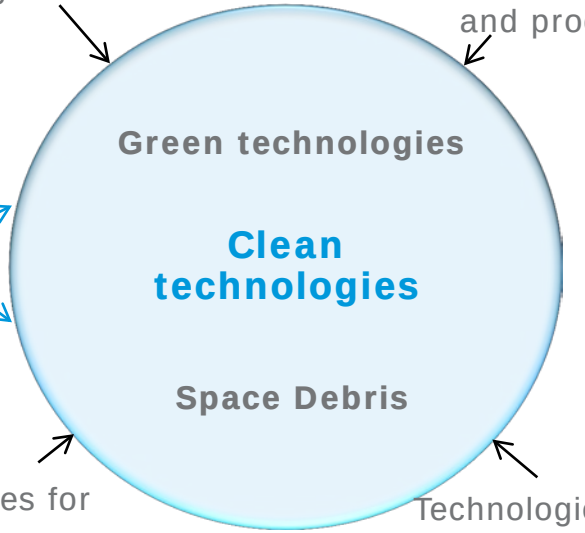
and pollution resulting from space activities"

Branch 1

Eco-Design to evaluate the environmental impact and monitor legislation risk

Branch 2

Green technologies – green propulsion, green electronics, new materials and processes



Studies to improve understanding

Technologies for **active debris removal**

Branch 4

Technologies to support **debris mitigation**

Branch 3

Objective of the Clean Space Initiative

"Guaranteeing the future of space activities by protecting the environment"

Branch 4 Space Debris Remediation

Why 1/2

Sustainability of space exploitation

- Simulations show that the number of debris keeps growing even if no further objects are launched
- World-wide actions by active debris removal (~5 objects per year)
- Risk of in-orbit collisions is increasing (e.g. Iridium-Cosmos)
- Substantial increase of the number of Collision Avoidance Manoeuvres
- Risk of an ESA satellites encountering a catastrophic collision in the next 50 years between ~7.5% and ~11%

On ground safety

- Uncontrolled re-entry of debris causes a risk for on-ground safety

Innovation

- Innovative technologies (e.g. capture, sensors) are necessary, synergies with other applications (e.g. satellite servicing, capturing asteroids)
- Possibility of new market for ADR

Branch 4 Space Debris Remediation

Why 2/2

- On average, 50 objects need to be removed to prevent one collision, optimised by selecting density hot-spots (in high altitudes)

- Criteria for removal should be (a combination of):
  - Collision probability [cross-section, population density]
  - Altitude of the target orbit [lifetime of fragments]
  - Mass of the target

- Delays in starting ADR activities make ADR less effective

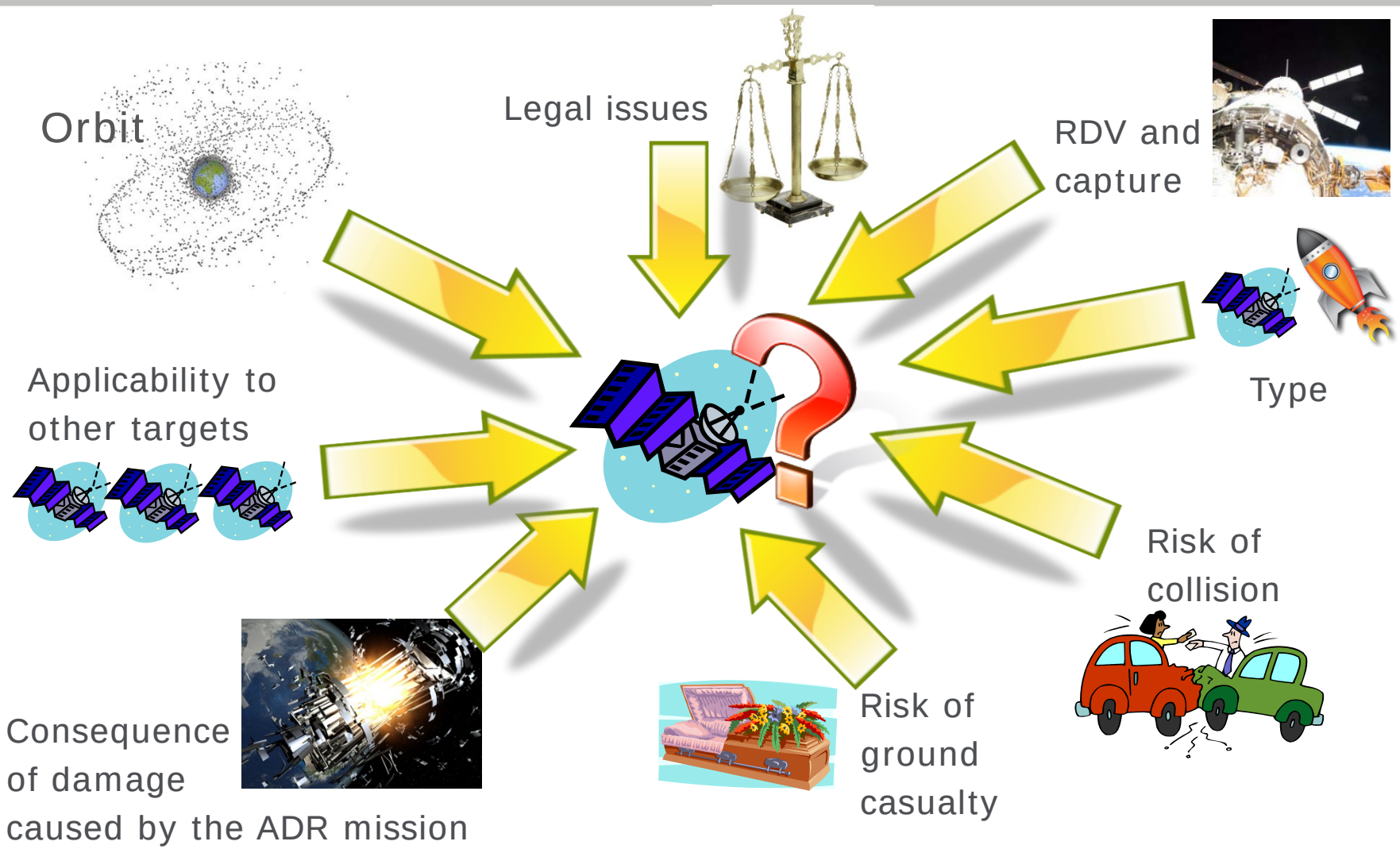
Branch 4 Space Debris Remediation

Objectives

Develop technologies for space debris rendezvous, capture and re-entry

- Adopting a system approach, technology developments are planned to be focused on a mission for the controlled de-orbit of heavy objects
- Place European industry at a forefront position on anticipated future markets

Target Selection: metrics



Branch 4 Space Debris Remediation

How? Recent and on-going activities

Technology and system studies

Technologies

- SMART-OLEV
- Conexpress
- RObotic GEostationary orbit Restorer (ROGER)
- Three Ariadna research studies on novel space debris removal concepts (foams, ion beam shepherd, hybridsail), 2010-11
- SysNova, June-December 2012

Concurrent Design Facilities studies

- Envisat De-Orbit, March 2011
- e.Deorbit, September 2012

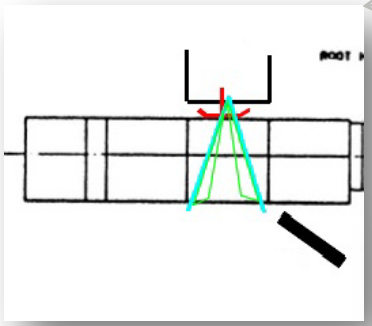
Recent and Ongoing ESA Activities

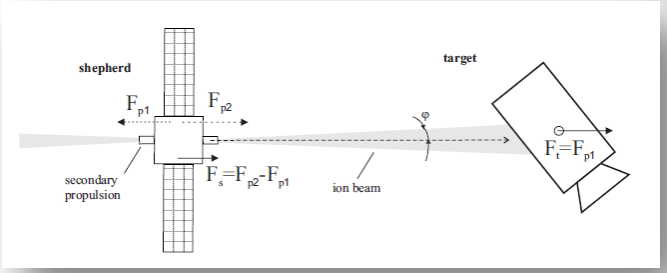
e.Deorbit – system options

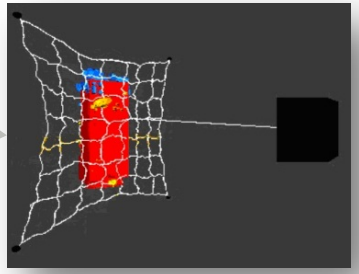
Orbit
- Re-orbit to >2000 km
- De-orbit to <600 km
- Controlled re-entry

Propulsion
- Chemical (CP)
- Electrical (EP)

Capture techniques
- Clamping mechanisms
- Robotic arm
- Ion-beam shepherd
- Net
- Others (harpoon, clamp, etc.)

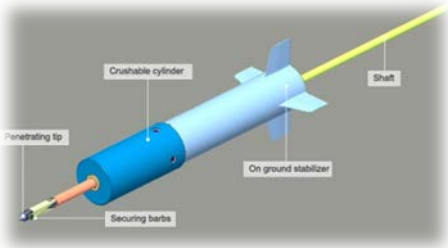
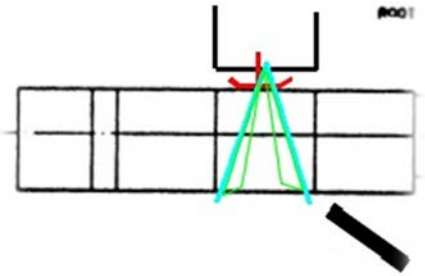
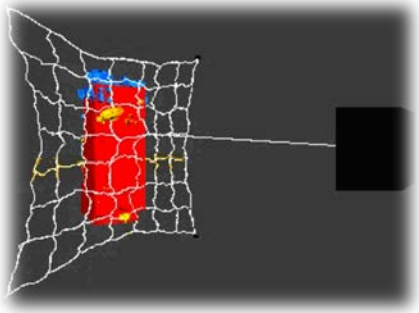






Recent and Ongoing ESA Activities

e.Deorbit – selection of capture technology

	Rigid connections (push)	Soft connections (pull)
Point contact		
Multiple / distributed contacts		

Branch 4 Space Debris Remediation

How?

Mature ADR technologies:

- Adapt and upgrade existing sensor suit to perform rendezvous with un-cooperative target
- Evaluate capture mechanisms (i.e. net, harpoon, clamping, robotic arm) and promote technology maturation
- Control of stack after capture, push or pulling approaches must be studied and developed
- Verification & Validation framework

System approach targeting an ESA S/C controlled re-entry:

- Phase A and B1 mission design
- Service oriented approach to ADR

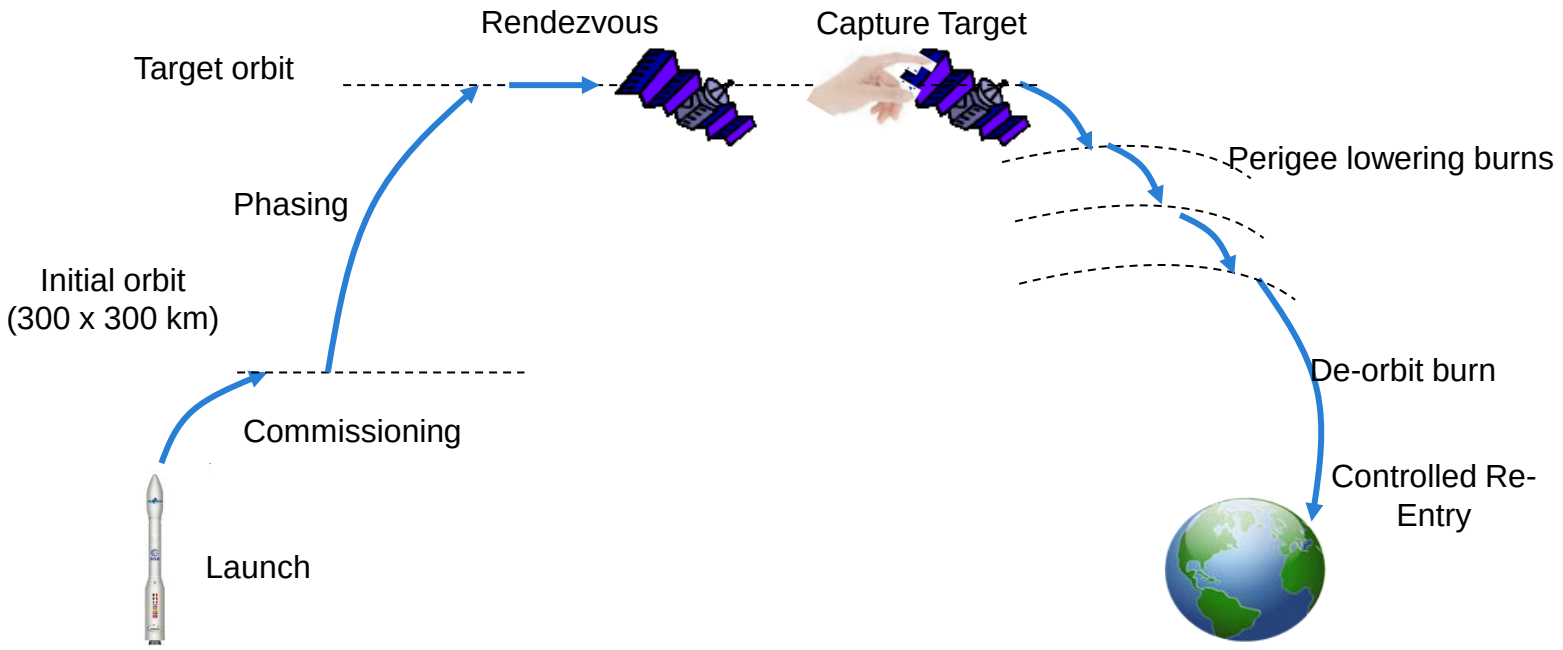
Study alternative approaches for other targets:

- Stabilisation of tumbling targets
- Ion Beam Shepherd

Recent and Ongoing ESA Activities

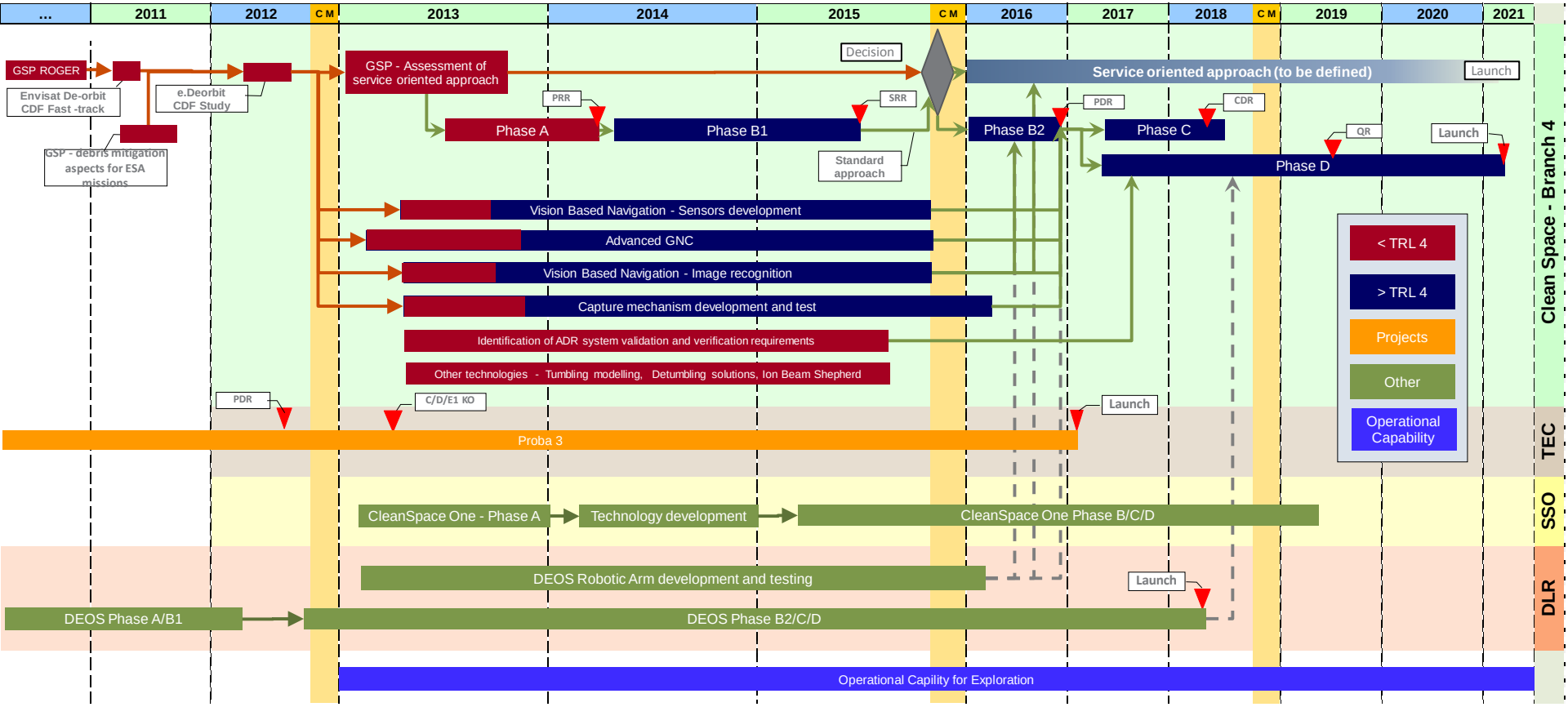
e.Deorbit

- Preliminary system design for most promising options, identify the required technology roadmap, and investigate its (their) applicability to other ESA missions
- Assessment of feasibility, programmatic, risk and cost aspects of a mission for the controlled de-orbiting and re-entry of a large, massive, un-cooperative target in SSO, using technologies analysed in previous CDF studies (e.g. tentacles, robotic arm, net)



Branch 4 Space Debris Remediation

Roadmap



Clean Space implementation

- Step-wised approach to the implementation of Clean Space roadmaps
- Selected activities have been proposed for implementation in 2013-2014 through ESA technology programmes
- Discussions with European partners to exploit synergies is on-going
- Talks with international partners for possible cooperation on ADR mission have been initiated

Clean Space implementation

Financial aspects

Priority activities, over the period 2013 to 2016, amounting to about 60 M€

Branch 1 - Eco Design	4-6 Meuro
Branch 2- Green Technologies	10-15 Meuro
Branch 3 - Debris Mitigation	15-20 Meuro
Branch 4 – Debris Remediation	15-20 Meuro

Conclusions

The Clean Space initiative is

- a cross-cutting theme within ESA's Technology programmes
- aiming at making ESA an exemplary agency in terms of terrestrial and space environmental protection
- containing technology activities presented grouped in roadmaps and proposing a series of technologies which will allow European space industry to:
  - effectively use resources
  - implement regulations
  - mitigate risks
- willing to turn an apparent threat into an opportunity for the entire space sector

Thank you

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