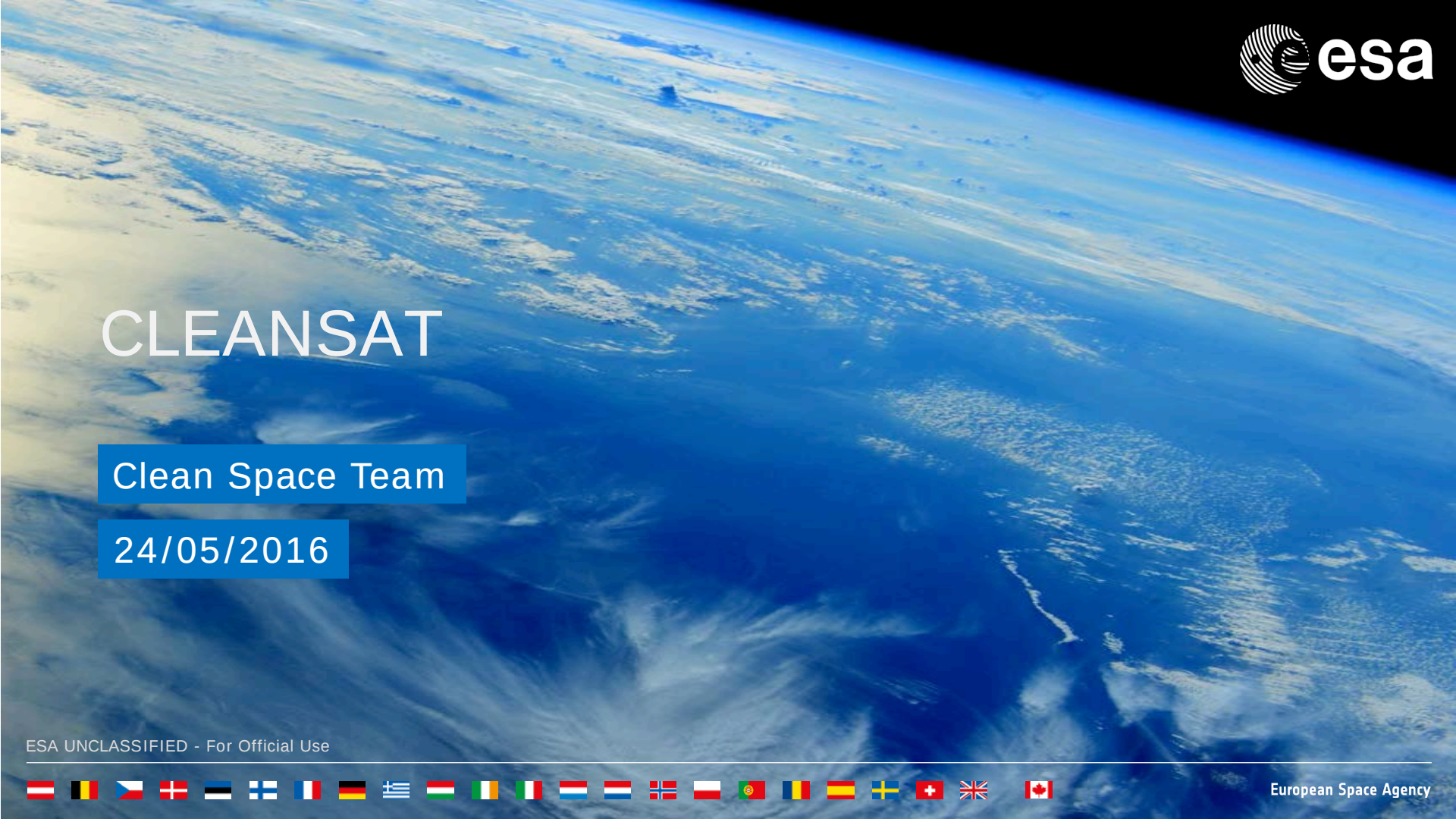


CLEANSAT

Clean Space Team

24/05/2016

Why Space Debris are a problem

7200
SATELLITES LAUNCHED

60 YEARS
OF SPACE ACTIVITIES

8 TONNES
THE TOTAL MASS CURRENTLY IN SPACE

Why Space Debris are a problem

What do we do at ESA?

cleansat

➔ TECHNOLOGIES FOR DEBRIS MITIGATION

CleanSat is cooperation!

➔ WITH THE SPACE SECTOR INCL. SPACE AGENCIES

➔ WITH THE EUROPEAN INDUSTRY

➔ WITHIN ESA

➔ WITH THE EXPERTS ON SPACE DEBRIS

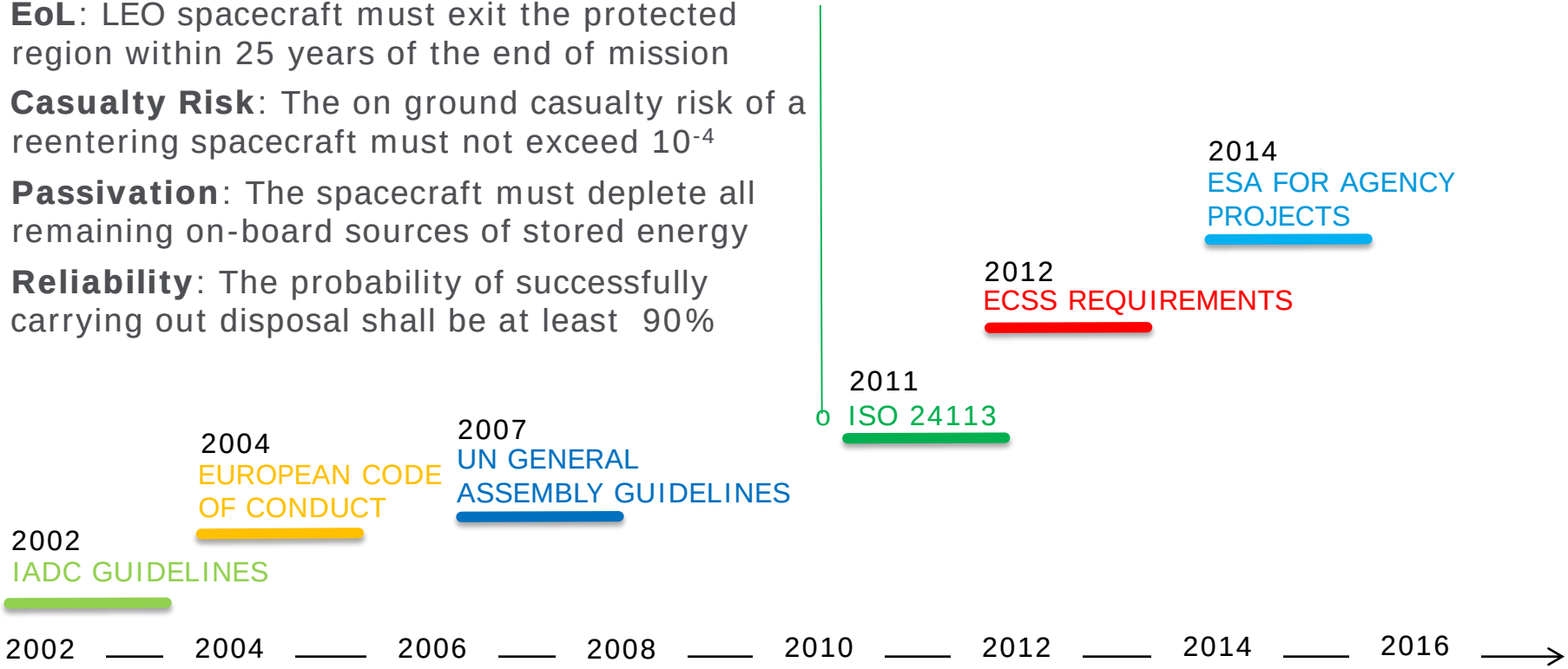
Space Debris Mitigation Requirements

EoL: LEO spacecraft must exit the protected region within 25 years of the end of mission

Casualty Risk: The on ground casualty risk of a reentering spacecraft must not exceed 10^{-4}

Passivation: The spacecraft must deplete all remaining on-board sources of stored energy

Reliability: The probability of successfully carrying out disposal shall be at least 90%



The consequences…

SPACENEWS

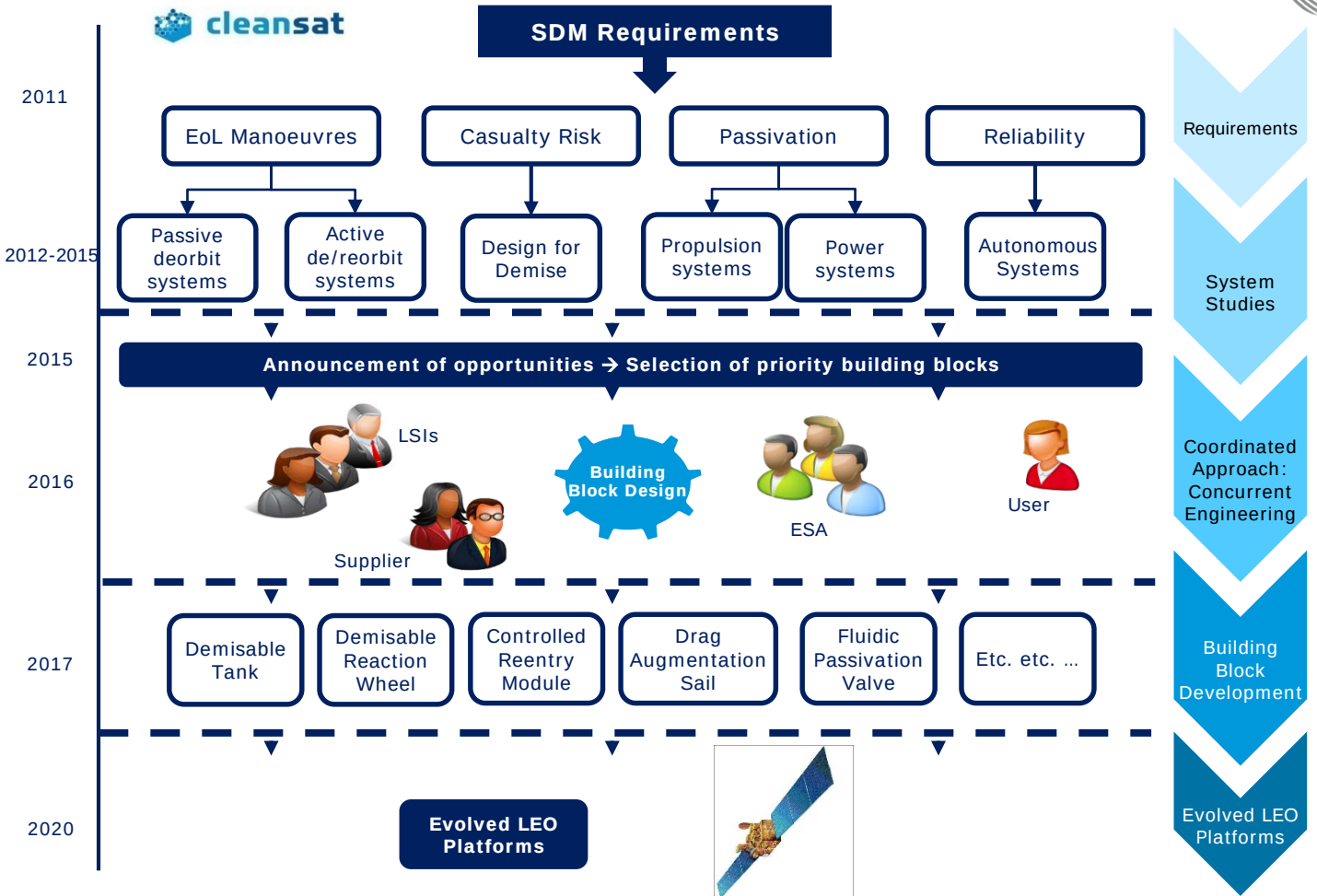
NEWS OPINION VIDEO LAUNCH BUSINESS MISSIONS POLICY & PO

Addition of Debris-mitigation Measure Delays MetOp-SG Award

by **Peter B. de Selding** — October 18, 2013

MetOp-SG will succeed the current MetOp satellites in a polar orbit of about 800 kilometers in altitude. Credit: ESA artist's concept

CleanSat: Past – Present – Future



CleanSat, ESA's response

to support European industry in complying with SDM requirements

➔ DESIGN FOR DEMISE

The risk of casualty on ground shall not exceed 10^{-4}.
To ensure this S/C must be based on designs that demise upon re-entry

➔ DEORBITING SYSTEMS

Satellites shall be removed from LEO within 25 years after their end-of-life; Ideally without detracting from mission efficiency

➔ PASSIVATION

At the end of life the satellite shall permanently deplete or make safe all stored energy, namely propulsion and power subsystems

CleanSat, ESA's response

to support European industry in complying with SDM requirements

DESIGN FOR DEMISE

From 2013 to 2016:

- Parallel system studies with 3 LSIs defined priorities
- Creation of database of material properties
- 10 Building Blocks studied with supplier and LSIs
- Pre-development of demisable tanks

Design for Demise

➔ EQUIPMENT DESIGNED FOR DEMISE

- Demisable propellant tanks for chemical and electric propulsion
- Demisable Reaction Wheels
- Demisable Optical Payload Elements
- Demisable Magnetorquers

➔ TECHNOLOGY TO IMPROVE SYSTEM DEMISE

- Development of break-up mechanisms, for separation of modules and open-up structure
- Development of demisable joints, to ease the separation of structure external panels and equipment

CleanSat, ESA's response

to support European industry in complying with SDM requirements

➔ DESIGN FOR DEMISE

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CleanSat, ESA's response

to support european industry in complying with SDM requirements

➔ DEORBITING SYSTEMS

From 2013 to 2016:

- Drag augmentation sail developed to TRL5
- Assessment of needs to optimise controlled re-entry
- Study solid propulsion autonomous de-orbit system
- 12 Building Blocks studied with supplier and LSIs

De-orbiting Technologies

➔ ACTIVE SYSTEMS FOR MEDIUM & LARGE SATELLITES

- Controlled Re-entry Mono-propellant Module
  - Re-pressurisation system
  - low cost de-orbit engine.
  - hydrazine arcjets for mass optimisation
- De-orbit system based on solid propulsion

➔ PASSIVE SYSTEMS FOR SMALL SATELLITES

- Drag Augmentation Systems, deployable sails
- Electrodynamic tethers

CleanSat, ESA's response

to support European industry in complying with SDM requirements

➔ DESIGN FOR DEMISE

The risk of casualty on ground shall not exceed 10-4.
To ensure this S/C must be based on designs that demise upon re-entry

➔ DEORBITING SYSTEMS

Satellites shall be removed from LEO within 25 years after their end-of-life; Ideally without detracting from mission efficiency

➔ PASSIVATION

At the end of life the satellite shall permanently deplete or make safe all stored energy, namely propulsion and power subsystems

CleanSat, ESA's response

to support European industry in complying with SDM requirements

➔ PASSIVATION

From 2013 to 2016:

- Analysis of system impacts of approaches and propulsion passivation
- Development of guidelines and tool-box for implementing electric passivation
- 4 Building Blocks studied with supplier and LSIs

Passivation

➔ PROPULSION PASSIVATION

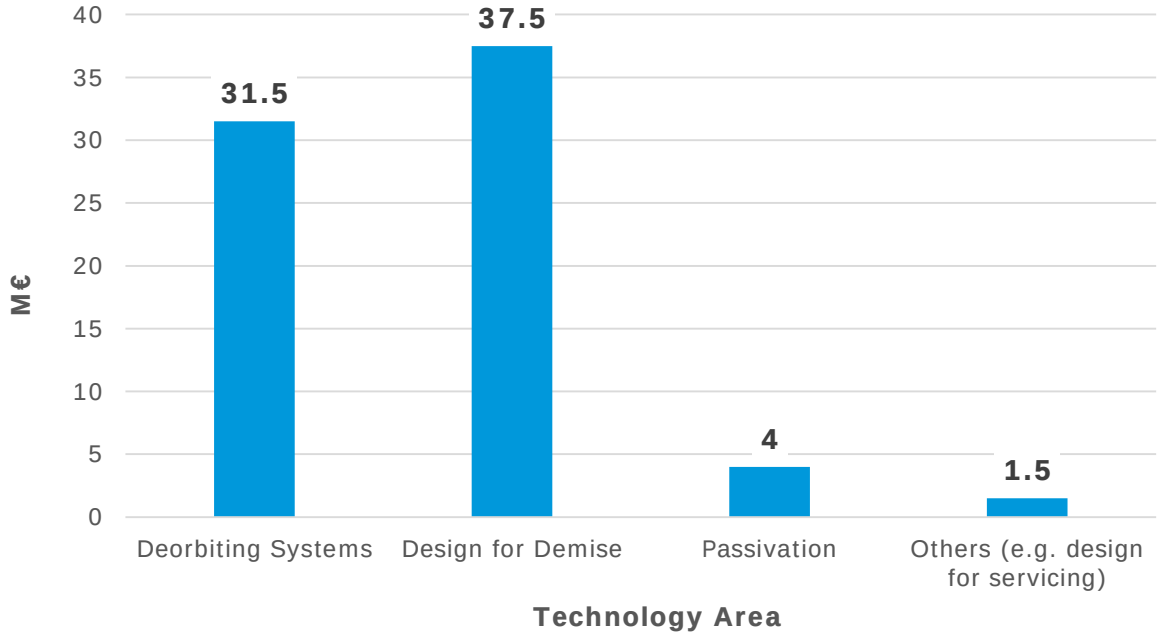
- Fluidic passivation valve, robust, reliable, long lifetime – compatible with propellants and pressurant
- Characterization of reaction control thrusters for low inlet pressure

➔ POWER PASSIVATION

- Upgrade the current PCDUs to allow for Solar Array isolation

CleanSat: the total costs

The total cost to develop the whole portfolio of technologies up to TRL 6 is estimated at 74.5 M€



CleanSat proposal for CM 2016

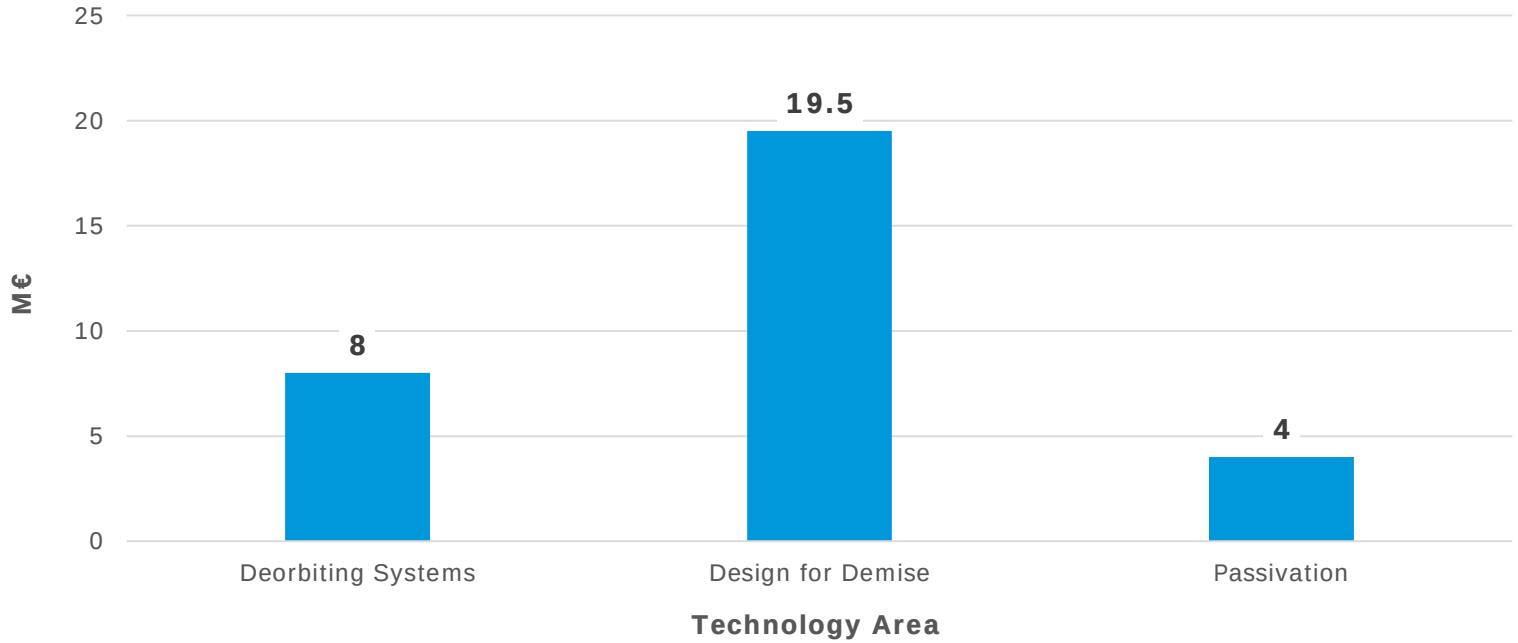
Strong prioritisation takes into account the inputs from all stakeholders, through concurrent approach:

- Users
- Large System Integrators
- Small System Integrators
- Suppliers

Criteria:

- Contribution to compliance
- Accessible market and ESA missions needs
- Maturity level (time-to-market)

CleanSat: high priority activities



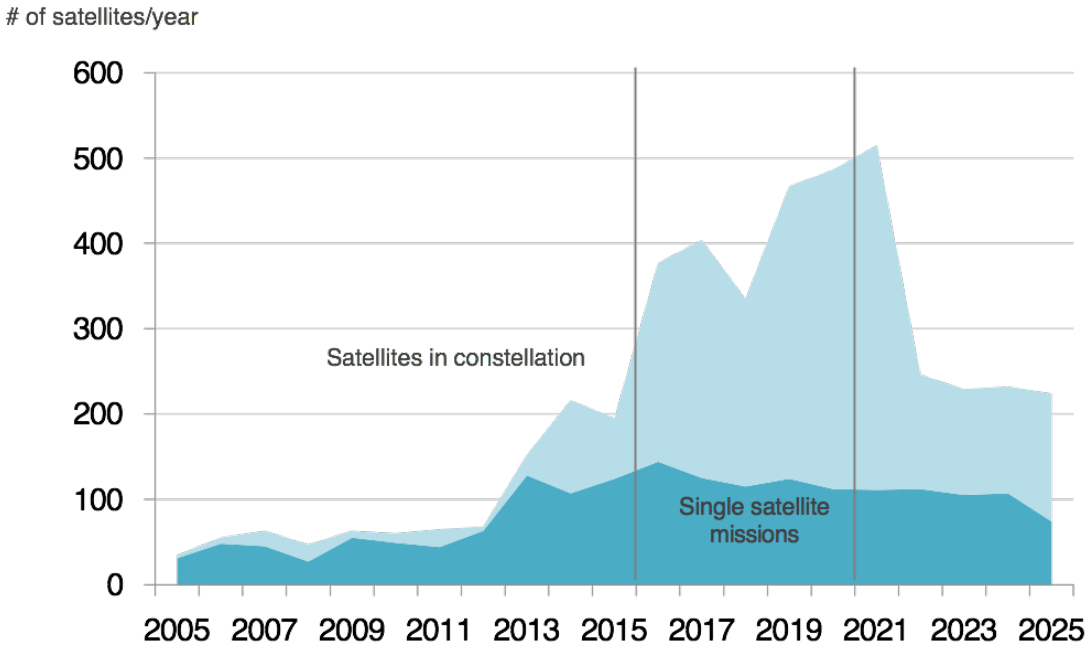
Expected contributions by countries

NATION	BUDGET
Austria	0 ➔ 9
Belgium	0 ➔ 15
Canada	0 ➔ 4
Czech Republic	0 ➔ 5
Finland	0 ➔ 5
France	0 ➔ 25
Germany	0 ➔ 30
Italy	0 ➔ 20
Luxembourg	0 ➔ 4
Norway	0 ➔ 13
Poland	0 ➔ 11
Portugal	0 ➔ 6
Romania	0 ➔ 5
Spain	0 ➔ 14
Sweden	0 ➔ 7
Switzerland	0 ➔ 13
The Netherlands	0 ➔ 5
UK	0 ➔ 15

COMPETITION

31.5 M€ TOTAL

Market for SDM technologies



3800 launches in LEO by 2025

3500 satellites accessible to European suppliers

Steps for C-Min preparation

April

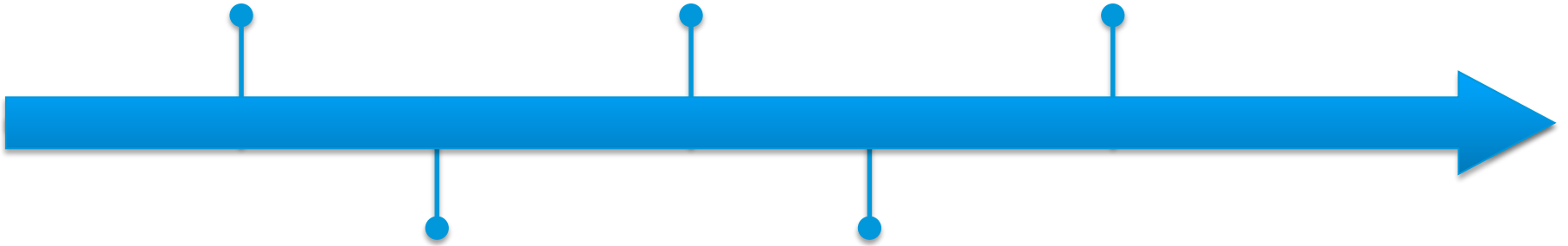
Discussion with industry

May

Clean Space Industrial Days At ESTEC

December

Council at Ministerial Level



May

TAWG: Tech strategy presentation

June

Discussion with delegates on priorities

CleanSat Programme Proposal

Conclusions on CleanSat

➔ EUROPEAN COOPERATION

CleanSat brings together European integrators and manufacturers opening up the prospect of shared supply chains and optimised costs

➔ INNOVATION

CleanSat leads to an evolution in LEO platforms fostering innovation and technology development in areas of consolidated designs - a “think different” approach

➔ COMPETITIVENESS

CleanSat will give European industry a competitive edge in the application of space debris regulations

CleanSat Building Blocks session

Batch	Theme	Title	Speaker
-	-	Introduction to CleanSat	ESA
1	Tanks	Demisable Aluminium lined COPV	Airbus DS SAS
1	Tanks	SDM compliance & Regulation / Thermoplastic tanksfor green propell	Airbus DS SAS
1	Tanks	Demisable metallic propellant tanks	Airbus DS GmbH
1	Tanks	Demisable metallic propellant tanks	MT Aerospace AG
1	Tanks	Questions	
2	Demisability	Demisable Reaction Wheels	Altran
2	Demisability	Demisable structural joints	Belstead Research Limited
2	Demisability	Demisable Magnetorquer	Lusospace
2	Demisability	Demisable optical instruments	OHB System AG
2	Demisability	Questions	
3	Electrical	Battery safety assessment	ABSL Space Products
3	Electrical	Isolation of Solar Array in PCDU	Selex Es SPA
3	Electrical	Performance improvement / Wireless Temperature Sensing System	Selex Es SPA
3	Electrical	Isolation of Solar Array in PCDU	Thales Alenia Space Belgium
3	Electrical	Questions	
		Coffee Break	

Batch	Theme	Title	Speaker
4	Propulsion (chemical)	Repressurisation module for deorbit ma	Airbus DS GmbH
4	Propulsion (chemical)	SDM compliance & Regulation / Green propellant based deorbit engin	Airbus DS GmbH
4	Propulsion (chemical)	100N-200N dual mode de-orbit engine	Airbus DS GmbH
4	Propulsion (chemical)	SDM compliance & Regulation / Green propellant based deorbit engin	Sitael SPA
4	Propulsion (chemical)	Questions	
5	Propulsion (chemical)	Fluidic passivation valve	Airbus DS GmbH
5	Propulsion (electrical)	100 W HET deorbit system	Sitael SPA
5	Propulsion (electrical)	Arcjet deorbit system	Sitael SPA
5	Propulsion (electrical)	Arcjet deorbit system	University of Stuttgart- IRS
5	Propulsion (electrical)	Questions	
6	Demisability	Mechanisms for early structure break up	Airbus DS GmbH
6	Demisability	Mechanisms for early module release	Altran
6	Deorbiting Systems	Drag augmentation deorbit system	Cranfield University
6	Deorbiting Systems	Electro-Dynamic Tether deorbit system	Finnish Meteorogical institute (FMI)
6	Batch 6	Questions	
7	Propulsion (solid)	Autonomous deorbit system	D-Orbit-SRL
7	Deorbiting Systems	Autonomous deorbit system	GMV Aerospace and defence SAU
7	Propulsion (solid)	Solid Rocket Motor for deorbit	Institut Lotniciwa (Institute of Aviation)
7	Propulsion (solid)	Solid Rocket Motor for deorbit	Nammo Raufoss AS
7	Propulsion (solid)	Questions	
-	-	Wrap up	Luisa Innocenti