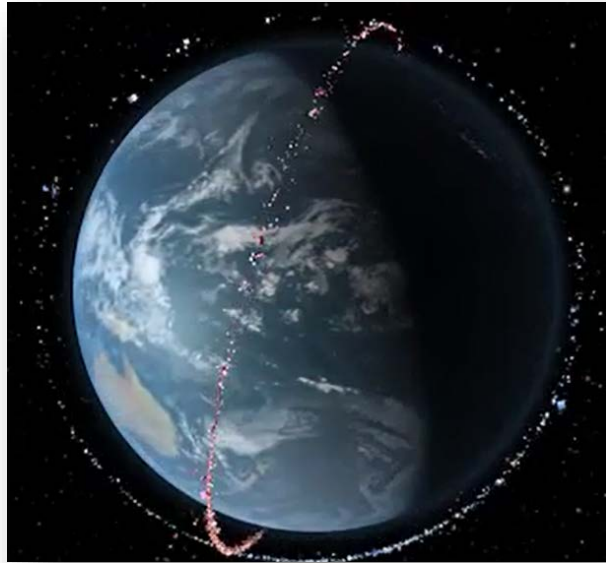


# Introduction to the ADR session: e.Deorbit and the MC2016

Robin Biesbroek

24/05/2016



→ 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

→ MISSION GOAL

### Remove

- ❑ an ESA-owned heavy debris
- ❑ from 800-1000 km (near polar region)

# Why e.deorbit...

## → AS A STEPPING STONE

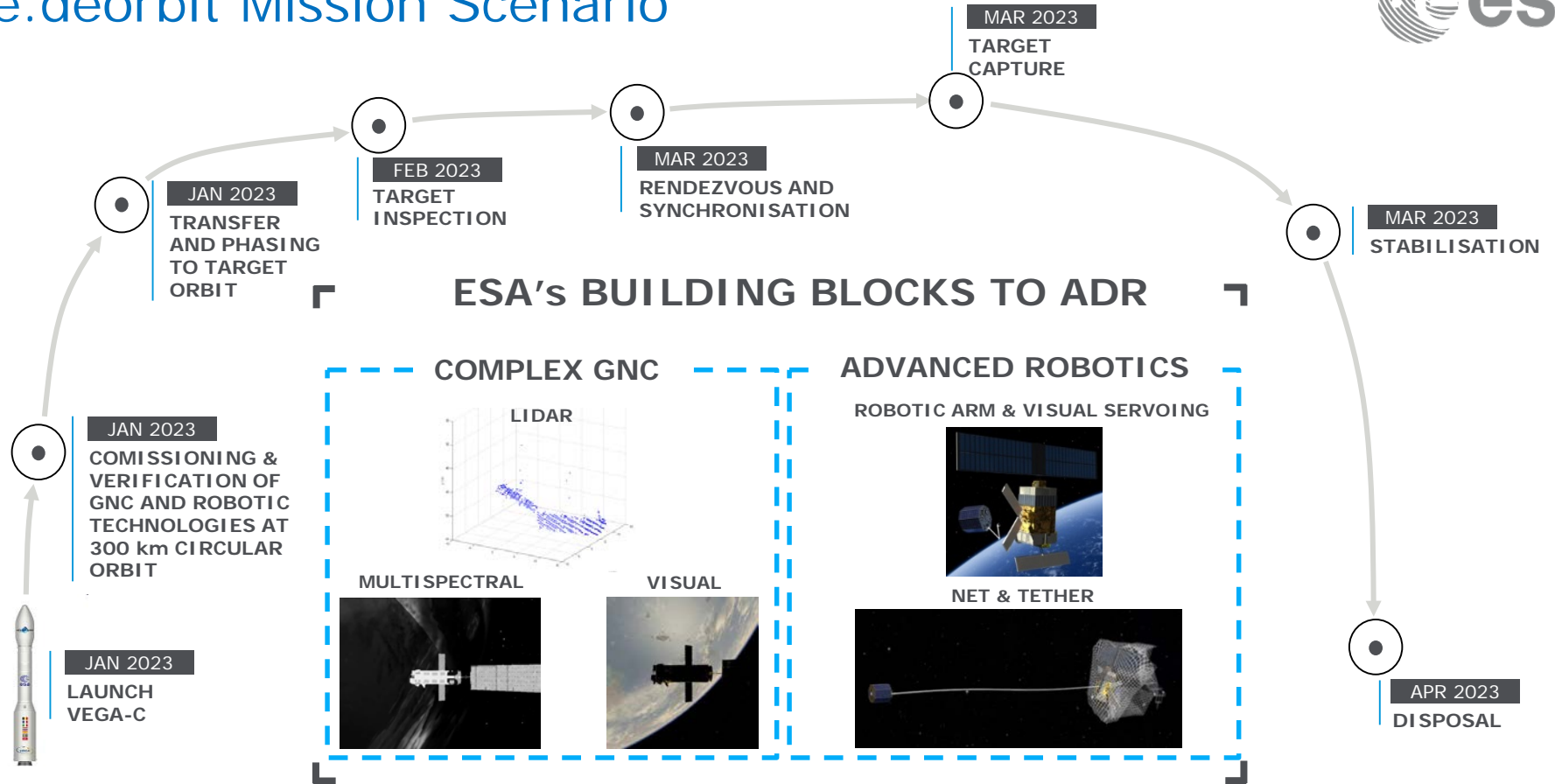
- Space tugs
- Active Debris Removal markets
- In-orbit servicing markets
- Sample-Return missions

## → ENABLING BUILDING BLOCKS

- Uncooperative Rendezvous and Docking
- Robotic arm & gripper with visual servoing
- Advanced GNC with complex image processing & recognition



# e.deorbit Mission Scenario





# The coolest team at ESA...



Michel (cost dude)  
Kjetil (net/robotics dude)  
Tiago (Clean space dude)  
Andrew (system dude)  
Jesus (GNC dude)  
Robin (manager dude)  
Luisa (boss dudette)

Adam (mechanisms  
dude)  
Fulvio (risky dude)  
Monica (comms dudette)  
Kate (ops dudette)  
Arnaud (trajectory dude)  
Benjamin (debris dude)  
Finn (GNC support dude)  
Sarmad (robotics support  
dude)  
Mark (software dude)  
Otto (AIV dude)  
Rogier (propulsion dude)  
Jessica (coordination  
dudette)



# What have we done so-far ?

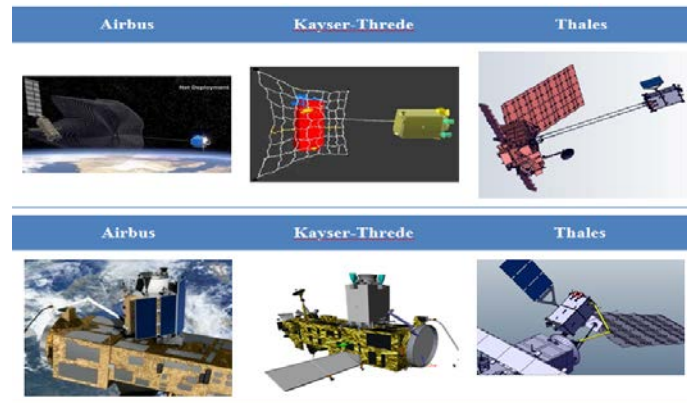
## → e.deorbit PHASE A

3 consortia led by:



3 Options:

1. Flexible deorbit
2. Rigid deorbit
3. Reorbit



## → e.deorbit PHASE B1

Kicked-off Q4 2015

e.deorbit SRR expected in mid-2016

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QuinetiQ Space nv (BE), DLR (DE), SENER (PL), GMVIS (PT), GMV (PL), MDA (CA)



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

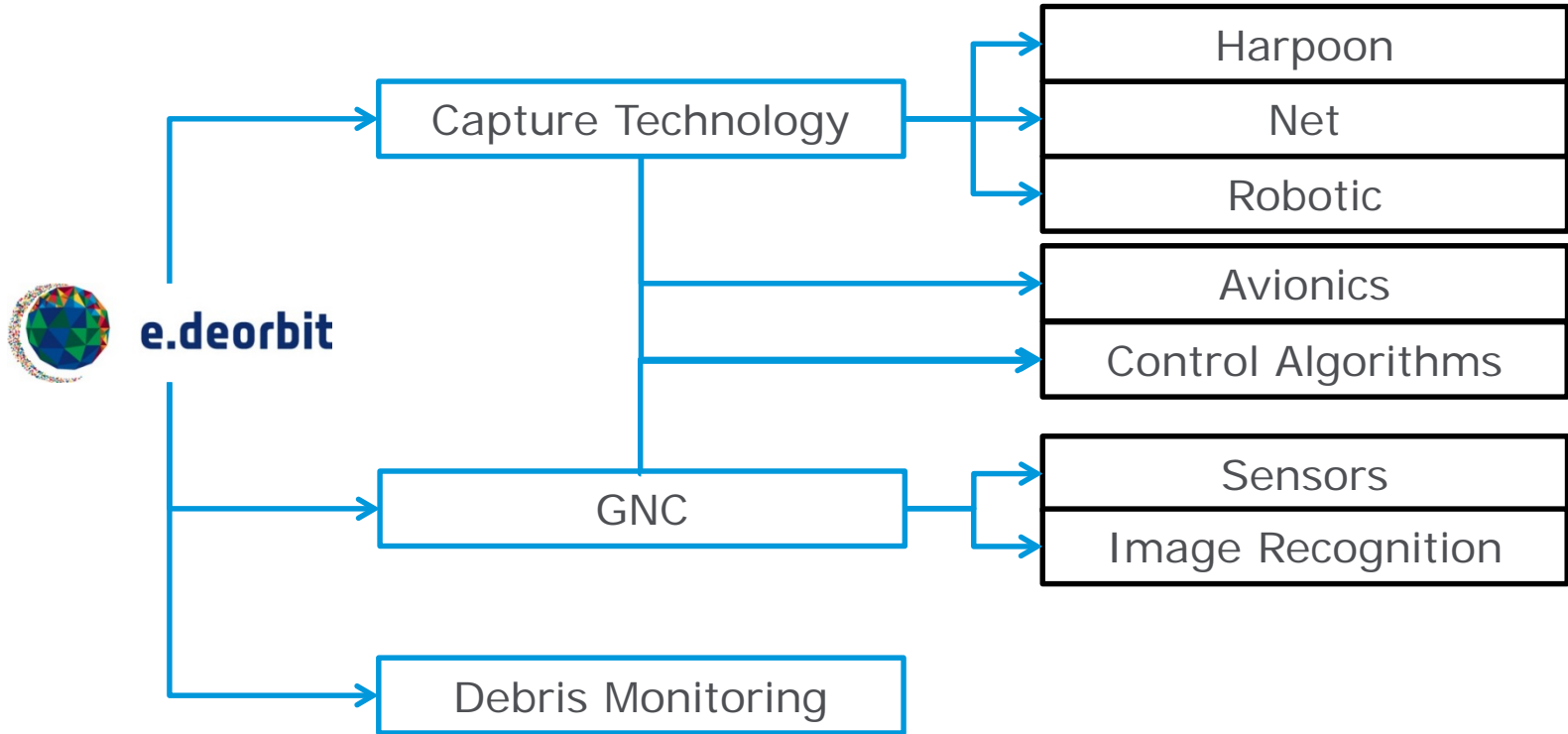
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EU has/is funding activities linked to Active Debris Removal, particularly:

- 
- A 3D CAD model of a mechanical assembly, possibly a robotic gripper or a similar device. The model is rendered in a semi-transparent green wireframe style, showing the internal structure and geometry. The assembly consists of several interconnected parts, including a long horizontal arm, a central joint mechanism, and a curved end effector. The background is dark, and the lighting highlights the edges and surfaces of the model.



# and the technologies ?



# Technology developments Implemented in TRP & GSTP

## → NET - HARPOON

5 Activities, total value 1.7 M€ in the period 2014-2015

9 Activities, total value of 3 M€ proposed in period 2016-17

## → ROBOTICS

2 Activities, total value 350 k€, (2014-2015)

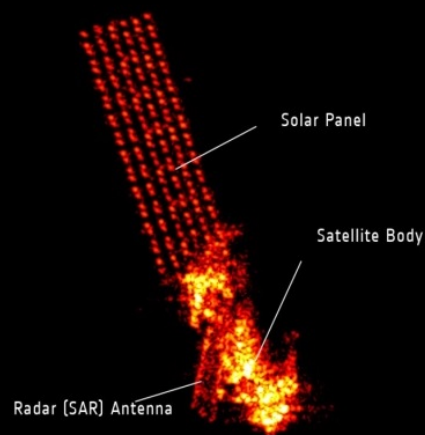
3 Activities, total value 3.5 M€ proposed (2016-2017)

## → GNC & DEBRIS ATTITUDE

7 Activities, total value 2.7 M€ (2014-2015)

2 Activities, total value 650 k€ proposed (2016-2017)

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# What will we do:

## 1) Technology developments 2016-2017

### Net / Harpoon (TAS/GSTP)

- ISS Spheres test plan (kicked off)
- Hot gas plume interaction

### Robotics (TRP)

- LAR gripper pre-development (2016)

### GNC & avionics (TRP/GSTP)

- High-performance avionic solutions (HIPNOS – kicked off)
- Control and management of robotic for ADR (COMRADE – ITT in 1 month)
- Consolidation of tethers advanced GNC algorithms
- Consolidation of rigid link advanced GNC algorithms
- Infrared camera for RDV
- Compact imaging LIDAR
- Multi-spectral sensor breadboard

### And also (GSP):

- EOL Operations for megaconstellations
- ADR for megaconstellations



# What will we do:

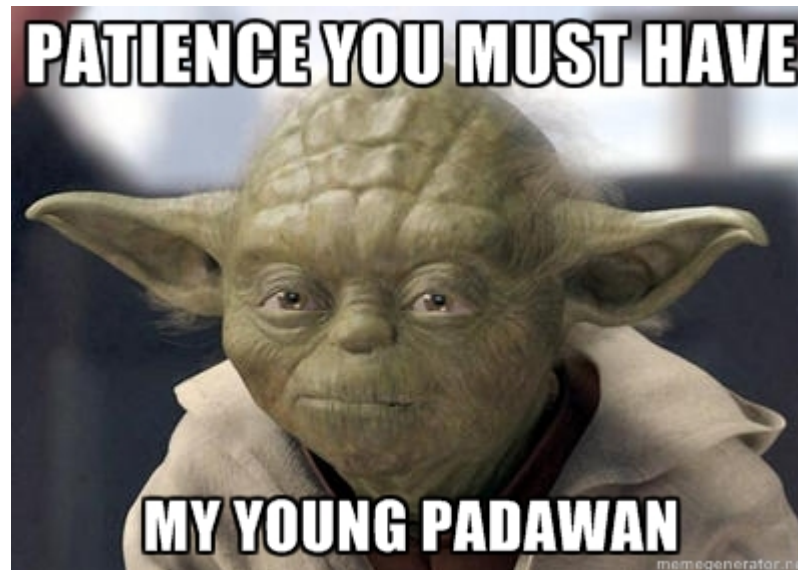
## 2) Phase B1 consolidation phase

### GSTP study with objectives (TBC!)

- Updated consortium
- Consolidation of phase B1
- Higher Synergy with space tugs
- Robot arm + net

## 3) MC2016 proposal

- See next slides



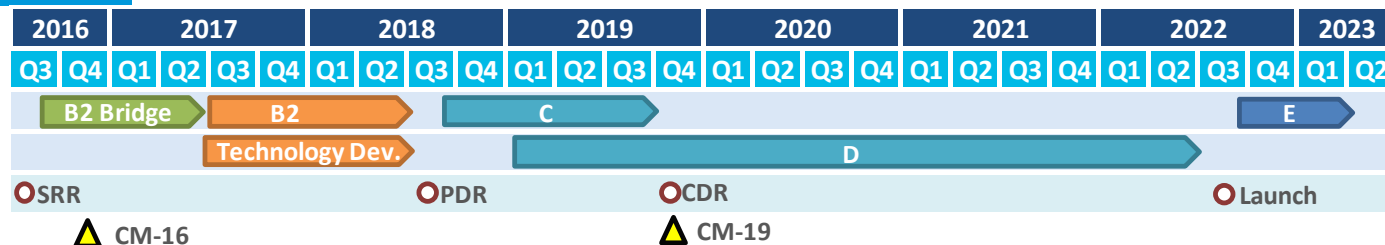


# e.deorbit "Full Mission"

## → ASSUMPTIONS

☐ FULL MISSION 
 ☐ ROBOTIC AND GNC DEVELOPMENT ONLY 
 ☐ LAUNCH 2022

## → SCHEDULE



## → COST SPLIT

All Values in e.c. 2016	Total	
Contract Value (B2, C, D, E1)	170	
Management Reserve for Industry	45	
Technology Development	22.5	
Total Industrial		237.5
ESA Project + O/H	45	
Management Reserve ESA Project	45	
GS & OPS (ESA + Industry)	30	
Launcher	40	
Total		160
Grand Total		397.5

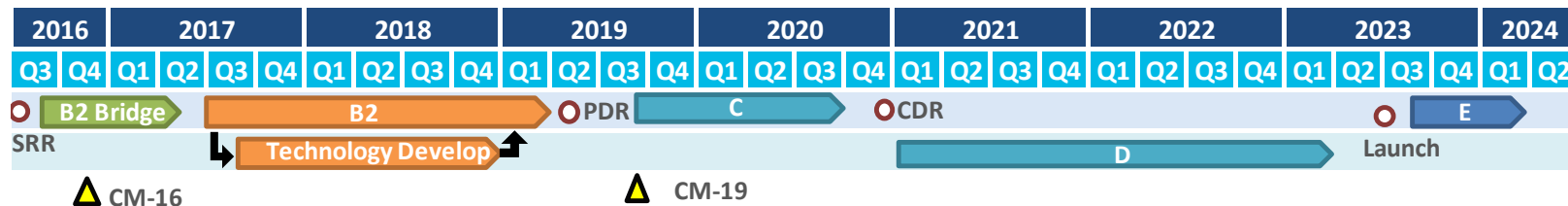
# CM 16 proposal: e.deorbit "Maturation Phase"



## → ASSUMPTIONS

□ B2 □ GNC, ROBOTIC + FLEXIBLE DEVELOPMENT (TRL 6) □ Launch 2023

## → SCHEDULE

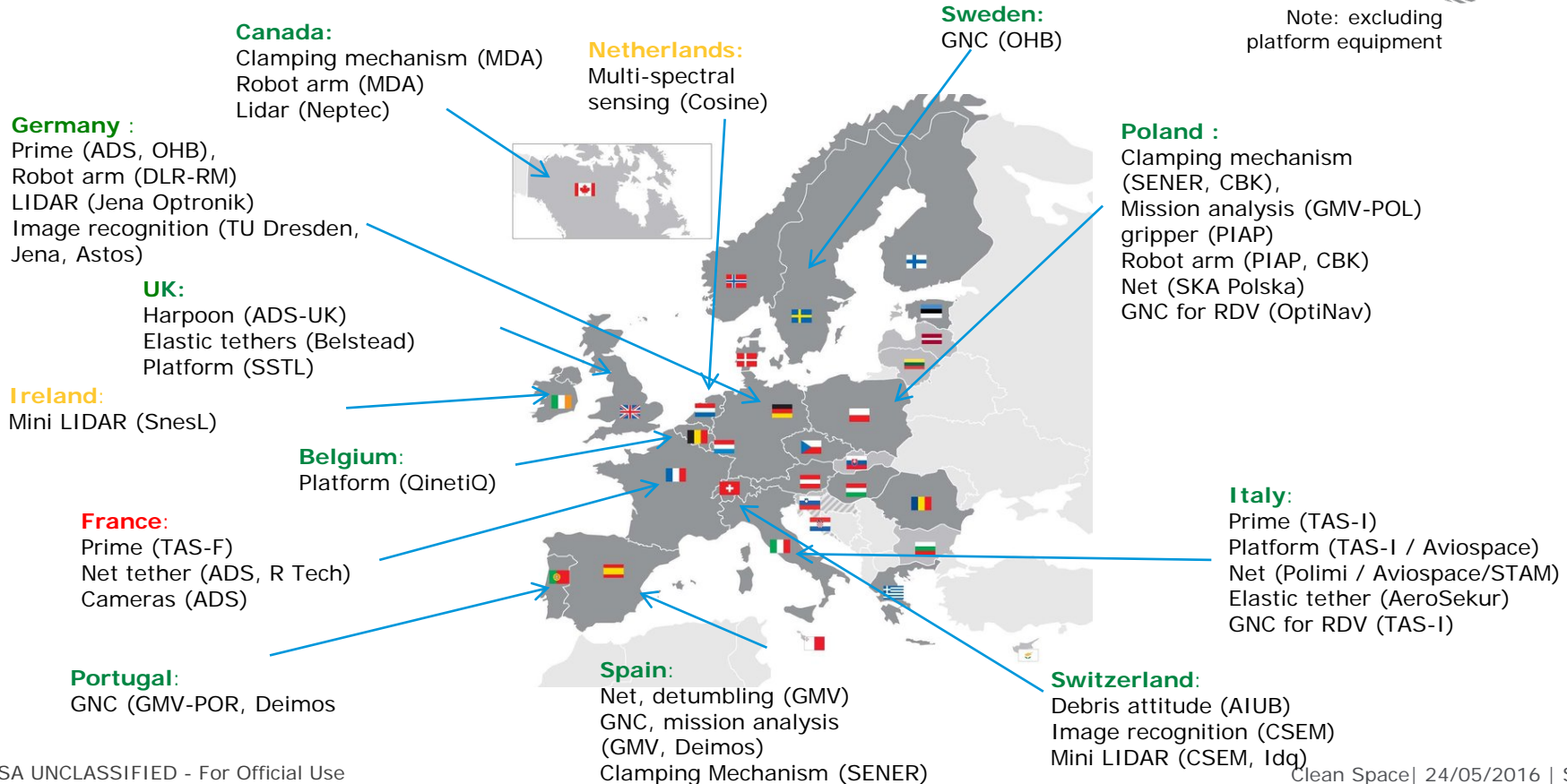


## → COST SPLIT

	2017	2018	2019	2020	Total
Phase B2	2	4	5	4	15
Robotics	2	3	5	2.5	12.5
GNC	1	3	3	3	10
Flexible	1	1	4	2.5	8.5
ESA Internal	1	2	3	3	9
<b>Total</b>	<b>7</b>	<b>13</b>	<b>20</b>	<b>15</b>	<b>55</b>

# Which countries could support us?

Note: excluding platform equipment



# e.deorbit Maturation Phase Potential Members States



Potential contribution based on industrial competencies:

Nation	Budget (M€)
Austria	0 – 1
Belgium	0 – 16
Canada	0 – 19
France	0 – 25
Germany	0 – 32
Italy	0 – 30
Ireland	0 – 2
Luxembourg	0 – 2
Poland	0 – 10
Portugal	0 – 6
Romania	0 – 7
Spain	0 - 15
Sweden	0 – 5
Switzerland	0 - 2
The Netherlands	0 - 5
United Kingdom	0 - 10

COMPETITION



**e.deorbit**

## Maturation Phase

	Total
Phase B2	15
Robotics	12.5
GNC	10
Flexible	8.5



## → INSPIRATION

e.deorbit will be the world's **first active debris removal mission**

## → LEADERSHIP

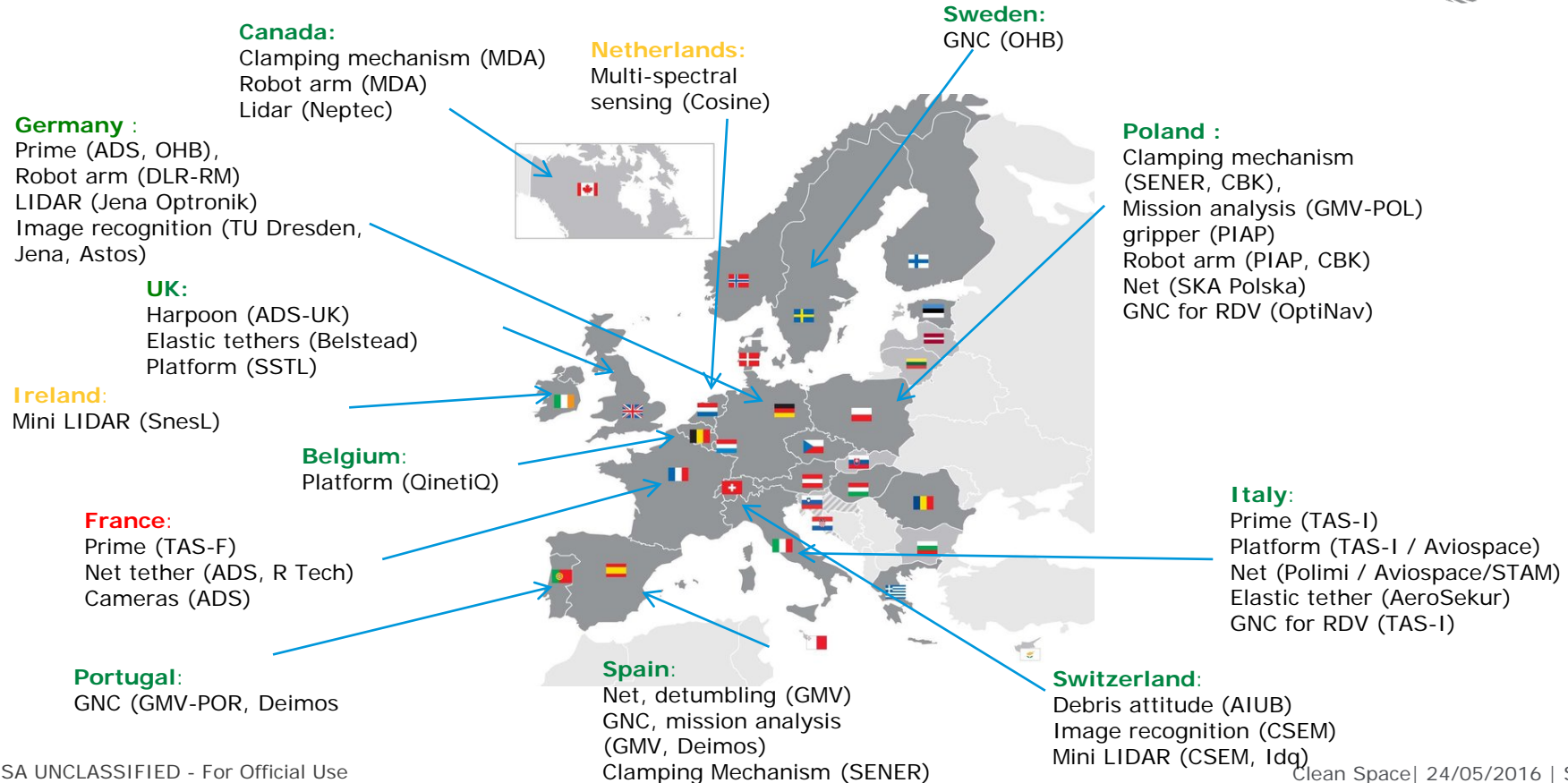
**e.deorbit will ensure European industry is the global leader for ADR technologies** such as:

- ❑ non-cooperative rendezvous and formation flight (synchronised motion)
- ❑ Robotic arm & gripper with visual servoing
- ❑ Advanced GNC with complex image processing & recognition

## → COMPETITIVENESS

**e.deorbit will act as a stepping stone** for the creation of new services (in-orbit servicing), markets (active debris removal) and mission (sample return)

# Thank you!



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European Space Agency