

WE LOOK AFTER THE EARTH BEAT



ADR and OOSS: Thales Alenia Space views

SWF / Ifri Conference, Brussels 30 Oct. 2012

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- ADR and OOSS in a nutshell

- Active Debris Removal
 - ADR systems and technologies, way forward
 - Thales Alenia Space involvement and expertise

- On-Orbit Satellite Servicing
 - OOSS as “game-changing innovation”
 - Thales Alenia Space involvement and expertise

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- **ADR: LEO contamination will continue to increase. Recovery actions to be put in place as a matter of urgency to maintain space sustainable for satellites**
- **From a manufacturer viewpoint, ADR technologies must be further investigated. Numerous reasons makes it compulsory within international cooperation.**
- **Legal and policy issues must also be deeply addressed, i.e. legal definition of space debris, ownership and jurisdiction, legislation, control and liability**

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- **Other political and strategic barriers :**
 - **Space objects are military or national security assets making it difficult to “interact” with them.**
 - **ADR/OOSS technologies are dual-use**
 - **If ADR/OOSS have “noble objectives”, they could also be used for adverse missions**

- **ADR/OOSS means new insurance policies and markets**

- **Prerequisite : debris removal must demonstrate its “value for money”**

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- **Is there a market ? (for commercial ventures)**
 - **The answer for GEO is probably yes**
 - **The answer for LEO is probably no**

- **OOSS is not yet mature for commercial business; at this stage it has to be supported by public entities.**

- **Techno flight demonstrations: affordable in the short-term to demonstrate and support feasibility and markets prospective**
 - **as Public Sector initiatives**

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Promote and raise funds for ADR/OOSS?

- **Risks related to orbital debris has reached a critical threshold hopefully capable of pulling public investments**
- **A dedicated Public (and Private ?) Fund to seed R&D**
- **Compensations TBD for debris removal and “clean launches”**
- **A debris removal “X-Prize” for successful removal**
- **Incentives to satellite manufactures to introduce standards to facilitate servicing and removal**
- **Regulations to enforce debris removal (e.g. sufficient level of fines for non compliances, above debris removal actual costs)**

Government initiatives are the most viable solutions in the short-term

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Going into more details...

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- **Prevent future spacecraft to contribute to environment degradation, through e.g. additional fuel reserve and hardening of space systems; but this is not sufficient.**
- **Select technologies, low cost high TRL solutions at minimum risk to guarantee investment returns**
- **ADR technologies have wider applications and synergies, from space exploration to in orbit servicing for launcher injection error or EOL additional lifetime. The investment therefore goes far beyond debris removal.**

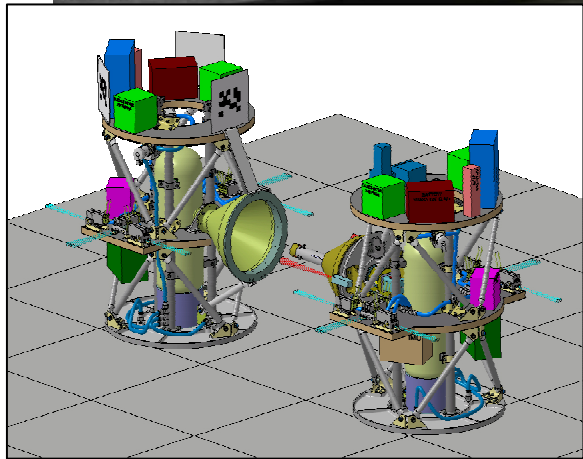
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- **OTV CNES contract (2011) : Systems trade-off, rendezvous strategy and sensors, capture strategy, de-orbiting, ... Most preferred solution was OTV seeking multiple debris removal with robotic capture**

- **Thales Alenia Space validation facilities to address Rendezvous and Docking with a vision-based Navigation**

- **ESA, National, EC and Regional contracts on enabling technologies, such as:**
 - **RVD, Robotics, Electric Propulsion, Vision-based Navigation, GNC, Metrology, Manipulators, Avionics**

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Thales Alenia Space ground validation facilities



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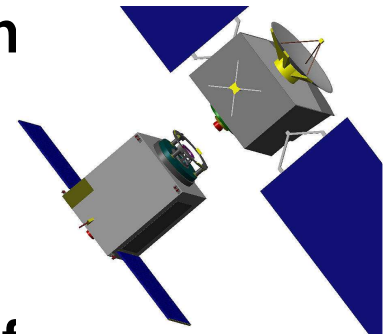
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- **On-orbit servicing is a “game-changing innovation”**
- **OOSS is a tool for satellites / fleet management, which:**
 - **Improves operational reliability**
 - **Increases returns on investment on space assets**
 - **Ensures better management of space environment**
 - **Delivers more system flexibility to the customers**
 - **Has a “green footprint” with the possibility to recycle space junk into satellites ...**

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➤ **Thales Alenia Space is committed in commercial and institutional studies (ESA, National, EC & Regional funds) studies of SPACE TUGS on various uses and missions :**

- **Support transfer maneuvers (& attitude control) of man and unmanned elements / payloads in LEO**
- **Rendezvous and docking with satellites for servicing, maintenance and disposition functions**
- **Support refueling operations or resource (fluids) transfer**



➤ **Thales Alenia Space ties with MIT on the ISS-SPHERES project (Synchronized Position Hold, Engage, Reorient, Experimental Satellites). Objective is to test instructions for spacecraft autonomous rendezvous and docking.**



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Thales Alenia Space outstanding expertise lie on :

- **Rendezvous, docking and operations, including attitude control and propulsive functions**
- **GNC algorithms including techniques for trajectory and on-board resources optimization**
- **Multipurpose robotic grapppling/capture and release devices (with vision system) addressing both collaborative and non-collaborative targets**
- **Solutions addressing final closing, alignment & robotic actions**
- **Lightweight structures (e.g. inflatable techniques for capture)**

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Thank you for your attention

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