

Italian Space Agency Space Debris Mitigation Activities Delegation Presentation

Luciano Anselmo

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Statistics (box score) since last IADC meeting

- 1 satellite launched, the Unisat 6 microsatellite (2014-06-19), on a 611 x 696 km and 98 deg orbit
- 2 orbital decays of microsatellites, E-STAR (2015-01-16) and Unicubesat (2015-02-16), from 70 deg inclined orbits
- 0 breakups/collision events
- 22 satellites in orbit: 16 in LEO, 1 in MEO, 5 in GEO
- 11 operational satellites
 - ASI: 6 in LEO (4 Cosmo-SkyMed, AGILE, LARES) + 1 in MEO (LAGEOS 2)
 - Ministry of Defense: 2 in GEO (SICRAL 1, with no N/S control, and 1B)
 - GAUSS : 2 microsats in LEO at 98 deg, Unisat 5 (587 x 633 km) and 6
- 2 spent rocket bodies in orbit
 - 1 in LEO/MEO (IRIS)
 - 1 in MEO (MAGE-1S)
- 0 end-of-life mitigation maneuvers

Report of debris mitigation measures

- The four ASI/MoD satellites of the COSMO-SkyMed Earth observation constellation, in sun-synchronous orbit at the altitude of 620 km, are maneuverable and conduct avoidance maneuvers when deemed necessary
- The same applies to the two MoD SICRAL satellites, in geosynchronous orbit, supported by a dedicated telescope
- The AGILE astrophysical satellite, in equatorial orbit (2.5 deg) at 484 x 504 km, has no orbit maneuvering capability and is partially operational with relaxed attitude requirements
- End-of-life re-orbiting, 400 km above GEO, is foreseen for the two SICRAL spacecraft managed by the Ministry of Defense
- The oldest spacecraft (SICRAL 1) will be re-orbited in 2018
- SICRAL 2 will be launched in April 2015

Conjunction analysis for COSMO-SkyMed (I)

Satellite	TCA Event		Range (Km)	Angle (deg)	Prob. Max.	Radial distance (Km)	Delta V1 (cm/sec)	Delta V2 (cm/sec)	Delta Mass (g)
SAR 4	Event 1 26/01/2014	PRE-MANOEUVRE	0,242	-41,891	1,219E-03	0,189			
		POST-MANOEUVRE	1,034	-41,891	6,60E-03	0,218	2,00	/	-17,0
SAR 2	Event 2 12/06/2014	PRE-MANOEUVRE	0,217	-9,626	2,007E-03	0,171			
		POST-MANOEUVRE	0,343	-9,626	0,712E-04	0,129	1,30	/	-12,0
SAR 3	Event 3 20/06/2014	PRE-MANOEUVRE	0,173	-0,312	4,554E-03	0,158			
		POST-MANOEUVRE	0,582	-0,312	4,380E-04	0,581	+14,50	-12,0	-223,0
SAR 2	Event 4 12/08/2014	PRE-MANOEUVRE	0,293	-0,214	1,033E-03	-0,343			
		POST-MANOEUVRE	0,516	-0,214	4,710E-04	-0,515	-6,0	8,8	-124,0
SAR 2	Event 5 29/08/2014	PRE-MANOEUVRE	0,248	-60,986	1,221E-03	0,044			
		POST-MANOEUVRE	1,791	-60,986	2,400E-03	0,049	-1,5	/	-13,0
SAR 1	Event 6 13/09/2014	PRE-MANOEUVRE	0,085	-73,668	2,012E-03	0,004			
		POST-MANOEUVRE	1,097	-73,669	5,100E-03	-0,014	2,20	/	-20,0

Conjunction analysis for COSMO-SkyMed (II)

SAR 1	Event 7 14/11/2014	PRE-MANOEUVRE	0,206	-5,580	2,782E-03	0,176			
		POST-MANOEUVRE	0,530	-5,580	4,410E-04	0,231	-1,5	/	-13,0
SAR 1	Event 8 15/11/2014 (multiple)	PRE-MANOEUVRE	0,176	-9,713	3,706E-03	-0,061			
		POST-MANOEUVRE	0,527	-9,711	4,380E-04	-0,494	-15,0	23,00	-320,0
SAR 1	Event 9 15/12/2014 (multiple)	PRE-MANOEUVRE	0,047	-9,673	3,060E-02	-0,061			
		POST-MANOEUVRE	0,347	-9,633	9,802E-04	-0,327	6,2	-2,0	-73,0

Conjunction analysis for SICRAL 1B in GEO

REFERENCE PERIOD	SECONDARY OBJECT	MIN. DISTANCE	EVASIVE MANEUVER PERFORMED
JANUARY 2014	RADUGA 1-8	9.713	NO
MARCH 2014	RADUGA 1-8	4.439	YES
APRIL 2014	RADUGA 1-8	9.697	NO
MAY 2014	RADUGA 1-8	3.387	YES
JUNE 2014	RADUGA 1-8	5.732	YES
JUNE 2014	GALAXY 2	6.182	NO
JULY 2014	RADUGA 1-8	5.668	YES
SEPTEMBER 2014	RADUGA 1-8	4.829	NO
JANUARY 2015	RADUGA 1-8	2.436	YES
MARCH 2015	STTW-T2	3.701	NO (*)
MARCH 2015	SL 12 RB 2	2.665	NO (*)

(*) Collision avoidance maneuver needed, but it was impossible to perform it because the two objects were contemporarily too close to SICRAL 1B.

Other activities related to orbital debris (I)

- **Studies and Activities**

- STARDUST: The asteroid and Space Debris network (Initial Training Networks, Marie Curie Action of the European Community), with current research activity on orbital dynamics in MEO (IFAC-CNR)
- University of Rome “La Sapienza” is involved in optical observation campaigns, in cooperation with IRA-INAF (Medicina) for LEO tumbling rockets and with IFAC-CNR for the physical characterization of GEO objects using the Loiano 1.5 m telescope
- ESA funded study on Fragmentation Consequence Analysis in LEO and GEO (IFAC-CNR, ISTI-CNR and University of Southampton)
- ESA funded study on Disposal Strategies Analysis for MEO Orbits (IFAC/CNR, ISTI/CNR, University of Southampton, IMCCE and University of Strathclyde)
- Participation in the IADC Test Reentry Campaign 2014 (ISTI-CNR)

Other activities related to orbital debris (II)

- **Studies and Activities**

- ESA funded contract on development and validation of debris cloud engineering models for assessing the vulnerability of spacecraft internal equipment (CISAS)
- ESA funded contract on development of catastrophic breakup models accounting for spacecraft structure and impact point (CISAS)
- Memorandum of Understanding between CISAS and CARDC (China) for collaboration on spacecraft vulnerability, as well as catastrophic breakup models development
- Contribution to IADC action item 31.5 on the potential benefits of active debris removal in LEO (IFAC-CNR)
- Contribution to the IADC WG-2 internal task concerning the review of uncertainty sources affecting the long-term predictions of the evolutionary space debris models (ISTI-CNR and IFAC-CNR)

Summary and outlook

- **Most important events since last IADC**

- IADC related activities continued
- A limited level of research activity was maintained in very tight economic conditions
- Most of the funding came from ESA, the European Union (EU) and the National Research Council (CNR)

- **Planned work until next IADC**

- Participation in the next reentry test campaign and in the IADC action items
- Activation of a new national Space Debris Project (2015-2017), funded by ASI and managed by the National Institute of Astrophysics (INAF)
- Italian participation in the EU Space Surveillance & Tracking Program (Commission Implementing Act of the European Commission on the Decision n. 541/2014/EU of the European Parliament and of the Council establishing a Framework for Space Surveillance and Tracking Support)