



AGI

Indian ASAT Test Post-Event Analysis

Dan Oltrogge and T.S. Kelso

AGI's Center for Space Standards and Innovation (CSSI)

Bob Hall

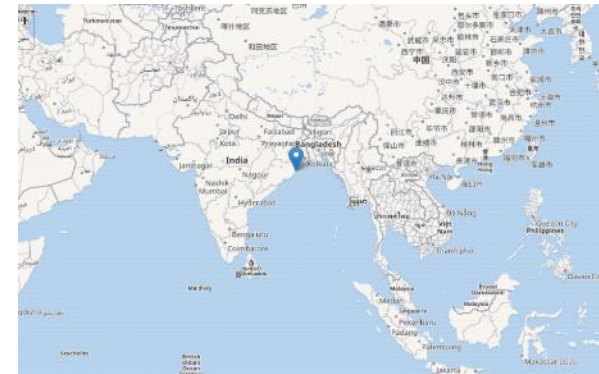
AGI's Commercial Space Operations Center (ComSpOC)

India ASAT test occurred 27 March 2019

- Indian government announced “Mission Shakti” successful test of new ASAT weapon
- Reconstructed plausible scenario based on their disclosures and public data
- Key elements of information:



- Time to intercept was less than 3 minutes
- NOTAM blocked out area of Indian Ocean
 - Indicated Microsat-R satellite (282 km alt.)
 - Military imaging satellite mass of 740 kg
 - Launched January 2019
- 18SPCS announced tracking of 250 debris
- As of 3 May, orbital elements for 94 fragments have been published



Notice to Airman (NOTAM)



Safety: NavArea VIII, India
SafetyNET, NAVAREA/METAREA Warning, MET Forecast or Pracy Warning to NAVAREA/METAREA

NAVAREA VIII 248.

CENTRAL BAY OF BENGAL AND NE INDIAN OCEAN.

CHARTS IN 31 351 352 707I (INT 71).

1. EXPERIMENTAL FLIGHT TRIAL SCHEDULED FROM ITR ON 27 AND 30 MAR 19 FROM 0430 TO 0830 UTC IN DANGER AREA BOUNDED BY 20-48.06N 087-02.24E, 18-07.27N 086-25.03E, 01-46.62N 087-30.52E, 02-57.91N 093-50.49E, 18-33.79N 088-46.21E, 20-48.95N 087-06.99E. WIDE BERTH ADVISED.

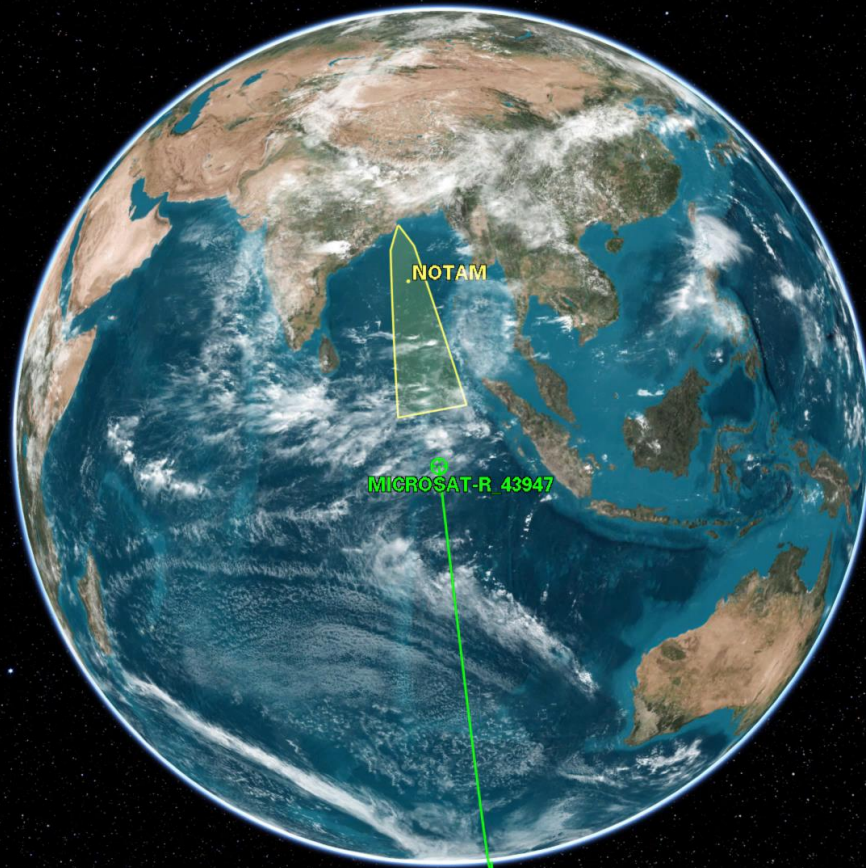
2. CANCEL THIS MSG 300930 UTC MAR 19.



<https://i.imgur.com/AYMhKBj.jpg>

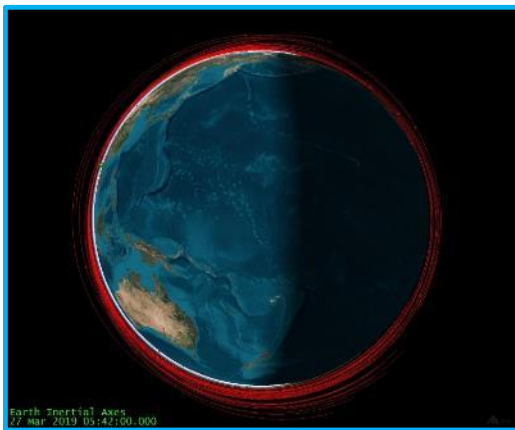
Representative scenario of intercept

27 Mar 2019 05:37:00.50

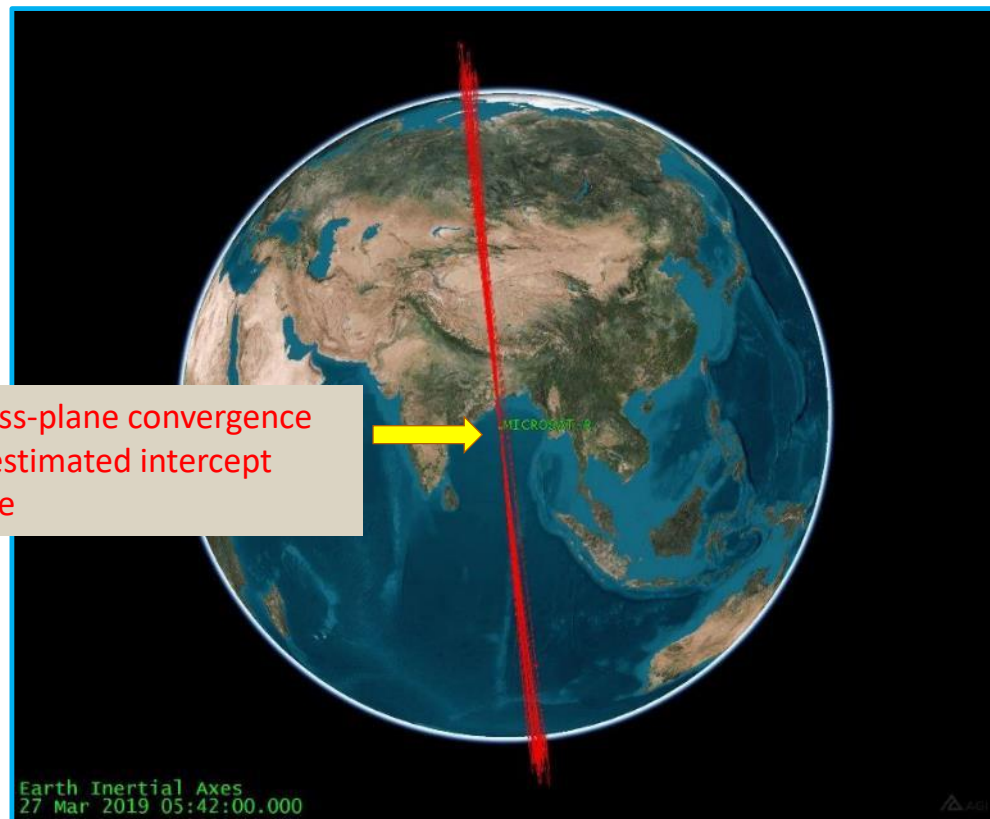


18SPCS TLEs confirm assumed impact location

- First 58 TLEs released 5 Apr
- Cross-plane convergence of fragments consistent with our reconstructed time of 05:42 UTC



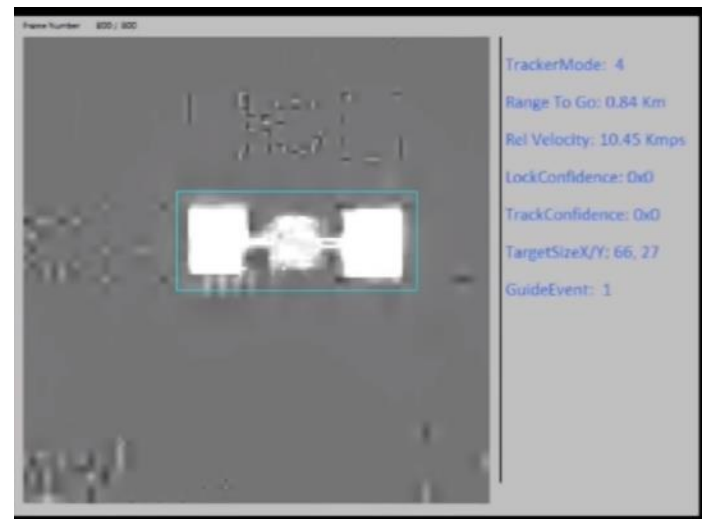
Cross-plane convergence
at estimated intercept
time



India published mission details 7 April

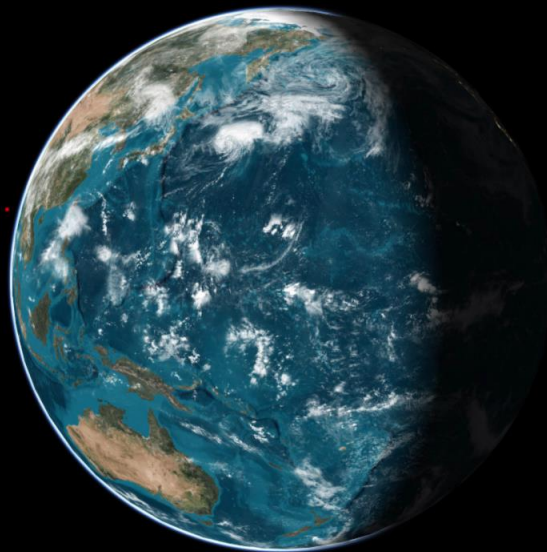


Official ASAT - Anti Satellite Missile Mission / Mission Shakti Video by DRDO
115,081 views



Discrete fragmentation simulation

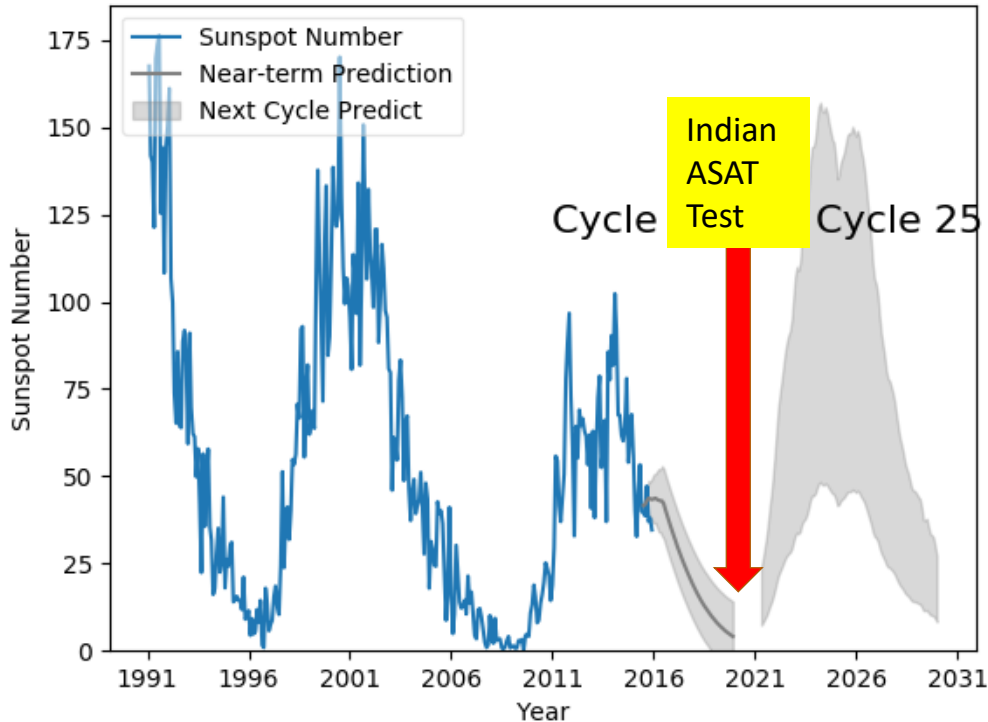
27 Mar 2019 05:00:00.00



Note high apogees for some RSOs

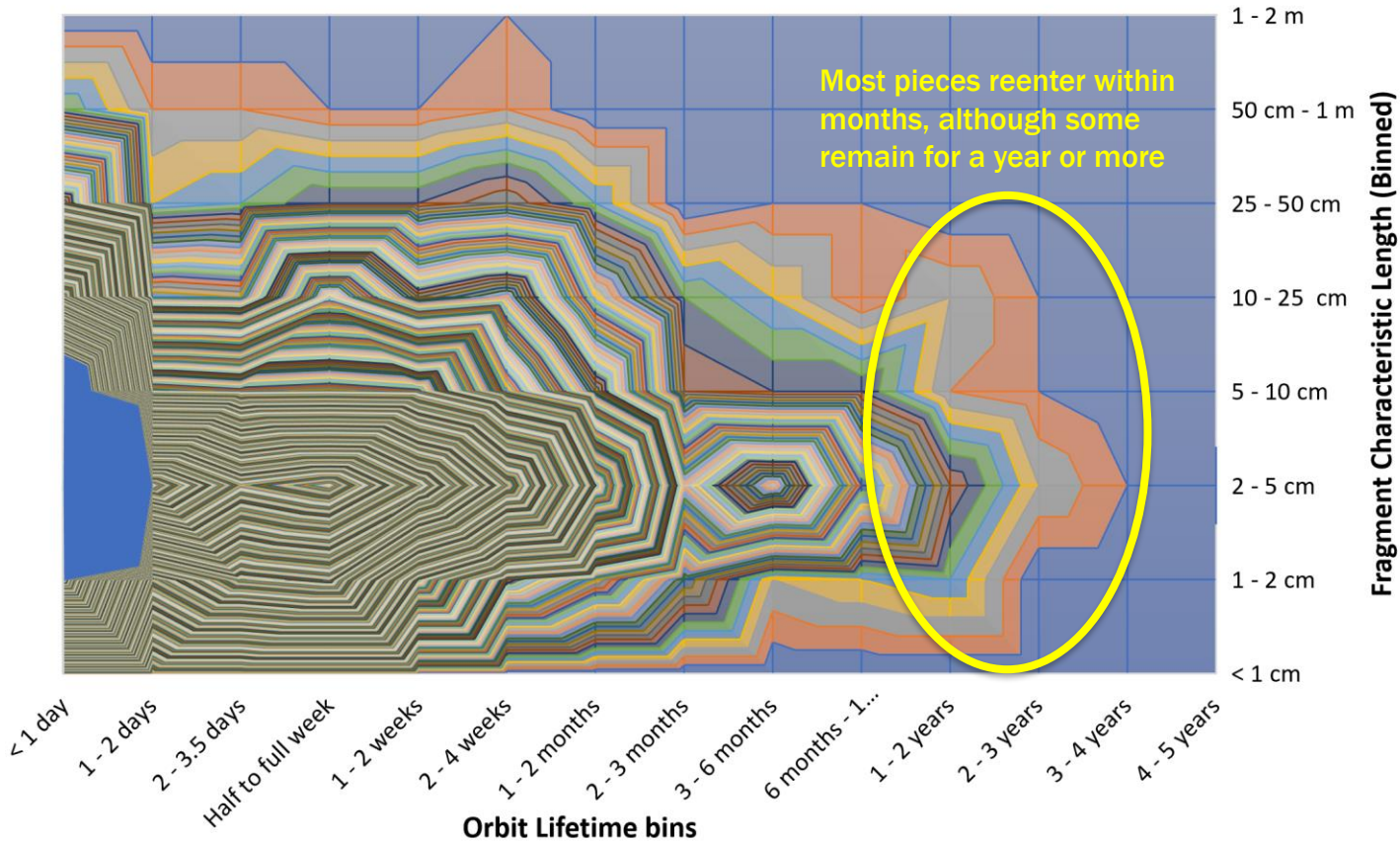
Impact of Solar Cycle on debris lifetime

- Unfortunately “between” solar cycles #24 and #25, maximizing lifetime



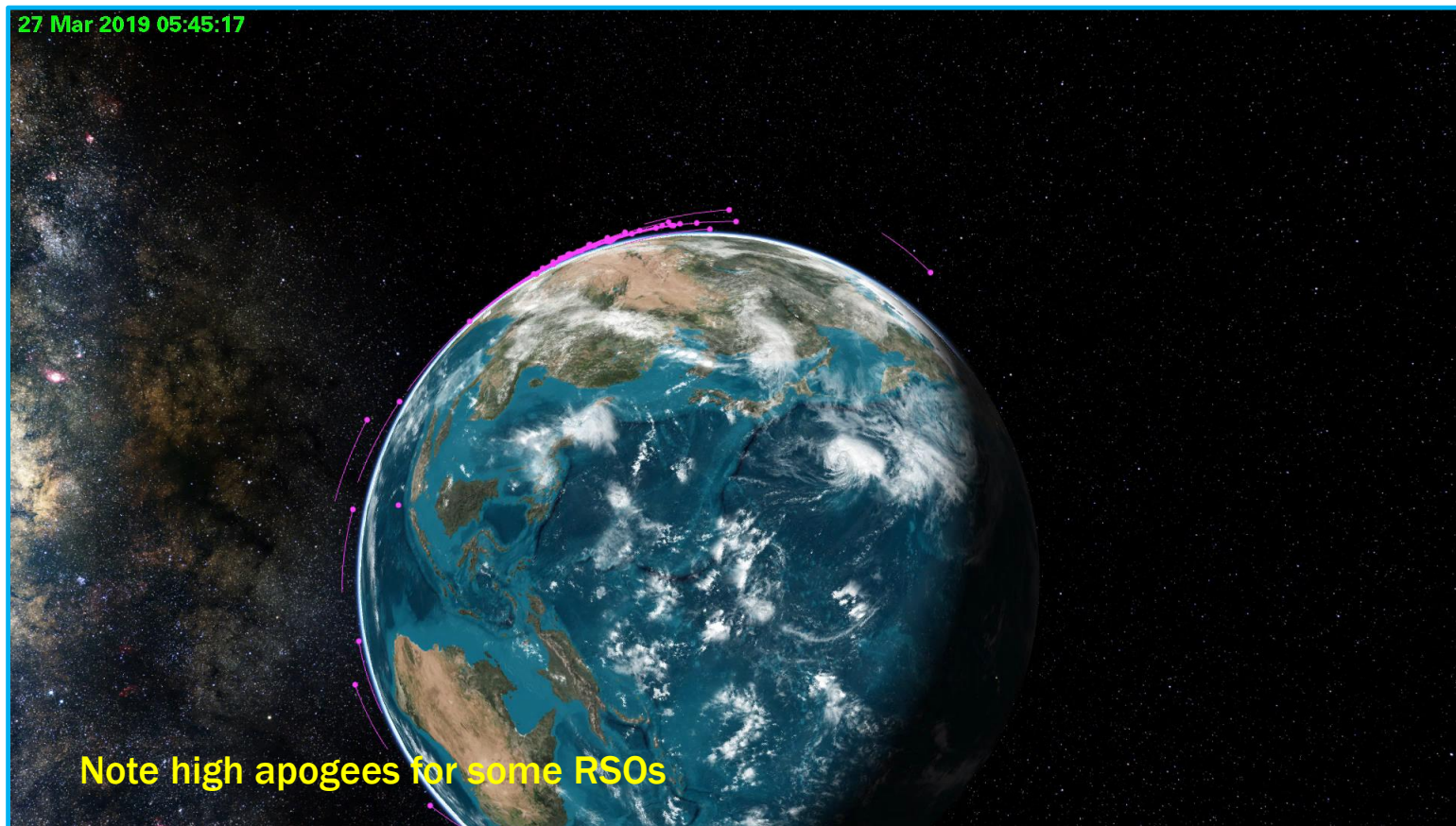
Discrete simulation fragment orbit lifetime

Simulated using ESA enhancement to NASA standard breakup model



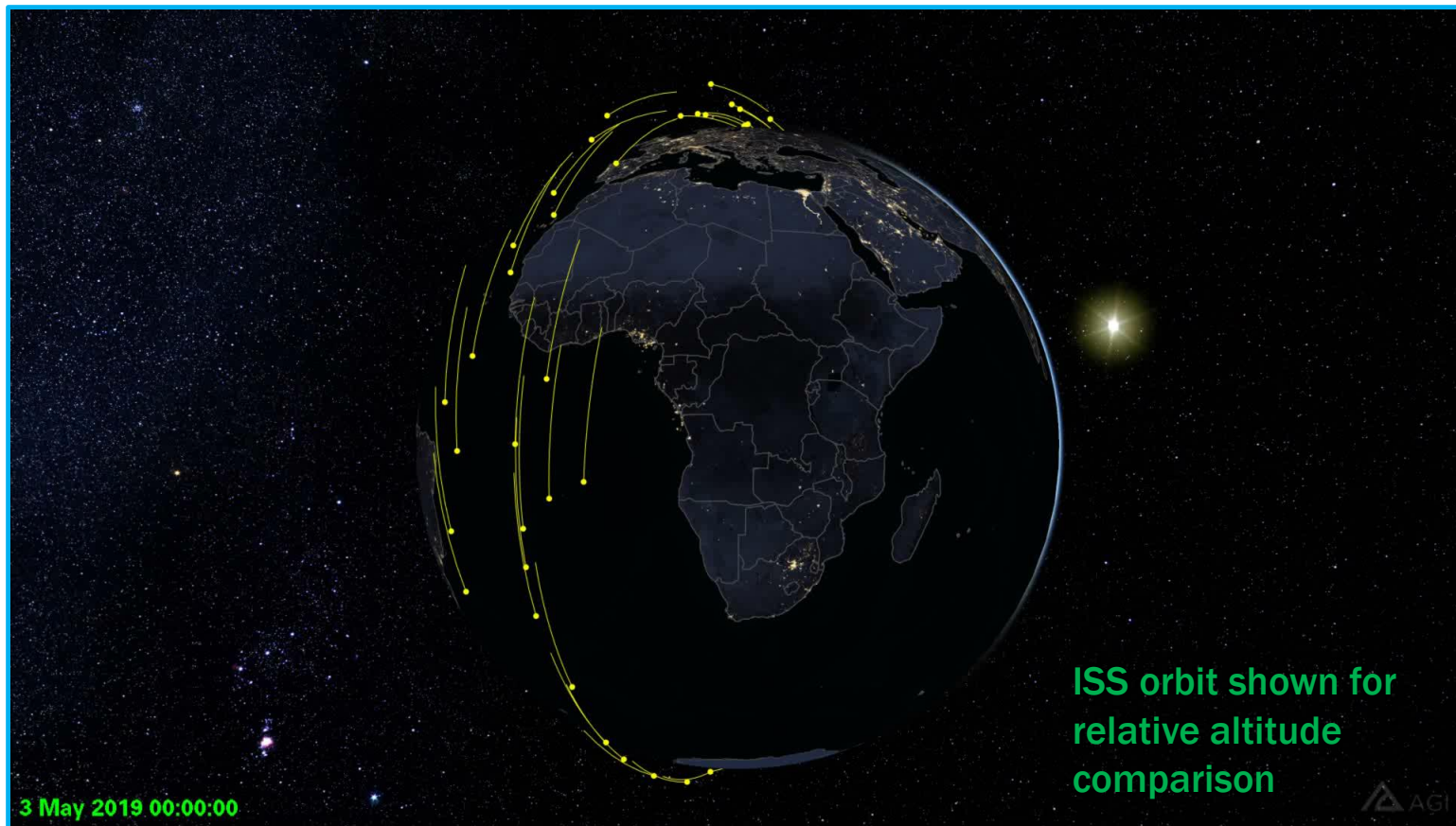
Fragments tracked by 18th SPCS

27 Mar 2019 05:45:17

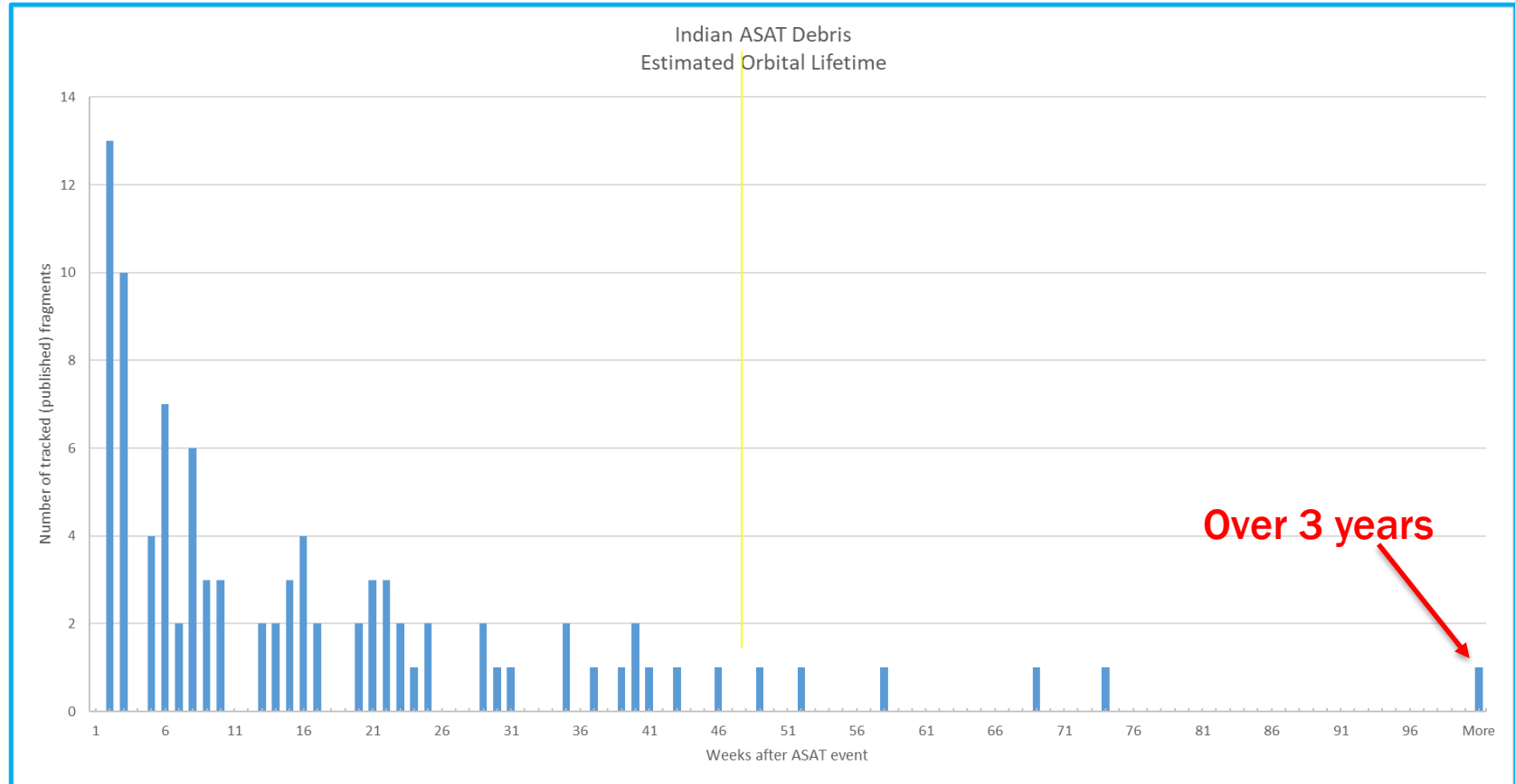


Note high apogees for some RSOs

Fragments tracked by 18th SPCS – 5 weeks later



Lifetime Analysis of tracked fragments



Potential effect on operational spacecraft



- Using its volumetric assessments and data, DREAD* tool flies active spacecraft through the fragment likelihood 3D characterization to assess spacecraft placed at greatest risk of secondary collision
- “Top 25” list correctly identifies Microsat-R (nice quality control check)
- Quite a few commercial CubeSat missions placed at risk
- **ISS (ZARYA), SSC 25544, is #58 on the list**

SSC	Intl Desig	Integrated likelihood of fragment's presence
43947	MICROSAT-R	1.77E-08
43876	KANOPUS-V 5	4.16E-10
40037	PERSEUS-M2	3.85E-10
43880	UWE-4	3.32E-10
43905	FLOCK 3K-10	3.30E-10
43891	OBJECT R	3.20E-10
43904	FLOCK 3K-11	3.10E-10
38707	KANOPUS-V 1	3.07E-10
43906	FLOCK 3K-9	2.34E-10
43913	YUNHAI-2 5	2.25E-10
43881	D-STAR ONE (SPARROW)	2.03E-10
81427	UNKNOWN	1.77E-10
43907	ZACUBE-2	1.66E-10
43908	LUME 1	1.55E-10
40025	QB50P1	1.50E-10
89341	UNKNOWN	1.46E-10
43600	AEOLUS	1.38E-10
41731	QSS (MOZI)	1.32E-10
43181	KANOPUS-V 4	1.31E-10
43903	FLOCK 3K-12	1.31E-10
38708	BKA 2	1.27E-10
40039	PERSEUS-M1	1.22E-10
43882	LEMUR-2	1.20E-10
81661	UNKNOWN	1.20E-10
43180	KANOPUS-V 3	1.16E-10

* Debris Risk Evolution And Dispersal tool



- **Both debris fragmentation modeling and post-event orbital data show**
 - Debris spread different than was claimed
 - At least a dozen tracked, publically released pieces pushed into higher orbits, resulting in higher risk for operational spacecraft
 - Debris lifetime different than was claimed
 - Most debris will reenter within several months (not 6 weeks)
 - Some debris will be up for a year or more

Thank you and Questions ...



Dan Oltrogge (oltrogge@agi.com)

+1 719-482-4552

Bob Hall (rhall@agi.com)

+1 610 981-8076

