Space Debris Mitigation Activities in Indonesia

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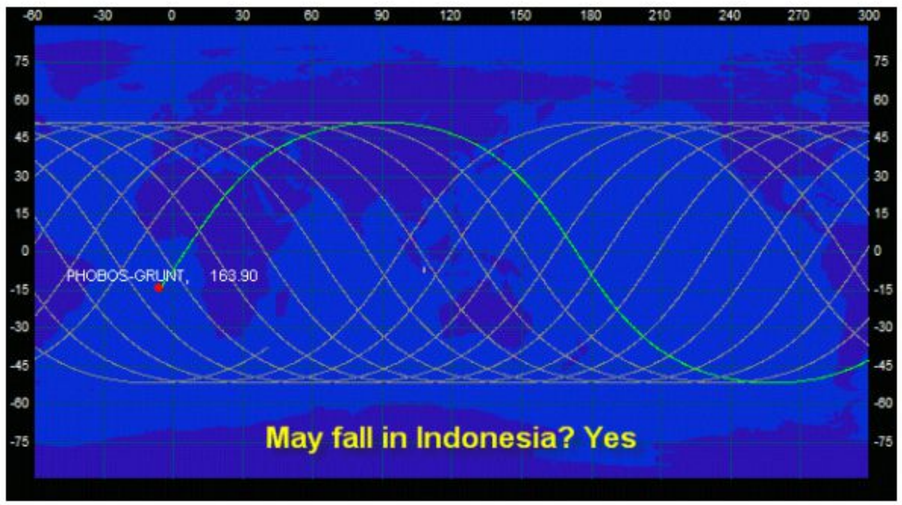
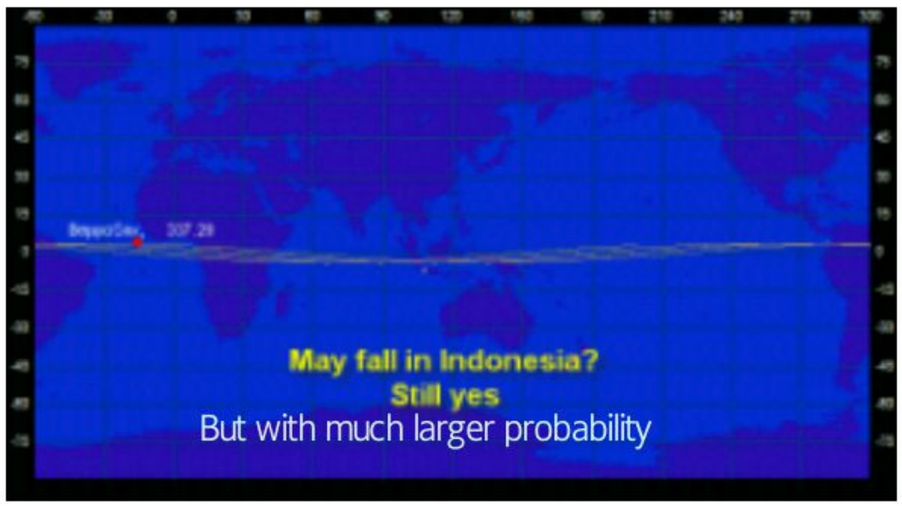
Outline

1. Why do we need to be concerned?
2. The development of standard operating procedure for mitigating risks from reentry of space debris
3. Our notes on monitoring reentry of space debris in Indonesia
4. Our notes on debris population
5. Implementation of the space debris mitigation guidelines
6. Final words

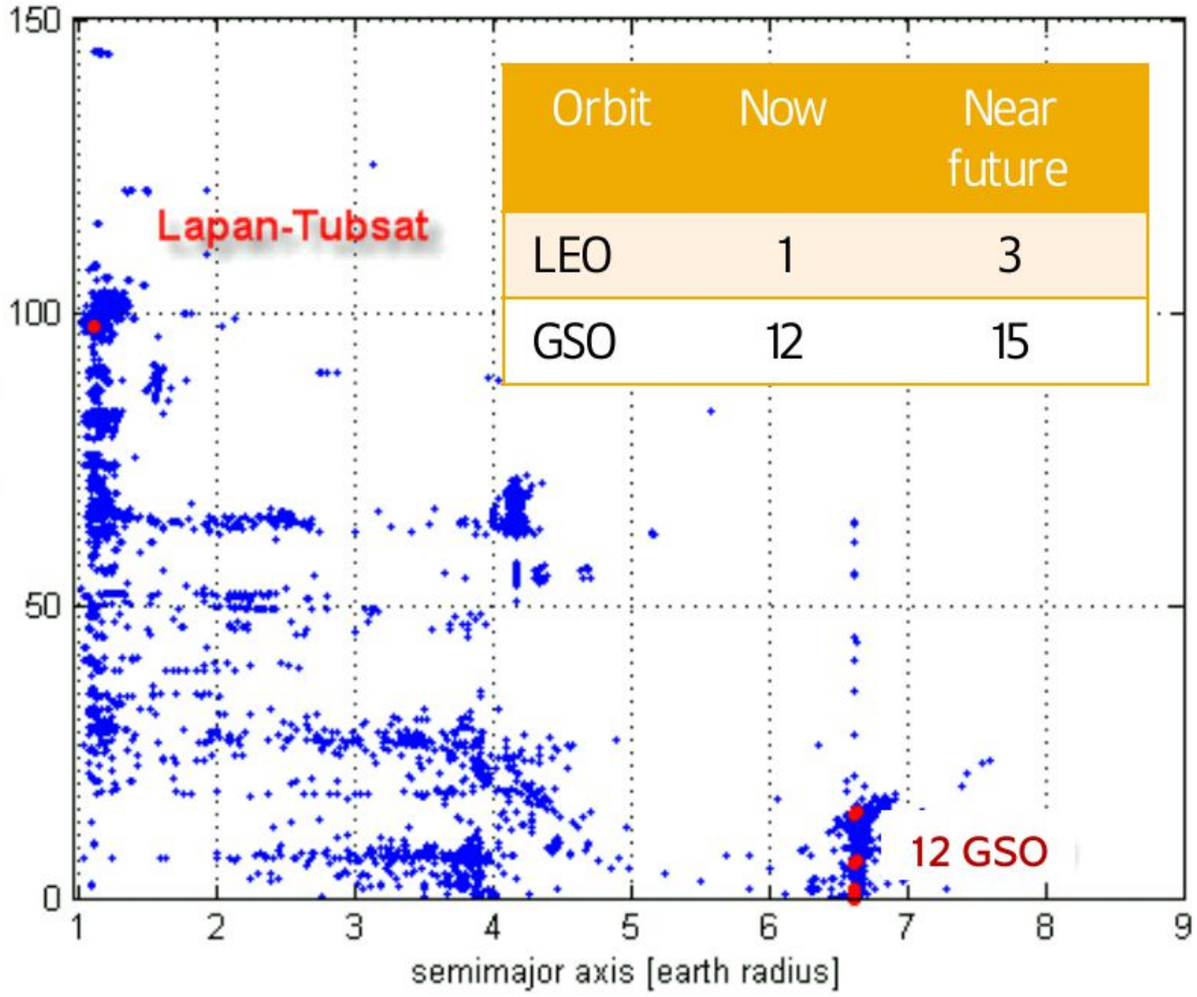
Why do we need to be concerned?

- With a large geographical region extending in the equator, every large reentering space objects always have potential to fall in Indonesia regardless of their inclination.



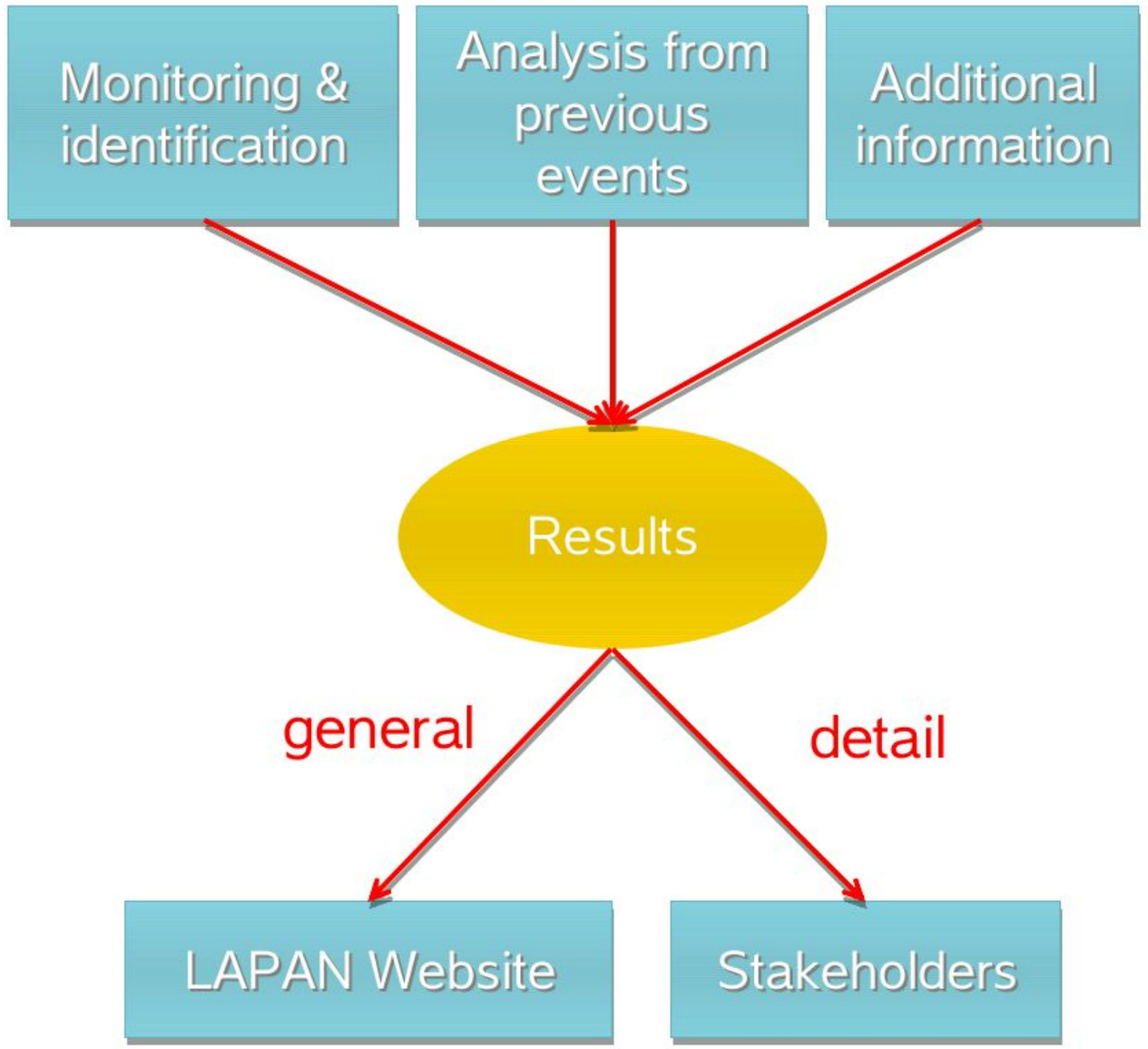


- The probability of collision between space debris and Indonesian satellite is getting bigger because of the increasing number of them both.

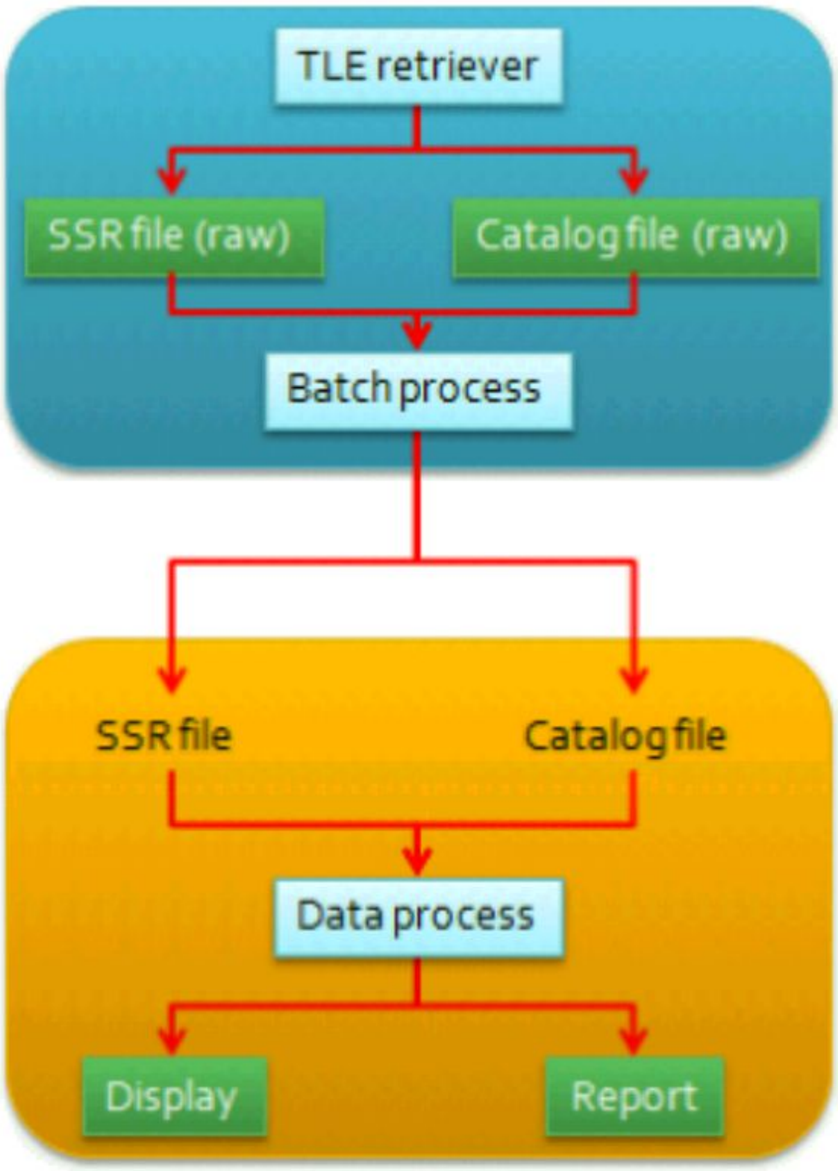


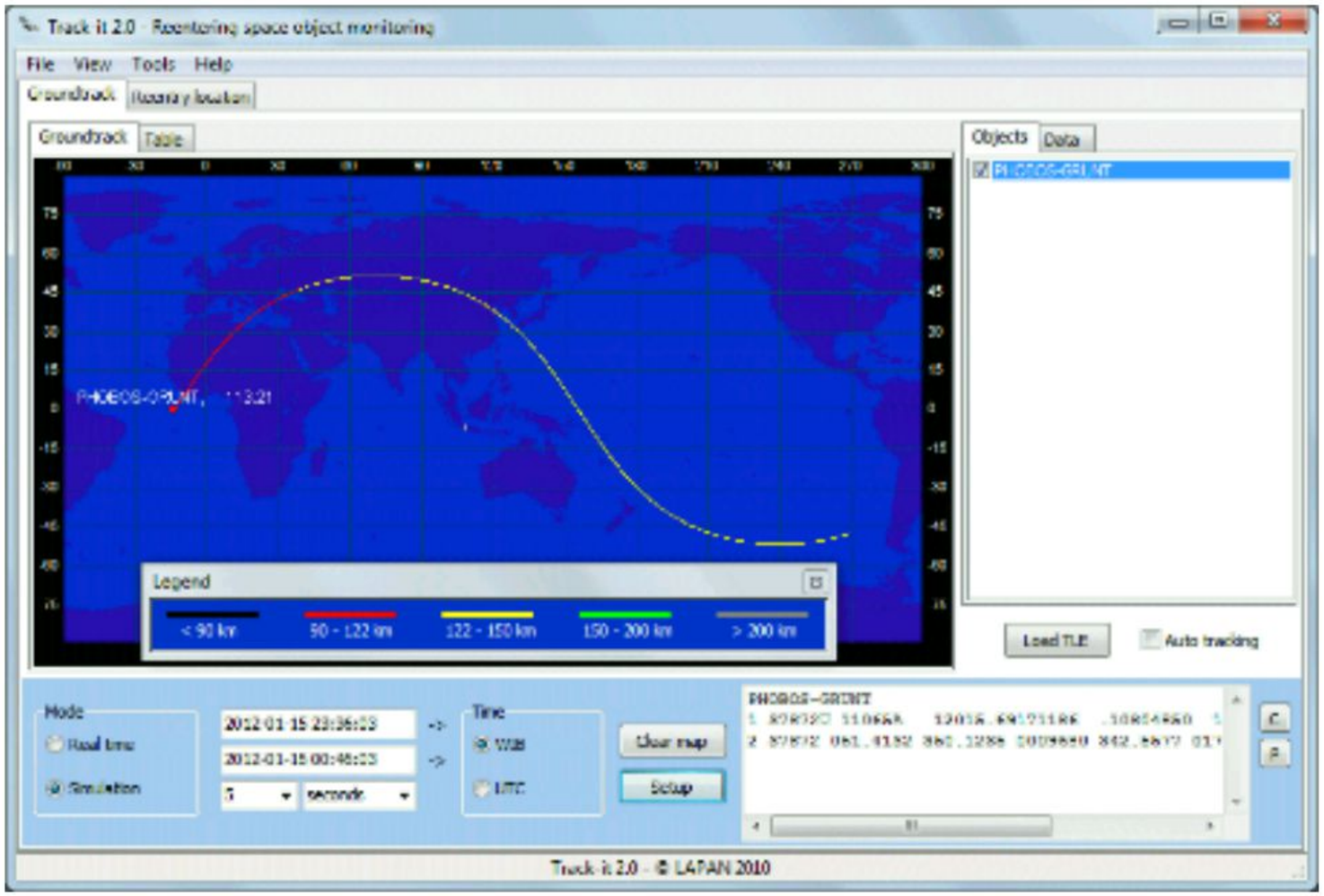
The development of standard operating procedure for mitigating risks from reentry of space debris

- The SOP involves LAPAN for monitoring and identifying the reentering space debris (natural and main-made) together with other stakeholders
- Analysis of space debris related problems is carried out mainly by using TLE (two-line elements) and TIP (tracking and impact prediction) report from Space-Track
- Utilizing popular tracking software only (before 2011)
- Utilizing our own information and dissemination system beside popular tracking software (since 2011)

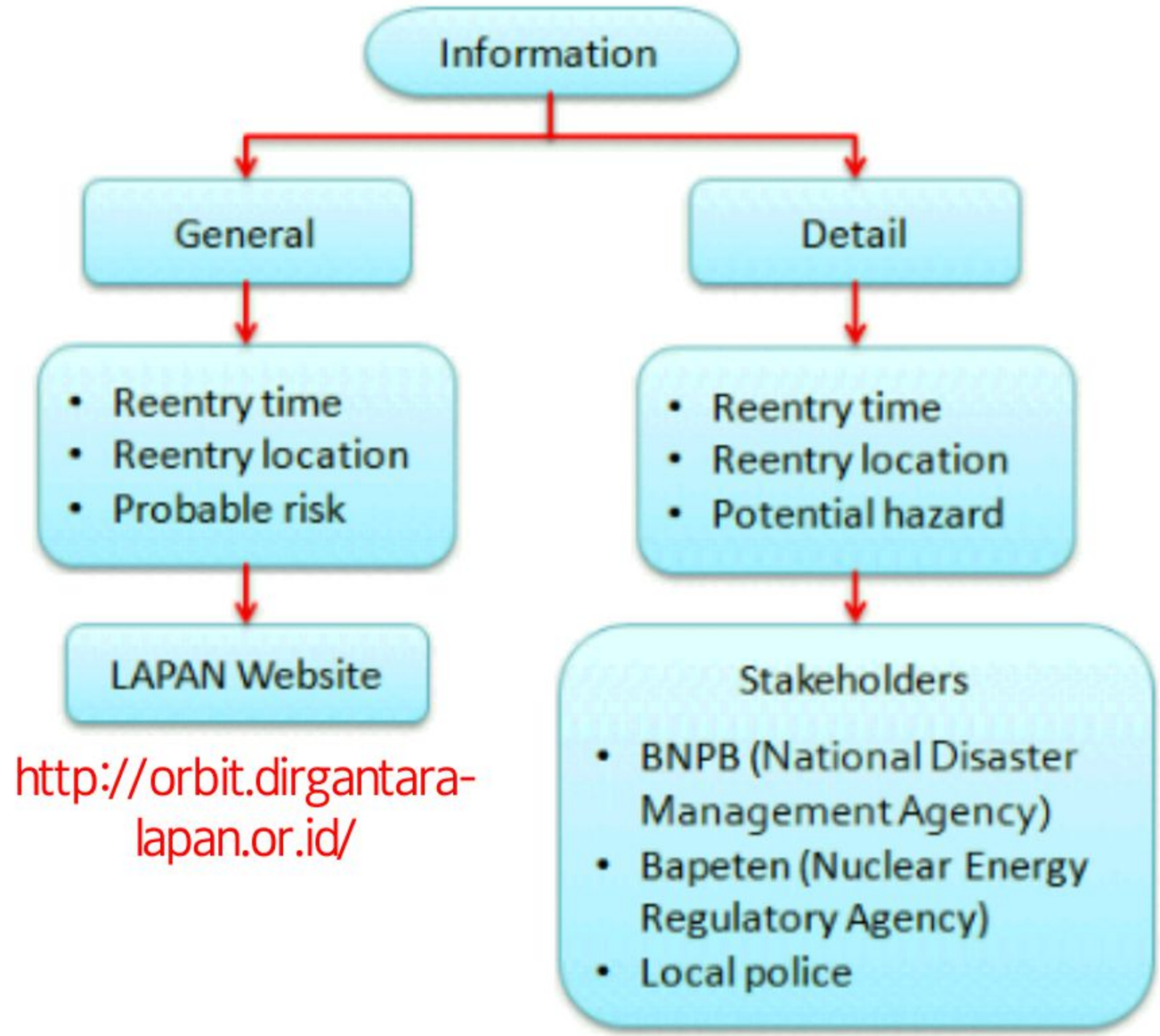


Information system





Dissemination system



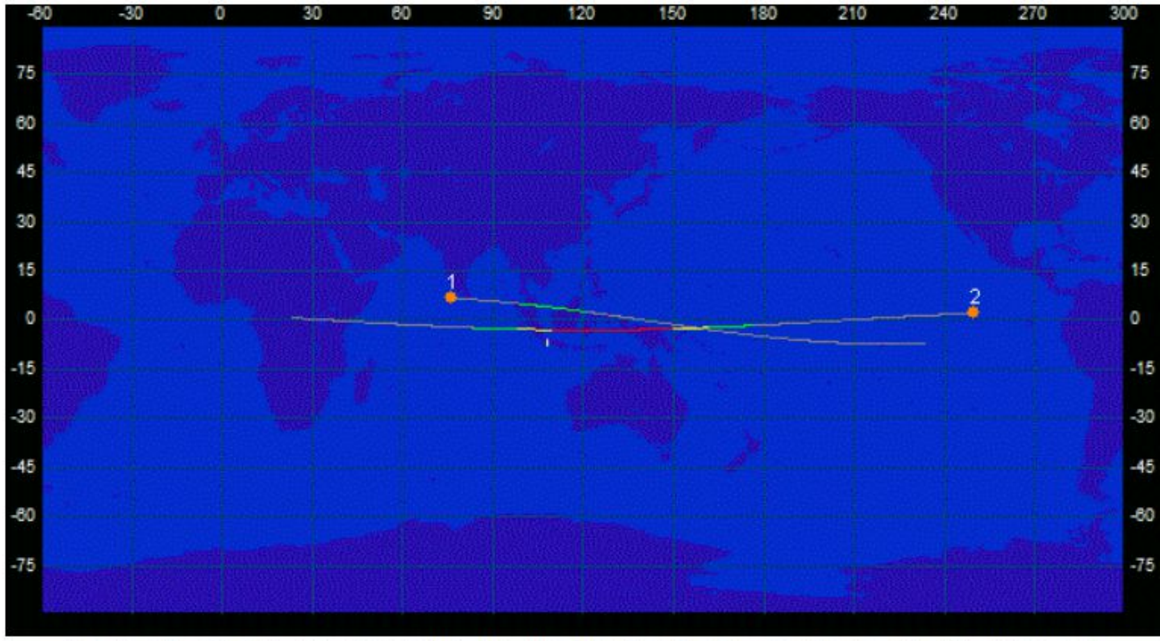
http://orbit.dirgantara-lapan.or.id/

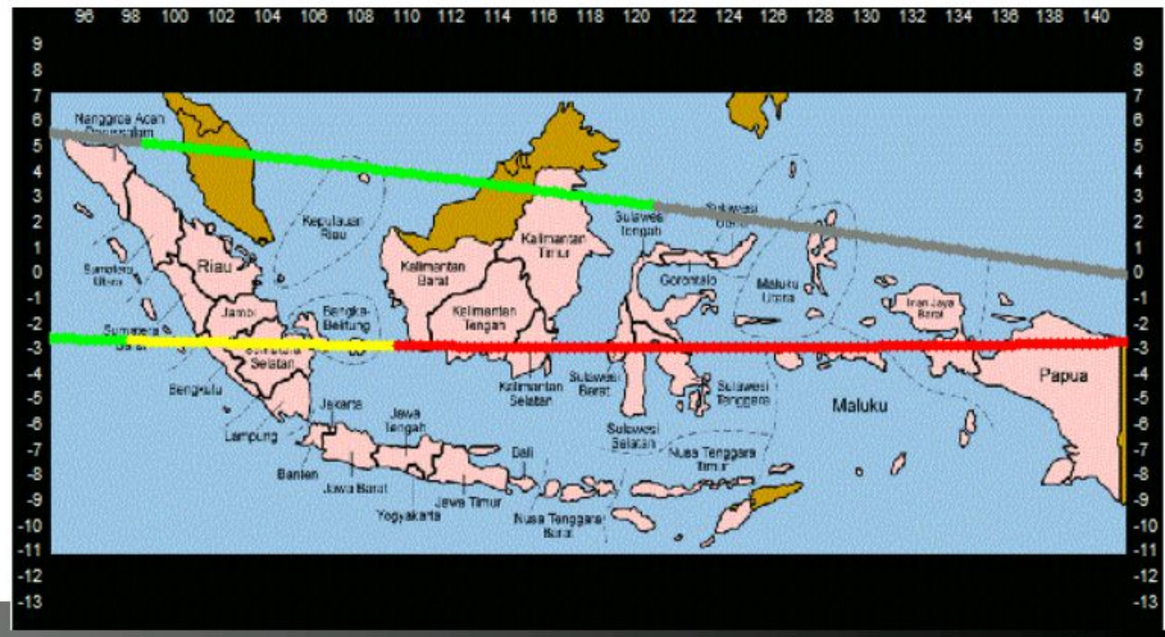
Sample report: reentry of BSAT-2B satellite in January 2014

Last update: 2014-01-27 22:02:30 WIB (update tiap menit, refresh manual browser anda)

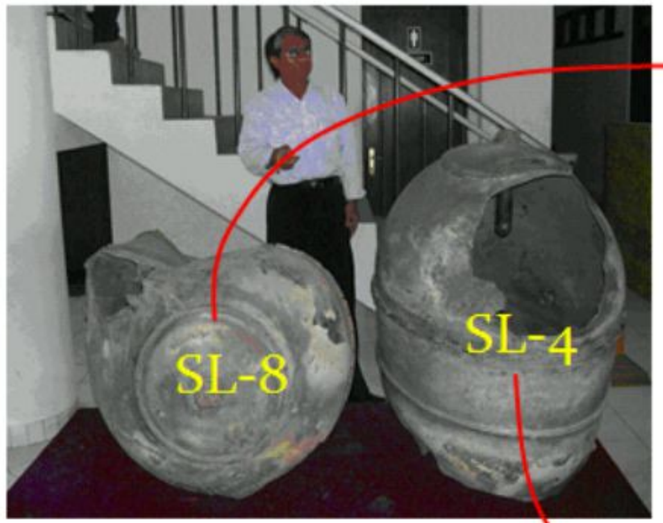
no	nama	catnum	pemilik	RCS	altitude [km]	prediksi jatuh*
1	ARIANE 44L R/B	21766	FR	14.2869	535.03	2014 November 3
2	BSAT-2B	26864	JPN	4.4326	578.32	2014 January 29
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

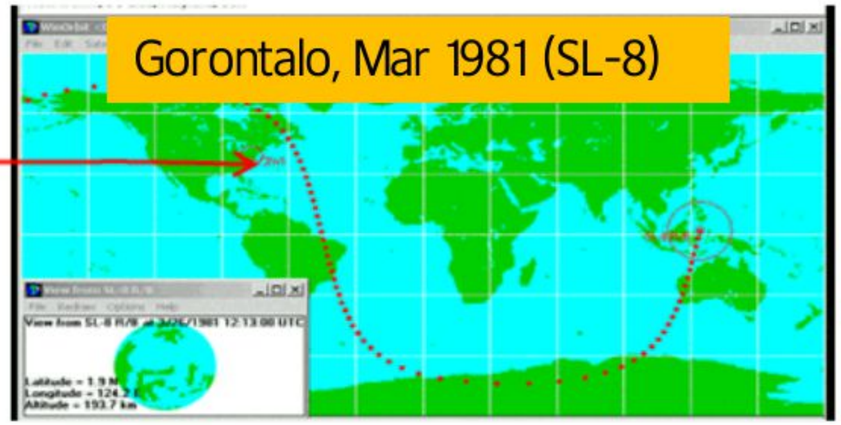
* Berdasarkan SatEvo v0.51

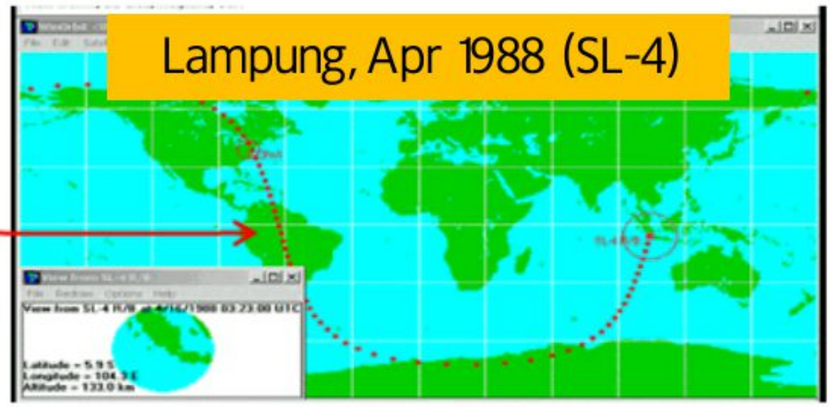




Our notes on monitoring and identification of reentry of space debris before 2011





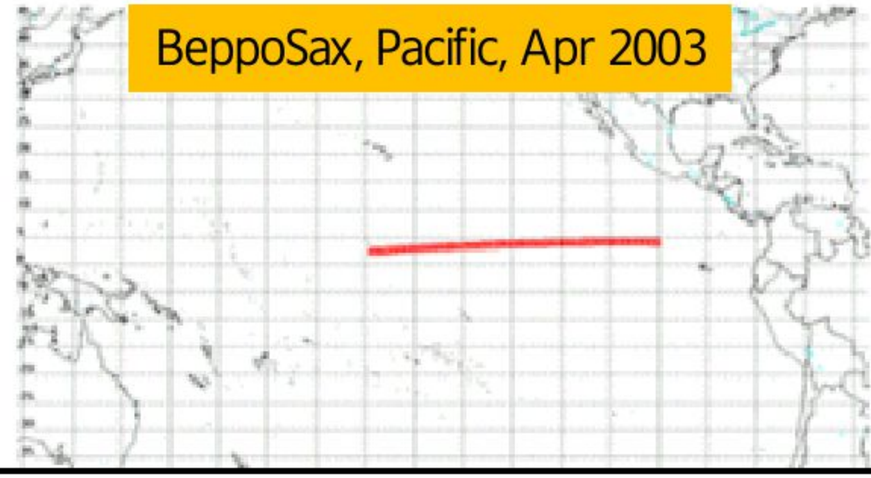


lit BeppoSAX telah jatuh pada 30 April 2003.

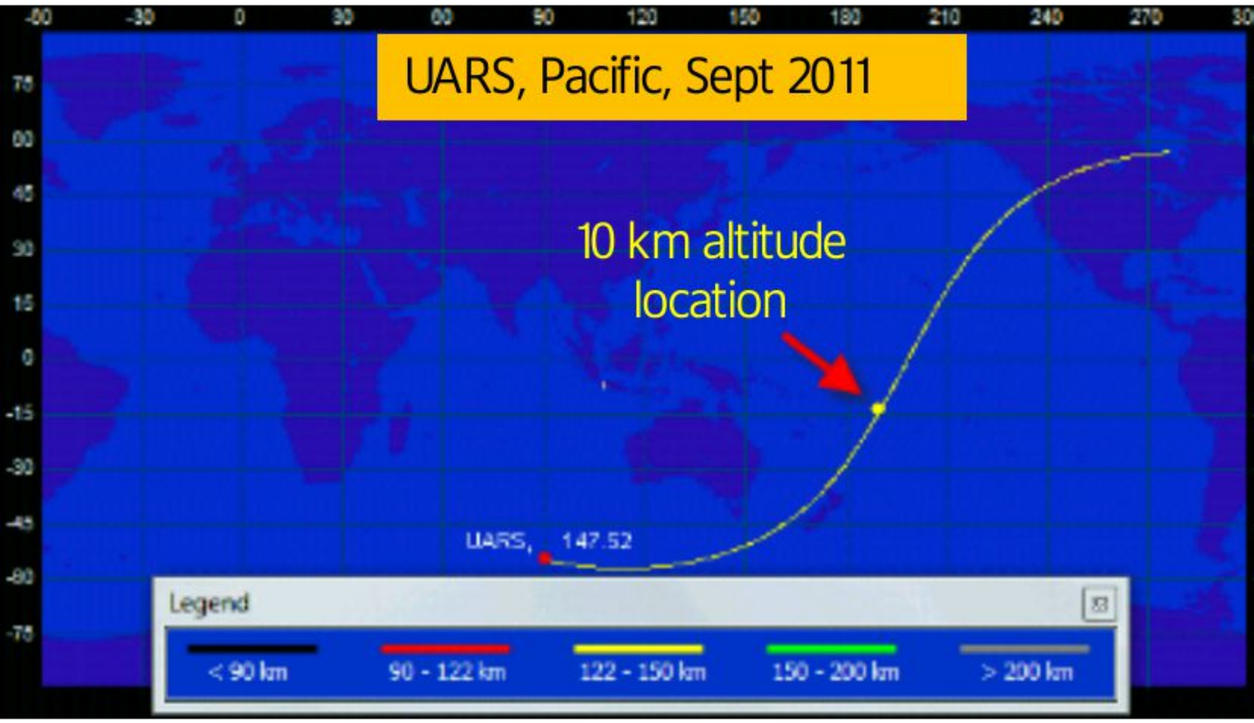
iraan waktu dan lokasi jatuh:

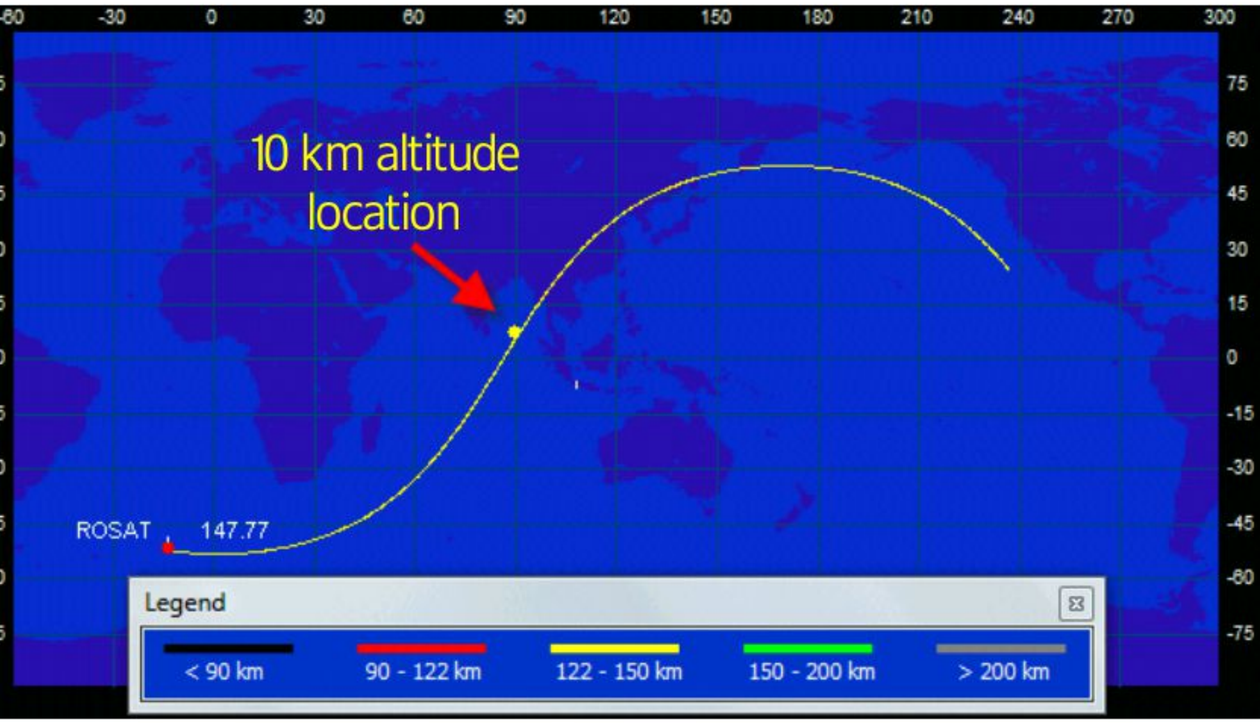
NASA : 30 April 2003, pukul 05:01 (+/- 7 menit) WIB
Di Lautan Pasifik sekitar 4° LU, 130° BB

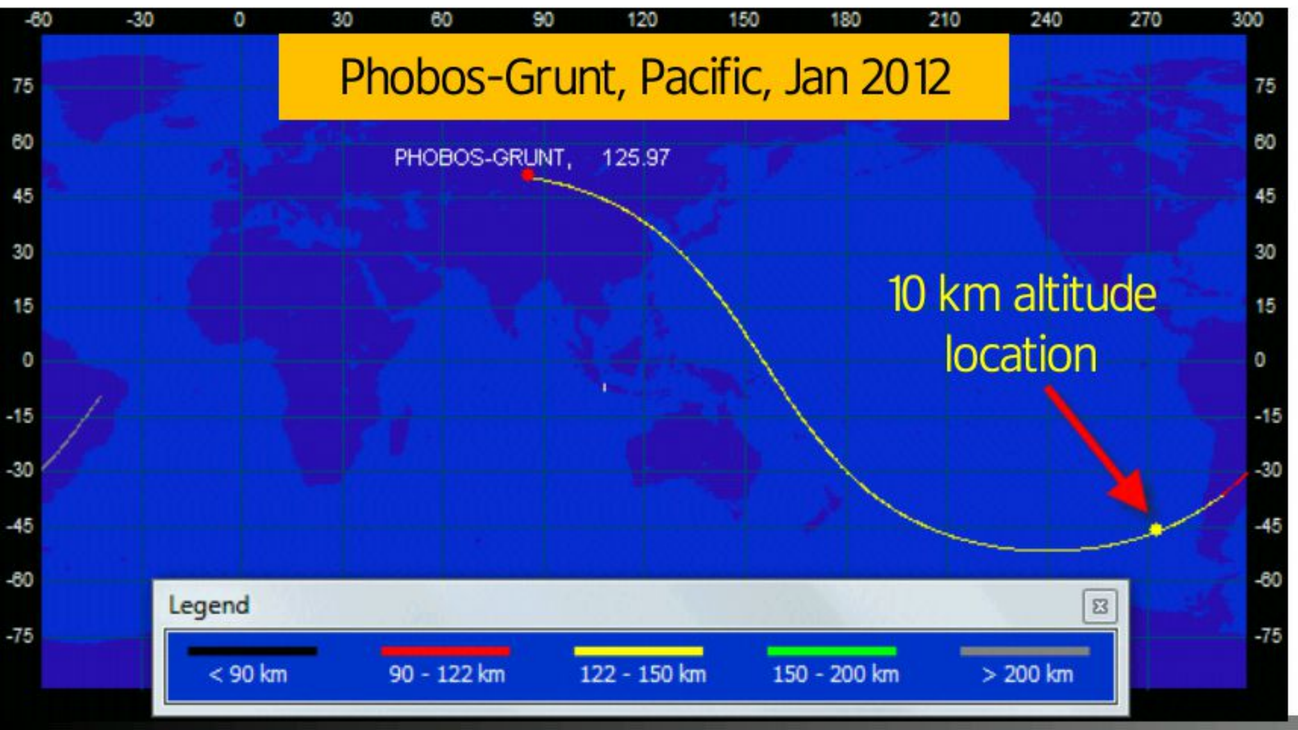
SatEvo : 30 April 2003, pukul 05:10 WIB
Di Lautan Pasifik sekitar 3,95° LU, 100° BB



Our notes on monitoring reentry of space debris since 2011

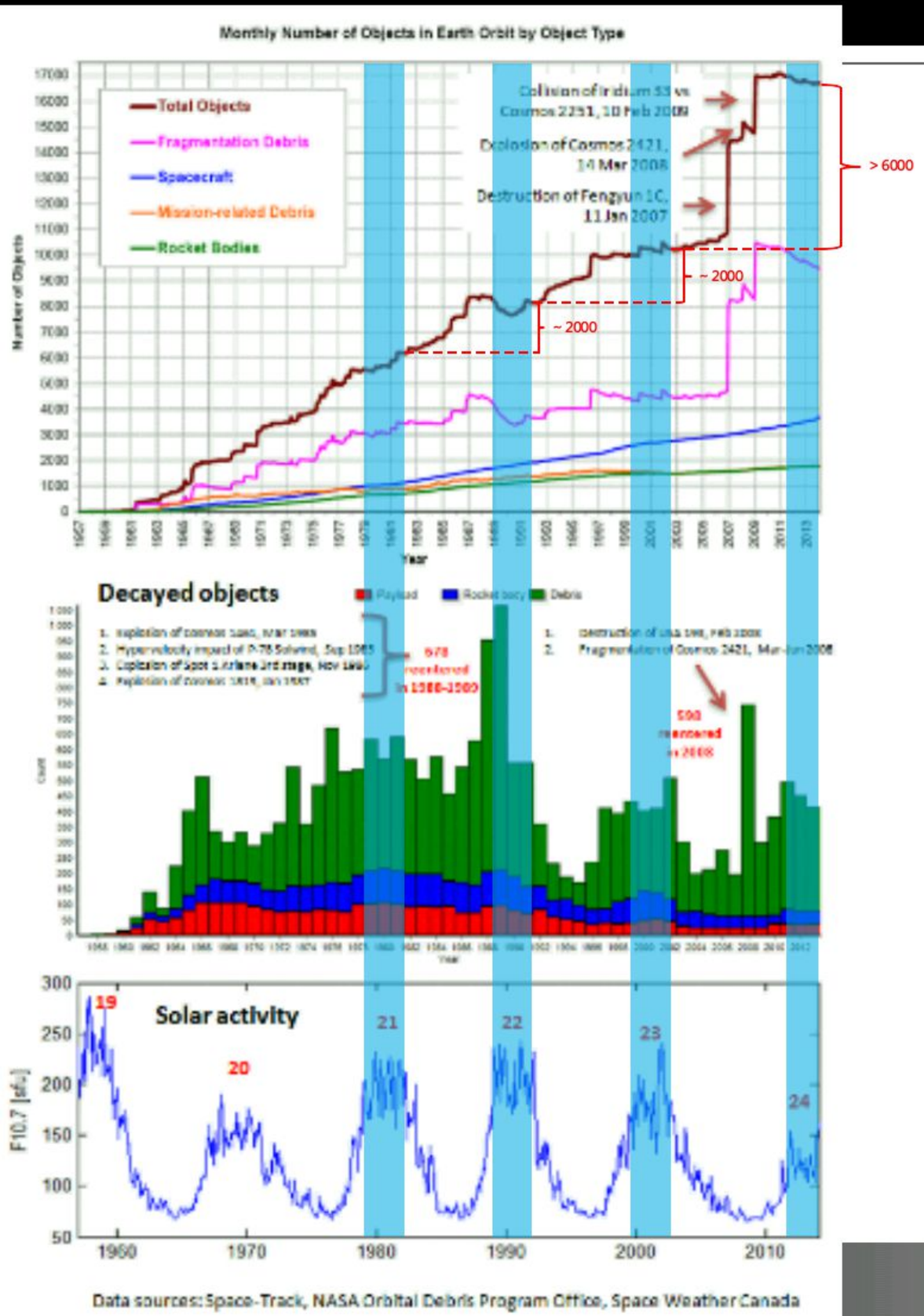






One day before reentry we could predict that Indonesia will be safe from the impact of UARS and ROSAT but not until less than 4 hours before reentry for Phobos-Grunt which, as we experienced, had an unusual and limited Tracking and Impact Prediction Report on Space-Track.

Our notes on debris population



We notice that the number of reentered space debris related with the increasing solar activity in the latest solar cycle is incomparable with the increasing number of fragmentation debris after 2007. In fact, we now face a lot more challenging situation compare with the previous two cycles.

Our study found that if we consider only objects with nearly circular orbits, their spatial density trends for altitude from 400 until 700 km in 100 km bin were increasing from 2009 until late of 2013 despite the decreasing number of the total number of space objects in that period.

Implementation of the space debris mitigation guidelines

Efforts to minimize the threat from existing debris in GEO region have been done since 1981 by sending Palapa 1 to its disposal orbit. However, no implementation of space debris mitigation guidelines in LEO region has been conducted so far.

Predicted conjunction between LAPAN-TUBSAT and Space Object (contd..)

NO	TIME APPROACH	CLOSED DISTANCE
7	Primary Object: LAPAN-TUBSAT (SCC# 29709) Secondary Object: SCC# 27609 Time of Closest Approach: 04 SEP 2012 at 17:21 UTC	Overall miss distance: 630 meters Radial (dU) miss distance: 189 meters In-Track (dV) miss distance: 536 meters Cross-track (dW) miss distance: -274 meters
8	Primary Object: LAPAN-TUBSAT (SCC# 29709) Secondary Object: SCC# 25442 Time of Closest Approach: 14 SEP 2012 23:49 UTC	Overall miss distance: 553 meters Radial (dU) miss distance: 63 meters In-Track (dV) miss distance: 6 meters Cross-track (dW) miss distance: -550 meters
9	Primary Object: LAPAN-TUBSAT (SCC# 29709) Secondary Object: SCC# 3386 Time of Closest Approach: 22 NOV 2012 15:09 UTC	Overall miss distance: 185 meters Radial (dU) miss distance: -52 meters In-Track (dV) miss distance: -105 meters Cross-track (dW) miss distance: -144 meters
10	Primary Object: LAPAN-TUBSAT (SCC# 29709) Secondary Object: SCC# 18422 Time of Closest Approach: 29 JAN 2013 22:09 UTC	Overall miss distance: 283 meters Radial (dU) miss distance: 99 meters In-Track (dV) miss distance: -2 meters Cross-track (dW) miss distance: -266 meters
11	Primary Object: LAPAN-TUBSAT (SCC# 29709) Secondary Object: SCC# 14820 Time of Closest Approach: 02 NOV 2013 20:12 UTC	Overall miss distance: 40 meters Radial (dU) miss distance: 28 meters In-Track (dV) miss distance: 2 meters Cross-track (dW) miss distance: 29 meters
12	Primary Object: LAPAN-TUBSAT (SCC# 29709) Secondary Object: SCC# 18153 Time of Closest Approach: 25 JAN 2014 22:10 UTC	Overall miss distance: 100 meters Radial (dU) miss distance: -87 meters In-Track (dV) miss distance: 12 meters

Joint Space Operations Center
(JSpOC) Orbital Protection Team
California-US

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Final words

- The issue on space debris is important for Indonesia due to its large regional coverage in the equator (with large population) and increasing number of space objects (including Indonesian satellites).
- Currently, analysis of space debris related problems in Indonesia can only be carried out by using available data from other institutions (especially USSTRATCOM).
- Nevertheless, efforts have been carried out in Indonesia to minimize risk from space debris including the disposal of GSO satellites since 1981 and development of information system and dissemination of reentering space debris in 2010.
- Current technology and system of monitoring and cataloging artificial space objects needs to be improved to be able to assess the risk from a new fragmentation better.

Acknowledgements

- USSTRATCOM for sharing TLE and TIP report in Space-Track
- Dr. T.S. Kelso for sharing TLE Retriever and Socrates in Celestrak website

Thank you