Business model for ADR – Preliminary ideas

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1. Several studies (ANRICO, CNES-ONERA; P²ROTECT, TAS-I) have evaluated the probability of loss of function of a spacecraft due to collisions from small undetected debris.

   - The first study considered a Spot satellite, 800 km SSO, without SA, and came out with a 0.35% per year figure, i.e. 5% over the 15 years lifetime of the satellite.
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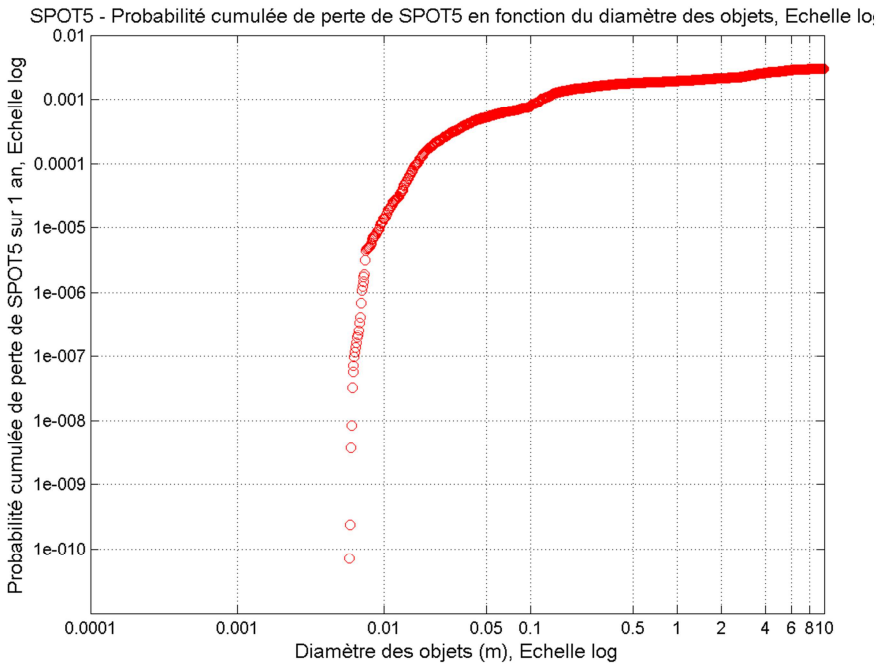
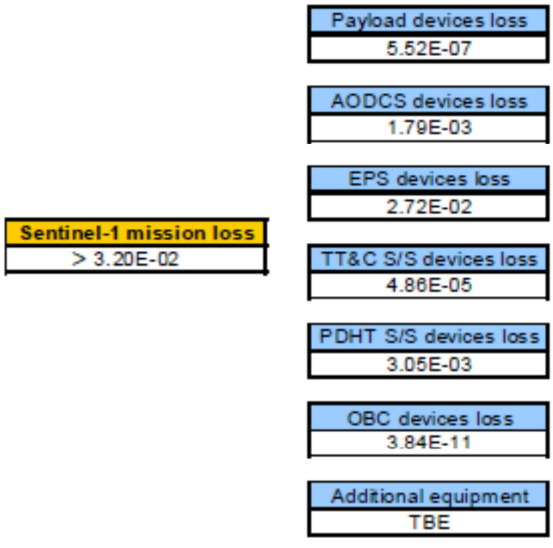
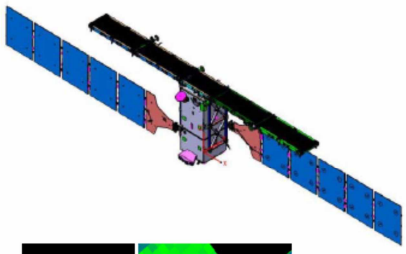


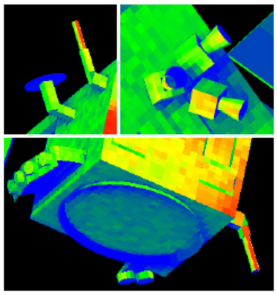
Cumulated probability of loss of Spot 5 as a function of size of the debris

   - The second study was done by TAS-I (L. Grassi, R. DeStefanis) in the frame of P²ROTECT study for EC.
     It considers Sentinel 2, slightly smaller than Spot, on a slightly lower orbit, with a 7.5 years operational lifetime; the probability of losing the satellite over lifetime is 3.2 % (with a completely different and independent method), or 0.43% per year.



FTA approach

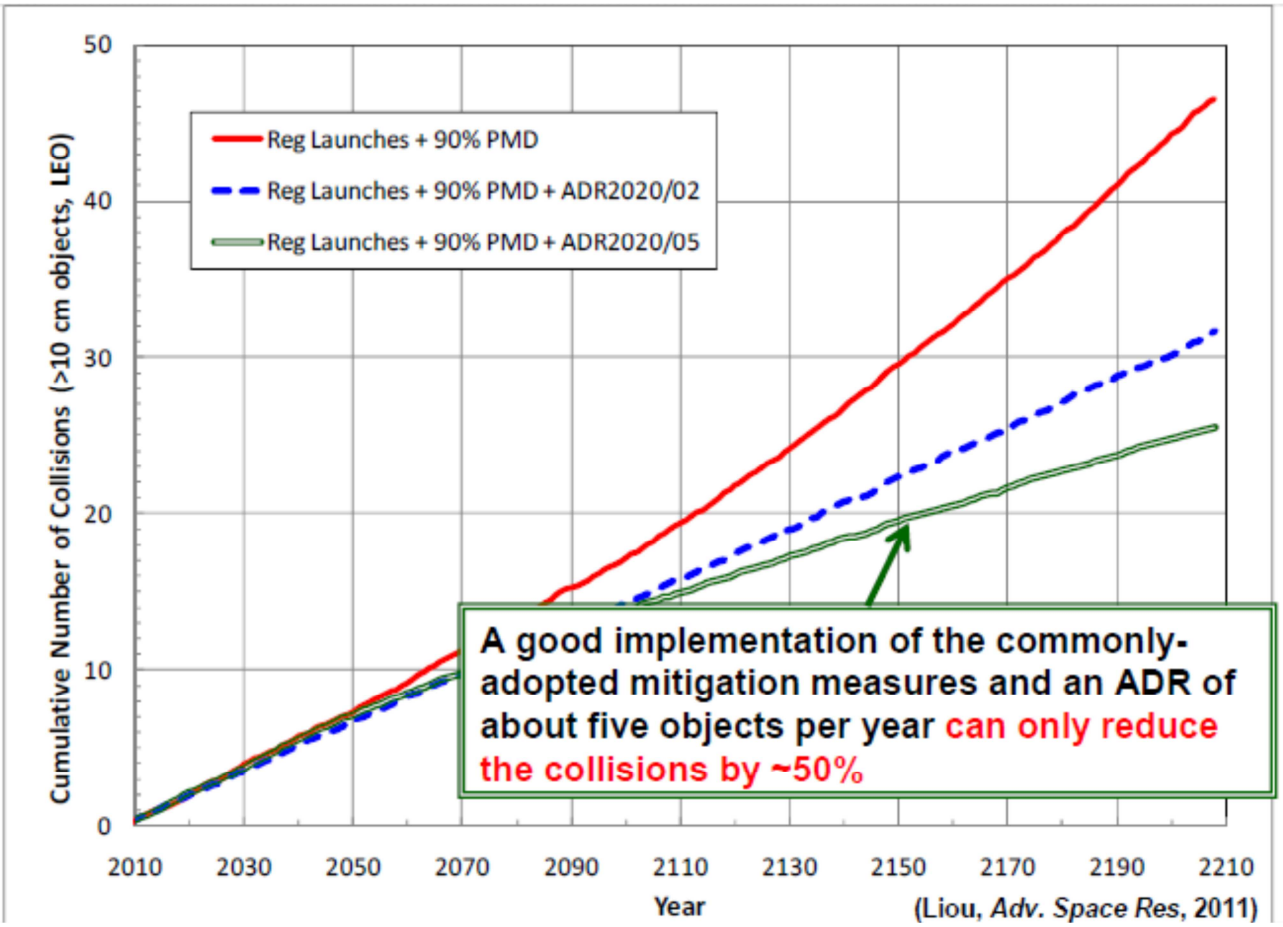




   ↳ Two different methods, but very coherent results.

The following is based on very rough values which need to be consolidated, but just to give the principle. Please use you own figures.

2. According to several simulations, a good implementation of Mitigation measures and an ADR of about 5 objects per year could reduce the cumulative number of collisions by 25% (14 instead of 19, see following figure) by 2110, equivalent to 500 large objects retrieved.
   If we assume that the reduction in collision rate is the same for small objects, and if we assume globally a linear trend, the gain is 0.05% collision risk per object retrieved.
   It means that if you retrieve 20 large objects, the probability for Spot will decrease from 5% to 4%, meaning you save 1% of its revenue per year.



3. Such "valuable" satellites have a yearly revenue of 200 M€ (please, use your own value), much more for a "critical" asset such as a military satellite (Pleiades, Helios), much less for an element of a commercial constellation. Say 200 M€ in average.
   There are roughly 450 active satellites in LEO
   Other way to evaluate this:
   - According to SWF, global Space Activity in 2014 = 330 G$ (250 commercial, 80 institutional)
   - Rough distribution: 75% GEO, 20% LEO
   - ROM LEO Space Activity = 66 G$
   - 450 LEO satellites ⇨ 147 M$ average per satellite

   Let's assume that 100 of them do generate this kind of 200 M€ yearly revenue. Global yearly income is 20 G€.
   Let's assume these satellites have an operational life of 10 years.

4. Retrieving 20 large debris from overcrowded regions (over 4 years) leads to a gain of 1% of this yearly income, so 200 M€ per year, or 800 M$ (over 4 years).

5. If I know how to retrieve 20 large debris for a cost lower than 800 M$ (40 M$/debris), I have a global positive outcome.

6. In the CNES OTV studies led with our prime industrials (2 parallel studies led by TAS and Airbus; details confidential, not published) the worst cost we found for retrieval of 1 debris, in recurring mode, was 30 M€. Most probable cost was 15 M€ (with controlled deorbitation) or 7.5 M$ (with random reentry within 25 years).

7. Worst realistic case: if the cost of retrieving one large debris is 20 M€ in the recurring phase, the statistical benefit for the satellites is 400 M$ per year. Shared among the 100 “most valuable” LEO satellites, it corresponds to 4 M$ per year.

8. I could theoretically be possible to explain to LEO operators that it is their interest to invest in “orbit cleansing”…