SRE-O/HSO-O bilateral
Integral Disposal Options

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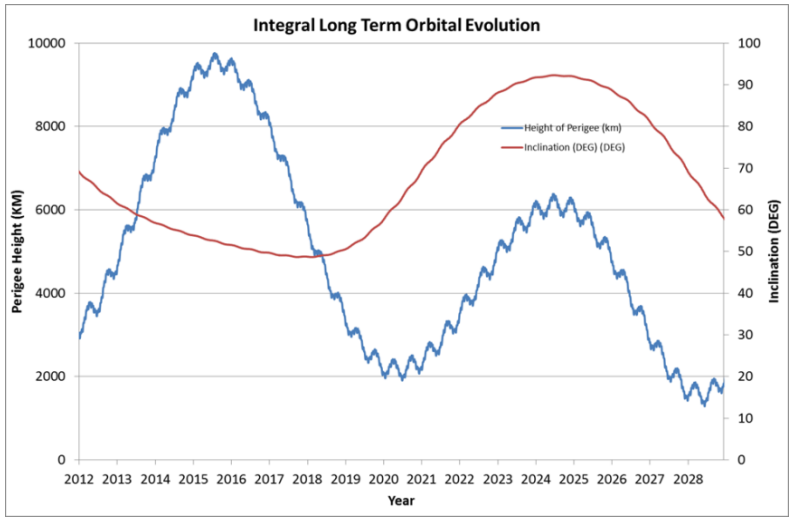
Background

- Orbital Evolution Long Term
  - Orbit, particular the perigee altitude will undergo large natural variations over the next 200 years
  - Perigee altitude will go intermittently below 2000 km (LEO Region), although for a relatively short amount of time
  - Orbit will cross the GEO ring roughly every decade
  - No natural reentry



- Preliminary analysis showed:
  - Controlled re-entry in 2020 not within fuel budget
- More detailed study has now been carried out

Perigee Adjustment Manoeuvre

- Perigee Lowering Manoeuvre - Using all available fuel
  - If done early 2013 would (probably) have lead to uncontrolled re-entry in 2020, now too late
  - If done in mid 2013, re-entry in 2082 with some uncertainty due to very low perigee in 2020
    - Re-entry location cannot be controlled so long in advance
    - Now too late
  - End of Science Mission
  - LEO Clearance long term not fully achievable
  - Once the manoeuvre is done we are committed
  - Not controlled re-entry
  - Too late now
- Perigee raise Manoeuvre doesn't keep INT out of LEO or re-enter

Apogee Lowering Manoeuvre

- Done at perigee
  - Much more efficient manoeuvre, effect is to amplify natural orbital perturbations
- Up to mid 2017 manoeuvre possible leading to uncontrolled re-entry in 2029
  - In some cases leaving fuel for further mission extension
  - Tentative Ex: 25m/s early 2015, re-entry in 2029, 5+ years science
  - Possible later trim manoeuvre to finalise re-entry location
- Alternatively many LEO Clearance opportunities Once the manoeuvre is done we are committed
- Station coverage affected
- Not controlled re-entry
- Trade off between end of control and accuracy of re-entry location
- Further study needed to confirm / refine options

Lunar Resonance Delta-V

- Lunar orbit exact multiple of Integral Orbital period
  - Amplifies lunar perturbations, removes randomness
  - Special cases of Apogee adjustment manoeuvre
  - Tentative Ex: 19.0m/s early 2014 to Moon resonance of 10:1 => re-entry in 2029 (*Last chance for this case is mid 2014!*)
    - End of life (fuel) early 2022, worst case
    - Orbital period of 2.8 days (currently 3) => Station coverage affected + Possibly small reduction in science time.
- Not a controlled reentry - Trade off between end of control and re-entry location spread
  - Once the manoeuvre is done we are committed
  - Possibility to trim re-entry location later
- Further study needed to confirm / refine options
- 8:1 or 7:1 resonance have best long term LEO clearance
- Possible modest fuel advantage wrt Apogee lowering – tbc

Second Manoeuvre Option

- Option of a twin manoeuvre strategy was also analysed
- 1st manoeuvre 2015, 2nd in 2020
- OR: 1st manoeuvre 2017, 2nd in 2020
  - No realistic options for controlled re-entry in 2020
  - 2nd manoeuvre has no re-entry advantage wrt the options above
  - Could lead to LEO avoidance scenarios, combined with earlier apogee lowering

Sundry

- Some options for uncontrolled re-entry (>2080) much later exist
  - Reliability of such long propagations has some uncertainty
  - Entry location cannot be selected
  - Discard in favour of 2029 options

Next Steps

- Break up Analysis study commissioned, expected XXXXX
- Feasibility study of early re-entry location targeting options and accuracy to be done in parallel, expected XXXXX
- Further study of lunar resonance options (including LEO clearance)
  - 2 mm
- OR: Further study of Apogee lowering options (including LEO clearance)
  - 2 mm (1mm extra for LEO analysis – 2 burn strategy)
- Chosen option to be studied after break up analysis available
- Remaining Fuel Uncertainty?