Overview of Controlled re-entry activities

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Outline

- Why controlled re-entry?
- What does it entail? Technical challenges
- Current technology solution
- Possible solutions and range of applicability
- Conclusions

Why controlled reentry?

- LEO satellites should perform an atmospheric reentry at the End of Mission.

- With the current models, depending on the payload design even for relatively small spacecraft (~700 kg) may have a estimated casualty risk on ground above 10^{-4}.
  → Great uncertainty in early design phases, risk for recurrent platforms

- Design for Demise is a complex design process that is still not fully understood or modelled

- Systems for controlled reentry must be optimized but they are available and have been implemented in several systems in the past.

  → Need for solutions to avoid mass increase leading to change launcher and that are affordable!

What does it entails?

Controlled reentry implies several technical challenges!

- It has a significant impact at system level:
    - Huge impact on propellant mass (70% of MetOp SG propellant mass)
    - Need for high thrust
    - Need for re-pressurisation
        - Even with re-pressurisation before final burn, thrust level of MetOp SG falls to ~150N out of 400N
    - Impacts in AOCS
        - Need to control during large manouvre, sloshing, etc.
    - Impacts on thermal subsystem

Current technical solution

- At the moment the solution is an adaptation of the monopropellant system based on existing equipment
  - Inclusion of high thrust monopropellant engine(s)
    - series of 20N or single 400N (designed for launchers applications)
  - Increase of RCS thrust capacity
    - to 5N or 20N thrusters instead of 1N
  - Increase of propellant
    - can go up to ¾ of total propellant mass
  - Re-pressurisation e.g. done at end of life and before final burn.
    - Not regulated

Possible solutions and range of applicability (1/3)

Applicability

- From work done with the primes:

- the short to mid-term **trend in LEO is to keep using monopropellant systems** for medium to large platforms → the ones needing controlled reentry.
    - Hence, solution complementing this system are of higher interest.

- Electric Propulsion may be used in longer term evolutions of the LEO platforms or for some specific applications.
    - For those systems a simpler system such as solid rocket motors.

Possible solutions and range of applicability (2/3)

Improvement of monopropellant systems

Reduce mass of propellant needed for a reasonable cost!

→ Solutions needed to increase Isp, improve thrust. Some solutions identified:

- Electronic pressure regulators
- Arcjets (using hydrazine with Isp ~550s rather than 230s)

→ Reduce cost and improve efficiency

- Low cost high thrust hydrazine engine ?
- Hybrid propulsion solutions ?

→ Reduce sloshing of high amount of propellant

- Large monopropellant with sloshing control

Possible solutions and range of applicability (3/3)

Solid propulsion systems to support controlled reentry

Development of solid rocket motors

→ High thrust, compact, low cost. Some technical points still open:

- Ageing of the propellant
- Particle ejection
- Thrust vector control

Could it be the basis of an autonomous deorbit system?

May be a nice solution for smaller satellites w/o or w/ limited propulsion capabilities or for ADR modules.

Conclusions

Controlled reentry

Short term (<2020)

- Arcjets (1)
- Electronic pressure regulator (1)
- Low cost high thrust engine (2)
- Slosh control tanks (2)

Long term (>2020)

- Solid propulsion deorbit system (2)
- Extended life HET thrusters (TBC) (2)

(1) High priority
(2) Medium priority

Needs: perform controlled reentry without moving to a bigger launcher.

Short term: Improved monopropellant system to allow controlled deorbit with minimum mass impact.

Long term: Solid propulsion system to support controlled reentry of EP platforms or smaller platforms without propulsion. Interest on autonomy TBD.