

Ten Commandments for Future Operational Missions

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Satellites placed in the same orbital plane of a heritage mission shall follow these rules

- *Operational missions tend to recursively use the same orbital planes*
- *For those missions especially, orbits are an essential infrastructure.*
- *An infrastructure that shall be kept clean and must be actively maintained.*
- *It is not someone else's business, it is our business.*

Only functioning satellites can be de-orbited
via their own means

- *There is no guarantee that any given satellite will be functioning by the time you will need to de-orbit it*
- *Hence you must develop a way to de-orbit "non-responding" satellites*

De-orbiting a 'non-responding' satellite must be exceptionally reliable

- Otherwise the de-orbiting operation will worsen the situation, by polluting the orbit and making it potentially unusable*

To achieve a high reliability of the de-orbiting operation by active removal, a standard interface shall be defined, with aids to each phase of the approach and capture

- *Define a standard interface for active removal*
- *eg satellite always captured at launcher interface*
 - *avoid/minimise tumbling of the satellite to be de-orbited*
 - *integrate optical and RF markers to guide approach phase*
 - *capture before contact*
 - *etc*

Any future Copernicus Sentinel satellite shall be equipped with the interface defined above, to make it a cooperative target for active removal

- *As the largest European public space infrastructure in LEO, Copernicus shall lead the way*
- *It is desirable that more missions follow the same example and strategy*

Any satellite equipped to be de-orbited via active removal can be de-orbited by different means than active removal

- *Being capable (and prepared) to be de-orbited via active removal does not imply to be de-orbited via active removal*
- *Active removal is 'mandatory' only for 'non-responding' satellites (and subject to their orbital position being reachable with 'marginal' delta resources – see later)*

The cheapest and easiest way to be de-orbited is uncontrolled re-entry implemented via the satellite own means

- *Active removal shall never be the first choice for de-orbiting*
- *Hence demisable technologies must be pursued as much as possible*
- *Everything that can be made demisable shall be demisable (not just enough to meet any specific casualty risk probability but to the maximum possible technical extent)*

Controlled re-entry is best implemented via Active Removal by a separate space tug

- *Implementing controlled re-entry via the satellite own means is complex and not fault-free.*
- *Controlled re-entry is more efficiently implemented by a space tug launched at end-of-life of the satellite to be removed, possibly sharing the same launch together with the replacement satellite going to the same/similar orbit*

The most efficient implementation of a de-orbiting space tug is
the last stage of the launcher

- *The last stage of the launcher goes through controlled re-entry anyway. It is enough that it is equipped such to safely grab the satellite to be de-orbited (according to the standard interface defined)*
- *Of course this is only true if the satellite to be de-orbited can be de-orbited at the same time (or close to the time) of the launch of the replacement satellite and is located in the same (or close) orbital plane of the replacement satellite.*

For every new satellite launched, remove a non-operational satellite (provided there is one in the same orbital plane)

- *For every tree you cut, plant a new tree*
- *For every new satellite in orbit, remove an old satellite*
- *ESA could promote such policy and have a competitive launcher that would be able to implement such policy.*

ESA shall revise its own Code of Conduct

- *Today these "Commandments" are not allowed by our own Code of Conduct.*
- *Revise the Code of Conduct to make the proposed approach acceptable.*