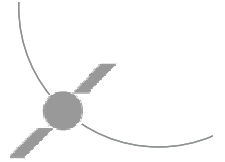


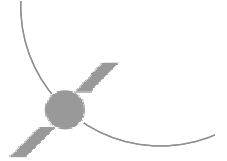
Eutelsat practice & views on long term sustainability

COPUOS/SCST - LTS Workshop
Vienna, 14 February 2013

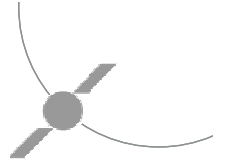
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Introduction

Introduction to Eutelsat



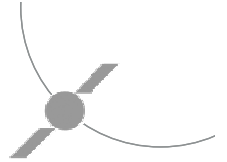
- Originally set up in 1977 as an intergovernmental organisation (IGO) to develop and operate a satellite-based telecommunications infrastructure for Europe.
- First satellite launched in 1983.
- IGO operations and activities transferred to Eutelsat S.A., a private company, in July 2001.
- Eutelsat Communications is the holding company of the Group since April 2005.
- Eutelsat's in-orbit resources comprise capacity on 30 satellites positioned in the geostationary arc between 15°W and 172°E (26 controlled from its own Satellite Control Centre).
- More than 300 years of accumulated in-orbit experience.
- Executive member of the Space Data Association (SDA).
- 12 satellites decommissioned: re-orbited out of the GEO arc and passivated.
- Average of 2-3 satellite relocations per year.

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Space Debris Mitigation Overview



Eutelsat Space Debris Policy

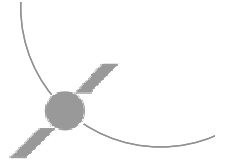


- **Before 2005 Eutelsat was acting as a responsible operator:**
 - Satellites controlled within their designated orbit control windows.
 - Orbit relocations guarantying not entering into the SK box of other satellites.
 - Avoiding/minimising debris generation during nominal operations.
 - 3-sigma propellant budget with allocation of propellant for re-orbitation inline with international recommendations.
 - Passivating satellites following re-orbitation as part of the decommissioning activities.

- **An Space Debris Policy in place since 2005 to:**
 - Respond to the requirements from the FCC to support our USA clients and from our ISO 9001 certification in operations.
 - Set a common baseline for our decommissioning activities.
 - Establish a process to improve our end-of-life disposal operations.
 - Minimise the risk of collisions and debris generation.



Eutelsat Space Debris Policy



- **Eutelsat Space Debris policy covers all phases from satellite separation from launcher till satellite decommissioning.**

- **The general principles are:**
 - **Limit the amount of debris released in a planned manner.**

 - **Minimise the probability of the satellites becoming a source of debris.**

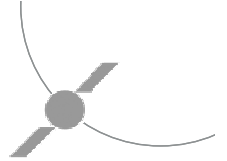
 - **Control of satellites within their allocated orbital windows by standard routine periodic orbit correction manoeuvres.**

 - **Avoidance of RF interferences.**

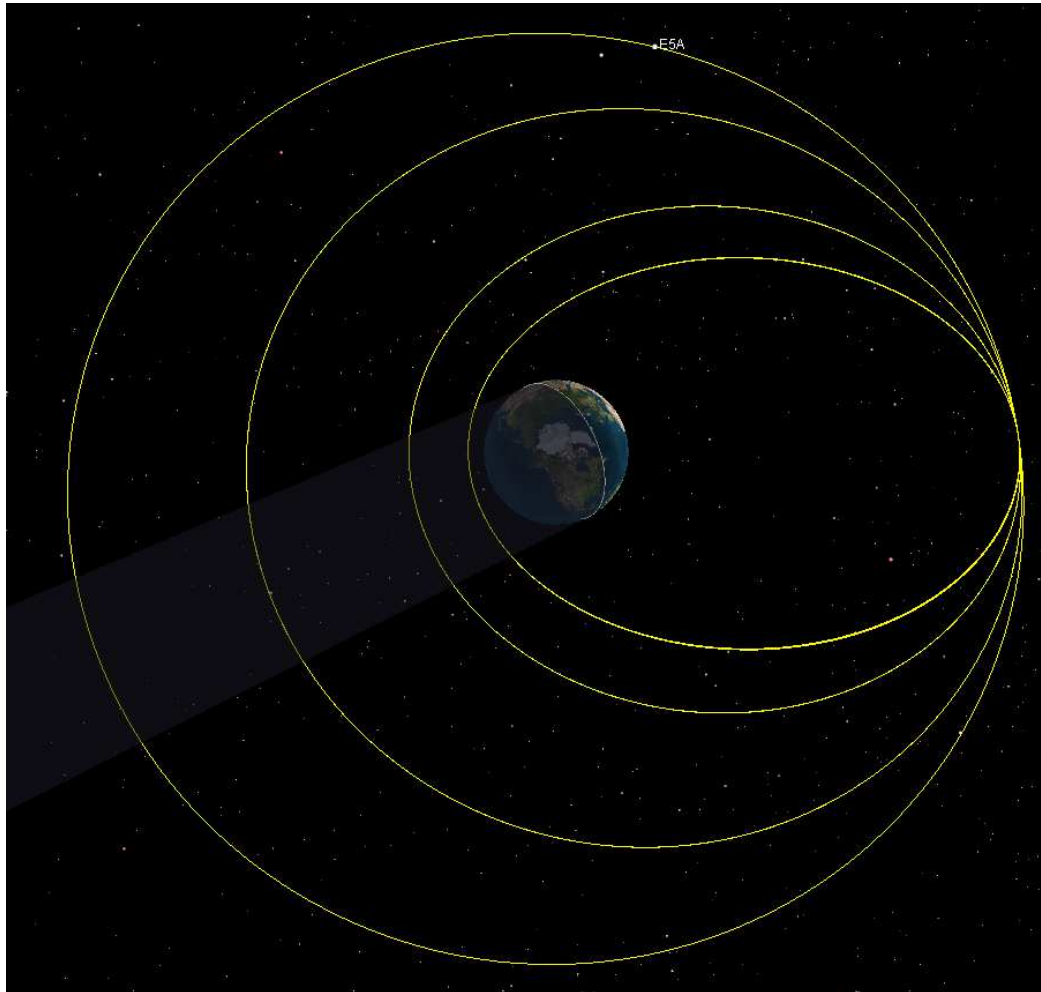
 - **Allocate propellant for re-orbitation to 300 km above GEO height.**

 - **Passivate satellite at end of life.**

Operations that require special care (1/3)

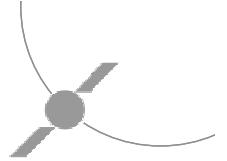


- **Orbit raising manoeuvres during Launch and Early Orbit Phase (LEOP) operations.**



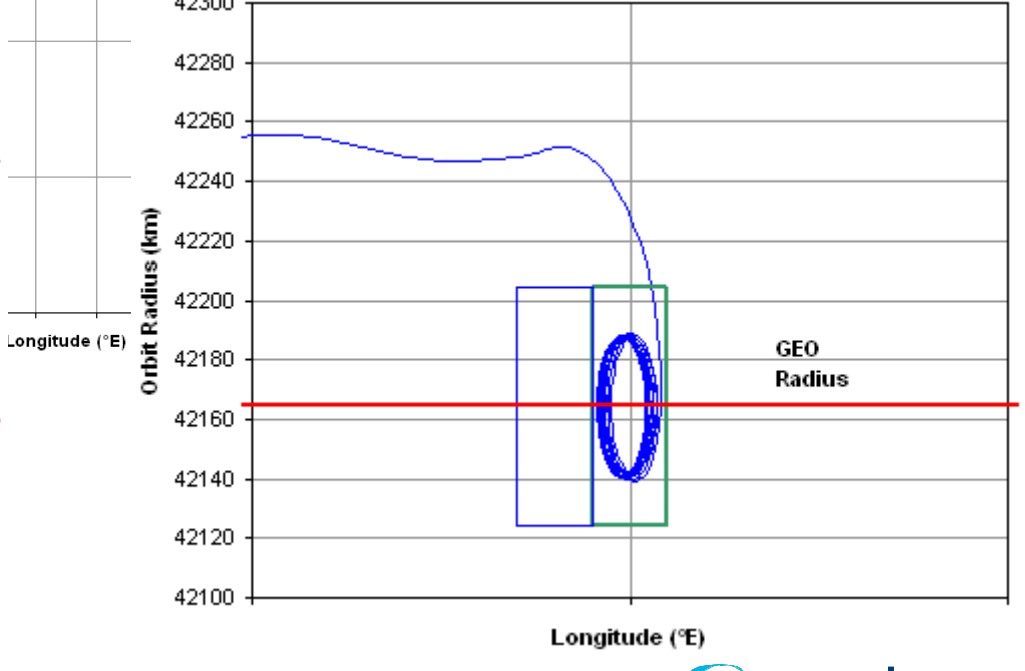
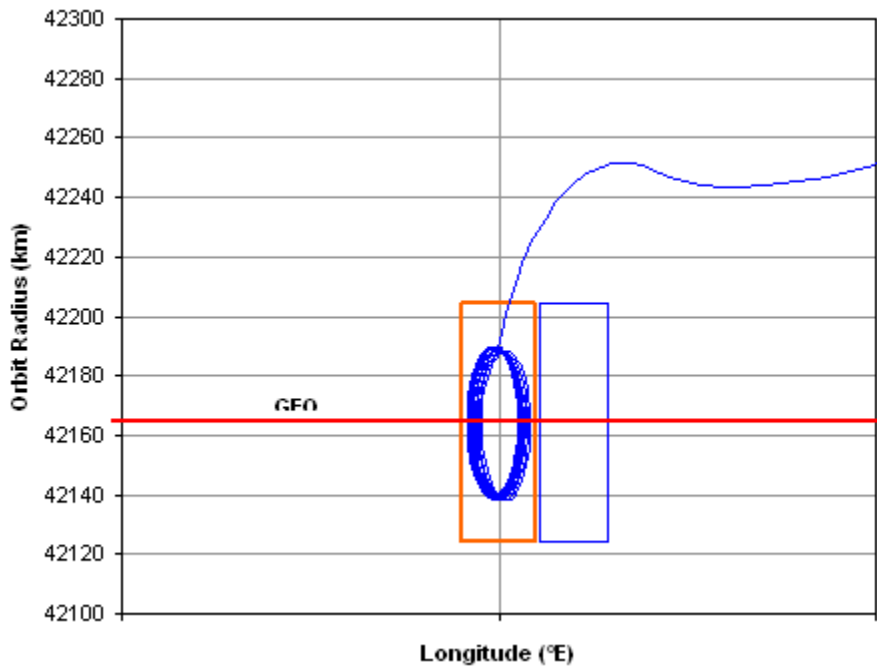
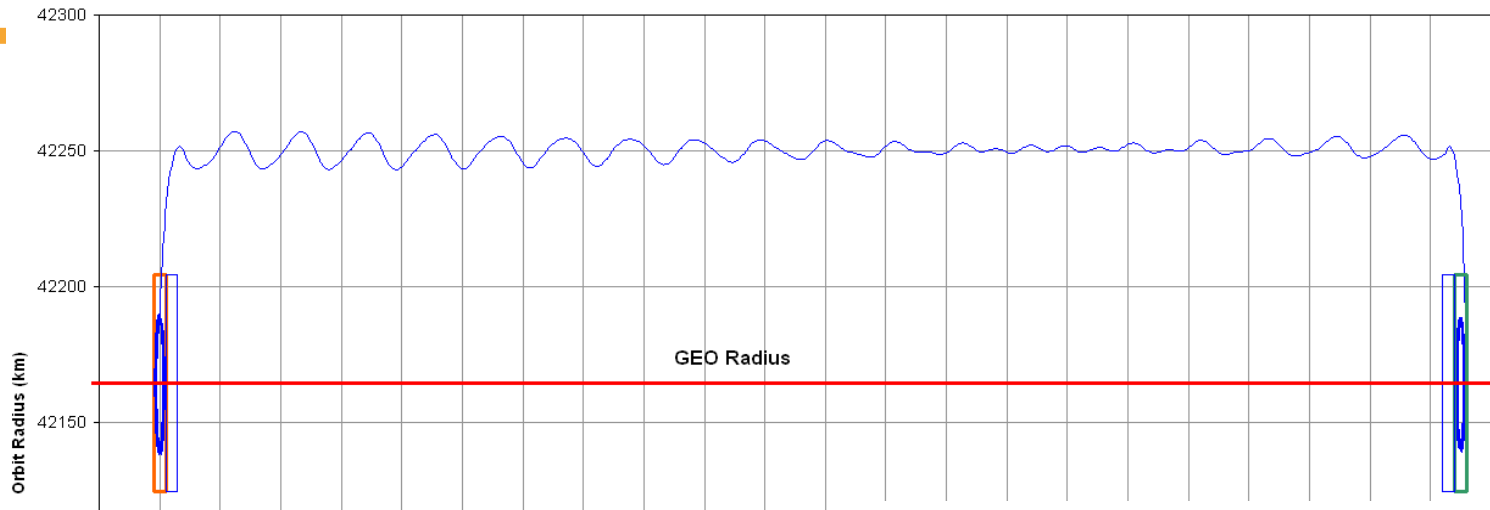
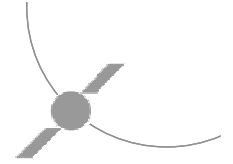
- **Close approach analysis required.**
- **If possible, keep satellite orbit out of the GEO arc.**
- **Avoidance of RF interferences with active satellites during the operations.**
- **Fine station acquisition manoeuvres to be treated like manoeuvres to stop the satellite drift during a relocation.**

● Operations that require special care (2/3)

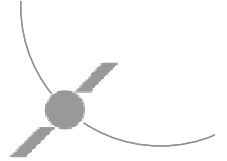


- **Satellite relocation manoeuvres: Changes of satellite position.**
 - Manoeuvres to move the satellite to new orbit position: Drift start manoeuvres and drift stop manoeuvres.
 - The general principle is to avoid close approach between the satellite being repositioned and other satellites in the orbit arc.
 - Relocate keeping the S/C out of the GEO +/- 40 km.
 - Close approach analysis required.
 - Avoidance of RF interferences with active satellites during the drift.

Satellite relocation example

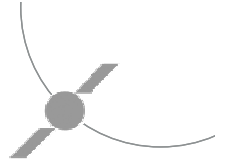


● Operations that require special care (3/3)



- **End of Life Operations:** Re-orbit the satellite to a graveyard orbit to keep the S/C beyond the GEO protected region (GEO height +/- 200 km) in the long term without entering in the Station Keeping box of other satellites
 - Close approach analysis required.
 - Avoidance of RF interferences with active satellites during the operations.
 - Passivate and switch-off the satellite.

Eutelsat Space Debris Mitigation plan



**International
Recommendations**

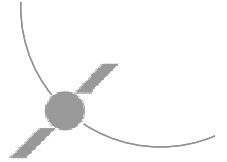
**Operational
Experience**

**Eutelsat
Space Debris mitigation plan**

French Space Law

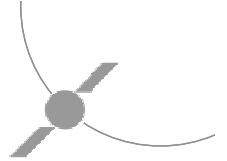


Eutelsat Space Debris Mitigation Plan



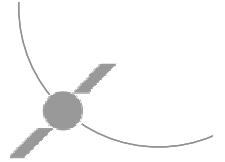
- **International Recommendations and Guidelines (in alphabetical order):**
 - **European Code of Conduct for Space Debris Mitigation.**
 - **FCC. Orbital Debris Mitigation Standard Practices.**
 - **IADC Space Debris Mitigation Guidelines.**
 - **ITU Environment Protection of the Geostationary Orbit.**
 - **NASA. Process for Limiting Orbital Debris. NASA-STD-8719.14**
 - **NASA. Safety Standard. Guidelines and Assessment Procedures for limiting Orbital Debris.**
 - **Space Product Assurance. Safety. ECSS-Q-40A.**
 - **UNCOPUOS. Technical Report on Space Debris.**
 - **UNCOPUOS. Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space.**

Eutelsat Space Debris Mitigation Plan



- **End of life disposal operational experience return:**

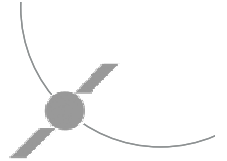
- Inclusion of all ground system and satellite constraints into the re-orbitation plan.
- Improve the computation of the terms to be taken into account to compute the minimum altitude required to ensure that the S/C will remain outside the GEO protected area (GEO altitude +/- 200 km) and the altitude stability.
- Re-orbitation operations in the absence of combustion.
 - Patent **EP 1852350 B1**: “Method of operating a geostationary satellite and satellite control system for implementing said method”

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The 2008 French Space Operations Act

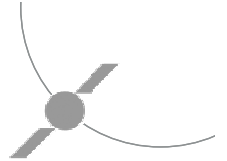


The French Space Operations Act



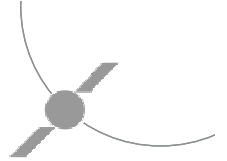
- **The French Space Operations Act was published on 4 June 2008, but the system has been in force since 10 December 2010.**
- **It is the direct result of France's international obligations, deriving from various UN treaties including:**
 - the 1967 Treaty on principles governing the activities of States in the exploration and use of outer space, including the moon and other celestial bodies; and
 - the 1972 Convention on international liability for damage caused by space objects
- **The application decree relating to authorisations was published on 10 June 2009**
- **The technical regulation was published by decree on 31 May 2011**

The French Space Operations Act



- **The Act creates an authorisation regime for space operations that may incur France's international liability:**
 - The launch of a space object from France
 - The procurement of a launch from France or abroad (French operators)
 - The control of a space object in outer space (French operators)
 - The transfer of a space object that has already been authorised
- **The Act also creates a licensing regime for operators involving certain guarantees**
- **The Act requires insurance (or another financial guarantee) throughout the space operation**
- **The operator may benefit from a State guarantee**
 - If, as a result of an operation authorised under this Act, any operator is required to compensate a third party for damage caused by a space object during and/or after launch
 - and for amounts exceeding the ceiling set out in the authorisation

Authorisations and licences held by Eutelsat



- **Control of space objects in geostationary orbit**

- 24 December 2010: one-year licence (*Technical Regulations not published*)
- 11 October 2011: new licence serving as autorisation valid until 31 December 2020 (*cf. interim provisions*)
 - Applicable to the entire fleet (*in-orbit satellites + satellites to be launched with certain existing platforms*)

- **Launch of space objects**

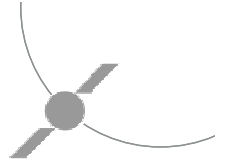
- Case-by-case authorisations

- **Administrative licence**

- 23 December 2010: 10-year licence certifying that Eutelsat has moral, financial and professional guarantees
 - Grants Eutelsat an exemption from the administrative part of such subsequent requests and reduces the authorisation timeframe

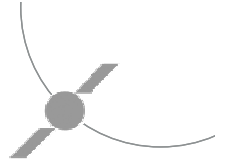


The technical regulation



- **Art. 40 of the Technical Regulation concerns Space Debris Limitation**
- **Compliance with this article requires to:**
 - Justify that the systems are designed, produced and implemented so as to avoid generating debris (*during nominal operations*)
 - Calculate and provide the probability of occurrence of accidental break-up (*must be less than 10⁻³ until the end of life of the space object*)
 - Present the feasibility, with associated strategies, of:
 - permanently depleting or placing all the on-board energy reserves in such a condition that they entail no risk of generating debris
 - permanently deactivating all the means for producing energy on-board
 - Present the plan to leave the protected regions once the space object has completed its operational phase
 - Justify the probability of having sufficient energy resources to successfully carry out the disposal manoeuvres (*must be at least 0.9*)
 - Calculate and provide the probability of being able to successfully carry out the disposal manoeuvres (*does not include the availability of energy resources, must be made for the total duration of the operation and take account of all systems, subsystems and equipment usable for these manoeuvres*)

The technical regulation



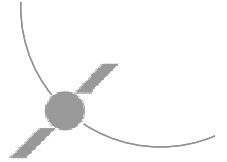
- The Technical Regulation includes interim provisions, given the implications in terms of methods and design of certain obligations

- Concerning space debris limitation, the interim provisions are:

- Justify that the systems are designed, produced and implemented so as to avoid generating debris
 - Calculate and provide the probability of occurrence of accidental break-up
 - Present the feasibility, with associated strategies, of:
 - Permanently depleting or placing all the on-board energy reserves in such a condition that they entail no risk of generating debris
 - Permanently deactivating all the means for producing energy on-board
 - Present the plan to leave the protected regions once the space object has completed its operational phase
 - Justify the probability of having sufficient energy resources to successfully carry out the disposal manoeuvres
 - Calculate and provide the probability of being able to successfully carry out the disposal manoeuvres
- } applicable only to space objects launched after 31 December 2020
- } for space objects launched between 10 December 2010 and 31 December 2020, the operator must implement the best possible strategy considering the space object definition ;
- } fully applicable to space objects launched after 31 December 2020
- } fully applicable to space objects launched after 10 December 2010



The technical regulation

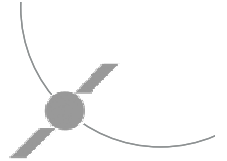


- **Other obligations related to the generation of space debris:**

- Provide a study of the potential hazards of the planned space operation for individuals, property, the environment and public health, and in particular hazards related to the generation of space debris.
 - production of space debris following an explosion, collision with a manned space object or a satellite in geostationary orbit, etc.
- Provide an assessment, for nominal operations, of the impact of the planned operation on the Earth's environment and the impact in terms of generation of space debris.
- Provide the prevention plan concerning the risks of accidental collision
 - with manned objects and satellites in geostationary orbit for which the orbital parameters are precisely known and available.



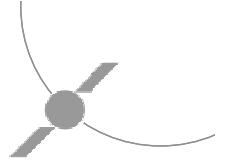
● Organisation and Control



- **Authorisations and licences are delivered by the Ministry for Space but the technical part of the applications is dealt with by the French space agency (CNES)**
- **Control before the delivery of the authorisation**
 - CNES is in charge of controlling the compliance of the planned space operation with the Technical Regulations > reviews the documentation provided by the applicant and the organisation set up to implement the planned operation
- **Control after the delivery of the authorisation**
 - Technical reviews are scheduled by the operator prior to the launch and the disposal manoeuvres > CNES is invited and can review if the provisions of the Technical Regulation are correctly implemented
 - The operator must inform the CNES without delay of any technical or organisational events that may affect the conditions of the space operation as authorised, in particular the disposal strategy
 - The operator is required to notify the Ministry and the CNES of any changes in orbital position one month before the start of its implementation, except in the event of an emergency

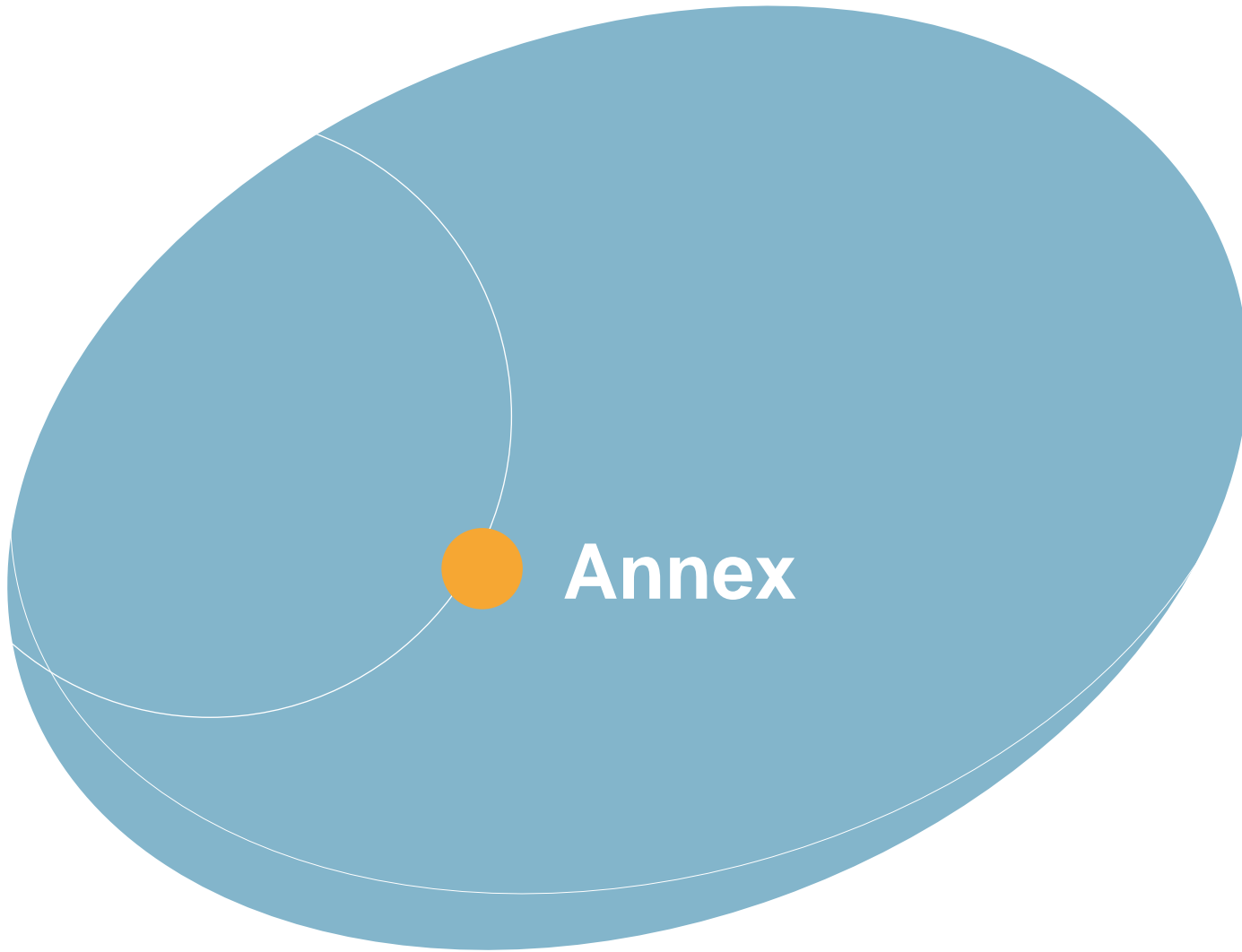
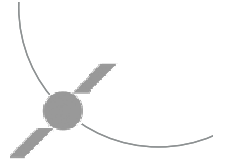
Through this process, France (CNES) can certify that the French space operators are compliant with ambitious stringent rules in terms of space debris limitation

Conclusion



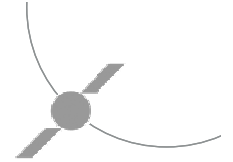
- **The aim of the French Space Law is to enable French industry/operators to protect the outer space to maximise its use.**
- **It is important to involve satellites operators/industry in the writing of the technical regulation in order not to impose requirements that will be hard to satisfy or that will jeopardise them.**
- **The inclusion of interim provisions is necessary to give time to the industry/operators to adapt their designs/processes.**
- **In 2010, the best practices implemented by Eutelsat were already in line with the provisions with immediate effect of the technical regulation.**
- **Eutelsat/industry ongoing work to make the appropriate design/process changes required to be compliant with the provisions applicable as of 2021.**

A similar approach followed by all countries/operators/industry would ensure that space debris limitation rules are systematically respected





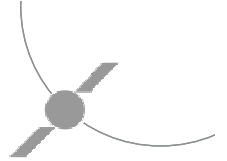
ACRONYMS



- **CNES: Centre National d'Etudes Spatiales**
- **ECSS: European Cooperation for Space Standardization**
- **FCC: Federal Communications Commission**
- **GEO: Geostationary**
- **IADC: Inter-Agency Space Debris Coordination Committee**
- **IGO: InterGovernmental Organisation**
- **ITU: International Telecommunication Union**
- **LEOP: Launch and Early Operations Phase**
- **NASA: National Aeronautics and Space Administration**
- **RF: Radio Frequency**
- **S/C: Spacecraft**
- **SDA: Space Data Association**



GLOSSARY



- **GEOSTATIONARY ORBIT:** Circular orbit around the Earth orbit having zero inclination and zero eccentricity, whose orbital period is equal to the Earth's sidereal period. The altitude of this unique circular orbit is close to 35786 km.
- **PASSIVATION:** Removal of any stored energy in the spacecraft or orbital stage at the end of its operational life to reduce the risk of break-up.
- **RE-ORBITATION:** Intentional changing of a spacecraft or orbital stage orbit.