CENTRE NATIONAL D'ÉTUDES SPATIALES

SUMMARY OF THE 2nd GEOSTATIONARY END OF LIFE WORKSHOP

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BACKGROUND: situation in GEO

- Population in January 2008 (ESA source):
  - 1147 objects are in the GEO region
  - 365 are controlled satellites
  - 12 satellites reached end of life in 2007
  - 11 were correctly re-orbited, compliant with the IADC guideline
- Satellites at end of life shall be replaced to continue the mission
  - Removal of old satellites necessary
- Prevention measures necessary to avoid congestion

BACKGROUND: regulatory activities

Reference documents for European operators:

- UN-COPUOS Mitigation Guidelines
- IADC Mitigation Guidelines (Inter Agency Space Debris Coordination Committee)
- ITU Environment Protection of the Geostationary Orbit. ITU-R S.1003-1.
- European Code of Conduct
- Space law/ licensing system
- ECSS/ ISO standards

NEEDS

- Particularity of the GEO orbit: unique resource
- Need to protect and to keep available orbital positions
- Mitigation measures are necessary
- Rules are being prepared by agencies
- End of life operations already performed by some operators

→ dialog between operators and agencies necessary
→ workshop organized by CNES

OBJECTIVES OF THE WORKSHOP

- Objective 1: To inform operators on regulatory issues under preparation:
  - to convince,
  - to support, encourage their implementation
  - to be prepared to future evolution
- Objective 2: to get feed-back from operators having performed end of life operations
  - to highlight implementation difficulties
  - to update the rules when necessary

GEO END OF LIFE WORKSHOP

- Workshop took place on January 24, 2008 at CNES's Headquarters in Paris
- 60 participants represented:
  - Administrations: French Ministry of Foreign Affairs, French Ministry of Defence
  - European space agencies: ASI, BNSC (RAL), CNES, DLR and ESA
  - Satellite operators: Eumetsat, Eutelsat, France Telecom, Hispasat, Inmarsat, SES-Astra, Paradigm Services
  - Industry: Thales Alenia Space, EADS Astrium, Astrium Space Transportation, SSTL
  - Insurance companies: Hiscox, Marsh

CONTENT OF THE WORKSHOP

Objective 1: information of operators and industry

- regulatory issues discussed at different levels:
  - United Nations Activities on Space Debris: UN-COPUOS Mitigation Guidelines
  - Udate of IADC Mitigation Guidelines
  - Long Term Stability of GEO Graveyard Orbit
  - Status of ISO Standards on Space Debris
  - UK Outer Space Act Compliance Monitoring: GEO End of Life Activities
  - Presentation of the Draft French Space Law

- general overview of the situation in GEO: population, reorbiting practices
- CNES Space Surveillance Activities in GEO

CONTENT OF THE WORKSHOP

Objective 2: feed-back from operators having performed end of life operations

- Eutelsat Space Debris Mitigation Practices
- Reorbit operations of EII-F6
- End of Life Re-orbiting – The Meteosat-5 Experience
- Uncommanded Orbit Change of the Geostationary Meteosat-8 Spacecraft - The Anomaly Investigation and Conclusions
- Astrium Experience Feedback on Reorbitation and Passivation
- Propellant Residuals Remaining at EOL for Inmarsat 2F3
- Final Satellite Configuration and Tests Performed at EOL for Inmarsat 2F3
- Recommended Practices for Traffic Management in the GEO Protected Region

MAIN TECHNICAL ISSUES

- **Remaining fuel estimation:**
  - **Different methods existing:**
    - different results
    - different accuracy, depends on the propellant
  - **Difficulty to estimate the last kg**
  - **Difficulty to decide end of mission:**
    - Over estimation of propellant: risk to remain in the protected region
    - Under estimation of propellant: risk to lose mission lifetime

MAIN TECHNICAL ISSUES

■ Re-orbiting operations

- When propellant exhausted thrusters are fed :
  - First with bad mixture ratio with presence of gas bubbles
  - Then with gas only
- Unstable attitude control, risk to lose control
- Need for dedicated manœuvre and control strategies
- Possibilty to perform end of life manœuvres with gas only
- Allows prolongating the mission and emptying the tanks

MAIN TECHNICAL ISSUES

■ Passivation:

- Emptying the tanks creates a thrust
- Need to control the direction of this thrust
- Risk to lose attitude control and radio frequency link with the satellite
- Risk for a thrust in a « wrong » direction, cancelling the altitude gain obtained after end of life manoeuvres

MAIN TECHNICAL ISSUES

- **Miscellaneous**
  - Particular case of spinned satellites
  - Difficulties for investigation in case of anomaly
  - Use of satellites in unusual conditions, out of the normal « flight domain »: complicated and risky operations
  - Particular collision risk during critical operations:
    - Positionning
    - Longitude change
    - Re-orbiting
  - Need for:
    - Coordination between operators
    - Set of recommended practices: traffic management

SUMMARY

- As space agency CNES promotes the application of the guidelines: workshop in Paris with industry and operators
  - Information on regulatory issues given by agencies
  - Feed-back from the operators based on their experience
- Main results:
  - Situation in GEO is improving
  - Operators welcome the evolution of the IADC GEO end of life guideline
  - Space law and licensing systems: lot of questions, more information necessary, monitoring implies surveillance capacity
  - Technical difficulties highlighted: fuel estimation, re-orbiting, passivation
  - Need for traffic management guidelines