OLEV – AN ON-ORBIT SERVICING PROGRAM FOR COMMERCIAL SPACECRAFTS IN GEO

C. Kaiser, Kayser-Threde GmbH, Germany
J. Kugelberg, Swedish Space Corporation, Sweden
J.-M. Delcura, Sener, Spain
B. Eilertsen, Orbital Satellites Services A.B., Sweden

www.kayser-threde.com
Business Case

■ Situation today:
Telecommunication satellites with full operational payload have to finalize its mission due to missing fuel for further attitude and orbit control maneuvers.

■ Idea:
To perform these attitude and orbit control maneuvers by a service satellite (OLEV), which docks to the client satellite and perform all required operations as an service up to the transfer of the client into its final graveyard orbit.

Development of a Service Satellite providing universal Rendezvous and Docking capabilities for GEO satellites life extension of up to 12 years.
Market

Customer:
- Operators of Telecom Satellites
- Insurances
- Institutional Market (Space Agencies, Military)

Offer:
- Dedicated Fleet Management of GEO-Satellites
- Life Extension of GEO-Satellites with Full Operational Payloads
- Berthing of Stranded New Satellites in GTO
- In-Orbit Testing and Demonstration of New RVD Technologies

Advantages for the Customer:
- Delay Capital Expenditures for New Investments
- Optimization of Telecom Services
- Reduction of Insurance Rates
- Increase of Operational Efficiency of “Space Assets”
- Emergency Services
Focus is set on non-cooperative clients enabling a “soft-docking” by being 3-axes stabilized with sensor part of AOCS switched off.

Use of the specific German docking technology “Capture Tool” as heart of SMART-OLEV under responsibility of Kayser-Threde being the Rendezvous & Docking Payload Prime Contractor and responsible for the Docking Phase.

Use of SMART-1 platform technology and heritage incl. electric propulsion system under responsibility of SSC as Platform Prime Contractor.

GNC Architecture and Rendezvous Phase under Sener responsibility.
OLEV Services (a-f) and Mission Profile (1-6)

a. Life Extension (design point 12 years for a 2 t EOL client)
b. Relocating in the geostationary arc
c. Undocking and re-docking from one Client to another (up to five times).
d. Orbital node rotation
e. Inclination Removing
f. Disposal/moving to graveyard orbit

1. Launch & Early In-Orbit Operations (some days)
2. Orbit Transfer (150 days)
3. Rendezvous & Docking (1 day)
4. On Station Operation (maximum 12 years)
5. Disposal (some days)
6. Undocking and Return to GEO (some days, back to 3.)
Spacecraft Overview (1)

- **Communications:** S-band transponders and deployable antennas with ranging capabilities
- **Data Handling:** Onboard processor and CAN data bus with 1 Mbps data rate
- **AOCS:** 3-axis stabilized using reaction wheels, star trackers, sun sensors, gyros and (RVD Payload) cameras
- **Power:** Two solar array wings with GaAs triple junction cell panels delivering 4.5 kW at BOL. Regulated power bus at 100 and 28 V.
Spacecraft Overview (2)

- **Structure**: Structure using lightweight panels and webs.
- **Thermal Control**: Use of constant conductance heat-pipes, blankets, thermistors, heaters and thermostats.
- **Reaction Control**: 24 cold gas thrusters using Xenon gas for increased control authority when required.
- **Electric Propulsion System**: Six Hall effect thrusters using Xenon-gas (330 kg capacity onboard) including thruster re-orientation mechanisms for thrust vectors fine adjustment needed for flexible station keeping maneuvers in composite configuration for different clients.
Rendezvous & Docking Payload Overview
(Kayser-Threde as Prime Contractor)

1) Capture Tool (CT)
2) CT Deployment Mechanism (CDM)
3) Client Support Brackets (CSB) (3x)
4) Target Illumination System (TIS) (2x)
5) Cameras (Far-, Mid-, Near-Range) (2x)
6) DP Control Unit (2x)
The Capture Tool

Key payload element for capturing is the Client’s apogee engine nozzle.

Technology developed by DLR Institute of Robotics and Mechatronics in Oberpfaffenhofen, Germany.

Re-design of Crown:
Now one crown size fits all existing (16 mm – 22mm) nozzle throats
Rendezvous & Docking Maneuvers & Strategy

- **Approach**
  - Duration: ca. 25 min
  - AOCS: $\Delta x, \Delta y, \Delta z$ from ground image processing (2 Hz)

- **Insertion**
  - Duration: ca. 2 min
  - AOCS: $\Delta x, \Delta y, \Delta z$ from ground image processing (2 Hz)

- **Capturing**
  - Duration: ca. 5 min
  - AOCS: $\Delta x$ from ground image processing (2 Hz)
  - $\Delta y, \Delta z$ from Capture Tool sensors (5 Hz)

- **Laser distance measurement**
- **Capture Tool locked**
Capturing & Docking Simulation

Docking simulations taking into account contact dynamics [RD02]:
• deployment speed is controlled as a function the CT position in the nozzle
• small contact forces during initial contact
• off-nominal cases analyzed showing capability to dock even under worst case conditions
Outlook

- A PDR and PDOR process has been successfully finalized in June 2008 together with the launching customer.
- The three industrial partners are close to finalize the selection of subcontractors.
- Start of Phase CD is scheduled for first quarter of 2009.
- Realization of first Mission using real client(s) within the frame of a commercial program with contribution of both national and the European Space Agencies by co-funding specific new technologies needed.
- Main part of the Non-Recurring Phase by private investments.
- Goal is to finalize all financing issues until end of 2008.
