On-Orbit Servicing (OOS)
Issues & Commercial Implications

Presentation 05

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Status Quo?

- OOS Activities for Decades: But Not as “OOS”!
- 30+ Projects Worldwide = 1000+ Man Years p.a.
- No Commercial OOS Yet (“ORC” on the Move)
- Space A&R Technology in Place
- OOS Business Drivers NOT Yet Understood!
- Potential OOS Market 1.000 MEUR p.a.
- Co-Operative Satellite Design
- Too Early to Judge on OOS!
- Changes to Culture & Mindset
- Paradigm Shift

“S2S” Business!

Multi-Level Complexity!
Does It Matter?

**Satellite Population**
(500+ kg, non-military)
- Orbit
- Type of Satellite
- Type of Operator
- Life Cycle

**Satellite Failures**
- Cause
  - Technical
  - Other (Impact
- Occurrence (Life Cycle)
- Probability
- Propagation!

**Impact on Operator (Threat)**
(Mission: Business Case vs. Project)
- Total Loss
- Partial Loss

**Value of Correction?**

Individual Case!
Alternatives

State of the Satellite
• Tumbling Mode +/-!
• Communication
• Power
• Propellant …

Non-OOS
• Design (Redundancy)
• Technical (Workarounds, S/W)
• Business Model
  • Spare
  • Switch/Lease
  • New Satellite Launch
  • Insurance Claim

Space A&R Capabilities!

Service?
## Services

<table>
<thead>
<tr>
<th>Service Class</th>
<th>Kind of Service</th>
<th>Co-Op. Satellite Design</th>
<th>Supplies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motion</td>
<td>• Re-Orbiting</td>
<td>?</td>
<td>?</td>
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<tr>
<td></td>
<td>• De-Orbiting</td>
<td>?</td>
<td>?</td>
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<tr>
<td></td>
<td>• Salvage</td>
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<td>2010</td>
<td></td>
<td></td>
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<tr>
<td>Manipulation</td>
<td>• Maintenance</td>
<td>+</td>
<td>+</td>
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<tr>
<td></td>
<td>• Repair</td>
<td>+</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>• Retrofit</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>• Docked Inspection</td>
<td>+</td>
<td>-</td>
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<tr>
<td>2015</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Observation</td>
<td>• Remote Inspection</td>
<td>-</td>
<td>-</td>
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<td>2005</td>
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### Drivers
- Service Needs (No.)
- Frequency
- A&R Task (Servicer)
- Orbit & Plane
- Responsiveness
  - Scheduled
  - Emergency
- Logistics (Supplies)

### Mission Architecture

### COST!
## Stakeholders

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Benefits</th>
</tr>
</thead>
</table>
| Commercial Satellite Operators     | • Profit (Revenues!)  
• Deferred CAPEX                                                      |
| Insurance Companies                | • Risk Reduction  
• **Premium Policy & Market**                                              |
| Satellite Manufacturers            | • Design Feedback  
• Servicer Production/Economy of Scale  
• Co-Operative Satellite Design                                          |
| Space Agencies                     | • Demonstration in Space  
• **Space Infrastructure Development**  
• Commercialization                                                      |
| Governments                        | • **Knowledge Base**  
• Budget Efficiency & Economic Growth                                     |
| Science Community                  | • Safeguarding Projects                                                  |
| Launch Service Providers           | • No. & Frequency of Launches                                            |
| Space A&R Community                | • Various                                                               |
| Intl. & Regulatory Bodies          | • Debris, Orbital Clean-Up, Frequency                                    |
| Suppliers                          | • Innovation & Standardization  
• Economy of Scale                                                        |

### Hard Factors
- Market
- Budget/Profit
- Cost-Benefit
- Structures
- Processes
- Technology
- Demonstration

### Soft Factors
- Culture
- Mindset
- Psychology
OOS Challenges

Business

• Potential Market p.a.:
  • 500-1,000 MEUR/100-150 Services

• Target Market Segment
  • Orbit/Plane, Customer, Type of Satellite
  • Multiple vs. Single Servicing (Servicer Design)
  • High vs. Low Value Services
  • Co-Operative Satellite Design

• Systems Engineering
  • Mission Architecture/Logistics
  • Servicer Design & A&R

• Business Engineering
  • Demonstration & Launching Customer
  • Business Model (Stake & Shareholders)
  • Financial Feasibility (Financing Strategy)

Focus

• Agencies
  • Technology
  • Demonstration
  • Non-Technical!

• OOS Providers
  • 1st Movers, ORC
  • Business Acumen

• Space Sector
  • “OOS” as Topic
  • Awareness
  • Sound Homework

• CAPEX & Cost
• Revenue Model
Implication & Opportunities?

Satellite Design?
- Reliability (Redundancy, etc)
- Life Time
- Subsystems & Components

↑ Co-Operative Design
↑ Serviceability

↓ Cost?
↓ Mass/Volume?
No. of Satellites?

Service Missions
- Service Vehicles
- Logistic Platforms
- Launches

↓↓ Insurance
Operators Case

Science Community
Agencies Gov’ts

Manufacturers
- Launchers, Satellites, Platforms

Launcher Selection

LSPs

Suppliers
- Economy of Scale

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