



Lockheed Martin Commercial Space Systems

**Second International Workshop on On-Orbit Satellite Servicing
Manufacturer's Panel**

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Introduction

- **Economics will define direction**
 - **Early life anomalies such as LV low orbit injection or deployment anomaly have potentially good returns if servicing can be accomplished**
 - **Providing fueling capability in GEO may allow larger/heavier payloads to be launched**
 - **Costs to move fuel to GEO and overall servicing costs need to be evaluated**
 - **Higher value S/C will likely drive servicing needs**
- **What is needed to allow on orbit servicing?**
 - **Manufacturers need to help define needs and value assessments of adding serviceability capabilities**
 - **Operators need to flow requirements**
 - **Manufactures are unlikely to add significant features to accommodate servicing without firm requirements from operators**
 - **Standardization of interfaces with open flexible architecture approach**
 - **Realistic understanding of cost trades and risks**

Assessment of Existing Spacecraft Serviceability



- **Inspection without contact - Shadowing, RF interference and contamination are not likely to be an issue but needs to be reviewed**
- **Standard LV interfaces and LAEs enable capture by servicing vehicle**
- **Assisting deployment would potentially be attractive due to significant increase of capability vs replacement cost and schedule**
- **Attitude control systems can be disabled**
- **Refueling would require tape , blanket, and lockwire removal from multiple service valves**
 - **Capability to perform these types of tasks is being demonstrated on the ISS with the Robotic Refueling Mission (RRM)**

RRM Module
Image Credit : NASA



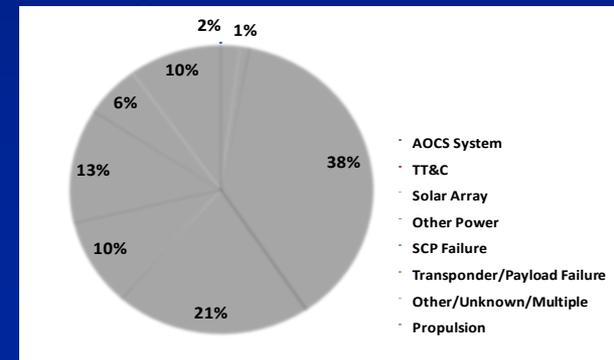
Significant Tasks Could Be Performed With Proper Planning

Accommodation of Serviceability Features



- Detailed layered closeout photos are not a problem to fully implement
- Optical Retro Reflectors- need to ensure thermal control surfaces are not overly compromised
- Transponders for ranging and telemetry- Could have significant cost to implement
- Grapple Fixtures- Need to be small to meet LV ICD requirements and would require evaluation of structural paths
- Standardization of interfaces- Difficult to settle on what the standard without industry cooperation
- Building in flexibility to allow change out all components on the S/C could add significant complexity
- Recommend looking to anomaly records to determine components most prone to failure
 - Batteries and solar arrays should be focus areas
 - Other life limited items such as thrusters evaluated

Credit: Atrium



No New Technology Is Needed Only Firm Requirements



Summary

- **Need firm requirements from operators**
- **Not clear yet whether servicing will require significant near term design changes in commercial GEO S/C**
 - Redundancy requirements are typically driven by infant mortality
 - Propellant life extension may be difficult due to thruster wear out modes
- **Largest near term benefit will be recovery of significantly degraded missions**
- **Manufacturers will continue to work to help further define servicing needs and standardization of interfaces**
- **Servicing will enable further growth and expansion of the commercial GEO fleet**
- **Once the servicing capability becomes more mature it will likely drive wholesale architecture changes to S/C design**

It Is All About The Bottom Line



Thank You