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Near-term Persistent Platform Orbital Testbed: Three Candidate Architecture Options

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Near-term Persistent Platform Orbital Testbed: Three Candidate Architecture Options



Terms Used

OSAM : On-orbit Servicing, Assembly and Manufacturing

Persistent Asset: Any space system that benefits from multiple visits or OSAM.

Persistent Asset Paradigm: Assets designed to leverage OSAM capabilities. A Persistent Platform is an example.

Outline

- Problem to be Addressed and Suggested Solution
- 3 Distinct Architecture Options
 - Bus Based Persistent Platform
 - Small Satellite Based Persistent Platform
 - Servicer Based Persistent Platform
- Comparison of Architectures
- Concluding Remarks



Problem: Lack of Confidence in OSAM Technologies

Solution: Persistent Platform Testbed to Validate Tech.



- State of the Art “Launch and Operate” Paradigm is Uncompetitive and Unustainable
- No Technology Showstoppers to a Persistent Asset Paradigm

Foundational Missions

- International Space Station
- Hubble Servicing
- Robotic Refueling Mission
- Raven
- Orbital Express
- EASE/ACCESS/ASEM
- Made-in-Space 3-D Printer
- Robotic Servicing of Geosynchronous Satellites
- In-Space Robotic Manufacturing and Assembly

Persistent Platform

Technologies Matured and Verified

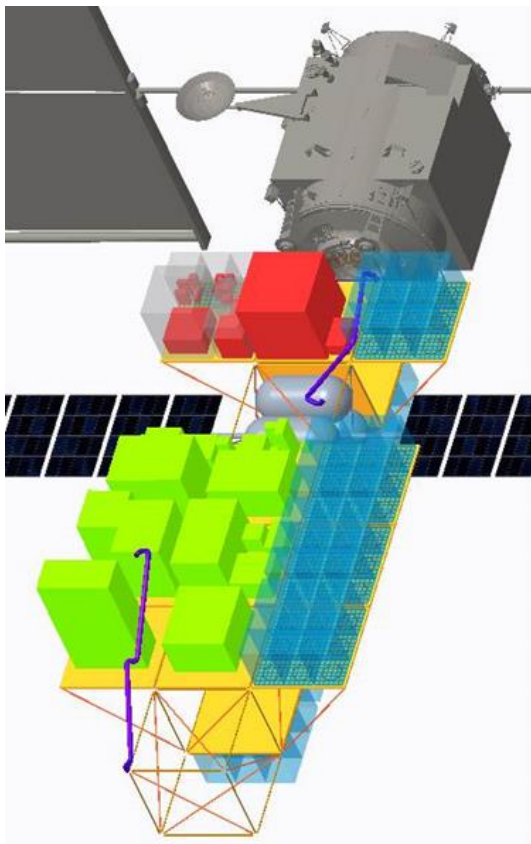
- Predictive Modeling
- Autonomous Robotics
- Autonomous Rendezvous and Docking
- Autonomous Berthing
- Standard Modular Interfaces
- Trusted Autonomy
- Situation Awareness



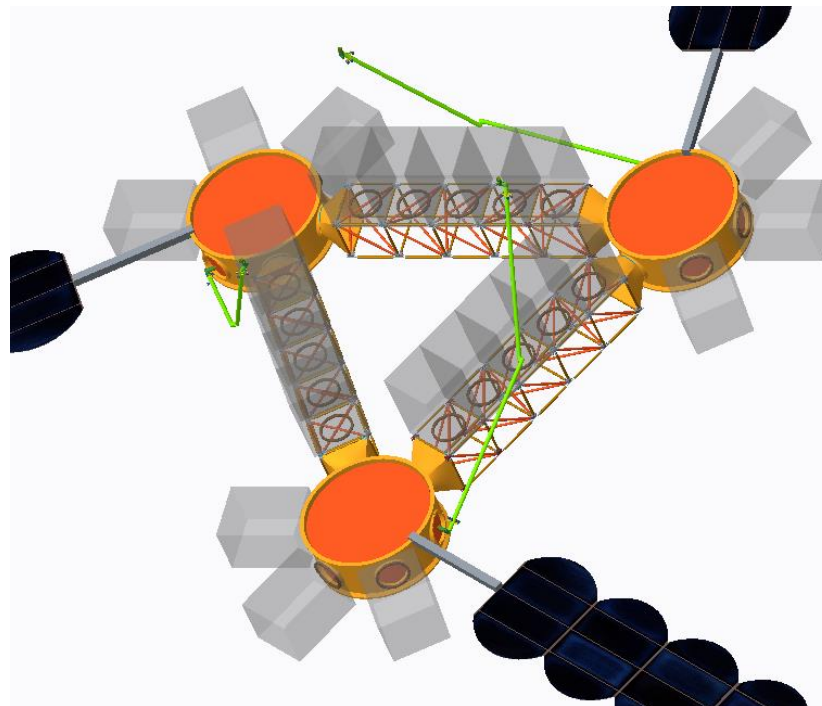
Civil
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University



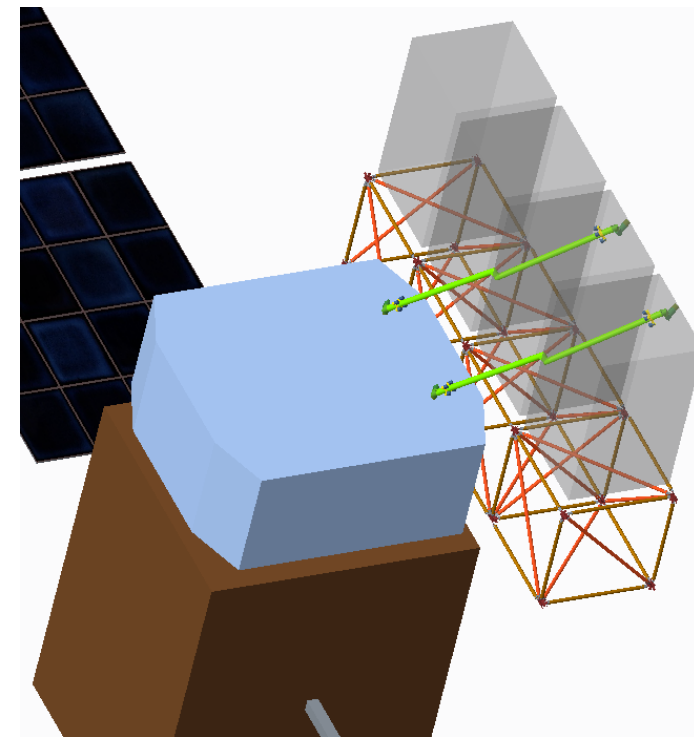
3 Architecture Options Compared from Initial Operating Capability to Common Baseline



Bus
Based Platform



Small Satellite
Based Platform



Servicer
Based Platform

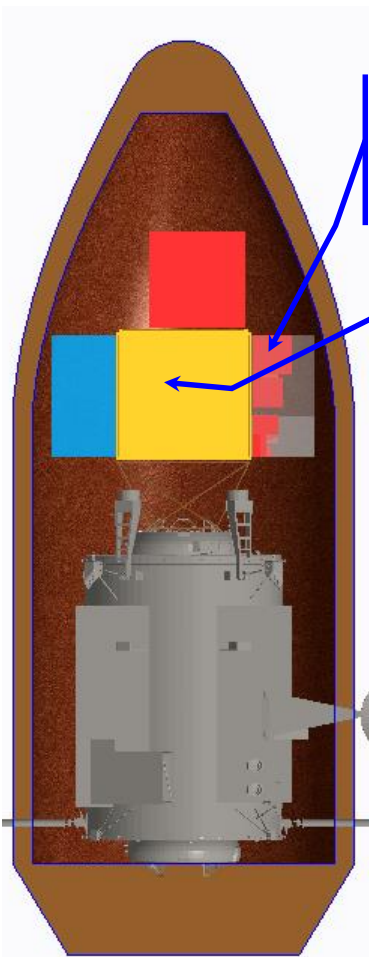
Baseline Configuration: Support 35 “Average” Payloads



Bus Based Platform Provides Expansion and Significant Delta V, Initial Operation Capability = Baseline Capability



Launch Packaging

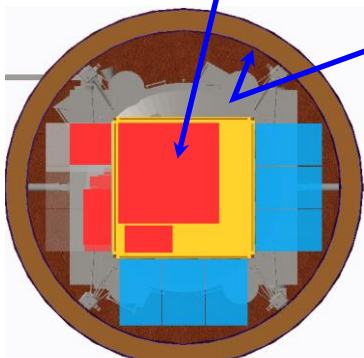


Side View

Deployable Panel Stowed for Launch

Panel Moved On-Orbit to Operational Location

Large Payload Packaged for Launch

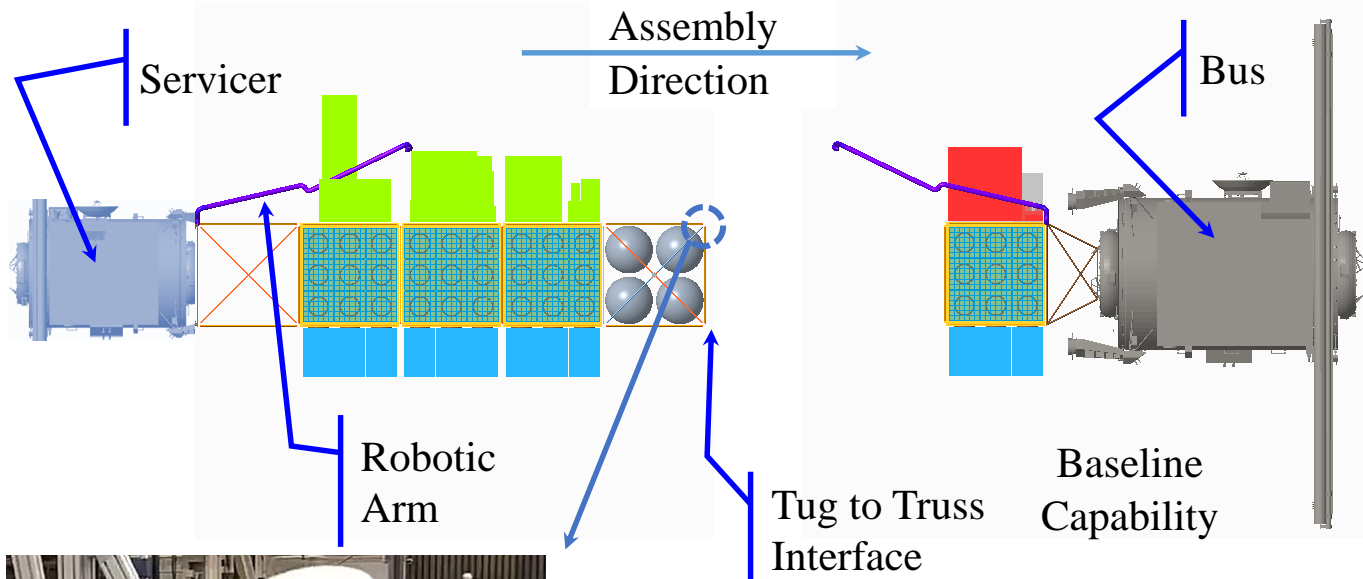


Top View

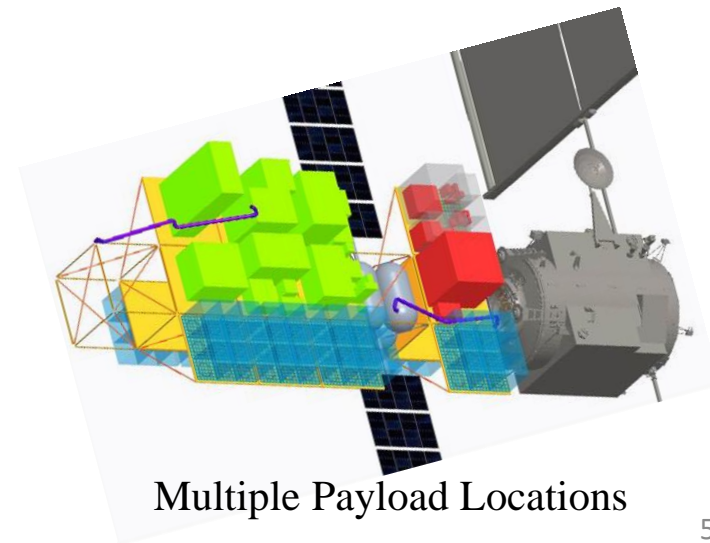
Falcon 9 Dynamic Envelope

Evolution

(Beyond Baseline)



Truss to Truss Connection (Removable Tool)



Multiple Payload Locations

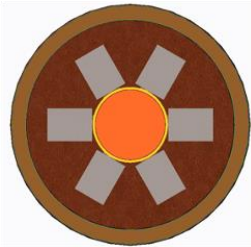


Small Satellite Based Platform Evolves with Common Repeating Unit based on Commercial Small Satellite

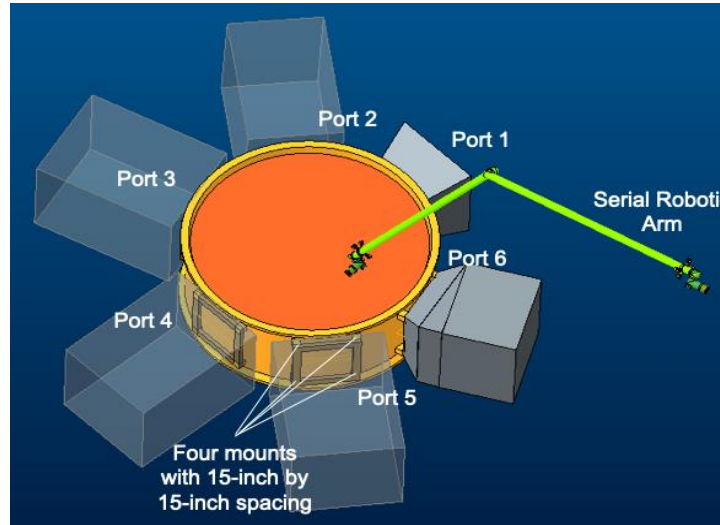


Launch Packaging

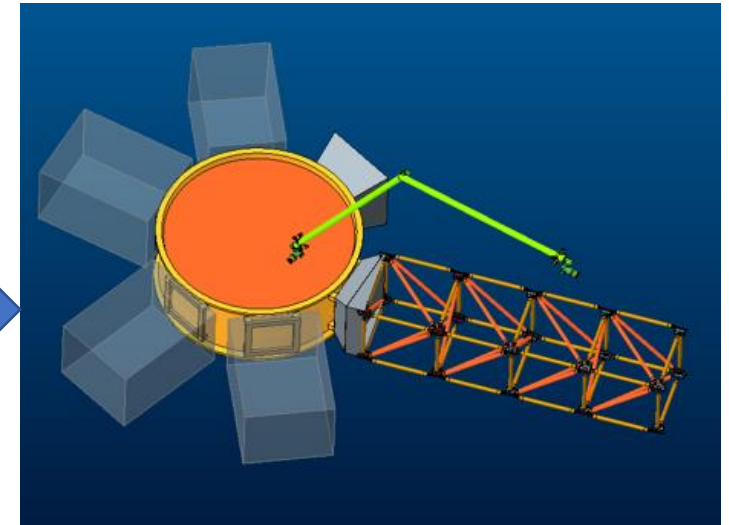
Evolution



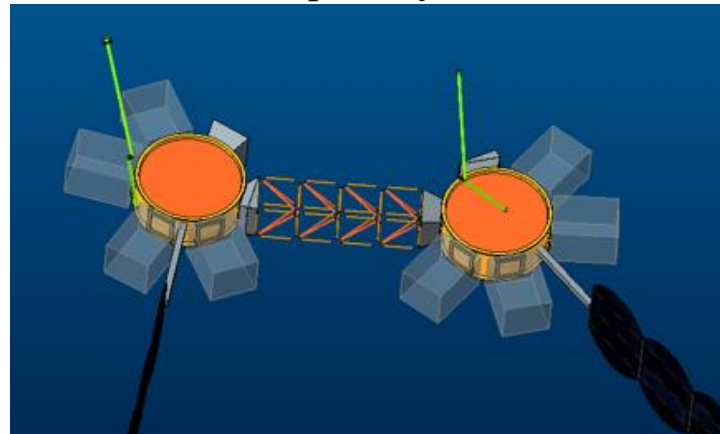
3 Repeating Units
Packaged as
Primary Payload



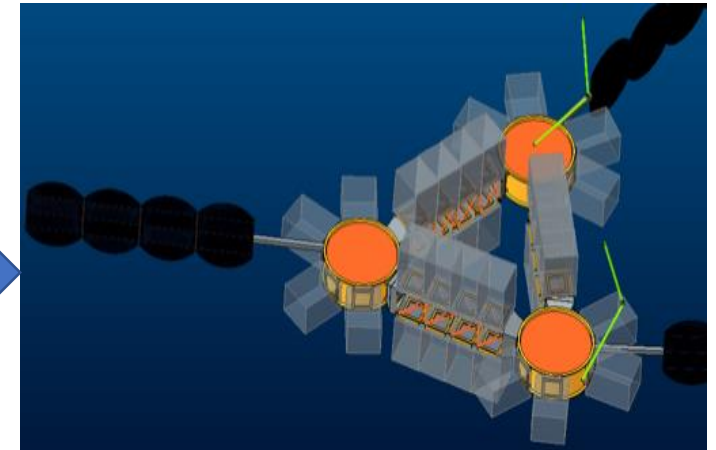
Initial Operating
Capability



Initial Module Deploys
Truss with Robotic Arm



Berths to 2nd Module



3rd Module Completes Baseline Configuration
with Multiple Payload Locations



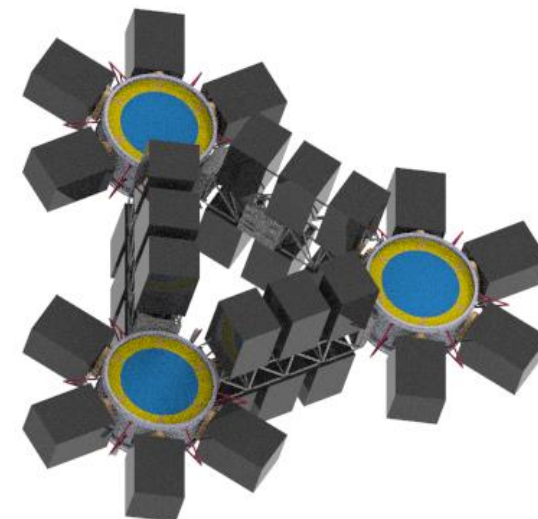
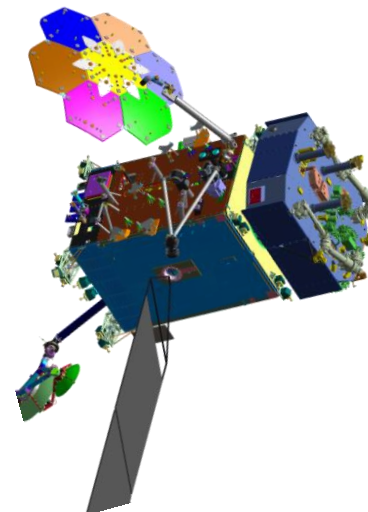
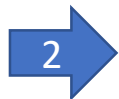
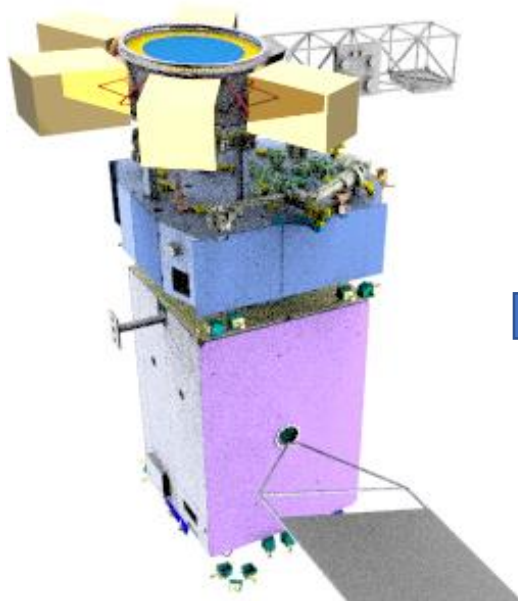
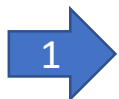
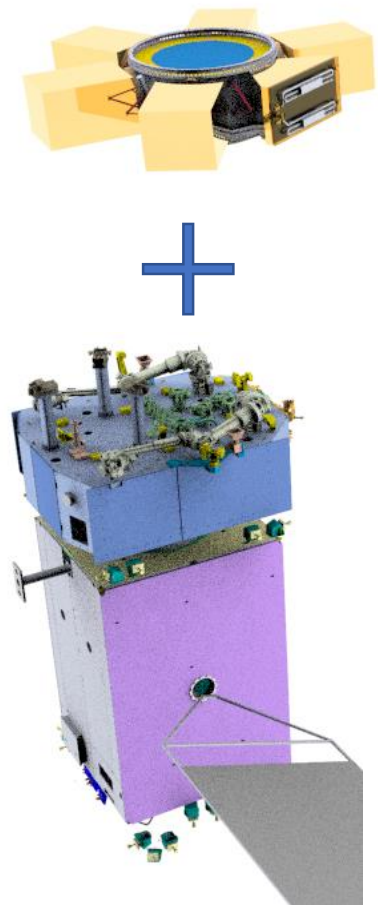
Servicer Based Platform Leverages Existing On-Orbit Servicer Simplifying Modules



Evolution

Initial Operating Capability

Baseline Configuration



Existing Servicer
(RSGS, OSAM-1, etc.)

Servicer Berths with Small Satellite Providing Robotic Capability, Station Keeping and Communications

- As Persistent Platform Evolves, it Becomes Independent
- Independent Persistent Platform Similar to Small Satellite Platform
- Persistent Platform Robotics Optional
- Servicer Can Support Multiple Platforms



3 Architecture Options Compared with No Clear Winner



Appendix E

Selected Distinguishing Attributes (Best First in List)

- Schedule: Time to Initial Operating Capability (Servicer, Small Satellite, Bus)
- Performance: Extensibility and Expansion Potential (Bus, Small Satellite = Servicer)
- Risk: Payload failure spreads or leads to platform failure (Small Sat. = Servicer, Bus)

OSAM Enables Many Architectures Meeting Requirements

- 3 Diverse Architectures Exploiting OSAM Capabilities Meet Requirements
- Versatility in Cadence and Initial Operating Capability
- Due to OSAM Versatility, Differentiating Parameters Difficult to Identify

Item	Description	Bus Based	Servicer Based	Small Sat	notes
1	Cost: Initial Operating Capability	5	1	3	Delta from nothing to IOC assuming servicers exist, Cost of Robotics for Small Sat
2	Cost: Baseline Capability	1	5	3	Delta from IOC to Baseline
3	Cost: Operation for 10 year after baseline	3	3	3	
3.5	Cost: To customer (smaller sizes)	3	3	3	Similar resupply mission possible
4	Cost: Robotic system	5	1	5	
5	Cost: To duplicate platform	3	1	1	Assume only one servicer
6	Schedule: time to initial deployment (to IOC)	5	1	3	Assume servicer available, may take longer to add robotics to small Sat, interaction between robot and spacecraft will take time
7	Schedule: payload refresh time (potentially diff in delivery options, limited by space on platform.)	3	3	3	
8	Performance: Payload Accommodations	1	5	5	
9	Performance: Size, power, data, thermal, etc. (power enabling for a LIDAR mission)	1	5	5	
10	Performance: Science Metrics (pointing, ability to support different orbits, support decadal survey characteristics (stability, jitter, pointing control and knowledge))	1	1	1	OSAM-1 is in LEO, RSGS in GEO so potential to support variety of orbits with servicers. ESPASat can support GEO
11	Performance: Extensibility and expansion potential	1	3	3	
12	Performance: Lifetime (50 yr. ... vs. 10 yr., then launch another (payload yrs./\$))	3	3	3	
13	Risk: External dependence (e.g. servicer needs)	1	5	1	
14	Risk: Payload failure spreads or leads to platform failure	3	1	3	Bus, because of the panels, maybe difficult to isolate a single payload. This is a design task. Independent servicer mitigates platform failures because it can stabilize platform.
15	Risk: Technology development	3	3	3	
16	Risk: Ability to jettison platform portion	3	1	1	
17	Robotic versatility (exchangeability, number, etc.)	3	3	3	
18	Payload/mission operation center	5	1	5	
19	% of launch (launch availability) to baseline capability	5	1	1	



Concluding Remarks



A Persistent Platform is an example of a system that benefits from multiple visits or OSAM.

- 3 Architectures Demonstrate the Versatility Available with OSAM to Execute a Mission
- All 3 Architectures Viable, with Each Architecture Having Different Strengths and Weaknesses
- Foundational Comparison Framework Developed which can be Leveraged in Detailed Study
- Architectures Achievable with Current State of the Art Technology
- Opportunity for Multi-Agency Effort under National OSAM Initiative Providing Mutually Beneficial Results.

Someone Must lead! Need that Leader. A Persistent Platform Testbed!



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