KALL MORRIS INC

Keeping Space Clear for All™

Addressing Orbital Debris with our
Fleet of In-space Capabilities

Introduction

Est. 2019
Marquette, MI

Presenter:
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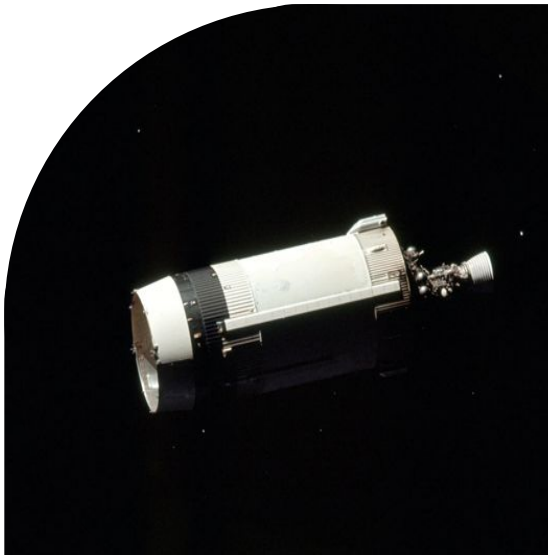
Co-founder & Director of Engineering

KMI is a space solutions company focused on orbital debris remediation



KMI Mission Overview

Focus:

- Capture multiple uncontrolled orbital debris objects with a single reusable spacecraft

Goal:

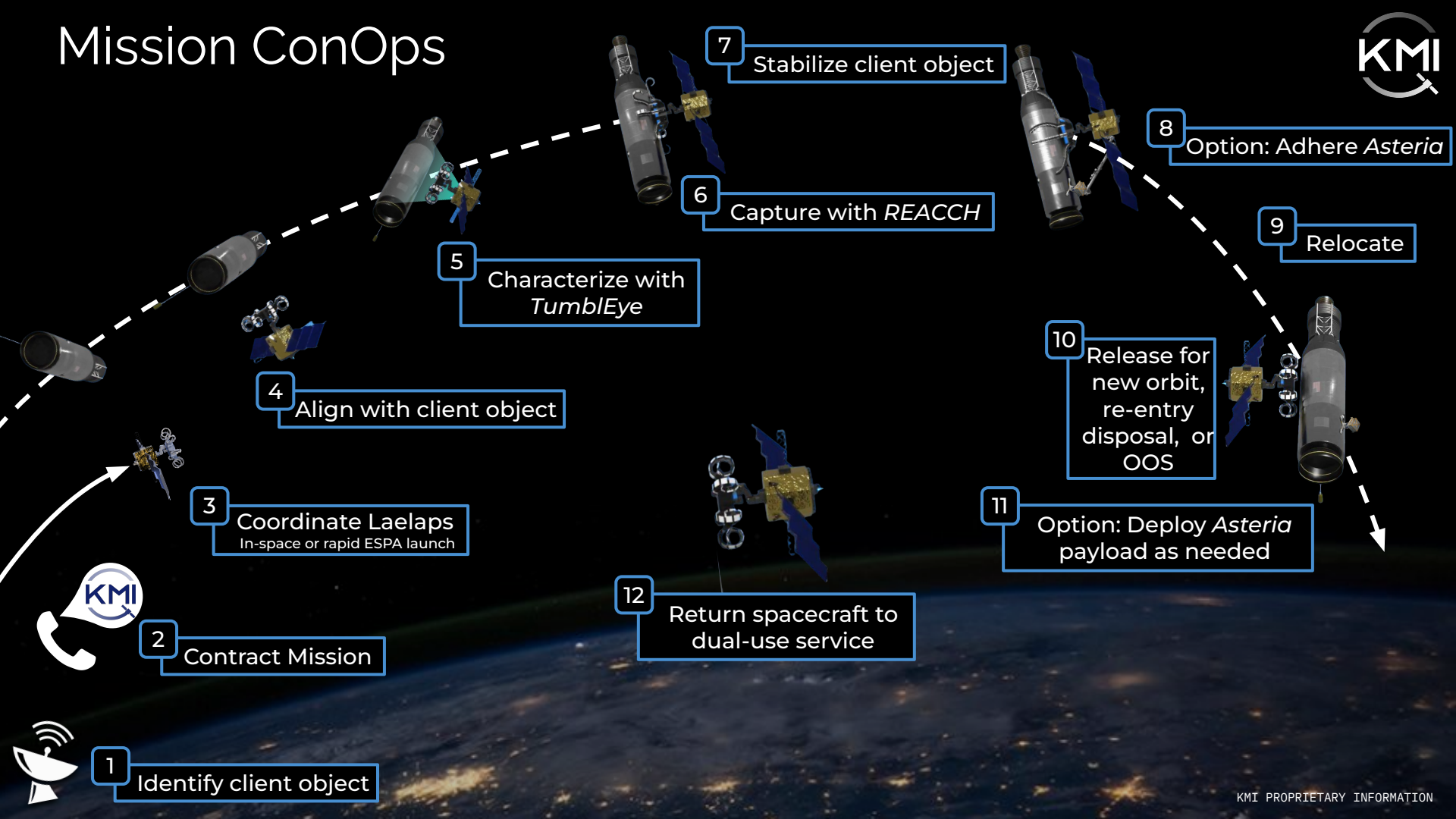
- Repeatable, efficient debris removal to stabilize the orbital environment

Steps:

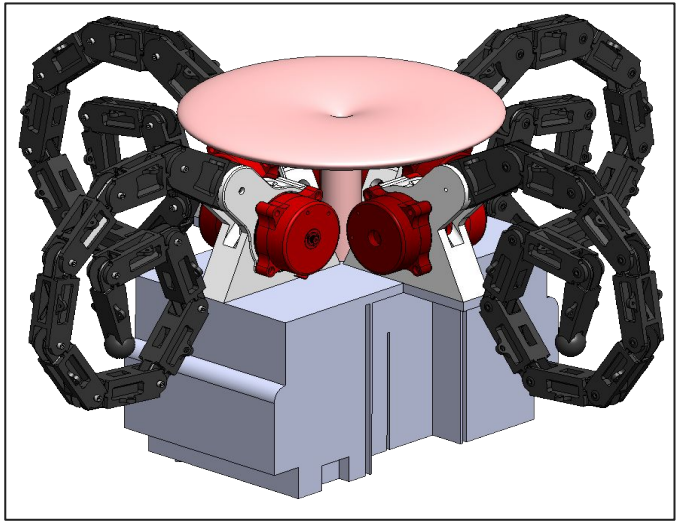
- Demo component technologies in relevant environments
- Combine technologies into system prototype
- Demo full system in orbit
- Establish ADR value chain
- Scale up industry to support space infrastructure development

Feb 2024	Prototype Ground Testing Complete
Jul 2024	Microgravity Testing Complete
Nov 2025	ADR Demo
Mar 2026	Commercial ADR
Sep 2026	2nd Craft Launch
Mar 2027	Debris Repurposed with Partner

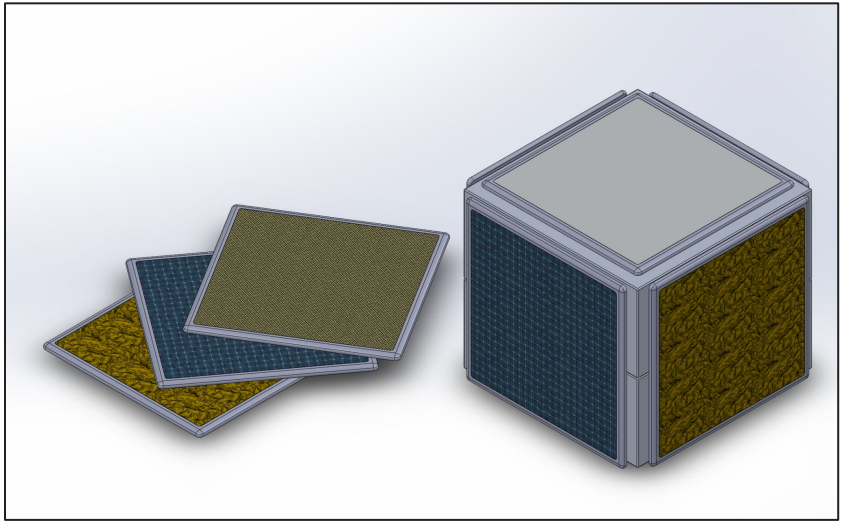
Mission ConOps



REACCH Overview

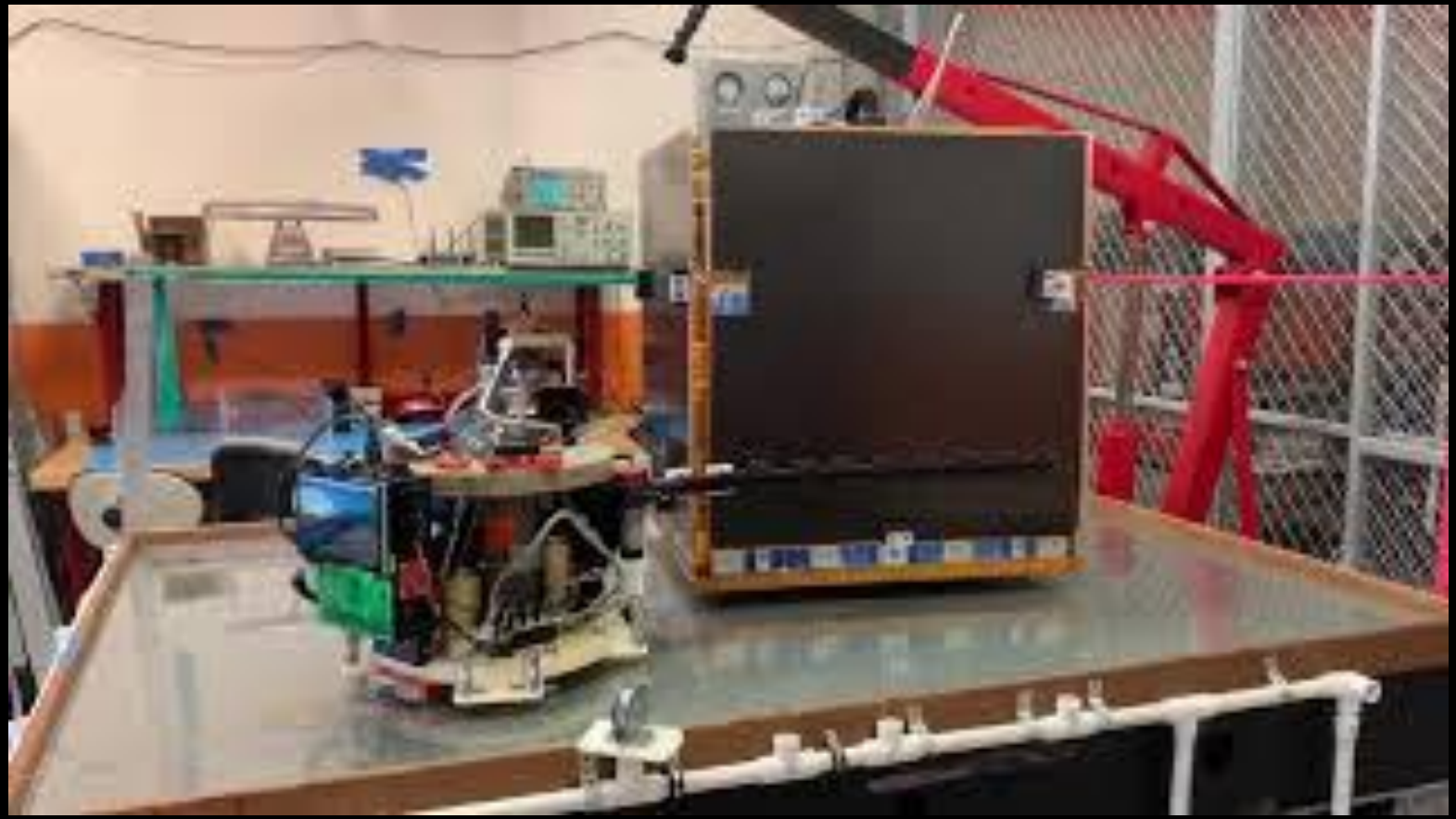


REACCH Astrobee Payload



Capture Cube & Swappable Faceplates

Demo



Video Courtesy of USC

Astrobee Payload Demonstration of REACCH Capture Mechanism

1. Astrobee is loaded with REACCH payload module

1a. Client object is prepared with planned material test surfaces

2. Astrobee is released for flight

3. Astrobee aligns with client

4. Astrobee approaches client with REACCH retracted

Experiment Operational Volume: 65cm diameter, 100cm long

5. REACCH deploys around client object

6. REACCH captures client

6a. If needed, adjust or reattempt

7. Move client (as necessary to test adhesion strength)

8. Release client and retract REACCH

9. Astrobee return to start position

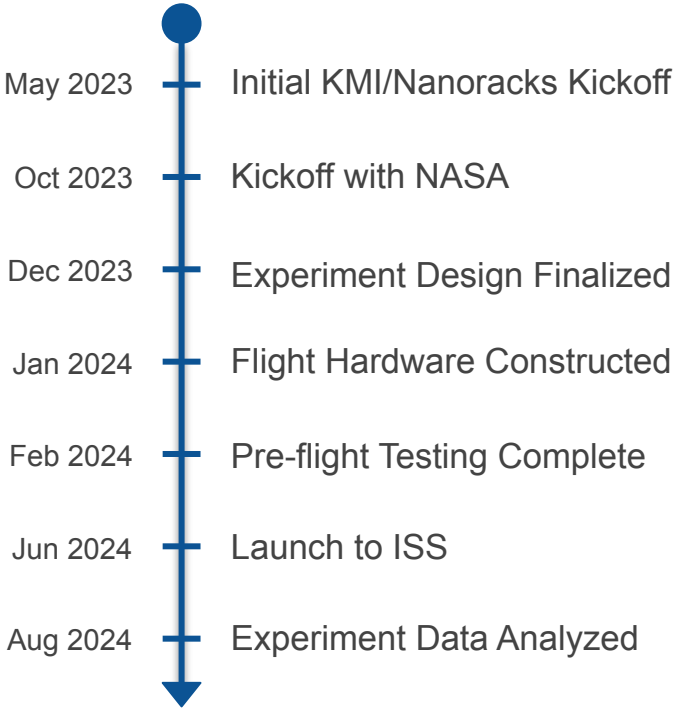
9a. Crew modify client object surfaces as necessary

10. Repeat experiment or advance to next testing as necessary

Milestone Overview

Experiment Objectives

- Demonstrate capture of a free-floating client object with REACCH
- Demonstrate capture of target objects having both smooth and rough surface conditions
  - This will include flat panels of Kapton, sheet aluminum, acrylic, and carbon fiber as well as crumpled aluminum, MLI blanket, solar cell arrays, and 3D printed surfaces with large and small bumps covered in Kapton
- Demonstrate release of a captured target without remaining residue or damage from adhesion
- Study physics interaction when REACCH and Capture Cube have differing angular velocities



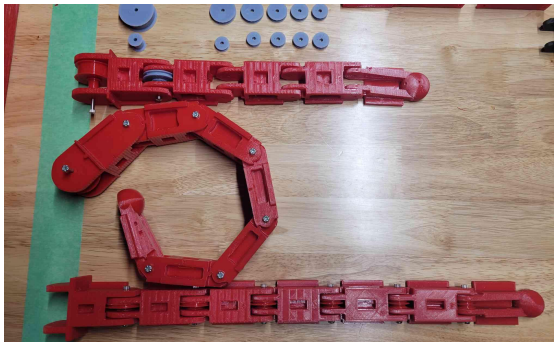
Project Timelines

Kickoff	10/18/2023
Phase I Safety Submission	11/27/2023
Phase I Safety Review	01/09/2024
Round 1 Testing at NASA Ames	01/29/2024
Phase II / III Safety Submissions	02/12/2024
Round 2 Testing at NASA Ames	02/18/2024

Payload Handover to Nanoracks	02/20/2024
Final HFIT Review	02/27/2024
Phase II / III Safety Review	03/12/2024
Safety Approved	03/19/2024
Payload Handover	03/19/2024
Launch - SpX-31	06/01/2024

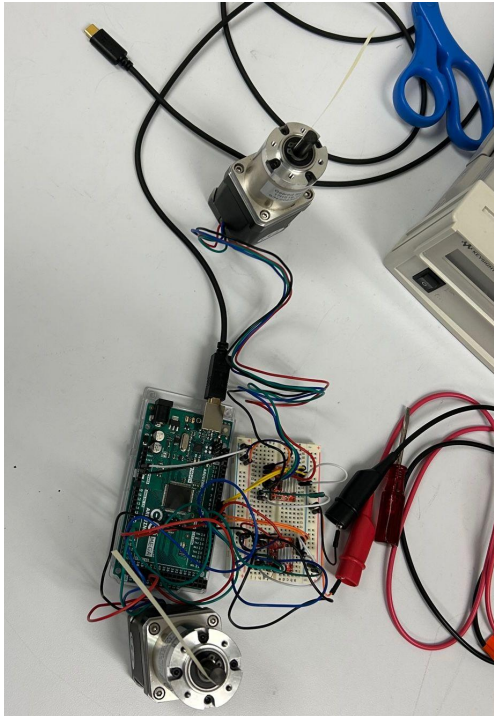
Prototype Progression

- Improving reliability of motion profile
- Improved print resolution and component structure
- 4 arms printed and being assembled for function verification
- Flight unit and future ground prototypes will include aluminum components in areas that experience higher forces and stress
- Space-ready components on flight unit will utilize alternate 3D printed materials (Ultem 9085 instead of PETG)



Software / Control Updates

- Computer sends serial commands to Arduino for motor control
- Software control of multiple arms simultaneously and independently
- Next steps: integrate sensors into control system, design motor drive PCB

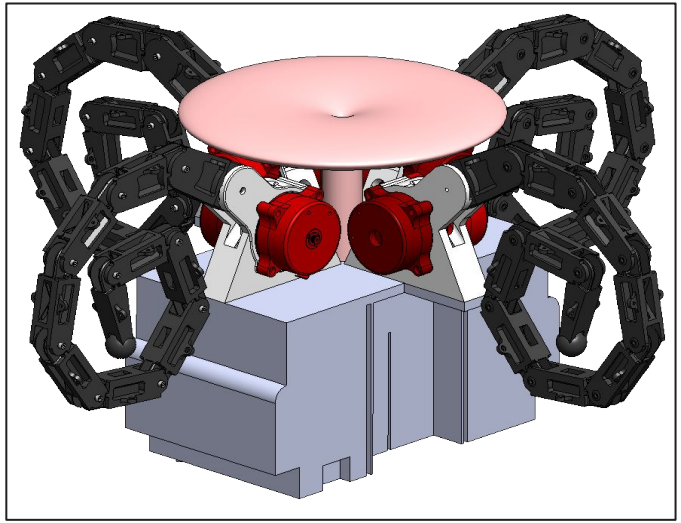


<u>Current Setup</u>

Press and hold 1, 2, 3, and/or 4 to select arm(s) to move, then ⇧ or ⇩ to actuate arm(s)

Flight Unit Sensors Under Consideration

- Pushrod force and position sensors
- Arm-base pitch & yaw force sensors
- Motor drive current meter
- Proximity sensors (From REACCH base to client object)
- Rotary encoders on arm base
- Limit sensors



Support Requested

Program Management

- Define remaining timeline details
- Finalize experiment procedure documentation
- Schedule events requiring external coordination, including testing at non-KMI facilities

Design

- Establish level of on-station serviceability
- Electrical interface guidelines & requirements

Integration

- Ensure Astrobee software/control interfacing
- Determine relevant EMI standards re: station / Astrobee

Testing

- Functional testing at NASA AMES
- Other testing facilities as necessary
- Launch survivability testing

Thank You

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