COBALT: a GN&C Payload for Testing ALHAT Capabilities in Closed-Loop Terrestrial Rocket Flights

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The COBALT (CoOperative Blending of Autonomous Landing Technology) payload is being developed within NASA as a risk reduction activity to mature, integrate and test ALHAT (Autonomous precision Landing and Hazard Avoidance Technology) systems targeted for infusion into near-term robotic and future human spaceflight missions. The initial COBALT payload instantiation is integrating the third-generation ALHAT Navigation Doppler Lidar (NDL) sensor, for ultra high-precision velocity plus range measurements, with the passive-optical Lander Vision System (LVS) that provides Terrain Relative Navigation (TRN) global-position estimates. The COBALT payload will be integrated onboard a rocket-propulsive terrestrial testbed and will provide precise navigation estimates and guidance planning during two flight test campaigns in 2017 (one open-loop and closed-loop). The NDL is targeting performance capabilities desired for future Mars and Moon Entry, Descent and Landing (EDL). The LVS is already baselined for TRN on the Mars 2020 robotic lander mission. The COBALT platform will provide NASA with a new risk-reduction capability to test integrated EDL Guidance, Navigation and Control (GN&C) components in closed-loop flight demonstrations prior to the actual mission EDL.

I. Introduction

Section will provide an overview of the importance of ALHAT capabilities to future NASA missions and the motivation behind the development of the COBALT payload for risk reduction with future precision-landing GN&C technologies. Some brainstorming notes follow:

The support for COBALT is across multiple NASA directorates and projects. The NASA Human Exploration and Operations Mission Directorate (HEOMD) Advanced Exploration Systems (AES) Program is investing in risk reduction activities for future robotic and human landers through the AES Lander Technologies (LT) Project. The AES-LT Project is leading the development of the COBALT payload. The third-generation NDL is receiving development support through internal-LaRC investments, the AES-LT project, and through NASA STMD (Space Technology Mission Directorate). The development of the LVS is supported through the NASA SMD (Science Mission Directorate), and incorporation of LVS into the COBALT payload is through the AES-LT project.

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The flight tests of the COBALT payload will be conducted onboard the Masten Space Systems (MSS) Xodiac rocket-propulsive terrestrial testbed; these flight tests are funded through the NASA STMD Flight Opportunities (FO) Program.

Provide overview of the importance of ALHAT capabilities to safely, precisely and softly land future robotic and human landers at scientifically compelling but geographically hazardous locations, as well as at in the proximity of pre-existing surface assets. Several near-term planetary science priorities involve robotic landings on the Moon, Venus and comets, as highlighted in the National Research Council (NRC) decadal survey on planetary science.[1] The NRC has identified safe and precise landing technologies as a high priority need for future Entry, Descent and Landing (EDL) missions.[2] An overview will also be provided of prior and current NASA investments into safe and precision soft landing GN&C capabilities.[3,4,5]

Include citations for NASA investments into TRN,[6,7,8,9] NDL,[10,11] other ALHAT capabilities,[12,13,14] and prior test campaigns (e.g., Morpheus, helicopters, sounding rockets).

II. COBALT Payload Design

Section will discuss the payload design and ALHAT sensors within the COBALT payload. Models and pictures of the hardware will be included.

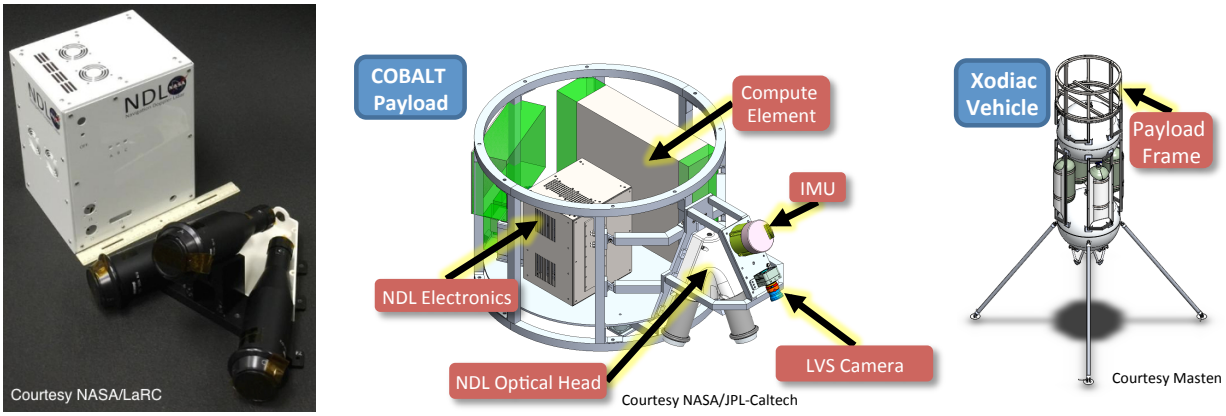

Figure 1. Representative images of sensors and payload: NDL (left) and COBALT layout (middle and right).

III. Baseline Flight Profile

Section will discuss the baseline flight profile and flight performance targeted for the COBALT flights onboard Xodiac. An image of the trajectory profile will be included, annotated with Nav modes (COBALT vs vehilce), sensor sequencing, and guidance events.

IV. Xodiac Rocket-Propulsive Terrestrial-Flight Vehicle

Section will discuss the development and target performance for the MSS Xodiac vehicle that will be utilized for the open- and closed-loop flight testing of COBALT.

V. Next Steps for COBALT

Remaining work for payload integration, followed by open-loop flight tests. Subsequent work in preparation for closed-loop flight tests.

Follow-on risk-reduction initiatives for maturing and demonstrating ALHAT Hazard Detection, new

implementations of Navigation algorithms and Guidance planning algorithms, maturation of the Xodiac platform and FO suite of test vehicles for advancing and testing EDL technologies in closed-loop GN&C systems prior to actual mission EDL.

Acknowledgments

We want to acknowledge the excellent engineering talent and commitment of our entire COBALT team, which is spread across multiple NASA centers: Johnson Space Center, Langley Research Center, and the Jet Propulsion Laboratory. We also want to acknowledge the team at Masten Space Systems that is working hard to complete the free flight envelop expansion of the Xodiac vehicle in preparation for the COBALT flight tests. Together we will demonstrate and advance new ALHAT capabilities one step closer to spaceflight infusion. We also want to thank our supporters at NASA Headquarters within the HEOMD-AES Program office and the STMD-FO Program office. They are providing the funding and programmatic support for the development of ALHAT and execution of COBALT. The work described herein is being performed within NASA at the Johnson Space Center, Langley Research Center, and Jet Propulsion Laboratory, as well as within MSS. The ALHAT and COBALT work at the Jet Propulsion Laboratory, California Institute of Technology, is being performed under contract with the National Aeronautics and Space Administration (Government sponsorship acknowledged).

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