NASAfacts

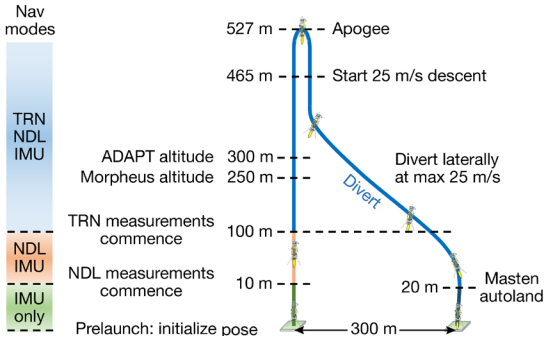
Space Technology
Game Changing Development
COBALT: Development and Maturation of GN&C Technologies for Precision Landing

Overview

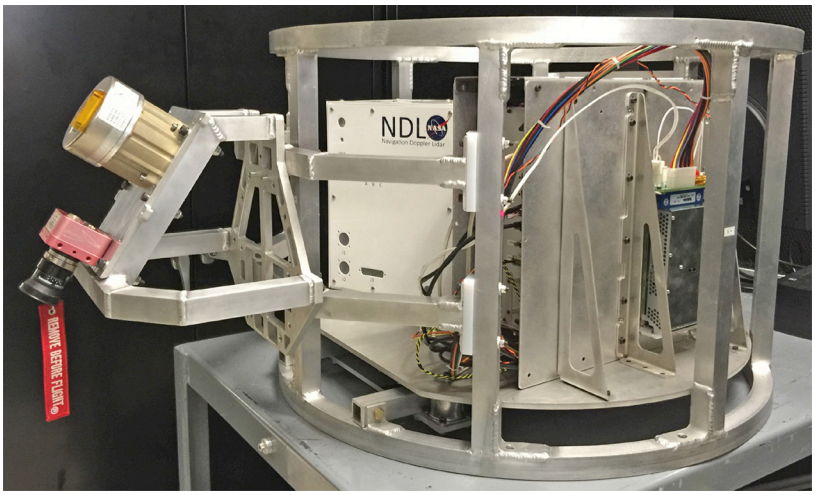
The CoOperative Blending of Autonomous Landing Technologies (COBALT) instrument is a terrestrial test platform for development and maturation of guidance, navigation and control (GN&C) technologies for precision landing. The project is developing a third-generation Langley Research Center (LaRC) navigation doppler lidar (NDL) for ultra-precise velocity and range measurements, which will be integrated and tested with the Jet Propulsion Laboatory (JPL) lander vision system (LVS) for terrain relative navigation (TRN) position estimates. These technologies together provide precise navigation knowledge that is critical for a controlled and precise touchdown. The COBALT hardware will be integrated in 2017 into the GN&C subsystem of the Xodiac rocket-propulsive vertical test bed (VTB) developed by Masten Space Systems, and two terrestrial flight campaigns will be conducted: one open-loop (i.e., passive) and one closed-loop (i.e., active).

Cobalt Concept of Operations

The COBALT flight profiles on board the Xodiac VTB will emulate a portion of propulsive descent that is relevant to Mars, moon and other soft landings. The figure below provides an illustration of the COBALT concept of operations, including the flight phases and the measurements that are contributing to the COBALT navigation system at any given time and altitude. The flight campaigns will test the COBALT sensors at higher altitudes



COBALT flight concept of operations.



COBALT hardware.

Xodiac vehicle (Masten Space Systems).

(527 m) and velocities (25+ m/s) than were achievable with prior NASA VTB tests, including Morpheus. The flight campaigns will expand the NDL's current flight test envelope, plus test the performance of a new navigation filter that blends NDL and LVS TRN measurements. The open-loop flights will characterize COBALT navigation filter performance and verify system components and interfaces in a passive manner without risk to the Xodiac vehicle, which will utilize GPS for navigation. The closed-loop flights will make COBALT active within the Xodiac GN&C subsystem, and the vehicle will perform guidance and control planning and maneuvers based on the precise COBALT navigation knowledge. Xodiac GPS will provide a backup/monitor during the flights to minimize risk to the commercial VTB, and it will also be used for auto-landing the vehicle below the final 20 meters of descent.

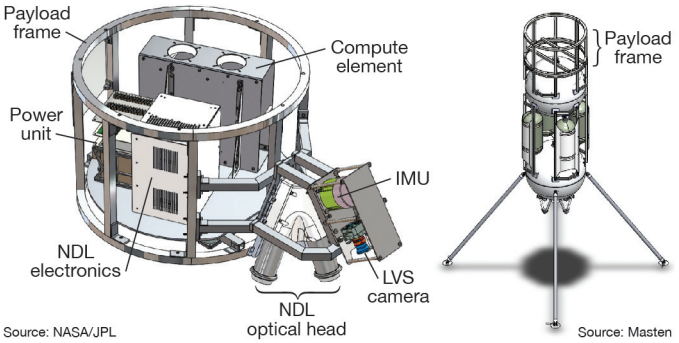
Innovation and Infusion

The COBALT project will mature precision-landing GN&C technologies for infusion into near-term robotic science and future human exploration missions. The NDL is a prime candidate sensor for Mars, moon or other planetary missions because of the high resolution velocity and range measurements. One of the key deliverables of the COBALT project is to mature NDL technology in preparation for the development of a space-qualified unit. In addition to the hardware, the COBALT navigation algorithms for blending and flight testing LVS TRN and NDL together provide a compelling new solution for future precise landing missions.

Navigation Doppler Lidar (NDL)

The third-generation NDL provides both velocity and range measurements. The sensor hardware consists of a custom optical head and electronics box. The electronics includes a seed laser, fiber amplifier, synthesizer, wide-band receiver and a NASA-developed command and data handling (C&DH) board. The NDL is designed for a velocity envelope of 200 m/s per telescope line-of-site (LOS), and an LOS range of 4+ km. The NDL will achieve TRL6 in 2019 and could be infused onboard a robotic moon or Mars lander mission in the 2020s.

Navigation Doppler lidar.



COBALT hardware (left) and Xodiac vehicle.

Lander Vision System (LVS)

The JPL-developed LVS provides an estimate of global position relative to a reconnaissance map. Its TRN function compares real-time acquired images from an onboard, passive-optical camera with reconnaissance maps (also stored onboard) to determine landmark matches and to estimate the spacecraft position relative to the map. LVS has already been baselined for flight infusion onboard the Mars 2020 mission.

Partnerships and Collaborations

COBALT is a collaboration between multiple NASA centers: Johnson Space Center (JSC), JPL and LaRC. JSC provides project management, technical planning and operations support. JPL provides systems engineering, development, integration and testing of the COBALT payload and LVS. LaRC provides development, integration and testing of the NDL. The COBALT project derives funding from multiple NASA directorates: HEOMD-AES, STMD-GCD and STMD-FO. The LVS technology was developed with funding from SMD and STMD.

The Game Changing Development (GCD) Program investigates ideas and approaches that could solve significant technological problems and revolutionize future space endeavors. GCD projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. GCD is part of NASA's Space Technology Mission Directorate.

For more information about GCD, please visit http://gameon.nasa.gov/

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