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GRYPHON: A FEASIBLE HORIZONTAL TAKEOFF NEXT GENERATION ARCHITECTURE CONCEPT

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Abstract

NASA's Next Generation Launch Technology (NGLT) program recently funded studies of the Gryphon launch architecture. Gryphon combines existing technologies with moderate propulsion advancements and a design for operations approach into a unique, aircraft-like architecture. A joint NASA/industry team was assembled by NGLT's Systems Analysis Project to assess the Gryphon concept and produce a conceptual design to specific performance, reliability, safety, and life cycle cost goals while meeting NASA and DoD requirements. The effort demonstrated the fundamental feasibility of the architecture. This paper describes the study, outlines the architecture's features and benefits, and highlights the critical issues identified for further study.

Acronyms

ACES	Air Collection and Enrichment System
CFD	Computational Fluid Dynamics
DRM	Design Reference Mission
FOM	Figure of Merit
GTOW	Gross Takeoff Weight
HTHL	Horizontal Takeoff Horizontal Landing
IVHM	Integrated Vehicle Health Management
L/D	Lift-to-Drag Ratio
LEO	Low Earth Orbit
LOM	Loss of Mission
LOP	Loss of Payload
LOV	Loss of Vehicle
LOX	Liquid Oxygen
NGC	Northrop Grumman Corporation
NGLT	Next Generation Launch Technology
POD	Point of Departure
R&D	Research & Development
RLV	Reusable Launch Vehicle
SAP	Systems Analysis Project
SBIR	Small Business Innovation Research
SLI	Space Launch Initiative
TAT	Turn Around Time
TPS	Thermal Protection System
TSTO	Two Stage To Orbit

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Introduction to Gryphon

Horizontal Takeoff, Horizontal Landing (HTHL) architectures typically either use highly advanced technologies (such as hypersonic propulsion, advanced materials, etc.) or are incapable of delivering substantial payloads to orbit. The Gryphon Two-Stage-to-Orbit (TSTO) HTHL architecture, however, meets NASA and DoD payload requirements without significant technology advancements. This is made possible by an in-flight propellant collection system, the Alchemist™ Air Collection and Enrichment System (ACES), developed by Andrews Space, Inc. Alchemist ACES generates liquid oxygen (LOX) through separation of atmospheric air, which allows Gryphon to take off without LOX on board, minimizing vehicle takeoff weight.[1,2] Studies have shown that ACES, previously proposed for hypersonic combined cycle reusable launch vehicles (RLVs), is a higher payoff, lower-risk technology if LOX generation is performed while the vehicle cruises subsonically.[3] This enables RLVs that operate with existing airbreathing and rocket propulsion systems, creating a paradigm shift in space operations.

Mission Operations

Figure 1 shows a nominal Gryphon trajectory. Both vehicle stages use liquid hydrogen and oxygen engines for rocket-powered flight. The second stage,