

IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Launch Vehicles in Service or in Development (1)

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COMPREHENSIVE STUDY OF THE INTERNATIONAL SPACE LAUNCH INDUSTRY:
PROGRAMMATIC ANALYSIS AND TECHNICAL FAILURES**Abstract**

The international launch industry is a complex industry that plays a pivotal role in advancing space exploration. Thus, understanding and addressing launch failures are of paramount importance in the evolving landscape of the international launch industry. While much research has been conducted on risk assessments and country-specific analyses, very little has considered a comprehensive study of the international launch industry and a generalized approach to analyze failure propagation within the system. This paper conducts a two-fold analysis into the international launch services, bifurcated into a comprehensive study of the launch industry and a thorough analysis of the technical launch failures, introducing a probabilistic failure assessment tool that simulates launch failures and assesses ways to mitigate them. The first objective of this study is to review the dynamics of the international launch industry, emphasizing programmatic intricacies and technical anomalies that have significantly influenced its trajectory. The paper proposes a multifaceted analysis of market dynamics, launch vehicles, and recent technical failures, providing a comprehensive understanding of the challenges and opportunities inherent in the domain. The study dissects the industry's current dimensions, growth patterns, the geographical distribution of major launch service providers, as well as the nuanced interplay between government policies and the industry. The second objective of the paper is to provide a comprehensive analysis of launch failures in both heavy and small lift launchers over the last 23 years to ensure reliability in new launch services. The paper introduces a probabilistic failure assessment tool to simulate failure scenarios, predict potential failures when using new launch technologies, and assess ways to mitigate them. The cause of failure and corrective action for each failed vehicle are documented, the critical systems leading to the failure are identified, and the reliability of the major space launch vehicles from different countries is compared. The failure assessment tool is then used to simulate the failure cascade profile for selected failures focusing on stage separation and engine failures. This multifaceted analysis does not only contribute to our understanding of the complexities within the international launch industry but it also introduces an innovative tool that holds the potential to revolutionize risk assessment and mitigation strategies. The presented analysis and tool are instrumental in ensuring launch services reliability especially when new technologies are incorporated into the launch system.