

SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Small Launchers: Concepts and Operations (7)

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DEVELOPMENT OF A FAMILY OF AIR-LAUNCHED SMALLSAT LAUNCH VEHICLES FOR
AFFORDABLE AND RESPONSIVE SPACE ACCESS**Abstract**

In recent years the capabilities and applications for satellites of less than 10 kg launch mass (called nanosatellites) have grown considerably, evolving from simple student “CubeSat” class projects. Many commercial applications of 3U to 12U CubeSats are now in development, including constellations of 16 or more spacecraft providing continuous global coverage. Microsat-class satellites (50kg to 300kg) have become mainstream spacecraft, with many different applications including several new proposals for massive LEO constellations in the hundreds of spacecraft. Rocketplane Global is developing a new category of hybrid launch system specifically to service the small satellite developer community with smallsats as the primary payloads. This launch system uses a family of reusable horizontal takeoff landing first stage air vehicles plus low cost expendable upper stages. For nanosat-class payloads, the first system uses the Mach 2.2 F-104 Starfighter with a unique two-stage expendable upper stage propulsion system to launch payloads up to 50 kg. For payloads in the 50 kg to 100 kg size range, the reusable Mach 3.5 XP suborbital spaceplane is used as the first stage carrier aircraft and a two stage low-cost expendable upper stage and payload fairing stack is used to reach orbit. The system is designed to launch up to 100 kg to a 500 km polar orbit. Multiple 1U to 3U CubeSats can be deployed via a dispenser system, or a single small satellite can be launched. For larger payloads up to 1,000 kg or cluster deployments of multiple 100 kg class smallsats, the larger XS-1 Mach 12 suborbital spaceplane will be used. All three vehicles share a common operating mission model and airport / spaceport launch infrastructure. For launch operations that will service the EU market (which is one of the global Centers of Excellence for nanosatellite development) a polar azimuth launch corridor over the North Sea from the proposed UK Spaceport has been identified. This launch flight plan takes advantage of dual-use opportunities for Military Restricted Airspace that is a common feature in US commercial spaceflight licensed launch activity. This paper will describe the business synergies, technical, operational and performance aspects of the F-104 air launch system; the Rocketplane XP nanosatellite launch system; and the Rocketplane XS-1 microsat launch system, along with launch cost projections and regulatory aspects of such launch operations in the US and Europe.