

Space-to-Space Transport Enabling a New Space Economy Beyond LEO

Missions beyond LEO are out of reach for many SmallSat companies. High transportation costs, long acquisition lead time, and limited propulsion system delta-V confine these missions to LEO orbits.

Bradford Space presents a paradigm shifting spacecraft, called Square Rocket, which enables routine and reliable deep space missions. Square Rocket uses the high ISP, high density LMP-103s propellant and ECAPS thrusters to provide access to high orbit and deep space missions from a small launcher or rideshare, while enabling trip times >10X faster than low thrust propulsion systems. For decades, the automotive industry has used pump-fed engines to enable low pressure storage in conformal tanks. The Square Rocket leverages this automotive approach to propulsion that enables packaging unpressurized green propellant with up to 4,600 m/s delta-V capability into a rideshare volume. Because the propellant is transportable by road and air, the spacecraft is fueled at the factory to avoid long lead time and expensive processing at the launch site. In addition, the use of unpressurized tanks greatly reduces the risk of significant leaks from the vehicle, improving overall handling safety and reducing logistics cost.

Square Rocket is capable of a wide variety of trajectories but is primarily designed to perform short sequential perigee thrusts to raise apogee to the desired altitude, followed by a series of circularization burns to the final orbit. The trajectory is essentially a “slow Hohmann” or a bielliptic transfer, where the short thrusts are representative of a cumulative impulsive change in velocity. The maneuver can be executed initially from LEO or GTO depending upon the delta-V requirements and mission needs.

Launch vehicle rideshare torque constraints require the spacecraft payload center of mass to be relatively close to the payload origin. The spacecraft is optimized for a target payload mass of 100 kg and envelope of a 60 cm x 70 cm x 90 cm. For payloads more massive than 100 kg, propellant mass can be reduced by approximately 2:1 ratio with the payload, resulting in a CM requirement of approximately 36 cm for payloads from 100 kg to 300 kg. Square Rocket accommodates many payload arrangements. Singular payload deployments may use a 15” Lightband or similar separation mechanism. The spacecraft can also accommodate missions such as 4 x 12U CubeSats or an equivalent combination of 6U or other small satellites.