Rainbow – A Launch Capability For Small Satellites From Esrange, Sweden

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ABSTRACT

As the number of small satellites increase so does the need for dedicated launch opportunities and to carefully designed orbits. To meet these needs, SSC has initiated project Rainbow, a launch capability for small satellites from Esrange Space Center.

Esrange is located in the very north of Sweden, above the Arctic Circle (68°N, 21°E) and has access to a vast, unpopulated area. The facility has been operated since 1966 and is presently used for sounding rocket and balloon launches. It also hosts one of the world's largest civilian satellite ground stations.

SSC has conducted a phase A study to investigate if a satellite launch service can be implemented at Esrange and the result shows it is feasible.

The launch service is intended for 1-150 kg satellites; however, CubeSats are the target payloads. The launch service will enable a standardized orbit suitable for most CubeSats and the launch period will be fixed.

A phase B1 study is ongoing and next phase, B2 will commence in the end of 2015/beginning of 2016.

The goal is to launch the first satellite from Esrange in 2020.

ESRANGE SPACE CENTER

Esrange Space Center is located in the very north of Sweden, above the Arctic Circle (68°N, 21°E) and has access to a vast, unpopulated recovery area, 5200 km^2. Esrange was founded in 1966 by the European organization ESRO, nowadays ESA. SSC has owned and operated Esrange since 1972. The facility is now undergoing a major modernization and expansion of capabilities to become a center of excellence for space tests and operations to meet an increasing demand of access to space. As part of this, SSC has initiated the project Rainbow, a launch capability for small satellites from Esrange. A "green" launch site meaning that Hydrazine and other highly toxic substances will be banned.

The facility is presently used by the international scientific community for launching sounding rockets for microgravity and atmospheric research as well as high altitude balloons for astronomy, atmospheric research and drop tests. It also hosts one of the world's

largest civilian satellite ground stations, a hub in SSC's global satellite ground station network, PrioraNet.

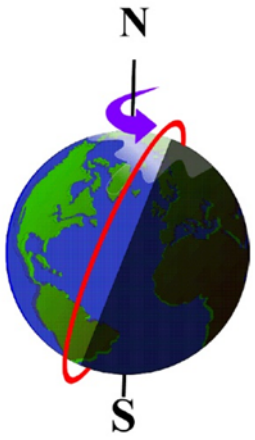
THE NEED FOR ACCESS TO SPACE

Nano and microsatellites, including Cubesats and even minisatellites are today mainly launched as piggyback payloads with very limited opportunities for choosing orbit or even knowing in which orbit the satellite will be placed. As the satellites get more sophisticated and for commercial applications, the need to launch them into carefully designed orbits have arisen. There is already a queue of Cubesats looking for launch opportunities and we can expect a further increase in the future. Thus, there is a need for dedicated launchers for small satellites which regularly launch into standardized orbits. Several initiatives are ongoing but very few, even none in Europe.

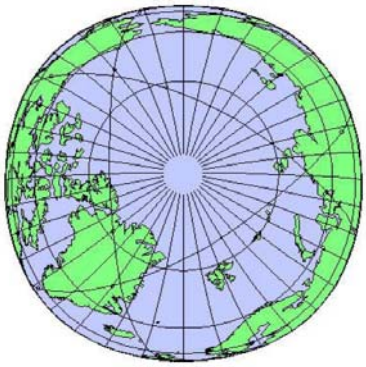
SMALLSAT EXPRESS – A "NO-NONSENSE" LAUNCH SERVICE

SmallSat Express will launch satellites 1-150 kg at pre-determined dates, one to four times per year and into a standard orbit. Cubesats are the main target.

- The standard orbit is a sun-synchronous orbit at 500 km latitude and at the following local times of the ascending node: 2200, 0600, "dawn-dusk" orbit, and 1400 (or 1000, 1800 and 0200).



- The 2200 Local Time orbit is very similar to those used by optical earth observation missions because satellites pass southbound over targets on the ground at about 10 a.m. local time – the optimum time of day for taking pictures of the ground.
- The 1400 Local Time orbit is very similar to those used by optical earth observation missions because satellites pass northbound over targets on the ground at about 2 p.m. local time – a local time used by weather satellites to get a close-up view of afternoon cloud cover to complement the 10 a.m. images. For satellites that desire a sun-synchronous orbit but are not engaged in optical imaging this is a perfectly viable alternative to the 10 a.m. orbit.
- The launch into the 0600 "dawn-dusk" orbit is proposed to occur in August giving eclipse-free conditions until the following spring – an advantage for power-starved missions.
- If only one launch is made per year it occurs in August. If two launches are made they occur in April and August. Three launches per year occur in January, April and August.
- By using the launch service on three consecutive launches a constellation of satellites covering every local time can be established. Consecutive launches will enter orbits with local times in the following succession: 0600, 2200, and 1400.

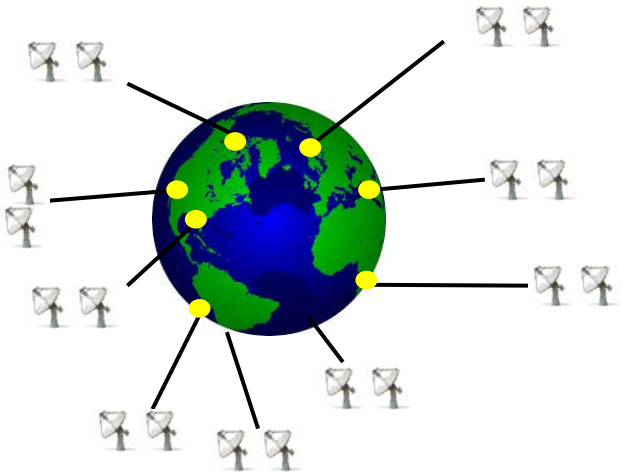


- If the demand for such constellation-building launches does not materialize the "dawn-dusk" orbit will be offered as the standard orbit with the 2200 Local Time orbit as the fall-back.

ADDITIONAL SERVICES AND PRODUCTS

As a complement to the launch service, the following additional services and products could be offered:

- Automated and standardized ground network services.A network of small antennas, nine to ten locations, geographically optimized for frequent, high capacity data download and satellite tasking. The operations will be fully automated with customer interfaces automatic access or manually via Internet.



- LEOP communication
- Frequency coordination
- Onboard radio
- Cubesat propulsion system with 4 individually controllable thrusters. Dry mass: 130 g. Fuel: 70 g. Size: 10x10x3 cm. Operating media: Butane. Total impulse: 40 Ns. Specific impulse: 90-110 sek
- "Green" orbit raiser

PROJECT STATUS

A phase A study with the aim to investigate if a satellite launch service can be implemented at Esrange has been conducted. The phase A study included launch site infrastructure, spacecraft handling, launch operations and flight safety. The Brazilian launcher VLM-1 was used as a base case in the study. The result of the study shows that the establishment of a launch site for small satellites at Esrange is feasible.

A phase B1 study was initiated at the end of 2014 and is currently ongoing. The B1 study focuses on political endorsement, partnership establishments and fundraising. Evaluation of different launch vehicle options are in progress and trajectory calculations based on the launch vehicle data will be performed.

The next phase will be a B2 study, foreseen to start end of 2015 or early 2016. The study will include flight safety risk assessment, design of infrastructure at Esrange and orbit raiser design (concept and main engine) if the need for an orbit raiser is verified. ECAPS' High Performance Green Propulsion is the preferable choice for an orbit raiser.

The goal is to launch the first satellite from the "green" launch site Esrange in 2020.