TAKASHI SPACE
Planning and Innovation for the Future of Space Access

Executive Memo on the Feasibility of a New Spaceport Facility in Cameroon

Revision No.: 1.4

Status: Draft Document, For Discussion

Date: 06 September 2005

Author: Dan Armstrong, Managing Consultant < dan@takashispace.com >

Distribution: Confidential

Takashi Space Offices:

Europe (main):

Binnen Bantammerstraat 8 - Suite 300
1011CK Amsterdam
The Netherlands

tel. +31 20 428 4895

North America (satellite):

909 N. 35th Street - Suite 203
Seattle, WA 98103
United States of America

tel. +1 425 467 3443

Contents:

1. Introduction

This project seeks to construct a detailed feasibility study on the opportunity for a space launch facility and associated infrastructure in Cameroon (referred to in this document as **Cameroon Spaceport** or "CSP"). Utilising industry professionals and a fresh view towards commercial opportunities that have arisen in the last 15 years for: a.) partnership with new countries and industries, b.) alternative-to-traditional access to space and c.) community involvement, the goal is to create a comprehensive view on the costs, benefits, opportunities and risks in such an endeavour.

There are, of course, costs and organisational components to such a planning process which we believe can be subsidised by a variety of organisations. However, at the very least, we believe that formulating a plan of the possibilities, hurdles and challenges, benefits and possible ways forward helps to generate positive discussion as to how Cameroon can play a role in the future lucrative space business, what next steps to take and the benefits they will bring.

This concept was initiated in early 2005 as a venture dedicated to planning this project geared towards a feasibility project to define the opportunities of a space launch facility in Western Africa. With main offices in Amsterdam NL, Takashi Space[1] seeks to assist companies, governments and the scientific community in defining these strategies for future space access.

Cameroon is one of the most attractive countries in Western Africa for realisation of this planning, based on its position, economy, education system and national goals. In March 2005, Takashi Space decided to focus on Cameroon based on the opportunity to present this planning idea.

Takashi Space believes that space access can be achieved with lower-cost operations and continues to look into a number of new, innovative technologies for alternate and/or lower-cost access to space, as well as envisioning new forms and locations for launch facilities that better suit the challenges of space access in the 21st century.

Our initial estimations are that a space launch facility in Cameroon would allow the launch of a payload[2] or fuel more than 17% heavier than at Cape Canaveral in the US, for the same cost. This represents a substantial benefit for satellite operators, scientific institutions and governments – one which will be described in more detail later in this paper.

With a healthy ecosystem of benefits for Cameroon and it's people and industry, as well as space launch customers, a new space launch facility will be sustainable in the long-run. We believe that these three elements are critical to successful future space access:

1. Mission Success
2. Cost Effectiveness
3. Community and National Benefit

Additionally, successful future space access projects will require new thinking and new business models. We believe that Cameroon is in a unique position to build a strategy based on the new technologies, lower-cost development, a number of new and exciting commercial space launch initiatives arising from refined development and commercial space activity, and the lack of any comparable launch facility anywhere on the African continent.

---

[1] Takashi Space is a registered trade name of United Solutions Advice BV – an incorporated company with headquarters in Laren, Noord-Holland, Netherlands. Takashi Space address is De Leemkuil 1 - NL-1251 AR Laren NH - The Netherlands, fax +31 842 112 795, VAT Nr. NL8115.81.780.B01, IBAN Nr. NL41 RABO 0328283789.

[2] "Payload" is meant to primarily describe the satellite or other piece of equipment (e.g. parts for the International Space Station or other component) being transferred to orbit.

2. The Market Opportunity

Around the world, the business of space is a US$100 billion yearly industry, including a great deal of money spent on rockets to launch satellites for weather forecasting, navigation, television broadcasting and telecommunications including global Internet and mobile phone service. Many analysts predict that the space sector will grow to over US$1 trillion in the next 40 years. The space launch industry grows at the rate of 20% a year. As a result, not just governments, but commercial firms want to build launch pads to grab a share of the market.

Critical to the business of space is affordable, reliable, frequent and flexible access to space. More often than not, however, civil, military and commercial organisations simply do not get it. As opposed to express shipping companies and delivery organisations, space access has problematic schedules (often requiring booking from two to four years in advance), huge expenses in launch systems and substantial paperwork / governmental limitations, and boasts a failure rate of from 2 to 18%. This limitation of access to space and the often prohibitive costs associated with launches are frequent complaints world-wide, and present a substantial business opportunity for groups willing to consider new plans for space access.

Acceptable access to space is naturally a mix of numerous elements, all contributing to smoother processes and more cost-effective operations. The costs and processes involved in access involve things like regulatory issues; launch systems (chemical, solid fuel or alternate propulsion); transportation and logistics; preparation; payload size, safety and security; launch trajectory and orbital position; ground control systems.

World-wide, there are only a few dozen possible locations for launching payloads to orbit, and many of them are critically limited in their capabilities by their position on the planet. Additionally, many launch facilities are overwhelmed with launch requests and have prohibitively slow and bureaucratic procedures to secure a launch slot. Of the launch sites on the planet, only a few have both equatorial benefits, accommodation for multiple size rockets and payloads and are open to international cooperation and collaboration. Launch sites in the United States, Russia, Japan, Europe, China and India are both at higher latitudes inappropriate for cost-effective Geosynchronous Transfer Orbit (GTO) launches and are often subject to tight control and scheduling.

Additionally, many established launch facilities are hesitant to de-focus their energies from lucrative, high-cost, mature, "traditional" launch customers to accommodate alternate space programmes and strategies, commercial and civil business and to work on new ways to reduce launching costs.

A Cameroon Spaceport (CSP) would be a positive development for the industry. In short, the CSP would:

- provide alternative equatorial launch capabilities;
- effectively compete on cost, speed, reliability and safety;
- provide substantial in-bound revenue to Cameroon;
- provide new and innovative partnerships with traditional and new generations of space business;
- benefit Cameroon as a country, as well as Cameroonian communities, education and industry; and
- provide Africa with its first, full-service space launch facility.

2.1. Benefits for the Space Industry

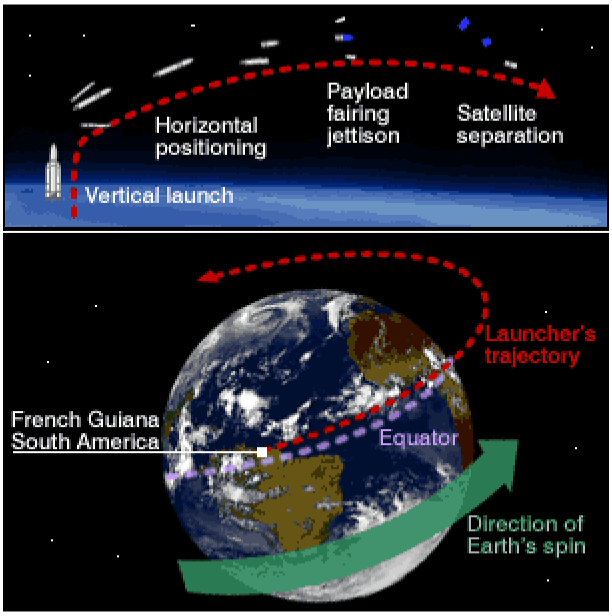
There are numerous benefits for the space industry to having an alternate and more cost-effective alternative to other launch facilities world-wide. There are only three tenable launch sites presently close to the equator which provide the substantial cost-savings of the equatorial slingshot speed boost. Additionally, many facilities are mired in scheduling and security problems having to do with priority military missions, regulations on export of technologies or political concerns. In the end, having a competitive choice for launch facilities will give most countries and companies of the world a better and more efficient space access industry overall. Some of the specific benefits follow:

2.1.1. Equatorial Launch Position

To escape the Earth's atmosphere, the laws of orbital mechanics[3] require rockets to reach more than 150 km in height and travel over 7.9 km per second. Companies like Sea Launch and Arianespace launch vehicles from the equator because the Earth's 460 metres per second rotation "sling-shots" rockets that are launched east, requiring less power and/or less fuel, and therefore larger payloads can be launched using the same launch vehicles. In short, CSP can provide more cost-effective traditional launch facilities for solid- and liquid-fuelled rockets than other current facilities further north or south of the equator.

Currently only 1.) the European Space Agency (ESA) Kourou launch facility in French Guiana – "Centre Spatial Guyanais" (CSG), 2.) the mobile Sea Launch, Russian-American ocean-based launch platform can provide such a cost-effective launch position, 3.) Brazil's Alcantara Launch Center and 4.) the planned new Asia Pacific Space Centre (APSC) on Christmas Island in the Indian Ocean are launching from positions within 10° (degrees) of latitude from the equator. In fact, recent news of Arianespace/Russian collaboration reinforces this advantage, and includes plans to launch Soyuz vehicles from CSG beginning in 2008. Russia has agreed to use the spaceport in CSG for medium-weight satellite launches, with the help of €344 million in European funding for construction of the launch pad.

The equatorial facility allows the Soyuz to expand satellite launch weight from 1,6 tonnes to approximately 3 tonnes into geostationary transfer orbit (the orbit needed for insertion to geosynchronous[4] position) and Russia expects to launch from three to four Soyuz missions a year from CSG. Additionally, Arianespace has become involved with the Soyuz (with the Fregat commercial upper stage) in launches at Plesetsk and Baikonur Cosmodromes.[5]



The cost/weight savings of launching form CSG, compared to Cape Canaveral in Florida, US are 17%, a substantial margin for commercial satellite operators, research institutions and governments.

Satellites launched into orbit also have roughly the same "inclination" (or position travelling around the Earth) as their latitude when launched. In Geosynchronous Transfer Orbit (GTO)[6], satellites must be in-line with the equator, so satellites benefit from an equatorial launch position as they will use less fuel in travelling to this equatorial position form their initial launch orbits, which are normally far more north or south.

The CSP position near the equator can provide substantial cost-savings for satellite launches, increasing satellite function and/or fuel capacity, extending greatly the life of geosynchronous satellites, which is of substantial commercial value to telecommunications and broadcast companies. In fact, depending on the final placement of CSP, the facility has the ability to boast the closest-to-the-equator, land-based launch facility in the world.

---

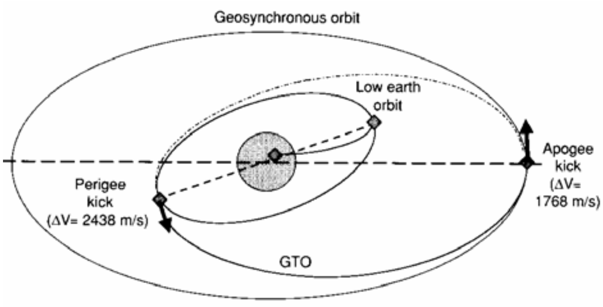
[3] *Originally, these laws were postulated by German Johannes Kepler in 1609 and 1618. His primary contributions to astronomy/astrophysics were his three laws of planetary motion.*

[4] *"Geosynchronous" refers to a stable position above one fixed point on the Earth.*

[5] *The most recent example of this new collaboration is the Soyuz-Fregat launch of the PanAmSat Galaxy 14 broadcast satellite on 14 August 2005 from Baikonur Cosmodrome (managed by Russia's Starsem) and the workhorse Soyuz family's 1,699th flight. Although originally slated for launch from an Arianespace Ariane 5 launch vehicle, the mission parameters required this change to the Soyuz launcher in mid-planning.*

[6] *"Geosynchronous Transfer Orbit" or "GTO" refers to the lower transfer orbit that a launcher needs to reach before the last stages of the launcher can move the satellite out to this stable position.*

The launch mission itself is a series of successful steps to get a satellite into GTO with a period of approximately 16 hours, so that it can be easily placed into Geosynchronous Earth Orbit (GEO)[7] and maintain it's position above one point above the Earth, with a period of 24 hours (see graphic to the right, although the orbital distances are exaggerated for clarity).

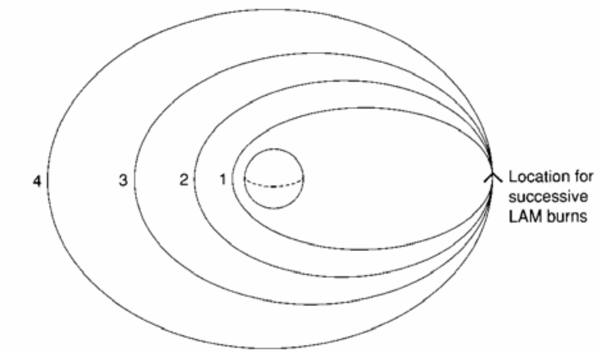


Major Orbit Changes to Reach GTO

For CSP, this launch is simply the last in a series of steps of logistics, transportation, satellite payload preparation, safety and documentation – but for the satellite operator it is normally the most expensive component of launching payloads to orbit and is the core of their business case.

For a typical GTO mission, the booster rocket lifts off from the launch platform and delivers the vehicle to an altitude of between 150 and 300 km, wherein the vehicle follows a roughly circular orbit path. Typically this manoeuvre is made up of two stages, wherein the first stage is a ballistic launch (that would theoretically land on Earth some distance away) and a second stage that pushes the vehicle into orbit.

Another rocket stage is used to push the vehicle either directly into GEO or into elliptical orbits and successively higher orbits by adding velocity incrementally (see second graphic to the right). At it's farthest point, GEO, the satellite is roughly 36.000 km from the Earth's surface



Injection from Transfer Orbit in GTO by Successive Burns

2.1.2. Reliable Traditional Launch Services

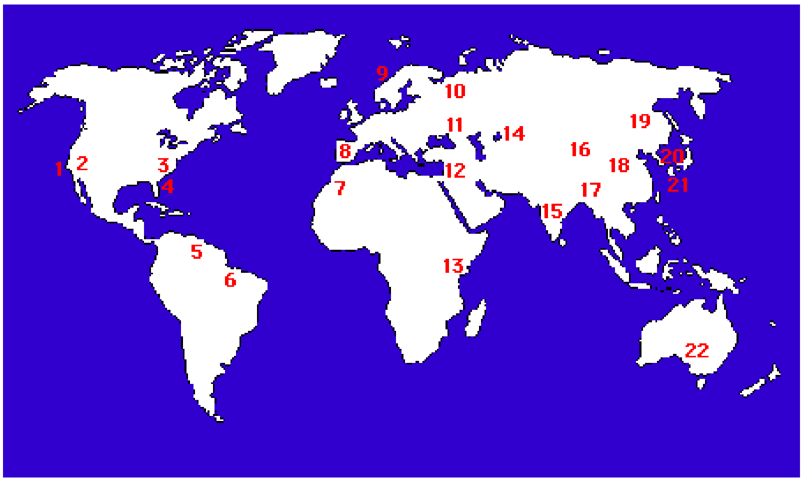
Around three dozen spaceports have been constructed to-date and dot the globe at locations dictated more by political realities than by technical requirements for lifting satellites to orbit. Over the decades since 1957, some 5.000 satellites have been boosted above the atmosphere from these sites - the busiest spaceports being Cape Canaveral, Vandenberg, Baikonur, Plesetsk, Kourou/CSG, Tanegashima, Jiuquan, Xichang and Sriharikota.

With increasing demand for launch facilities for not only traditional telecommunications, broadcast and research satellites, but alternate space ventures - there is a critical lack of launch facilities world-wide that can provide reliable, secure and fully-featured launch assistance and facilitation. The ESA CSG facility (pictured above), Sea Launch venture, Alcantara

[7] *"Geosynchronous Earth Orbit" or "GEO" is the final orbit for satellites to remain above a fixed position on the Earth. Most telecommunications and broadcast satellites are in a GEO position.*

Launch Center and APSC are presently the only active launch facilities one near the equator and many governments and commercial interests would benefit from a new, competitive choice and/or alternate location.

Previously used launch facilities world-wide include: 1.) Vandenberg (US), 2.) Edwards (US), 3.) Wallops Island (US), 4.) Cape Canaveral (US), 5.) CSG (ESA, Russia), 6.) Alcantara (BR), 7.) Hammaguir (FR), 8.) Torrejon (SP), 9.) Andoya (NO), 10.) Plesetsk (RU), 11.) Kapustin Yar (RU), 12.) Palmachim (IL), 13.) San Marco (IT), 14.) Baikonur (RU), 15.) Sriharikota (IN), 16.) Jiuquan (CH), 17.) Xichang (CH), 18.) Taiyuan (CH), 19.) Svobodny (RU), 20.) Kagoshima (JP), 21.) Tanegashima (JP), 22.) Woomera (AU).[8] For some key highlights on these launch sites, see Appendix 5.3: Non-Equatorial Orbital Launch Sites World-Wide.



In the profitable telecommunications satellite launch business, a number of major players and launch vehicles could be seen as customers for the CSP launch services and would each benefit from the equatorial position of the CSP and benefit from its overall cost of operations. Different construction and accommodation costs would be required to handle the different vehicles, naturally. These include: Arianespace (Ariane 5, Vega), Boeing (Delta), Rocket System Corporation (H2), China Great Wall Industrial Corp. (Long March), Orbital Sciences Corp (Taurus), Lockheed-Martin / ILS (Atlas, Titan, Athena) and RSC Energia (Soyuz, Zenit, Aurora, Proton).

For a detailed list of launch sites with a latitude of less than 10° ± from the equator world-wide, see Appendix 5.2 Equatorial Launch Sites. The CSP feasibility project should address individual launch vehicles' cost for integration, cost for ongoing operations and launches, price point versus competition and deployment issues, as well as payload capacity and cost-savings for equatorial launch, security and payload issues, etc.

2.1.3. Accommodation for Alternative Launch Services

In addition to the "traditional" space launcher markets listed in the previous section, there is a new and growing group of alternative or new-technology space launch vehicle manufacturers and consortia that aim to provide cheaper, more reliable access to space by breaking out of a number of traditional mindsets in design, production, and equipment re-use and launch processes.

These companies would be key targets for partnership, commercial customers and investment for the CSP facility and include various small space companies, experimental designs and participants in the recent X-Prize[9] competition for human space access, but also include developed space launcher companies with signed contracts for launches:

Kistler Aerospace – Kistler is creating the K1 reusable launch vehicle. Kistler has a number of contracts with US industry and government. The K1 is designed to lift from 2.500 to 4.500 kg into multiple orbits and inclinations.[10]

---

[8] Information taken from various sources, including Space Today Online.

[9] The "Ansari X-Prize" was the first of a number of contests sponsored by the X-Prize Foundation. The first Ansari X PRIZE involved twenty six teams from seven countries signed up to compete for the US$10 million prize to launch two consecutive private spacecraft into "space" – 100 KM + - in two weeks, returning each to safety. It leveraged more than US$100 million in private investment.

[10] "Inclination" refers in general to the angle between an axis of direction or a plane, and a reference plane. So, equatorial inclination is roughly in-line with the equator on Earth, whereas many LEO and MEO, Sun or Polar Synchronous satellites require different inclinations

Space X – Space X is creating the Falcon I and Falcon V launch vehicle and also enjoying a number of contracts with the US Department of Defence, Bigelow Aerospace, Malaysia and the US Air Force. The Falcon I is designed to carry 430 to 670 kg into various orbits and the Falcon V is designed to carry from 1.200 kg to 6.020 kg into various orbits. Whereas most launch systems deliver relatively small satellites for a total launch cost of between US$25 and US$50 million per flight (equating to between US$22.000 to $88.000 per kg of payload and fuel combined), for contracts completed in 2005, launches of the Falcon I is offered for US$5,9 million and the Falcon V for US$15,8 million plus modest range fees that vary by launch location. A half bay flight of Falcon V is also available at US$8,9 million to accommodate customers with payloads in between Falcon I and V. This is a substantial discount when compared to other competitors.

By embracing these new launch companies, CSP would be positioned to provide streamlined, fit-for-purpose services at substantially lower cost than competitors. The launch windows, schedules and bureaucracy inherent in traditional space access has spilled over into the new space industry, unfortunately – despite the extremely low cost of these launch vehicles based on their innovative design and construction.

For example, recent events have forced Space X to change their launch location of their initial launch, and 50% of all launches planned, from Vandenberg Air Force Base in California, US to the Ronald Reagan US Department of Defence launch facility in the Marshall Islands. CSP would make it a strong strategic goal to help streamline these problems and provide not only highly cost-effective space access, but access with the least hassle and paperwork, delays and unforeseen problems. Traditional launch facilities are often closed-minded about the viability of new launching vehicles and are protective of the ongoing revenue provided by governments, the military, major telecommunications companies and well-funded scientific research institutions.

The opportunity for CSP to accommodate a larger portion of the launch systems "value chain" can help establish a profitable and high-profile niche, in addition to the commitment to accommodate traditional launches.

2.1.4. African Space Launch Capability

From a commercial perspective, many African nations are beginning to take space seriously as a telecommunications and broadcast television enabler. Traditionally strong broadcast television countries like South Africa, Egypt and Morocco have utilised satellites for years to profitably broadcast television into homes and have taken steps to participate in remote sensing, Earth observation, meteorology and other scientific missions as well. However, new initiatives by countries like Nigeria and Algeria portend the future of collaboration between African nations on space projects that benefit all member countries (e.g. the Disaster Monitoring Constellation (DMC) in partnership with Surrey Satellite Technologies Ltd., detailed later in this paper).

A critical missing link in the space access value chain is modern, cost-effective launch facilities on the African continent. Examined in some detail by South Africa and rejected based on the cost vs. benefits from such a southern launch latitude, and minimally pursued in the 1970s by the Germans at Shaba North in the Democratic Republic of the Congo – launch facilities near the equator are a substantial natural asset for equatorial African nations.

The CSP plan brings that capacity to the table and enables retention of African capitol by providing more skill-sets and capabilities at home, while also providing a substantial revenue source from other foreign countries that could benefit from the CSP launch portfolio. With a bouquet of different orbital inclinations, launch platforms and preparation capabilities, CSP would provide a substantial opportunity for all African nations to launch satellites from Africa itself, and with a more cost-effective model, enable more research, telecommunications and other satellite functionality for African country's spend.

The partnership possibilities for enabling core services of the CSP are also truly pan-African, with countries like Nigeria and South Africa leading the way in other areas of satellite and space technology – partnership could be struck with these countries for skills, support, education and research programmes that would enable an influx of knowledge and skills far exceeding their commercial value.

2.2. Benefits for Cameroon

The benefits of the CSP are not simply revenue and job creation, but also benefits for the local communities surrounding the CSP, benefits in science and technology bargaining, partnership and position for the Cameroon government, enrichment and educational opportunities for the people and educational system in Cameroon, support and input for Cameroonian industry, as well as the creation of potentially dozens to hundreds of new industry opportunities in Cameroon and partner countries.

Initial, very high-level estimates for overall costs for construction of a moderate sized, one square kilometre CSP launch facility that includes technical complex, launch complex, mission control centre, energy management or production (as required), accommodation for staff and launch resources and administrative spaces (see later sections for more detail on these points) indicate that the total cost could be in the range of US$ 300 to 400 million, depending upon the common-use infrastructure upgrades required. Potentially construction could be substantially cheaper than this, depending on the phased business plan and facility construction.

If revenue indications for other proposed space launch facilities are taken as an indicator, total revenues for the CSP facility over a period of approximately five years could total more than double the revenue directly inbound to the project owners / Cameroonian government, indicating somewhere between US$ 600 and 800 million in revenues and a break-even total investment picture of between three and four years, given something like 10 launches per year.

The CSP would provide approximately 400 to 500 jobs in the construction phase of the CSP facility, and approximately 800 jobs during the ongoing operation of the CSP facilities, of which approximately 300 would be dedicated launch operations personnel. These personnel would likely not be primarily Cameroonians, but employees from the partner launch system company or companies involved in the CSP, trained and experiences in dealing with the launch vehicle and its deployment.

The employment for Cameroonian citizens in the CSP area will be long-term, sustainable revenue for these workers and their families. Along with the influx of technical professionals, specialists and associated workers, substantial opportunities for associated business, industry and services will emerge alongside the CSP core business. Opportunities include accommodation and hotels; agriculture, produce, food and catering; services industries like clothing, retail sales, domestic positions; tourism; and educational support programmes.

Note: These numbers are somewhat speculative at this point, as no business modelling has been done on costs, revenues, funding, investment structure, project phasing or partnerships.

The CSP would bring a new focus on science and technology throughout the country's universities and promote the creation of businesses, investment and development in areas that the Cameroonian Ministry of Higher Education has deemed of critical importance for growth. Educational partnerships with and involvement of the Cameroon University System would mean transfer of knowledge, learning new skills and proving hundreds of university students opportunities for learning and on-the-job skills in internships and paid positions that would have not been previously available.

The CSP also helps tie Cameroon into the larger African community in science and technology business and educational programmes, and helps carve a more solid position on the world stage in business, investment return, self-sustainability, science and technology initiatives and research.

2.3. Customers

There are a number of potential customers for CSP launch services, and in reality the CSP would work for pretty much all space payloads except for 1.) highly secret or dangerous US, Russian or potentially European military missions, which would likely not be competitive bid outside of tightly controlled facilities or owned military launch facilities in-country and 2.) specialised missions like the manned space programmes of the US or Russia utilising specialised facilities of Cape Canaveral and Baikonur Cosmodrome for US Space Shuttle and Soyuz manned missions.

Some space launch vehicles are also somewhat older and have required customised facilities to be constructed over time, and these launch systems might not be a good business investment to move from their expensive, existing launch facilities based on commercial revenue or military payloads. At this time, the authors cannot define which of these payloads would not be a profitable target customer, so this list includes all viable payloads researched. In truth, over 90% of these systems could be launched from a CSP facility and location with positive business benefits.

Launch Vehicle	Provider	Current Launch Site	Mass to GTO	Year First Launched
Angara 1.1	International Launch Services[11]	Plesetsk Cosmodrome, RU	NA	NA
Angara 1.2	International Launch Services	Plesetsk Cosmodrome, RU	NA	NA
Angara 3	International Launch Services[12]	Plesetsk Cosmodrome, RU	2.400	NA
Angara 5	"	"	5.900	NA
Angara 5 - UOHB	"	"	11.200	NA
Ariane 5	Arianespace	CSG, French Guiana	6.920	1996
Atlas V 401/402	International Launch Services[13]	Cape Canaveral, FL	4.950	2002
Atlas V 431	"	"	7.640	NA
Atlas V 501/502	"	"	3.970	2002
Atlas V 551/552	"	"	8.670	NA
Athena I	Lockheed-Martin	Cape Canaveral, FL; Vandenberg AFB, CA; Kodiak Spaceport, AK	812	1995
Athena II	Lockheed-Martin	"	2.055	
Avrora (Aurora)	RSC Energia	APSC, Christmas Island, AU	4.350	2006
Delta II	Boeing	Cape Canaveral, FL	4.723	1989
Delta IV[14]	"	"	12.797	
Dnepr RS-20	ISC Kosmotras	Baikonur Cosmodrome, RU	NA (LEO only)	NA
Eurockot RS-18	Eurockot Launch Services GmbH	Plesetsk Cosmodrome, RU	NA (LEO only)	2005
Falcon I	Space X	Marshall Islands; Vandenberg AFB, CA	NA	2005
Falcon V	"	„	1.920	2006
GSLV	Indian Space Research Organization (ISRO)	NA	2.500	NA
H-IIA	Rocket System Corporation	Tanegashima Space Centre, Japan	7.500 – 9.500	2001 / 2005

[11] *The Angara vehicle family is manufactured by Khrunichev's State Research and Production Centre, but has not flown commercial flights yet. It is designed to replace many of Russia's older booster rocket stages. It is unclear which of these rockets will be managed by ILS, but it is assumed all of them. The vehicles will be flown from the Plesetsk Cosmodrome, using ground infrastructure built for Zenit rockets.*

[12] *The Angara vehicle family is manufactured by Khrunichev's State Research and Production Centre, but has not flown commercial flights yet. It is designed to replace many of Russia's older booster rocket stages.*

[13] *Atlas launch vehicles are manufactured by Lockheed Martin Space Systems at its facilities in Denver, Colorado; Harlingen, Texas; and San Diego, California, US. Note: The Atlas II and Atlas III launchers are retired from service. The Atlas II was retired in March 1998 and the last Atlas IIA flown in December 2002. The last Atlas IIAS was successfully flown out in August 2004 and the final Atlas III flight was flown in February 2005.*

[14] *The Delta family includes The Delta IV Medium, Medium-Plus and Heavy versions. However, Delta launch vehicles are strictly utilised for military / US Air Force applications.*

Launch Vehicle	Provider	Current Launch Site	Mass to GTO	Year First Launched
K1	Kistler Aerospace	Woomera (Australian Spaceport), AU; Nevada Spaceport NV	4.500	2007?
LM 2C[15]	China Great Wall Industrial Corp.		NA (LEO only)	1975
LM-2D	"	"	NA (LEO only)	1992
LM-2E	"	"	3.500	1990
LM-3A	"	"	2.600	1994
LM-3B	"	"	5.100	1997
LM-4	"	"	1.149	1988
M-V	Rocket System Corporation	Tanegashima Space Centre, Japan	NA	?
Minotaur	Orbital Sciences Corporation	US military only	NA (LEO only)	2000
Minotaur IV	Orbital Sciences Corporation	US military only	NA (LEO only)	2003
Proton/Breeze M	International Launch Services	Baikonur Cosmodrome, RU	5.500[16]	1998 (1965)[17]
Soyuz 2-1a	RSC Energia / Starsem	Baikonur Cosmodrome, RU; CSG, French Guiana	7.000	2004 (1957)
Taurus	Orbital Sciences Corporation	Vandenberg AFB, CA; Cape Canaveral, FL; Wallops Flight Facility, VA; Kodiak Launch Complex, AK.	NA (LEO only)	1994
Titan II	Lockheed-Martin	US military only	NA	1995
Titan IV	Lockheed-Martin	US military only	NA	1995
Zenit-3SL	RSC Energia / Sea Launch	Sea Launch	6.000	1985
Vega	Arianespace	CSG, French Guiana	NA (LEO only)	2007

This is not a comprehensive list of potential launcher customers, but provides a fairly decent overview of the commercial opportunities and companies to approach in the feasibility study phase.

2.4. Partners

With the goal of exploiting access to space for the benefit of Cameroon, growth towards an increasingly technical and involved Cameroon management and workforce should be a stated goal of the CSP project. Although no launch facility can ever exist without substantial partnerships in many areas, the final goal of CSP operations should be a relatively self-sustaining organisation and operation in the long-term. In addition to any customers, which would be critical partners in service delivery, as well as infrastructure, the following is an indication of the types of partners CSP would require.

---

[15] "LM" = Long March

[16] Although the Proton launch vehicle is over 40 years old, it is a proven, cost-effective launch platform. The four-stage Proton/Breeze M, - the "modernised" version of the Proton - provides a 20% increase in performance and delivers this number of what Takashi Space believes to be 5.500 kg to GTO.

[17] Although in use since the mid-1960s, the first commercial Proton flight, under the auspices of ILS, lofted the Astra 1F satellite in April 1996.

2.4.1. Launch Systems and Space Technology

There are literally dozens of potential partners for the CSP project, and the feasibility study process will investigate potential partners and investors in some detail. Some examples of good potential partners and also the "categories" of potential future partners follow:

European Space Agency (ESA)

Located at various locations in Europe (http://www.esa.int/), the ESA is responsible for large amounts of space research, funding of new programmes and space launches from their primary launch facility in French Guiana. Primarily positioned as "Europe's gateway to space", the ESA's mission is to shape the development of Europe's space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe. The ESA could be a major source of funding, partnership, research and technical input, as well as commercial launch projects in the future.

S. P. Korolev Rocket and Space Corporation Energia (RSC Energia)

RSC Energia (http://www.energia.ru/english/) is a leader in the Russian rocket and space industry. Established in 1946, it became a pioneer practically in all areas of rocket and space technology. Today, it is the Prime Contractor for manned space stations, manned spacecraft and space systems built on their basis. Energia develops and collaborations on a large number of space programmes world-wide, including the Baikonur launch facility in Kazakhstan, Sea Launch, the International Space Station and delivery of launch vehicles like Aurora, Molniya, Soyuz, etc. Energia has been traditionally open to collaborations with many sorts of industries, technologies, countries and is pushing into new areas like launch facilities at the ESA CSG facility in French Guiana for a more cost-effective launch position. We believe that they could be a substantially valuable partner in launch systems, technology and the future roadmap for CSP development.

Surrey Satellite Technology Ltd. (SSTL)

SSTL (http://www.sstl.co.uk/) was formed in 1985 by the University of Surrey to commercialise the results of its innovative small satellite engineering research. SSTL was the first professional organisation to offer low-cost small satellites with rapid response employing advanced terrestrial technologies. Over two decades, we have built a profitable business around our unique approach to space. Today, SSTL employs over 200 staff and has been involved in 23 small satellite missions, making it the most successful and experienced small satellite supplier in the world. Uniquely, SSTL is a privately owned company, with majority share ownership by the University of Surrey (85%), but 10% is owned by alternate space pioneer Elon Musk (founder of Space X), with key staff hold the remaining 5%.

Asia Pacific Space Centre (APSC)

Although the APSC (http://www.apsc2orbit.com/) can be seen as stiff competition for the CSP in a number of ways, their investor construction, ability to generate investment from the Australian government for general and common use infrastructure and rehabilitation of enabling road, sea, energy and air facilities is a great model upon which to leverage. APSC is an Australian company founded in 1997 and is based in Sydney, with offices in San Diego, Moscow, and Christmas Island. It has a number of strategic investors from Australia, the United States and Asia, as well as working investment of US$100 million from the Australian government. Discussions with APSC on investment, collaboration or joint business development, partnership launcher and location strategies could be fruitful for both parties.

2.4.2. Universities and Research Institutes

One of the most important sorts of partnerships in CSP development is with institutions of higher learning. Involving students and professors in planning, deployment and day-to-day working of the CSP will be an important source of skills and new ideas, will bring in new talent and experience from other launch sites and industries and provide the much-needed network of academics and world-wide support required to make the CSP a success. In addition to the connections between Cameroonian and regional universities and institutions in Europe and the rest of the world, these partnerships will help ensure knowledge transfer, complete and innovative reporting on CSP operations and help ensure that there will be highly-educated, skilled and experienced Cameroonian and international personnel to carry on and expand CSP operations in the future.

A major focus of the CSP educational partnerships will be to involve students of many age groups and to build indigenous capacity for CSP management and growth. This supports overall goals of education, wealth generation for Cameroon and global involvement in the space industry. A secondary focus will be to actively engage with leading universities in key areas that will help transfer knowledge, generate new ideas and refine the CSP plans and working environment.

Some universities of importance include:

Cameroon University System

Composed of six active universities, the Cameroon University System targets training, development support, scientific and technical research, among other programmes as well – the universities include: University of Buea, University of Douala, University of Dschang, University of Ngaoundere, University of Yaounde I and University of Yaounde II. Programmes at most universities include a faculty of sciences, research programmes, etc. Although currently, no dedicated space technology or aerospace engineering programmes have been found, CSP would support any new or planned programmes in this area, as well as civil and structural engineering programmes, environmental studies, GIS and cartography, climate and weather studies, population, drought, disease, agriculture, city planning and other remote sensing activities, as well as internships, commercial partnerships and funding.

African University Foundation

African University Foundation is an international not-for-profit organization established on January 04, 1994 with a mission to develop and manage international support to establish African University in Tali, Cameroon. Although focusing on agriculture and business, one of the primary focuses of the African University will also be science and technology. It is proposed to be a new and different model of higher education in Africa. The Foundation seeks the support of individuals and organizations with the resources and interest in African higher education.

The African Regional Centre for Space Science and Technology Education (ARCSTEE)

ARCSTEE operates under the auspices of NASRDA Abuja and traces its history back to the UNISPACE 82 conference in Vienna which made a recommendation to the UN to help develop indigenous capabilities in space science and technology at the local level. Nigeria was picked (with Obafemi Awolowo University as host institution) to serve African countries where English is one of the official languages, and a separate centre to cater for French-speaking African countries is in Rabat, Morocco. The main goal of the Centre is the development of skills and knowledge of university educators, research and applications scientists, and others through rigorous theory, research, applications, field exercises and pilot projects in those aspects of space science and technology that can enhance socio-economic development in each country.

Other African Universities in the Region

Apart from ARCSTEE at Obafemi Awolowo University, individual relationships, or larger collaborations for CSP development, strategic partnerships with other important universities will create an influx of scientific knowledge, experience and institutional support for the CSP. Universities with strong science and engineering programmes could include: University of Ibadan (Nigeria); University of Benin (Nigeria); faculty of Sciences, Kwame Nkrumah University of Science and Technology (Ghana); University of Ghana (Ghana); The School of Science and Engineering (SSE) at Al Akhawayn University (Morocco); Polytechnic Institute at Tunisia Private University (Tunisia); Université Omar Bongo (Gabon); and many potential others.

International Space University (ISU)

Located in Toulouse, France (http://www.isunet.edu/), ISU provides graduate-level training to the future leaders of the emerging global space community at its Central Campus in Strasbourg, France, and at locations around the world. In its two-month Summer Session and one-year Masters program, ISU offers its students a unique Core Curriculum covering all disciplines related to space programs and enterprises – space science, space engineering, systems engineering, space policy and law, business and management, and space and society. Both programs also involve an intense student research Team Project providing international graduate students and young space professionals the opportunity to solve complex problems together in an intercultural environment.

Since its founding in 1987, ISU has graduated more than 2200 students from 87 countries. Together with hundreds of ISU faculty and lecturers from around the world, ISU alumni comprise an extremely effective network of space professionals and leaders that actively facilitates individual career growth, professional activities and international space cooperation.

University of Surrey / Surrey Space Centre (SSC)

Located in the United Kingdom (http://www.ee.surrey.ac.uk/SSC/), the University of Surrey runs the SSC – which is the world leader in small satellite research, design, development and launch projects. They have designed and supported many small satellite projects, including a number of innovative projects involving African countries, and would be important as a partner for CSP collaboration.

Other World-Wide Universities

Opportunities for participation by and cooperation with many other universities world-wide are clearly benefits to the CSP programme. Many universities in the United States, Europe, Russia, Asia and South America have strong aerospace engineering, space business studies and launch engineering programmes that could benefit from CSP experience and collaboration, and help fund and staff CSP operations with experienced and networked resources. Some major potential partners could be University of Toronto (Canada), Kyiv University (Ukraine), Oklahoma State University (US), University of Colorado at Boulder (US), Auburn University (US), University of North Dakota (US), Hong Kong University (China), Queen's University (UK), York University (UK), University of Leicester (UK), Ecole Nationale Superieure d'Electronique et de Radioelectricite de Bordeaux (France), among many others.

2.4.3. Funding and Development Possibilities

There are a number of funding possibilities, and the final CSP feasibility study will work these out in some detail. We also propose to meet with a number of key, strategic funding partners to explore the possibility for near-term and longer-term funding, as well as joint development and funding with commercial partners as well.

Apart from core development funding for launch facilities, a number of models exist for joint-financing of specific launch capabilities. For example, the recent agreement between the Centre National d'Etudes spatiales (CNES)[18] / ESA and Russian Space Agency for launch for Soyuz rockets beginning in 2008 will have the EU / ESA pay €344 million for construction of the Soyuz launch pad, and Russia to provide the hardware, erect the tower, ship rockets and manage the launch process.

Partnerships with major launch providers, like those mentioned above, will be critical for the CSP business case, but also in formulating funding models for construction of the CSP facility itself. In truth, with the right agreements, large amounts of the technical development and infrastructure could be provided for the CSP construction with the right commercial partnerships and terms in place. "Traditional" launch companies providing a backlog of satellite launches for civil, communications and scientific work could make a strong business case for the launch costs and equatorial position of the CSP, and would therefore be more willing to jointly-finance construction of appropriate facilities. "Alternate" space organisations (also mentioned above) have less capitol to call on, and would require more CSP funding – although their facilities requirements would likely be substantially less elaborate.

United Nations Office for Outer Space Affairs (UNOOSA)

UNOOSA is responsible for promoting international cooperation in the peaceful uses of outer space. The Office serves as the secretariat for the General Assembly's only committee dealing exclusively with international cooperation in the peaceful uses of outer space: the Committee on the Peaceful Uses of Outer Space (UNCOPUOS).

UNOOSA has supported African involvement in space for some time. This topic became a major issue beginning in the early 1980s with the UNISPACE conferences that established The African Regional Centre for Space Science and Technology Education, UNISPACE III in Vienna[19] and the Third UN/ESA Workshop at universities in Nigeria in 1993 and the Tenth UN/ESA Workshop, Held in Mauritius in 2001.

More recently with the UN/South Africa/ESA Workshop on Space Technology Provides Solutions for Sustainable Development in South Africa and Fourth UN/USA Workshop on the Use of Global Satellite Positioning Systems, for the benefit of Africa in 2002 and the UN/Sudan Workshop on the Use of Space Technology for Natural Resources Management, Environmental Monitoring and Disaster Management in 2004 and a similar conference in Algeria in 2005. Substantial thought and energy has been spent on these efforts, sometimes organised, chaired or hosting presentations by Nigerians and South Africans, but not notably addressing space launch facilities to-date. Instead, the African programmes discussed normally centre on micro-satellite deployment, earth observation, etc. (http://www.oosa.unvienna.org/)

---

[18] " Centre National d'Etudes spatiales" or "CNES" is the French government space agency (administratively, a "public establishment of industrial and commercial character"). Its headquarters are located in central Paris. It operates out of the Guiana Space Centre, but also has payloads launched from other space centres operated by other countries.

[19] For more information on the 2002 conference, see http://www.oosa.unvienna.org/SAP/act2002/wssd/presentations/ and on UNISPACE III, see http://www.oosa.unvienna.org/unisp-3/

EU Development Directorate

The stated EU Directorate General Development mandate is to enhance the development policies in all developing countries world-wide. DG Development provides policy guidance on development policy and oversees the programming of aid in the ACP countries (Africa, Caribbean and Pacific) and the Overseas Countries and Territories (OCT). The Cotonou Agreement provides the framework for a 20-year partnership for development aid to 77 ACP countries, funded mainly by the European Development Fund. The mission is to help to reduce and ultimately to eradicate poverty in the developing countries and to promote sustainable development, democracy, peace and security.

The EU and the African Union, as well as NEPAD have had numerous meetings to-date, and the EU funds a number of projects throughout Africa in various areas, including a number of important projects in Cameroon. The proposed EU funding programme (2003-2007) contains €80 million in transportation funding, €54 million in macro-economic and institutional support and €19 million in support to civil programmes and the private sector, totalling €153 million. Past funding projects total more than €419 million and span Transportation, Decentralisation and Social Sectors, Macro-Economic and Institutional Support, Rural Development, Filières Agricoles and Environment. (http://europa.eu.int/comm/development/)

United Nations Development Program (UNDP)

UNDP is the UN's global development network, an organization advocating for change and connecting countries to knowledge, experience and resources to help people build a better life. They are currently in 166 countries, working on solutions to global and national development challenges. As countries develop local capacity, they draw on the people of UNDP and their range of partners.

Although not directly supporting technology development in the UN Millennium Development Goals[20] set out in 2000, this group could be a substantial partner in realising the goals of the CSP and formulating sustainable programmes for involvement of energy and transportation resources, integrating with other national funding projects and facilitating the overall UN goals of crisis prevention through more cost-effective use of space technology. (http://www.undp.org/)

The World Bank

As one of the UN's specialised agencies providing funding for projects world-wide, the World Bank (International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA)) could provide funding in the form of a provide low-interest loan, interest-free credit or grant to Cameroon for components of the CSP development work. Also basing their focus on the UN Millennium Development Goals set forth in 2000, the World Bank could be a key partner in this initiative, as it is both an investment in Cameroon's future, but has spin-off benefits from the generation of genuine wealth for the country.

The World Bank already provides a number of loans to Cameroon and is a known partner. According to the World Bank, as of January 2005, they have approved 124 loans and credits for Cameroon for a total amount of approximately US$2,64 billion equivalent. The commitment value of 10 ongoing IDA/IBRD-financed operations is about US$227,8 million, with a to-be-paid balance of approximately US$135 million to-date. These 10 operations will focus on: information technology, government administration, transportation, health and social services, energy and mining, public administration and agriculture. (http://www.worldbank.org/)

Other World Bank-sponsored, pan-African groups are also running that deal intimately with remote sensing and environmental change, including groups like EIS-SSA (Environmental Information Systems in Sub-Saharan Africa). These groups, while not directly involved in space launch opportunities, would be targets for remote sensing micro-satellites and loose partnerships would be a positive asset as well.

African Development Bank Group (ADB)

The ADB is a regional multilateral development bank, established in 1964 and supported by 77 nations. Currently, they manage US$404 million. Headquartered in Abidjan, Cote d' Ivoire, the Bank Group consists of three institutions: The African Development Bank, The African Development Fund and The Nigeria Trust Fund. Resources of the ADF are made available to

[20] *See http://www.undp.org/mdg/ for the outline of the UN's Millennium Development Goals.*

support development activities aimed at creating an enabling environment for sustainable growth as well as contributing to poverty reduction in African countries. (http://www.afdb.org/)

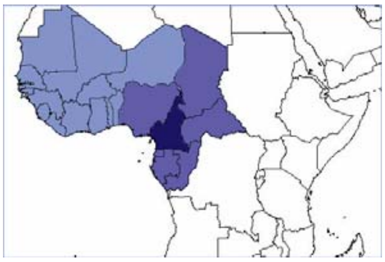
Islamic Development Bank Group (IDBG)

The IDBG is a multilateral development financing institution, established to foster social and economic development of its member countries, as well as Muslim communities world-wide. Cameroon is a member country of the IDBG and has awarded or is in the process of awarding a number of investment projects to Cameroon including infrastructure investments for shipyards, roads, land development and micro-financing projects. (http://www.isdb.org/)

2.4.4. African Regional Community

One of the most important partnership programmes to engage in is a regional one. The resources for making the CSP a success are not trivial, and collaboration across sub-Saharan Africa will both help to mitigate risk and bring educators, engineers and policy-makers together in strong and meaningful ways that will benefit the region substantially. Careful construction of these partnerships is required, so that they can survive changes in government and policy, and reassure commercial customers that their space access products and relationships are stable and long-term activities.

Sub-Saharan Country Partners



The CSP planning and feasibility programme is meant to be a stand-alone initiative that explores the potential and risks for such an endeavour for Cameroon. However, this development can also be seen as part of a larger African space initiative that includes current plans for micro-satellite deployment, regional institutional, industry and educational support and resource management on a regional basis as well.

Involving partner countries in Western Africa like Nigeria, Equatorial Guinea, Gabon, Congo, as well as other potential partners with similar interests could defray the costs and effort of the CSP, and integrate the plans with other national endeavours not focussing on space access.

An immediate possibility might be to engage in scientific and developmental discussions with, barring political issues, Nigeria. As Nigeria has The Nigerian National Space Research and Development Agency (NASRDA) and maintains The African Regional Centre for Space Science and Technology Education (ARCSTEE) and has launched a satellite as part of the seven-nation constellation known as Disaster Monitoring Constellation (DMC), they have substantial commitment to space business and could provide partnerships for launch, regional development and exchange of resources.

NEPAD and the African Space Programme

Focus for Africa has been traditionally on creating regional partnerships for space development. In 2002, Dr. Sias Mostert presented a space proposal within the context of the general "NEPAD" programme at the 2002 South African conference mentioned above - programme called "**NE**w **P**artnership for **A**frica's **D**evelopment". NEPAD is a holistic, integrated strategic development plan to enhance growth and poverty reduction in Africa by addressing key social, economic and political priorities in a coherent and balanced manner. Conceived and developed by African leaders, it is also a framework for new partnerships with the rest of the world to accelerate the integration of the African continent into the global economy.

NEPAD is a merger of two new initiatives that had emerged at the dawn of the new millennium as visions for Africa's long-term development. These are the Millennium Partnership for the African Recovery Program (MAP), proposed by the presidents Algeria, Nigeria and South Africa; and the OMEGA Plan, proposed by the president of Senegal. A third framework, the Compact for African Recovery (CAR), had been developed by the UN Economic Commission for Africa (ECA) as a technical input to the elaboration and implementation of a consolidated Plan for Africa. (http://www.nepad.org/)

Although South African-focused, Dr. Mostert's proposal called for intra-regional cooperation in making a significant contribution to knowledge within the context of an African space programme and also focussed on delivering local economic benefits to African communities. The specifics included resources management, the existing African LEO micro-satellite constellation, South Africa's SUNSAT, Unfortunately, no news on this proposal's next steps has been found.

This collection of strategies would be a critical partner for CSP from a space science, remote sensing, space engineering and space policy perspective, as well as generating satellite launch opportunities. It involves the Disaster Monitoring Constellation (DMC), Surrey Satellite Technologies Ltd., the proposed African Institute of Space Science, Stellenbosch

Satellite Group / Stellenbosch University, SunSpace Corporation and Howteq (South Africa).[21] Establishing links with this group could be beneficial to multiple areas of CSP operations.

2.5. Timing

We believe that the timing for this feasibility study proposal is perfect. With the renewed focus on African development, funding and support, the emergence of new commercial space initiatives, as well as the stable, committed and productive environment in Cameroon, 2005-2006 is the right time to initiate this planning process. The emerging support for lower-cost access to space, the tremendous profitability of many satellite operators, the focus on African development in the medium- and long-term, as well as the project fit with the stability, potential growth and politics of Cameroon make this an optimum time to move such a project forward.

2.6. The CSP Consortium

While detailed planning needs to be carried out during the feasibility portion of this project, one possible way forward would be to create a consortium of involved parties with a stake in the CSP's success and engage in investment discussions based on this strategy. Some examples of this shareholder construction of such a private company might be:

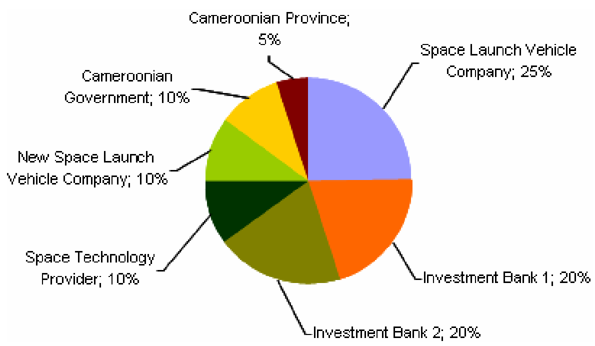
Strategic stake of space launch vehicle company (vehicle facilities, investment, launch pads) – 25%

Investment Bank(s) (common infrastructure, energy, transportation, etc.) – 20% to 40%

Space technology Provider (e.g. payload assembly, infrastructure, resources) – 10%

New Space Launch Company – 10%

Cameroonian Government (support, land , transportation) – 10% + Local Cameroonian Province 5%



One possible way to finance such a venture would also be to create a consortium of commercial entities:

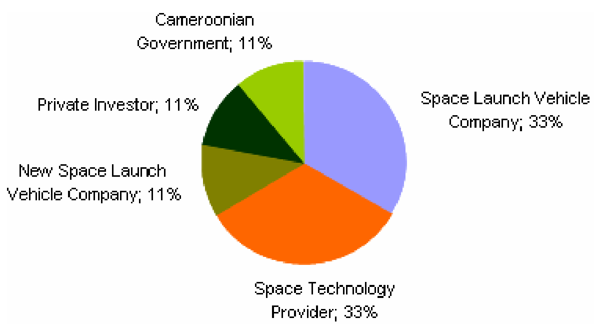
Space launch vehicle company – 33%

Space technology Provider – 33%

New Space Launch Company – 11%

Private Investor – 11%

Cameroonian Government – 11%



Whichever financial model is employed, each consortium partner brings the assets required for successful launch and maintenance of the CSP operation. The government would be a critical partner, but may not necessarily need to be a stakeholder in this venture – instead possibly providing infrastructure support through funding from the World Bank, Islamic Development Bank, EU, etc. and receiving the benefits in the form of taxation, employment, in-bound revenue and industrial benefits, etc.

Additionally, the space launch and / or technology companies could provide the infrastructure, design know-how and resources to create much of the technical platform and assembly / payload facilities, thus lowering the overall cost to other consortium members substantially, and earning them a large percentage of equity in the venture and it's long-term operation. Again, all these factors need to be worked out in detail in the larger feasibility project.

---

[21] See http://www.oosa.unvienna.org/SAP/act2002/wssd/presentations/session03/speaker05/sld001.htm for this presentation by Dr. Mostert.

2.7. CSP SWOT

One popular way to simplify the opportunity for the CSP is to create a "SWOT" analysis, a strategic planning tool used to evaluate the **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats involved in a project or in a business venture. Strengths and weaknesses are internal to the project. Opportunities and threats originate from outside the project. Overall, we find that this helps evaluate the environmental factors and internal situation facing the project.

Here, Takashi Space has attempted to summarise a number of the key issues into such a "SWOT" table.

Strengths	**Weaknesses**
• Cameroon equatorial position provides substantial (approximately 17%) benefits compared to other launch facilities not near the equator – both in launch momentum and in-orbit fuel to correct for launch outcome. • The timing is right for looking into it an African space launch facility, for numerous reasons. • There is substantial and latent demand for more cost-effective access to space. • The space industry is fragmenting away from old, cold-war players and making accommodations for new space business. • Creates in-bound technology pull, educational, commercial and research opportunities which spreads throughout many other Cameroon education programmes and sectors.	• Cost to enter the space launch market is relatively high – requiring a high-quality facility and surrounding support services. • Cameroon is on the western side of Africa, and as GEO orbital launches move from west to east, ocean drop zones are not feasible. • Partnerships with launch systems, technology companies and adjacent African nations could be hard to establish and fragile. • Arianespace / French interests, as well as the ESA have invested a lot of time and resources into CSG in Kourou. • US space missions may be wary of launching from African soil in the near-term. This is also an opportunity too.
Opportunities	**Threats**
• Has the potential to generate substantial revenue. • No current African nation is pursuing this potential development. • Relatively low-cost operation to build and run, with the right strategy and partnerships. • Richer, space-savvy countries in Europe, North America and Asia are looking for cheaper access to space. • Become a leading, innovative and profitable space technology operation. Helps put Cameroon on the map in lucrative circles, technology and politics. • Spin-off business and revenue, thought leadership and influence.	• Partnerships with launch systems, technology companies and adjacent African nations could be hard to establish and fragile. • While unlikely, Chad, Central African Republic, Nigeria, Congo, Zaire, Equatorial Guinea, Gabon, Uganda, Kenya, Somalia or Tanzania might be first to market. • Space industry might dry up and no longer require access to space. • Political situation in Cameroon, security and public / industry perception of that security.

3. Facilities Overview

There are a number of major decisions to research as part of the CSP feasibility project that critically impact both the operational feasibility of the centre, it's cost for development, cost per launch based on transportation, infrastructure, security, etc., as well as national partnerships needed for an effective launch programme that requires transit over other countries airspace. Additionally, the size of facilities, infrastructure required for launches, accommodating launch vehicle preparation, mission control and accommodation, etc. all need to be carefully considered.

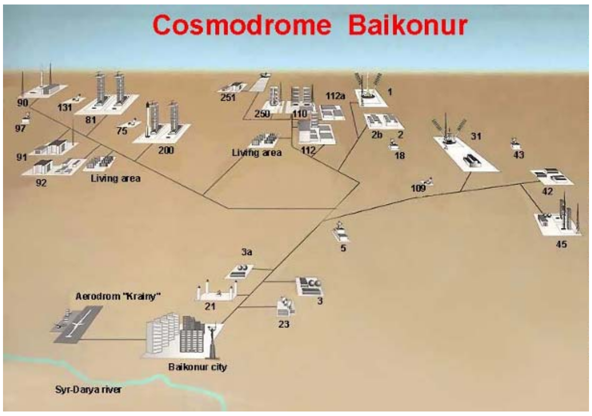
3.1. What Do We Mean by a "Spaceport"?

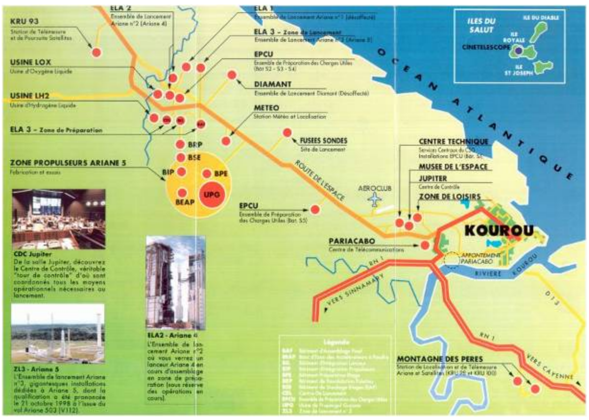
There are a number of examples of spaceports or space launch centres around the world today. They range in size from gigantic, costly centres designed and built in the 1950s, 1960s and 1970s during the space and satellite launch races, and maintained and expanded to varying degrees until now.

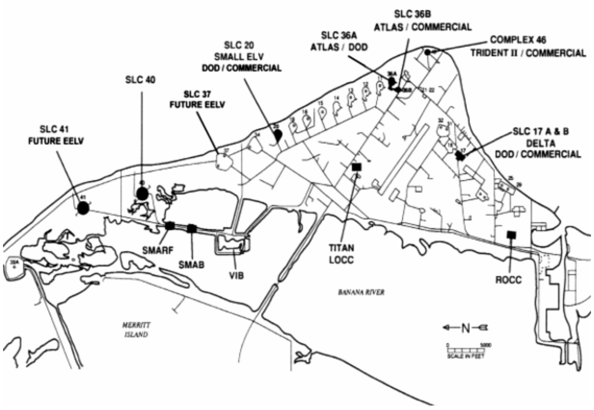
3.1.1. Large Launch Facilities

The Kennedy Space Center and Vandenberg Air Force Base in the US, Baikonur and Plesetsk Cosmodromes in Russia, as well as the ESA's CSG facility in French Guiana are all multi-purpose, multi-use centres with many assembly and preparation facilities and launch pads, energy facilities and transportation.

To the right is a diagrammatic map of Baikonur Cosmodrome[22] in Kazakhstan, below left is the ESA CSG facility and below right is the Kennedy Space Center in Florida, US – all examples of older, larger and highly expensive facilities that cater to the US, Russia and Europe's larger space programmes, manned spaceflight (all three are manned launch facilities as well), and also defence and military interests.







[22] *Although referenced multiple times in this paper, "Cosmodrome" is roughly the Russian term for "Spaceport".*

3.1.2. "Leaner and Meaner" Launch Facilities

However, there is a substantial need for space centres world-wide that accommodate smaller satellite payloads, primarily to GEO, the next generation of launching vehicles and new, alternate commercial launch companies working to fill the lucrative market opportunities for telecommunications, broadcast and earth-monitoring satellites – each needing reliable, cost-effective access to space.

A number of initiatives have been proposed or are being designed and constructed currently that accommodate smaller, more targeted launch strategies and are receiving substantial investor monies for execution. New space launch facilities like the APSC on Christmas Island is a smaller launch facility designed with one launch pad initially, and two in the near-term. This facility is designed around the new, cost-effective Russian launcher Aurora (depicted to the right, and described in more detail later) and includes the manufacturing and launching company as a strategic and financial partner in the APSC business case.

The Sea Launch venture is another entrepreneurial, equatorial launch facility using a movable floating launch platform and tailored for the Russian Zenit launch vehicle. The Australian SpacePort project is another new, smaller launch facility designed with the Kistler Aerospace K1 launcher in mind. Each of these new facilities is positioned as near to the equator as possible to maximise the launch benefits of that latitude.

Additionally, good examples of smaller and more manageable launch facilities can be seen in entrepreneurial initiatives for non-GEO launch facilities like the Spaceport Systems International (SSI) Commercial Spaceport operated from Vandenberg Air Force Base in California, US. Although launching satellites only to Low Earth Orbit (LEO)[23], Medium Earth Orbit (MEO)[24] and Sun-Synchronous orbits[25], their facility is a clear, manageable example of a multi-purpose vehicle and rocket preparation centre (originally built for the US Space Shuttle programme, and now managed commercially) and a newly-built launch pad for rockets like the Minotaur. The photo below is of the SSI facility in operation.

A complete overview of relevant world-wide launch facilities is found in the appendices of this memo.

3.1.3. The CSP Facility

Naturally, the design of the facility would need to be worked out in some detail in the feasibility project, we foresee a smaller facility with a space utilisation of around 1 square kilometre, requiring engineering and landscaping to house one to two launch pads initially, separate assembly facilities and transportation on the grounds between preparation and launch faculties. Partnership with a leading launcher company or two would dictate much of the details in this infrastructure, but also provide substantial amounts of the funding to build it.

One example of a plausible two-category launch pad strategy is to construct one facility with a strategic commercial partner or partners to accommodate a specific sort of launch vehicle or family, and work with an emerging space launch company like Space X or Kistler Aerospace to accommodate the most less-expensive facilities for their new launch systems, thus promoting a multiple-launch vehicle

---

[23] "Low Earth Orbit" or "LEO" A low Earth orbit (LEO) is an orbit around Earth between the atmosphere and the Van Allen radiation belt, with a low angle of inclination. These boundaries are not firmly defined, but are typically around 200 - 1200 km (124 - 726 miles) above the Earth's surface. Most manned spaceflights have been in LEO, including all Space Shuttle and various space station missions.

[24] "Medium Earth Orbit" or "MEO" (also referred to as Intermediate circular orbit (ICO)) is used by satellites between the altitudes of low earth orbit (up to 1400 km) and geosynchronous orbit (35,790 km).

[25] "Heliosynchronous" or "Sun-Synchronous" Orbit is also a geocentric orbit which combines altitude and inclination in such a way that an object on that orbit passes over any given point of the Earth's surface at the same local solar time - a useful characteristic for satellites that image the Earth's surface in visible or infrared wavelengths (e.g. weather, spy and remote sensing satellites).

facility immediately and gaining experience both with lucrative, "older" satellite launch business models and leading the way to accommodation of future, cost-effective space access companies as well.

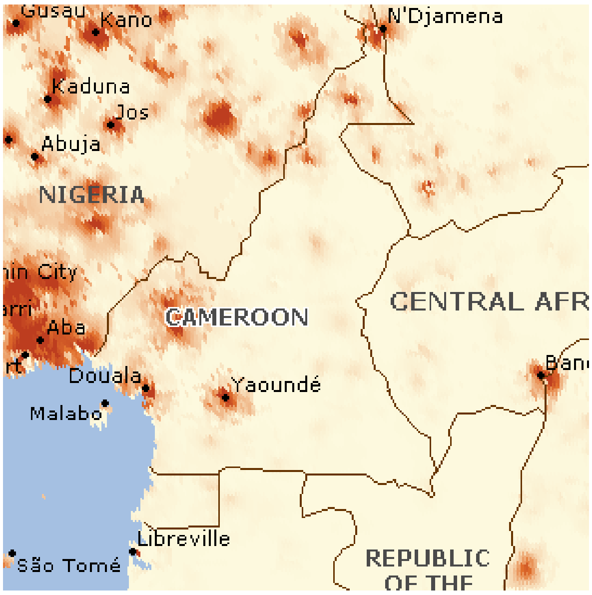
Although this endeavour is a highly technical one, demanding exacting science, engineering and facilities maintenance (as well as a sensitivity to weather and temperature, humidity, security and safety), it is a completely reasonable one and one which is achievable in a relatively small period of time with the right partners and financing, as well as commitment from the Cameroonian government.

3.2. Location

Planning for the location of the CSP must be made with a number of key notions in mind: 1.) population density of the urban and rural regions; 2.) land ownership and rights of way; 3.) availability of transportation systems; 4.) landscape / terrain / weather and 5.) easy implementation of energy and other support infrastructure.

3.2.1. Location Overview

Because of the population density of different regions in Cameroon and adjacent countries, careful planning must be made to ensure that large, sparsely populated areas exist directly east of the launch centre. Although accidents are rarities, falling launch debris is both a potential hazard, as well as a political hassle. Looking at the population models of Cameroon, a few key sites emerge as good candidate sites (simply based on population analysis presently).

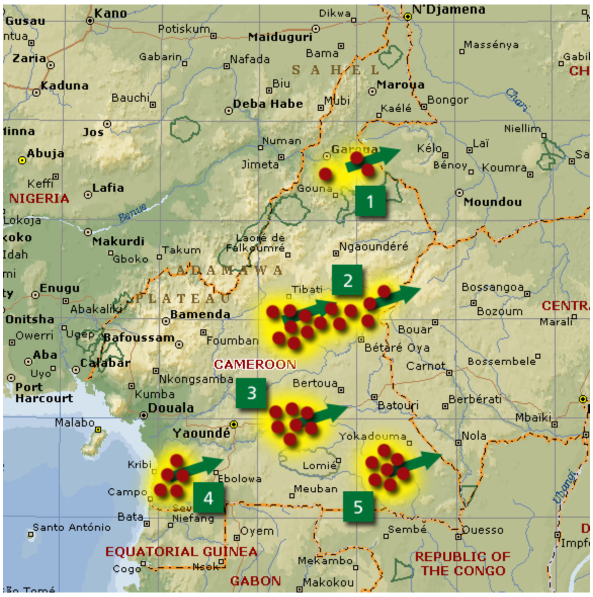


However, a number of the most attractive launch site possibilities raise both questions about transportation and infrastructure, and also require the cooperation/partnership of neighbouring nations (Central African Republic, Chad, etc.) which would have other positive benefits.

To garner the positive slingshot effect from the spin of the Earth, rockets must launch from west to east. As Cameroon is on the western side of the continent, launching rockets over water (as in CSG or Kennedy Space Center) or over desert like Baikonur is not possible. This is important for GEO orbit insertion, unlike primarily polar orbit[26] satellites, where eastward launch is less important.

[26] "Polar Orbit" refers to a satellite that passes above or nearly above both poles of the planet (or other celestial body) on each revolution. It therefore has an inclination of (or very close to) 90 degrees to the equator. Since the satellite has a fixed orbital plane perpendicular to the planet's rotation, it will pass over a region with a different longitude on each of its orbits. Polar orbits are often used for earth-mapping-, earth observation- and reconnaissance satellites, as well as some weather satellites.

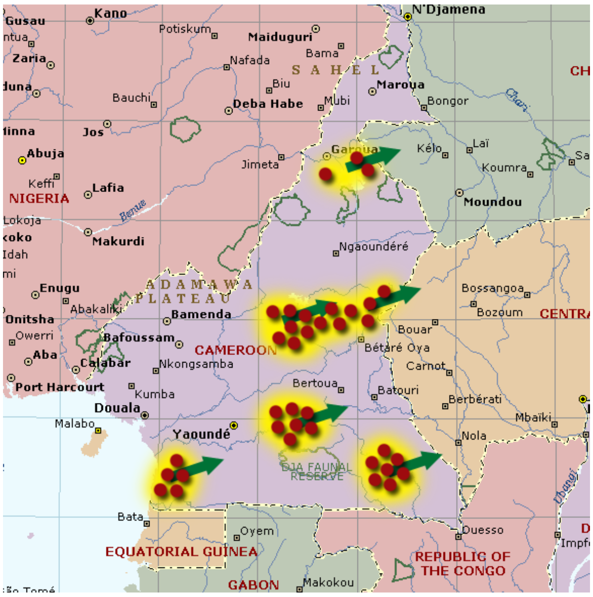
We have preliminarily identified a number of potential CSP locations, but further and far more detailed analysis on these points in collaboration with the Cameroonian government would be done in the final feasibility study, naturally. Each have different developmental effects, as well as political ramifications, as their launch trajectories would potentially cross different borders.



3.2.2. Some Site Concepts

Site Idea #1 in the North or Extreme North Provinces are attractive because of their sparse population and savannah terrain with light vegetation; however, the temperatures are hotter in this region and the politics and infrastructure is less developed.

Site Idea #2 is in the Adamawa Province, and is made up of a huge area of savannah and forest, and is very thinly populated. It is harder to get around in this area, and would require some road infrastructure or use of the train, but is rich in water resources.



Site Ideas #3 and #5 are in the East Province, but it may be largely rainforest as part of the Congo Basin and largely poor road and transportation systems as well. Environmental and natural concerns could force these regions to remain non-options. The smallest population density is enjoyed by these provinces, which accommodated placement of drop zones.

Site Idea #4 in the South Province (indicated to the right) is an attractive site from the standpoint of proximity to the Atlantic Ocean and the harbour at Kribi, as well as the deep-water harbour in Douala.

There have been a number of environmental issues raised about degradation of the area because of the oil pipeline from Chad into this region, so concerns about environmental usage and deforestation must be addressed, as well as consideration for Campo Ma'an National Park and Dja Reserve (World Heritage Site). Substantial work has been done for the inauguration of this pipeline in 2004 to ensure that this pipeline has the guaranteed security required – work and planning that we believe can be leveraged for the CSP project.

Site Ideas #4 and #5 seem to be the most attractive locations from a Cameroon-controlled territory perspective as well, with direct control of some of the initial drop zone area. In reality, we believe that the safe drop zone distance for a decent LEO launch vehicle requires some planning and drop zone positions to span approximately 1.500 km. along the selected trajectories. This would minimally mandate agreements with Chad, Central African Republic, Congo and/or The Democratic Republic of Congo.

3.2.3. Green Operation: The Rainforest Protection Fund

If the CSP does impact on the rainforest or other critical ecosystems, the activities should be carefully considered for various reasons. However, although the size of 1 square kilometre and other minimally disruptive infrastructure changes like re-doing existing roads and harbour facilities would cause minimal impact, in truth the psychological impact and negative connotations for using any forested areas

for alternate purposes is not an acceptable policy framework to many funding partners, and also not a positive public relations action either.

The proposed CSP project should assess fair market value of utilised lands and costs to maintain and protect them, and commit to many orders of magnitude of payments to existing or new programmes for environmental protection. The equatorial position of Cameroon is a natural resource, like many others in the country, and if it can be utilised in a unique capacity for high-value space launch business, it is fair, politically appropriate and morally required for the CSP programme to help support the protection of other resources that are more stressed.

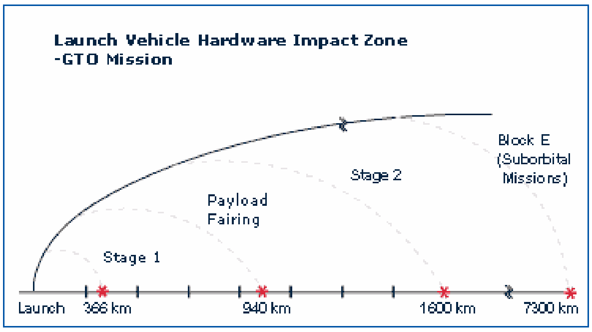
As for the substantial financial benefit from the use of approximately 1 km of land in Cameroon, it cannot be disputed that this is an extremely lucrative proposal, and if managed from, for example, the Ministry of Science – the revenues should be directly applied to more distressed environmental issues, community programmes that seek to encourage environmental stewardship and more joint-focus initiatives that blend together sustainable business practices with respect and protection for Cameroon's amazing natural resources.

3.2.4. Flight Paths and Drop Zones

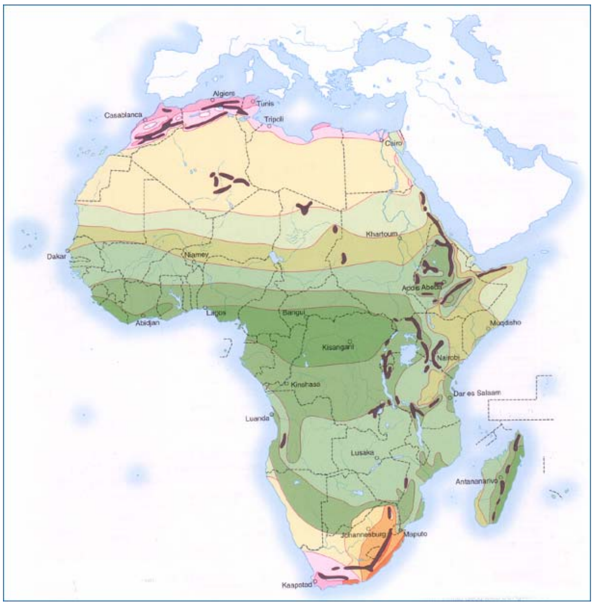
A critical series of questions remains surrounding launch flight paths and drop zones. For LEO or polar orbits, different flight paths need to be defined, than for GEO transfer orbit. "Drop zones" where parts of the rocket fall in predetermined, (e.g. strap-on boosters, rocket stages, payload fairing halves, etc.), as well as contingencies defined and agreed as to where missions can be safely aborted if need be and how.

Several flight corridors should be identified. An easterly flight path is used to put satellites into low inclination orbit. This flight path passes over Cameroon and either Chad or The Central African Republic from 200 to 1000 km. Although the risk of fire in these drop zones is minimal, recovery teams and care for population centres is an important consideration.

The figure on the right is an example hardware impact zone diagramme used in mission planning and construction of the APSC at the southern end of Christmas Island.



Other flight paths could be identified, intended to support launch to moderate inclination orbits or sun-synchronous orbit injection / polar orbits. In these cases, ascent profiles are tailored to ensure ocean impact for expended hardware.



3.2.5. Climate

From a climate perspective, the northern provinces of Cameroon are considered temperate and arid, while the southern provinces are technically rainforest areas. From a space launch perspective, clear skies and regular / predictable rainfall and visibility are critical, but the southern provinces, in this respect can be seen as similar to CSG in Kourou, French Guiana, South America – tropical, but clearly predictable based on seasonal rainfall and humidity changes.

The northern-most areas of Cameroon average from between 770 and 2000 mm of rainfall per year, while the southern and coastal regions average between 1000 and 4000 mm of rainfall annually.

Although relatively wet during monsoon seasons, a CSP facility placed in the southern provinces would be relatively comparable with the weather at CSG and also minimise some of the outside risks of flammability of portions of the terrain at the established launch stage drop zones. Extensive further work should go into this analysis in the complete feasibility study.

3.3. Size and Build Strategy

A number of examples of space launch facility sizes exist in the world today, from the huge centres like Cape Canaveral in Florida, US, Baikonur and the huge ESA facility in Kourou which stretches for 750 square kilometres (as large as the country of Singapore). A number of smaller launch facilities also can be seen as good examples for the recommended commercial models for, and size of the CSP, including the SSI Commercial Launch Facility in California (non-GEO), Woomera Australian Spaceport and the proposed APSC. However, these facilities cater only to one or two launch vehicles and have customised facilities to support those vehicles.

For example, the proposed APSC has been designed to accommodate the Russian Aurora launch vehicle and is designed to manage from 10 to 15 launches of the Aurora per year from one launch pad, but will also accommodate a second, with a number of pieces of common infrastructure. This strategy allows for highly cost-effective and focused programmes, infrastructure and partnership with the Russian RSC Energia organisation to streamline launch operations. Christmas Island also has adequate accommodation facilities and activities for free time, making it a pleasant long-term stay during launch preparation (hospital, resort, golf, international airport, etc.).

APSC (scheduled to launch services in 2006 and with their launch platform depicted here to the right) boasts a price-performance figure that will accommodate both traditional and new space operators' business cases, and is a decent model for the size of the initial CSP facility for the first phase of a proposed development roadmap. This baseline development requires approximately 85 hectares of property, of which (according to ASPC statements) 30% will be developed. Including administration facilities, infrastructure and accommodation which would need to be constructed – we foresee a total size of development of 100 hectares, or 1 square kilometre. Until detailed feasibility analysis is carried out, we feel that there is not a tenable reason to deviate from these figures substantially.

3.4. Launch Facility Components

The basic CSP facility would need to be composed primarily of a technical complex, launch complex and mission control centre. Additional infrastructure potentially required to accommodate a full-featured facility would include energy management or production (as required), accommodation for staff and launch resources and administrative spaces.

The technical complex would be composed of buildings / elements like the launch vehicle assembly building (probably a tall building, useful for booster stacking and inspection), storage for components awaiting assembly, a liquid oxygen plant and a fuel store (separated fuel and oxidizer[27]), workshops, laboratories, fire station, canteen and staff rest areas.

The launch complex would contain the actual launch pads and launch vehicle fuelling system. Some specialised construction would need to take place on the grounds of the launch complex, including a possible launch exhaust duct (depicted on the right in this photo from the SSI facility), a launch ring tailored for the rockets using the CSP, a launch tower, some camera towers, some support and equipment buildings and potentially some unique power facilities.

The mission control centre would contain all the communications systems required for launch and the payload preparation facilities.

During the CSP construction period, housing for something like 250-300 construction workers, engineers and supervisors would need to be provided, likely at a temporary construction camp or similar facility.

[27] Typical fuel/oxidizer combinations for rocket first stages include: hydrazine / nitrogen tetroxide (most common for satellite launches), kerosene / liquid oxygen (e.g. US Saturn V rockets) or cryogenic liquid hydrogen / liquid oxygen (e.g. US Space Shuttle). Rocket second and third stages can be liquid- or solid-fuelled rockets.

Depending on the proposed roadmap for accommodation of different launch vehicles vs. demand vs. cost for construction, the CSP feasibility study should consider accommodation for various types LEO, GTO, Intermediate altitude circular orbits (ICO), MEO, GEO itself, and even high-inclination, high eccentricity (Hi HEO).

3.5. Transportation and Shipping Access

Transportation to and from the CSP facility is critical, both for construction, staff and for payload and supplies like fuel during the ongoing CSP operation. Location with access to the Atlantic Ocean and the various Cameroonian harbours is preferable. The harbour at Kribi is an option, although shallower than the deep-water harbour in Douala. Additionally, road and most likely train shipping from the harbour are preferable both during construction, and for movement of pre-integrated larger launcher stages and payloads, etc.

(Note: An example of rail transportation of the assembled Russian Soyuz launcher with upper stages is to the right. Although this is a rail line on-site at Baikonur Cosmodrome, it shows the relative size of medium-sized launchers to train systems themselves.)

This specific piece of investment is also a specific area where other funding bodies like the EU could be a potential partner, as transportation and shipping infrastructure are investments that benefit the larger Cameroon economy, business environment and people. This sort of funding also has numerous precedents in Africa that demonstrate similar funding by bodies like the EU, World Bank, African Development Bank, Asian investors, etc.

3.6. Security

Another critical concern for all parties involved is effective security procedures and systems. Many of the launch payloads will be of a sensitive nature, constructed of valuable and potentially secret or proprietary equipment and technologies and will require substantial safety and security assurances to customers and the Cameroonian government. While these processes are well-known to many established space nations like Russia, The United States and European countries, there is a lucrative opportunity in enabling lower-cost space access to new companies and countries interested in space. If CSP decides to also target under-served markets segments by providing commercial space access to many different sorts of customers and countries, the need for safety and security becomes even more tantamount.

Providing reliable and flexible security is also an opportunity for partnership between the Cameroonian government and commercial customers. A complete security strategy, budget overview and security plan for different launch facility scenarios should be carried out in the CSP feasibly project.

3.7. Education and Research

As mentioned briefly previously, apart from the core commercial opportunities enjoyed by the proposed CSP, there are numerous opportunities for educational enrichment and development of new programmes possible, as well as substantial research opportunities available.

3.7.1. Education

In education, this scope of possible programmes includes collaboration with various national universities and international institutions, hands-on education and training of personnel in the high-tech space launch industry, as well as interpretive education and programmes for younger students interested in the space or high-tech industries, schools and normal Cameroonians.

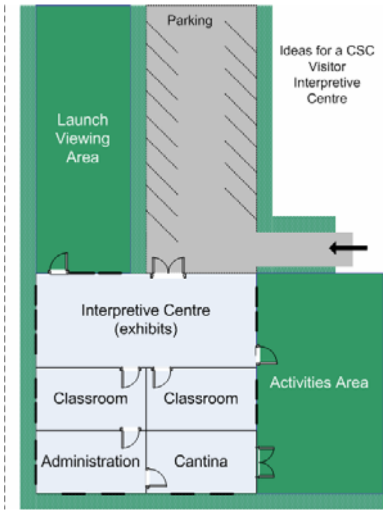
Collaboration with international and pan-African universities that are working in areas like launch systems, micro-satellites, remote Earth sensing, engineering, environmental management and statistical analysis could benefit from student work at the CSP and / or with CSP partners and customers. Bringing in experienced professional, educators and graduate students in CSP development and operations also provides substantial benefits for both sides – hands-on, real-world delivery and operations of a new launch facility for international partners, low-cost, highly skilled support for Cameroon, as well as partnerships that can be leveraged for the life-time of the CSP facility.

The logical beginning in educational partnerships would be in the construction and delivery of the CSP facility itself, with educational opportunities provided to experienced international universities and programmes in Cameroon and other partners African nations involved from the start.

In Cameroon, a space sciences and / or engineering programme (or series of programmes) may be initiatives with one or more of the national universities strong in science and technology, allowing groups of students and professors to immediately contribute and benefit from international educational partnerships. Establishing undergraduate and graduate programmes in this area would provide both substantial opportunity for enriching the Cameroonian university system, and ensure Cameroonian staff, skills and management capabilities of the CSP in the future.

One of the potential recommendations for the CSP facility upon start of commercial operations would be to include a modest educational visitor / interpretive centre with exhibits, and staff it with knowledgeable guides. This would describe the programme, goals, roadmap, as well as technologies and benefits for Cameroonians, and provide an exciting way for students and citizens of all ages and backgrounds the ability to learn and get feedback on the programme.

It could include administrative areas, speaking facilities and the ability to accommodate younger students and classes for tours and day programmes, parking for larger transportation like busses, potentially food facilities and areas for classes to separate and manage other daily affairs at the discretion of teachers. Although isolated from the secure, mission critical CSP launch, fuel storage and assembly facilities, it would also provide a good venue for viewing CSP launches. An example basic layout of such a centre is shown to the right. Although the actual architecture and implementation would likely be different in numerous ways, this centre could be constructed for relatively little money.



3.7.2. Research

An opportunity to support national and international research in key areas related to space also exists for the CSP. Although not necessarily critical to the initial phases of the purely commercial space launch work, research partnerships with institutions working on remote Earth sensing, agriculture, micro-satellites, telecommunications, meteorology, etc. could be an important part of the ling-term CSP value proposition. Although, as a launch facility, active involvement in these programmes would likely be limited, providing payload assembly, testing spaces and accommodation for groups executing scientific and engineering research may be an added value that CSP could provide, at rather inexpensive incremental costs once the facility is operational.

3.8. Roadmap

An important part of CSP planning is the roadmap defined for services, infrastructure and investment on common infrastructure, energy and transportation. As is always the case with launch facilities, the most critical part to defining this roadmap is the partnerships and customers involved, as large components of the design will be based on the specific launchers utilised, payloads and orbital insertions / trajectories. Most of the facilities world-wide have been designed with a certain percentage of modular and reusable infrastructures, and a certain percentage of launch vehicle-specific components. In defining the roadmap, a dedicated partner or series of partners is required. However, an example roadmap, based on an assumed partner and target launch vehicle, could look something like the following.

YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
Planning Funding Partnerships Design Communication	**Construction** - CSC facilities - common infrastrcuture	**CSC Phase 1** - 1 vehicle - 1 launch complex - 1 technical complex - 1 mission control - accommodation - surround services	**Operations Year 2**	**Operations Year 3**	**Operations year 4** **CSC Phase 2** - 2nd vehicle - new launch complex - ? technical complex - ? mission control

This is simply a speculative concept timeframe. Depending on demand, the CSP business case, funding and investments – this timeframe could be extended, naturally. Some portions of the process could require substantial time and effort on the fundraising and partnership side, and traditionally, these projects are slower to develop and secure commercial clients for than many other types of projects. The CSP feasibility project should define timeframes for different execution scenarios, as well as contingencies and all of the variables that could impact delivery of such a centre, profitability and competition, as well as development of new technologies.

Future directions that a successful CSP programme could follow include collaboration with new Cameroon micro satellite programmes that emerge over the next 10 years, work on facilitating a number of new launch technologies currently being researched (potentially aiming to become the premier new space launch technology enabler) and even exploiting Cameroon's excellent equatorial location and light usage of airspace for investigation into future-thinking space access models, for example, space tethers. However, the core to all future developments is a successful near- to mid-term CSP commercial launch strategy, and this should be the focus of the feasibility study.

4. Next Steps

This is a brief overview of what the project initiators propose as "next steps" should this initial memo resonate positively. We are in no way blinded by complete optimism in this proposal, as we realise that there are serious challenges; technical, political and financial hurdles to define before they can be overcome; and a national reality in Cameroon that may make this a future-thinking proposal in the end.

After careful consideration, we believe that the idea has substantial merit, the market opportunity is out there and the timing is correct to work out this plan in a feasibility study of some detail. As mentioned at the beginning of this memo, we believe that formulating such a plan helps to generate positive discussion as to how Cameroon can play a role in the future lucrative space business, what next steps to take and the benefits they will bring.

4.1. Project Proposal

Our proposal is to create a feasibility study that will include all components outlined in this introductory memo. It will be a solid, readable document accompanied by financial analysis and presentations that enables the government of Cameroon to make a decision on how to progress forward with this concept. This could lead to future discussions and partnerships to deliver a form of CSP to Cameroon, other collaborations and partnerships at other facilities, in Africa or internationally, or simply a clear view of the project's cost and benefits, as well as a heightened knowledge, profile in the world-wide space marketplace and scientific community.

4.2. Project Components

This project calls for a feasibility study carried out over a period of from three to five months, optimally delivered in the first half of 2006. Depending on the funding model and personnel involved, this feasibility study could be completed in a shorter or longer amount of time. It would require significant input from the government of Cameroon, the Ministry of Science and its network, as well as cooperating in meetings with funding partners, potential customers and companies.

The feasibility study itself would include the final recommendations, market opportunity, potential customers and partners, government involvement and regulatory issues, financial analysis / cost and revenue projections, funding sources, sensitivity analysis and execution scenarios, as well as all technical detail for the proof of concept to move to the next level. Also treated in this study would be construction and transportation requirements, staffing, security and safety requirements, sustainability and environmental protection issues, a space access and satellite industry overview, profiles of major players and competitors, joint-venture and collaboration possibilities, etc.

4.3. Personnel

Currently, Takashi Space has undertaken the research, interviews and project work to-date, but realises that a completed and professional feasibility study requires a number of other financial and technical resources for success. Specific skill-sets and experience are required in the launch and mission parameters, facility location and planning areas, as well as space industry / partnership and financial modelling sections.

Specific roles we believe are required for the feasibility study phase of this project include (with variable degrees of involvement):

- Programme / Consortium Management – this role is proposed for Takashi Space and it's partners, and will be in charge of interfaces with major players, governments, technology suppliers, local and international sponsorship and funding, as well as provide public relations support, marketing and presentation materials, manage project timelines and reporting to the stakeholders and all administrative tasks.

- Space Launch Systems Engineering – experience in space launch facilities, the engineering and facilities requirements, construction techniques and with a broad amount of famiiarity with launch-systems in general (including launch and orbital dynamics, rocket fuel storage and systems, safety measures and control and command systems).

- Financial Planning / Business Analysis – experienced financial planning, including space facility planning, satellite industry, or space launch business models.
- Large Project Landscape Architecture / Engineering – experienced large project design in the Sub-Saharan Africa region, including engingeering of non-standard structures, unique power and fuel requirements, transportation of materials, and preferably with some experience in working with local contractors and personnel in Cameroon.
- Commerical / Technical Launch System Liasion – this function would provide the initial business development / presentation function with other members of the team, and be responsible for all elements, information and input of a target / or targeted launch system providers.

Takashi Space has engaged in discussions with a few potential partnerships in this area, including one of the world's top strategic space consultancies and project management companies, Booz Allen Hamilton (BAH), although on a strictly informal basis to guage their interest in such a project. Normally quite expensive in their hourly rates, depending upon the budget that the Cameroon government has for such projects, work done by organisations like Takashi Space or BAH could be discounted or donated as part of corporate development efforts and involvement in future project work should the proposals be accepted and funded by investment groups or commerical partners. Companies like BAH bring to the table immediate, top-notch personnel, as well as networks to space technology and launch partners and development funding resources.

Currently, the head of Takashi Space is Dan Armstrong, an experienced project and business leader that has been working on this concept for approximately six months. The larger project team would be composed of space planning and industry professionals, as well as key involvement from the Cameroon government, educational institutions and industry. Mr. Armstrong has been living and working in Europe for 8 years on the technical, business planning and marketing side of mobile and fixed telecommunications industries. He has a background in liberal arts, writing, lobbying and marketing and has worked on business planning, frequency and network planning, architecture, mobile television via satellite, terrestrial digital broadcasting and internet projects for major companies like British Telecom, MCI, Irdeto Access, SK Telecom, GSM operators Telfort (Netherlands), ONE (Austria), MobilTel (Bulgaria) and design of the 10-country Starmap Mobile Alliance. Recent projects include work on satellite broadcast television to mobile handsets in South Korea, satellite broadcast technology strategy white papers for Irdeto Access BV, and work on a proposed World Health Organisation / World Bank project to construct a "health passport" system for satellite transmission of critical patient information in Central America.

Mr. Armstrong has a BA from The American University in Washington DC, US and graduate work in architecture, cartography and business management and has lived and worked in East Africa during 2003 and 2004.

5. Appendices

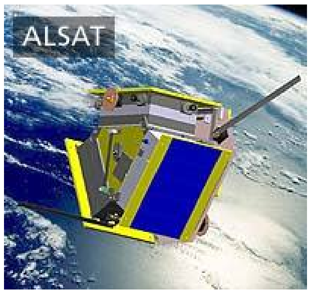
5.1. African Country Profiles

The following country summaries include the identified active African countries and their space programmes, involvement, launched and planned satellites. This information was combined and filtered from various sources including the Global Security Newsletter, The African Regional Centre for Space Science and Technology Education website, SpaceDaily, various space policy professionals and books.

The bulk of the active space programmes, satellite launches, tracking stations, earth observation, telecommunications and broadcast services can be found in northern Africa (primarily Morocco, Tunisia and Egypt) as well as South Africa. However, it must be noted that the predilection of the authors of this proposal is to create a view of opportunity for Cameroon both in Africa as a whole, but also within the context of Sub-Saharan Africa specifically.

5.1.1. Algeria

Currently, Algerian space technology activities continue to be largely directed by the National Centre for Space Technology, until such time as the new Algerian space agency becomes operational.



The most prominent feature of Algeria's space activity was the 2002 launching of the first Algerian micro-satellite (ALSAT). The project forms part of an enlarged micro-satellite constellation designed to (a) To reduce the vulnerability of persons and property; (b) To assess damage and facilitate the organization of disaster relief. Space technology has been adopted as a strategic endeavour for Algerian national socio-economic development. Algeria is planning for a new ALSAT 2 high-resolution Earth observation micro-satellite project in the future.

ALSAT was launched at the Plesetsk Cosmodrome in Russia under a seven-nation constellation known as Disaster Monitoring Constellation (DMC) led by SSTL and involving Algeria, China, Nigeria, Thailand, Turkey, the United Kingdom and Vietnam, with launches handled by the Russian firm, Cosmos. Each satellite belongs to one country, but they will share information with each other when disaster monitoring is needed. The project forms part of a programme designed to: a.) acquire capacities in space technologies through international cooperation; b.) assimilate emerging applications; c.) provide the national user community with the resources for utilising satellite data gathered; d.) evolve space technologies to promote sustainable development and environmental protection; and e.) promote training and skills development in the field of space technology applications.

5.1.2. Egypt

Since the early part of the twentieth century, Egypt has been interested in space sciences and their use, including astronomical studies, meteorological applications, communications and remote sensing applications in a multitude of fields, including geology, soil and agriculture, urban planning, antiquities, environment, engineering and natural hazards. To achieve more coordination and cooperative thinking, the Egyptian Space Science and Technology Research Council was recently established. It is affiliated to the Egyptian Academy of Scientific Research and Technology and comes under the aegis of the Ministry of State for Scientific Research. The Council includes 125 members who represent the main Egyptian players in the field of space research and studies. The structure of the Space Science and Technology Research Council includes four divisions: Peaceful Uses of Space and Strategic Studies; Space Technologies and Space Vehicles; Applications and Technologies of Remote Sensing and Climatic Change; and Communications, Navigation and Basic Space Sciences. **Because of its advanced programmes, relatively close links to the Mediterranean and Middle East regions, Egypt's space programmes are not included here in detail.**

5.1.3. Morocco

Morocco currently operates three satellite stations providing national and international circuits (Mohammed V station at Rabat, a station at Laayoune and one at Dakhla). Morocco is also a partner in the operation of the ARABSAT system and has signed a cooperation agreement with EUTELSAT and INTELSAT for the direct transmission of national television and radio programmes in Europe, Canada, the US and certain Scandinavian countries. In 1995 it became linked to the international Inmarsat network and to the VSAT business communication network. These networks are managed by the government PTT.

In addition, the National Office for Post and Telecommunications, which comes under this Ministry, carried out an extensive modernisation programme in 1995 in order to digitize and extend the entire equipment of Earth stations. Satellite data stations currently in operation to receive METEOSAT weather satellite data, for example at the National Department of Meteorology (NDM). There are plans to set up two US NOAA stations, one for meteorological studies at the DMN and the other at the Royal Centre for Spaceborne Remote Sensing (CRTS) for receiving high resolution radiometer data. This station is co-financed by the EU. The distribution of satellite images is the responsibility of CRTS. In order to accomplish this task, the Centre has concluded contacts with a number of satellite image distributors.

A number of projects combining space-borne remote sensing and GIS are in the process of development or implementation. These projects are designed to meet needs in the areas of natural resource stocktaking and management, environmental protection and town and country planning within the context of national and regional development programmes. With regard to natural resources and the environment, several significant projects might be mentioned:

- The national AGRIMA project (co-financed by UNDP, the Ministry for Agriculture and CRTS) on the incorporation of satellite data in the country's agricultural statistics;
- The FORMA project (at the development stage and co-financed by the European Union, the Ministry for Agriculture and CRTS) on satellite surveillance of Moroccan forests;
- A study of the changes in land use and the estimation of the biomasses involved (financed by UNEP/GEF and managed by the Ministry for the Environment);
- The GEOSTAT project on vegetation mapping and the survey of common grazing land in Morocco, with the collaboration of CRTS, the Ministry for Agriculture and the French National Centre for Space Studies (CNES). CRTS and CNES are currently working with the Sahara and Sahel Observatory to consider the possibility of extending this study to the region.

With regard to the coastline and marine environment monitoring, Morocco is currently working on applications for lagoon management and beach mapping. The national GERMA project (co-financed by the EU, the Ministry for Maritime Fisheries and the Merchant Navy and CRTS), for the development of a system based on satellite images for marine resource management, is in the implementation phase;

Morocco has participated in the airborne GLOBESAR campaign initiated by Canada to prepare for the launching of that country's RADARSAT satellite and, in that connection, has embarked on coastline and soil erosion research. In the area of town planning, CRTS, together with the Rabat Urban Agency and Belgian Cooperation, is setting up a project using satellite data to monitor cities in developing countries. The aim of this project is to take advantage of existing methodologies and adapt them to towns with high growth rates.

5.1.4. Nigeria

The Nigerian National Space Research and Development Agency (NASRDA) was established in 1998 by the government of Nigeria, as well as a National Council on Space Science Technology to oversee the program, underscoring the importance with which government viewed the program, President Obasanjo was the chairman while Vice President Abubakar Atiku was the vice chairman and is part of The Federal Ministry of Science and Technology. The primary objective of NASRDA was to establish a fundamental policy for the development of space science and technology and to establish and coordinate the activities of Nigerian space research centres and planned to spend US$93 million towards the development of an actual space program. Initial funding for NASRDA was spread over four years, beginning in 2001, after which it is expected to generate its own revenues. NASRDA is to have six centres including one handling space transport and propulsion. A space command centre at the Nigerian defence ministry will be created. The Centre for Atmospheric Sciences and Astronomy (CASA) at the University of Nigeria Nsukka is one of the four campus-based Centres for Space Science and Technology.

The African Regional Centre for Space Science and Technology Education (ARCSTEE)[28] operates under the auspices of NASRDA Abuja and traces its history back to the UNISPACE 82 conference in Vienna which made a recommendation to the UN to help develop indigenous capabilities in space science and technology at the local level. Nigeria was picked to serve African countries where English is one of the official languages, and a separate centre to cater for French-speaking African countries is in Rabat, Morocco.

---

[28] *For more information, see http://www.oauife.edu.ng/research/arcsstee/*

As mentioned above in the section on Algeria, Nigeria launched its first satellite, the US$ 13 million NigeriaSat 1[29], into orbit in September 2003 after Nigerian experts underwent training at Surrey Satellite Technology Ltd. NASRDA is also embarking on the next generations of satellites: a communication satellite to be called NigcomSat-1 (deal signed in December 2004) and a high resolution African Resources Management Constellation satellite, NigeriaSat-2 (to be launched in 2007), as it was recognized that ineffective communications represented one of the greatest barriers to socio-economic development and NigeriaSat-2 would be designed to contribute to providing an adequate telecommunications system throughout Nigeria and regional coverage to ECOWAS countries. NigeriaSat-1 was launched under a seven-nation constellation DMC led by SSTL.

Although Nigeria had partnerships with the US in the 1950s and 1960s (e.g. radio tracking installations as part of the forerunner of NASA's Deep Space Network Other, radio tracking for the US Mercury-Atlas orbital flight programme, organisations in Nigeria that are involved with space include:

- Geomatics Nigeria Ltd. - Working on satellite imaging and analysis of Nigerian images for vector disease studies, agricultural and production.
- Interstate Forecasting Centre - Established in 1985 to benefit the nine Niger Basin Authority (NBA) countries (Benin, Burkina-Faso, Cameroon, Côte d'Ivoire, Guinea, Mali, Niger, Chad, and Nigeria. Primary objectives are to assist in protecting citizens' life and goods, augment food security and hydro-power, minimise the catastrophic effect of draught and flood. The immediate focus was to establish a real-time hydrological forecasting system covering river Niger and its major tributaries.
- Ilorin, Nigeria (ILO) [Lat - 8.53, Lon - 4.57] is a CERES ARM Validation Experiment [CAVE] station which is part of the World Climate Research Programme aimed at detecting important changes in the earth's radiation field which may cause climate changes.
- Nigeria's television market was deregulated in 1995, resulting in the formation of eight private stations and more than 20 satellite redistribution companies.

5.1.5. South Africa

The Satellite Applications Centre of the South African Council for Scientific and Industrial Research (CSIR)[30] is located at Hartebeesthoek (near Johannesburg). Its business interests are in remote sensing and satellite tracking services – largely through data from the polar orbiting satellites of the US National Oceanic and Atmospheric Administration (NOAA), LANDSAT thematic mapper sensor, French SPOT series (panchromatic and multi-spectral data) and SAR sensors of ESA ERS-1 and ERS-2. Data products conforming to international standards are being supplied to users worldwide for use in GIS. The Centre has its second area of business in the provision of tracking, telemetry and command services, 24 hours per day, all year round. The facility is part of the CNES 2-gigahertz network. South African satellites include SUNSAT (high resolution photography) launched in 2000, as well as television broadcasters like NASPERS / MIH utilising the Eutelsat satellite. **Because of its advanced programmes, South Africa's space programmes are not included here in detail.**

5.1.6. Tunisia

Under the national space programme, directed by the National Commission for Outer Space Affairs, whose role is to coordinate the activities of the various ministerial departments and organizations concerned with outer space and to generate media awareness of the benefits of exploiting space technology benefits, the activities of the different players have been facilitated by the setting up of five discussion groups on legal and regulatory aspects, space techniques and technologies, space telecommunications, Earth observation and remote sensing, training and awareness-raising. These groups aim to bring about participation of a large number of institutions with an interest or expertise in space. Discussions held on drawing up a national space programme have involved governmental departments, schools and universities, public and private enterprises, recognized experts, associations of civil society and trade unions.

---

[29] *For more information, see http://www.oauife.edu.ng/research/spael/current.htm*

[30] *For more information, see http://www.csir.co.za/ and http://www.sac.co.za/*

Tunisia's main achievements in space-related activities have been the utilization and operation of existing space systems, namely, space telecommunications, location and data collection, Earth observation and research and development. For international telecommunications purposes and, in particular, for its telephony services, Tunisia possesses a terrestrial satellite communication station. This station, which is administered by Tunisia Télécom, can communicate with the satellites of (INTELSAT and ARABSAT.

Since 1992, it has been possible for programmes broadcast on the national television channel, Canal 7, to be received in Europe, North Africa and the Middle East thanks to transmissions by the National Broadcasting Office via a satellite channel leased from EUTELSAT. The National Broadcasting Office has, in cooperation with the Telecommunications Study and Research Centre, set up a project involving the operation of a network for the selective dissemination of multi-service data via the EUTELSAT satellite. One of the applications is the transmission of meteorological data provided by the National Meteorological Institute.

Tunisia has since 1993 been a user member of the COSPAS-SARSAT International Search and Rescue Satellite System for tracking aircraft, vessels and land vehicles in distress. An operation designed to demonstrate this humanitarian application has been organized with a view to the introduction of a national satellite search and rescue system.

Tunisia has been making use of these services to collect data for mapping, monitoring and evaluating natural resources. In this connection, a pilot remote-sensing project known as the Arid Zones of Tunisia (ARZOTU) experiment, which began in 1975 has enabled Tunisia to assess the contribution of the first observation satellites to the study of arid environments. The General Directorate for Water and Soil Conservation, whose functions involve combating erosion, the harnessing of run-off water and groundwater protection, is administering a scheme to gather climatic data at dams using the Argos data collection and position location system. The information gathered by a network of transmitters provides rainfall, dam water-level and water temperature readings and is used for evaluating and monitoring the water balance.

In addition to making use of space technology applications, Tunisia operates a centre to track the Arabsat geostationary satellites. The main functions of this centre are to monitor and correct the altitude and orbit of the Arabsat satellites. The centre possesses national expertise in geostationary satellite tracking. In the area of Earth observation, Tunisia has focused increased efforts on the operational applications of space technology, meteorology and remote sensing.

5.2. Equatorial Launch Sites

This is an appendix which lists relevant launch sites with latitude of less than 10° ± from the equator world-wide. Not all sites are operational or relevant to the CSP programme, but are listed for completeness. These are listed in the order of their distance to the equator.

5.2.1. Alcantara Launch Center (CLA) - Brazil

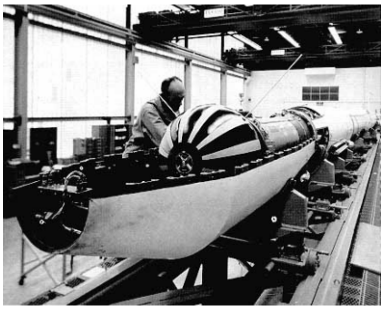
2°S x 44°W – The seaside Alcantara Launch Center (6 above, and indicated on the map on the right as "A") has been carved out of the jungle only 150 miles (2,3°) south of the equator on Brazil's northeast coast (outside Sao Luis) launches primarily the prototype VLS rocket, Sonda 3/4 sounding rockets, meteorological rockets and other science launchers. The Brazilian Space Agency (AEB) has plans to launch rockets and satellites from Alcantara for other nations, including the US, Russia, China, Ukraine (small Tsiklon-4/Cyclone-4 rockets for GTO orbits) and Israel (Shavit rockets).

However, Alcantara has presently only one dedicated VLS rocket pad and has seen some technical problems in the recent past, with three consecutive VLS failures and a 2003 explosion killing 21 engineers due to an electrical malfunction.

In October 2004, Alcantara resumed operations with the successful launch of a VSB-30 prototype (an exploration vehicle developed with the German Space Agency). Brazil hopes to launch the fourth prototype of the VLS-1 by the end of 2006 on the newly- reconstructed VLS launch pad, although some sources cite the 2006 launch date as being overly optimistic. In addition, a 2004 national conference stated that developing space tourism was among several recommendations emerging from a national conference on the country's future goals in space. The conference participants, who included senior government, congressional and industry officials, also recommended continued work on domestic satellite and launch capabilities, as well as major industry-funded infrastructure upgrades to Alcantara.

Last September, Brazil's Congress appropriated about US$5 million in supplemental funding to "begin immediate engineering work" on infrastructure improvements at the facility to prepare for future launches of the Cyclone-4. Along with becoming an international spaceport, AEB also wants to transform Alcantara into an aerospace centre that would host a university campus and a complex of space museums, hotels and even an ecological reserve. Brazil has also stated that it will take three to four years to complete the proposed infrastructure improvements, but that industry can start investing in the project within the next year and a half. (http://www.cla.aer.mil.br/)

5.2.2. San Marco Equatorial Range (SMER) - Kenya



2°S x 40°E – NON OPERATIONAL – Italy's San Marco Range (13) is an unused pair of platforms in Formosa Bay three miles off the coast of Kenya. The facility was initiated by an agreement with NASA in 1962 and specialised in launching Scout rockets that were previously launched from the Wallops Island Launch Facility in the US. This station was composed of two oil platforms and two logistical support boats. The San Marco platform is the launch pad and Santa Rita platform holds the firing control blockhouse and boosted eight satellites between 1966 and 1976, and one in 1988.

The first platform (Santa Rita) was towed from Italy to Kenya during the winter 1963-1964. In the shape of a 40m side triangle, it was anchored at 25 km of the coast, its feet lying 20m deep. Preliminary tests took place in March and April 1964 with three Nike Apache sounding rockets launches. The San Marco platform, with the installations necessary to the Scout rockets assembly and launching, arrived in 1966. This 30 x 100 m rectangular unit was used for the first time for the San Marco 2 satellite launch, in April 1967 (photos to the right). Three years later, Explorer 42, alias Uhuru, became the first American satellite launched by a foreign team. A total of 9 satellites (4 Italian, 4 American and 1 British) were launched from the San Marco station, the last in 1988. The San Marco station has not been used since 1988, although the platforms were certified until 2014.

5.2.3. Guiana Space Centre (CSG) – French Guiana

5°N x 52°W – The ESA fires space rockets like the Ariane from the CSG complex known as Centre Spatial Guyanais (CSG) owned by the French national space agency, CNES. CSG is one of the most favourable sites for launches of satellites to geostationary orbit. CSG's position near the equator offers an advantage over Cape Canaveral for eastbound launches. French Guiana's coastline permits launches into both equatorial and polar Sun-synchronous orbits with inclinations up to 100.5. Hundreds of sounding rockets and balloons and space satellites have been launched from Centre Spatial Guyanais.

5.2.4. Centro de Lançamento da Barreira do Inferno (CLBI) - Brazil

6°S x 35°W – **SUBORBITAL** – Also called "Natal" and owned by Brazil, this sub-orbital launch site has been used for sounding rocket launches from 1965 to present. This is a regular launch site for rockets of the types Nike-Cajun, Sonda, Black Brant, Super Loki, etc. are launched.

5.2.5. Ronald Reagan Ballistic Missile Defence Test Site (RTS) – Kwajalein Atoll, US Marshall Islands

8°N x 167°E – Primarily a USA military launch site and ballistic missile test site, recently also authorised for launch of the first and third planned Space X Falcon I launch, their new cost-effective cost vehicle – contracted for missions for the US Defence Department (DARPA) and for Malaysia (ATSB). This launch location is likely to have been provided to Space X because the US military introduced problems for Space X in their original schedule to launch at Vandenberg Air Force Base, and offered them an alternate facility. This is rarely used for civilian purposes. (http://www.smdc.army.mil/)

5.2.6. Shaba North – Democratic Republic of the Congo

8°S x 28°E – INACTIVE / REMOVED – Shaba North is an inactive suborbital launch site that was operated by German company Ortag (Orbital Transport und Raketen AktienGesellschaft) in the Democratic Republic of the Congo. In 1975, Otrag signed an agreement with the Congolese government to establish a rocket range to test its low-cost rockets deep in the interior at Shaba, and the Libyan government allegedly provided seed funds for a test launch series. Logistic support was via antique British Argosy transports landing at a dirt strip on a plateau overlooking the jungle. Here a pad and gantry were erected and flight tests began in 1977. However, the government of the Congo was pressured by the USSR to withdraw permission to use the site and Otrag was essentially asked to leave the country in 1979, although the site itself supposedly still remains.

5.2.7. Thumba - India

9°N x 77°E – SUBORBITAL – Thumba is suborbital launch site owned and managed by India, mostly used for sounding rocket launches, and in use from 1963 to present. The Sriharikota orbital launch facility is India's primary space launch centre, located on the east coast of the peninsula with a firing sector over the Bay of Bengal and in use from 1971 to present. However, it is located slightly more north at 13°N x 80°E.

5.2.8. Asia Pacific Space Centre (APSC) - Australia

10°S x 106°W – In 2001, the Australian Government has agreed to provide AU$100 million to help establish the World's first fully commercial space launch facility on Christmas Island – an Australian external Territory, located in the Indian Ocean, approximately 360 km south of Jakarta, Indonesia, and 2650 km northwest of Perth, Western Australia.

The APSC facility will be targeting the growing Asian satellite market and commence operations with the Aurora launch vehicle being supplied by their Russian partners. As a site for an Australian Space Port facility, Christmas Island offers many advantages, not least of which is its proximity to the equator. The project will provide up to 400 jobs in its construction phase and up to 550 jobs when operational and ensure the economic future of the Island presently dependant on phosphate mining. To-date this centre is not operational, but launches are expected to commence mid 2006. (http://www.apsc2orbit.com/)

5.2.9. Sea Launch

NA°N/S x NA°E/W – Formed in 1995 as a partnership between Boeing, RSC Energia, SDO Yuzhnoye / PO Yuzhmash and Kvaerner ASA, providing operational services of the launch platform Odyssey and assembly and command ship, Sea Launch Commander. Sea Launch offers launch capacity from heavy lift performance capability of 4.000 – 6.000 kg as well as launch to all inclinations from a single launch pad from an equatorial platform. Sea Launch has completed 17 missions to-date using the Russian Zenit-3SL launch vehicle and also offers land launching capabilities at the Baikonur Cosmodrome in Kazakhstan. (http://www.sea-launch.com/)

5.2.10. Orbital Sciences Corporation – Pegasus

NA°N/S x NA°E/W – In addition to the ground-launched Taurus, Minotaur and Minotaur IV launch vehicles, Orbital launched their Pegasus programme in 1990, a rocket system launched for the first time from beneath a NASA B-52 carrier aircraft. Normally launched from a "Stargazer" L-1011 aircraft at approximately 40,000 feet over open ocean, Orbital has conducted 36 missions, launching more than 70 satellites to-date. The three-stage Pegasus is used by commercial, government and international customers to deploy small satellites weighing up to 1.000 pounds into LEO. Pegasus launches have been conducted from six separate sites in the U.S., Europe and the Marshall Islands. (http://www.orbital.com/)

5.3. Non-Equatorial Orbital Launch Sites World-Wide

Some highlights of key strategic launch sites follow. Space launch facilities that do not currently launch to valid orbital positions are not included, although many are serious scientific and commercial facilities. For the purpose of this plan, these facilities are not investigated in detail. These sites are listed by latitude from closest to furthest from the equator. The furthest launch sites from the equator are strategically positioned for polar orbits and would compete with other facilities for non GEO orbital insertion business. There are a number of other orbital facilities world-wide, but many have only launched one vehicle or are stalled in development for various reasons, including the Iraqi Al Anbar (one launch in 1989), the US Barbados launch site (discontinued in 1968), etc. – as well as planned or proposed sites - which are not included.

5.3.1. Sriharikota Island, India

14°N x 80°E – Beginning use in 1980, India launched the Rohini 1 satellite atop a rocket called SLV (Satellite Launch Vehicle). This centre on the east coast state of Andhra Pradesh is used by the Indian Space Research Organization (ISRO) to launch space satellites on PSLV (Polar SLV) and GSLV (Geostationary SLV) rockets as well as atmospheric sounding Rohini rockets.

5.3.2. Xichang Space Launch Center, China

28°N x 102° E – This centre, first used in 1984, offers better access to geostationary orbits than China's Jiuquan and launches Long March rockets.

5.3.3. Cape Canaveral Air Force Station / Kennedy Space Center – Patrick Air Force Base / Merrit Island, Florida, US

29°N x 81°W – Beginning operations in 1958, Cape Canaveral Air Force Station at Patrick Air Force Base is now part of the US Space Command 45th Space Wing. Cape Canaveral has active Titan, Atlas and Delta launch complexes and provides facilities for military, NASA and commercial organizations. More than 500 space launches have been made from the Cape, including NASA's many manned missions. The annual launch rate is about 25 to 30 flights. Currently, Titan rockets are launched from pads 40 and 41, Delta from 17A and 17B, and Atlas Centaur from 36A and 36B. Orbital inclinations range up to 57o. Polar launches from Canaveral are not permitted because they would have to fly over populated areas. The Cape's Eastern Range tracking network extends all the way into the Indian Ocean where it meets the Western Range network. Spaceport Florida Facility is a commercial launch site at Cape Canaveral Air Station operated by the Spaceport Florida Authority (SFA), a state agency. It converted the Navy's old Launch Complex 46 pad for firing small to medium commercial launch vehicles ferrying satellites to equatorial orbit. The Navy originally used the pad for testing the Trident II fleet ballistic missile. (http://www.patrick.af.mil/)

The Kennedy Center is NASA's site for processing, launching and landing space shuttles and their payloads, including components of the International Space Station. It also prepares and launches missions to places beyond Earth. KSC is located on Merrit Island adjacent to the U.S. Air Force launch facilities known as the Cape Canaveral Air Station. Kennedy was built first to support the Apollo lunar landings of the 1960s. After the last Apollo lunar launch in 1972, launch complex 39 supported Skylab space station in 1973-74, then the Apollo-Soyuz Russian-American linkup in space in 1975, and now space shuttles since the late 1970s. Numerous expendable launch vehicles are blasted off from KSC. (http://www.nasa.gov/centers/kennedy/)

The Spaceport Florida Authority has proposed commercial spaceport venture, but currently catering only to visitors of Cape Canaveral and Kennedy Space Center launches. (http://www.spaceportflorida.com/)

5.3.4. Tanegashima Island, Japan

30°N x 131°E – Japan's National Space Development Agency (NASDA) operates the Tanegashima Space Center orbital launch site on the south-eastern tip of Tanegashima Island. The complex's northern Osaki Launch Site fires H2 and J1 rockets and has static test facilities for liquid-fuel rocket engines. The southern Takesaki Launch Site fires sounding rockets and carries out static firings of H2 rocket solid-fuel boosters. It has the H2 Range Control Center.

5.3.5. Spaceport Australia / Woomera

31°S x 136°E – Launched only two rockets in 1967 and 1971 for Australia and the United Kingdom, and to-date most of the rocket range equipment has been destroyed or sold off for scrap. However, the pads at Woomera compose something new called Spaceport Australia.[31] The Australian Space Council is planning for launches from Woomera as well as from Darwin and the Cape York Peninsula. Sparsely populated Woomera has some infrastructure, is usually cloud-free, and would be a good location for access to polar orbits. Kistler Aerospace announced in 2001 that it will use Woomera as a launch site for their new, reusable K-1 launcher, in addition to Spaceport Nevada.

5.3.6. Kagoshima – Kyushu Island, Japan

31°N x 131°E – Beginning with launches in 1970, hundreds of suborbital and 24 orbital launches have been made.

---

[31] *For more information, see http://www.asicc.com.au/*

5.3.7. Southwest Regional Spaceport – Las Cruces, New Mexico, US

32°N x 107°W – **INACTIVE** – A proposed commercial Southwest Regional Spaceport is near the White Sands Space Harbor at Las Cruces, which NASA uses as one of its three space shuttle landing sites in the United States. The Ansari X-Prize was awarded at Las Cruses. No launches currently planned.

5.3.8. Palmachim Air Base - Negev Desert, Israel

32°N x 35°E – Used since 1988, Israel launched Horizon 1 (Ofeq 1) atop a rocket called Shavit in a launch this air force base south of Tel Aviv near the town of Yavne in the Negev Desert.

5.3.9. California Spaceport / Western Commercial Spaceport – Lompoc, California, US

34°N x 120°W – Vandenberg Air Force Base – Space Command 30th Space Wing is operated by the US Space Command 30th Space Wing on the central Pacific coastline 12 miles north of Lompoc, California, and 150 miles northwest of Los Angeles. Vandenberg is the only military installation in the US from which unmanned government and commercial satellites are launched into polar orbit. It sends satellites to polar orbits by launching them due south. The base also test fires America's intercontinental ballistic missiles (ICBMs) westward toward the Kwajalein Atoll in the Marshall Islands. Vandenberg operates the Western Range tracking network, which extends all the way into the Indian Ocean to meet the Eastern Range tracking network. Western Range sites are on the California coast and downrange in the Hawaiian Islands. Vandenberg was to have provided a base for space shuttle launches on high inclination missions, but no shuttles ever have flown from there. Delta rockets take off from space launch complex 2W, Titan from launch complex 4, and Atlas from launch complex 3. Until 1994, Scout rockets were launched from complex 5. Vandenberg's military service dates back to 1941 when it was an Army training facility for armoured and infantry troops known as Camp Cooke. California Spaceport is a commercial launch facility at Vandenberg Air Force Base for launching satellites to polar orbit. (http://www.vandenberg.af.mil/)

The California Spaceport, also known as the Western Commercial Spaceport, is a commercial launch facility on Vandenberg Air Force Base at Lompoc, California. The spaceport can launch satellites to polar orbit on Delta 2 and Delta 3 rockets. The climate permits year-round launches to low Earth orbit (LEO), medium Earth orbit (MEO), or sun-Synchronous orbit. The spaceport is operated by Spaceport Systems International (SSI), a subsidiary of ITT Industries, Inc. California Spaceport was the first federally-licensed private "Commercial Space Launch Site Operator" in the United States. Its license was issued by the Office of Commercial Space Transportation in 1996.

5.3.10. Mojave Civilian Aerospace Test Center – California, US

35°N x 118°W – The world's first commercial spaceport and America's first inland and first non-federal spaceport. Philanthropist Paul Allen and aviation legend Burt Rutan launch their private spacecraft, SpaceShipOne, on suborbital flights from Mojave. For more information, see http://www.mojaveairport.com/

5.3.11. Taiyuan Space Launch Center – Wuzhai, China

38°N x 113°E – This centre started as test base for missiles and rockets too big to fly from Jiuquan. Its single space launch pad opened in 1988 for launching Long March 4 space rockets ferrying remote sensing, meteorological and reconnaissance satellites to polar orbits. Long March 2C rockets carried Iridium satellites from there for the U.S. in the 1990s.

5.3.12. Jiuquan Space Launch Center – Shuang Cheng Tzu, China

40°N x 100°E – Built in the 1960s in the Gobi desert 1,000 miles west of Beijing, China, this was China's first launch site. Jiuquan is normally limited to south-eastern launches into 57-70 degree orbits to avoid over-flying Russia and Mongolia. Long March space rockets and atmospheric sounding rockets are fired from Jiuquan. Jiuquan is used for recoverable Earth observation and microgravity missions and not most of the Chinese commercial flights; however, the piloted spacecraft Shenzhou 5 atop a Long March 2F rocket launched from this facility in 2003.

5.3.13. Baikonur Cosmodrome – Tyuratam, Kazakhstan

46°N x 63°E – Beginning in 1957, Baikonur launched Sputnik 1. Baikonur is a large cosmodrome with nine launch complexes encompassing 15 launch pads. All of Russia's manned space flights and interplanetary probes are launched from here and it is the only cosmodrome launching Proton, Zenit, Energia and Tsyklon SL-11 space rockets. Launches headed due east would be the most efficient, but are not flown from Baikonur because lower stages of the rockets might fall into China.

5.3.14. Svobodny Cosmodrome – Russia

51°N x 128°E – Svobodny is a relatively-new cosmodrome created in 1996 and built out of a decommissioned missile site at Svobodny-18 about sixty miles from the Chinese border -- for Start, Rockot and Angara space boosters.

5.3.15. Plesetsk Cosmodrome – Russia

63°N x 40°E – Beginning in 1957, Plesetsk Cosmodrome for launches of the old R7 or A-class missiles-rockets were constructed in support of the USSR ICBM program. Today, there are launch pads for Cosmos, Soyuz/Molniya Tsyklon and Zenit space boosters and allows the launch of communications satellites and spy satellites to polar and highly elliptical orbits. Range safety restrictions limit flights from Plesetsk to 62.8o, 67.1o, 73-74o, 82-83o.

5.3.16. Barents Launch Area, Barentsovo More – Murmansk Oblast, Russia

69°N x 35°E – Launch area for Russian submarines firing submarine-launched ballistic missiles on suborbital or orbital trajectories, in operation from 1977 until the present.