

## **Unreasonable Rocket Nanosat Business Plan Executive Summary.**

### **1. Stage one proposal summary**

Unreasonable rocket believes there is a real need for a responsive commercial nanosat launcher. The nanosat market is maturing with real missions and real funding. The growth of this market is limited by launch availability and the restrictions associated with the nanosat status as secondary payload. Secondary payload status precludes a whole range of possible missions by imposing very stringent rules on the payload. In addition the launch wait can be measured in years. It's very difficult to do iterative scientific development when the iteration cycle is measured in years. Unreasonable Rocket intends to solve this problem by providing dedicated nanosat launches without any of these restrictions. We will do this using the simplest possible pressure fed launcher, launched offshore. We have the technology in hand for all major systems and built and tested prototypes of all major systems: Tanks, structures, engines, guidance and control. We have manufactured and flown guided liquid rockets of equivalent complexity to our proposed launcher. The next step is to put together a full time team to integrate the technology and provide this much needed service to this growing market.

### **2. The Market and our value proposal.**

Overall the global launch market is a multibillion dollar business. Long term this it's the market we want to address. Unless one can find investors willing to sign 10 digit checks addressing this large market as a first effort is unrealistic. In this proposal we are going to focus on the first step in a multistep plan. We are addressing the nanosat launcher market.

In the last 5 years the nanosat has transitioned from an interesting idea sponsored by a few universities to a market with satellites performing real missions funded by a broad range of customers. The number of manifested nanosat missions in 2011 increased by more than three times over the previous 5 year average. There are now multiple organizations that have flown repeat missions. There are 250+ nanosats presently waiting for a ride.

All nanosats launched to date have flown as secondary payloads on other missions. Getting a ride as a secondary payload is a lot like hitchhiking, you stand by the side of the road trying to look presentable and unthreatening, hoping that some driver will stop and pick you up. The car that stops to give you a ride may not be going where you really want to go, you must decide, take the ride close to where I want to go, or continue to stand in the road and wait? If your standing by the side of the road holding a strange piece of equipment the drivers can't identify you aren't going to get a ride. If your nanosat has a piece of equipment, propulsion, radio,

energetic batteries, pyro deployment features, whose risks the primary payload can't fully understand, you're not going to get a ride. To date I do not believe that any nanosat with active chemical propulsion has been flown. Estimates of the cost of qualifying such a propulsion system to fly as a secondary payload are in excess of \$1.5M

As a secondary payload the Nanosat has the following limitations:

- Cannot choose their orbit or schedule.
- Cannot have energetic propulsion.
- Cannot have energetic radio emissions.
- Cannot have energetic/pyro deployment features.
- Cannot have timely access to the launcher to load things like biological samples, active reagents etc...
- US based payloads have ITAR problems with foreign launchers.

With these limitations the current published price (spacex) for a secondary 3U launch is \$350K, this does not include the hidden costs of maintaining your team while waiting months or years for a launch. It does not include the costs of negotiating with the primary payload any additional validation and verification the primary payload may require. Unreasonable rocket intends to offer scheduled quarterly launches on dedicated launchers for a price of \$400K., and launches with custom schedules for 600K.. Given the current price and market size the initial market we intend to address is about \$10M a year in 2012 and growing.

### **3. Competition**

The only preset day competition is the secondary payload market. If you place no value on your time and are patient this is probably a lower cost alternative to the services we offer. If you have real mission needs and any realistic time valuation this is not realistic competition.

Unreasonable rocket is not the only company currently pursuing a dedicated Nanosat launcher. Garvey Space, Ventions, Dynetics. All three of these efforts are SBIR funded and have launch concepts based on traditional ranges. . Only Ventions has flown a guided vehicle and its concept is a very complex turbo pumped vehicle that will be expensive to duplicate. Having good mass fraction and high performance is only important if you are limited in gross liftoff weight or your propellants become a significant part of your costs. Simple is lower cost.

### **4. The Team**

Unreasonable rocket was one of three teams to build and fly vehicles for NASA lunar landing competition. Our vehicles were more mass efficient and an order of magnitude lower cost than the other competitors.

Unreasonable's founder Paul Breed is CTO and founder of NetBurner Inc. (est 1998) Paul has been a serial entrepreneur profitably designing, producing and selling complex computer controlled engineering products in multiple fields for more than 25 years.

Unreasonable has also established partnerships with Microcosm for tank and structure development, Flowmetrics for aerodynamics and fluid flow solutions, and the FAR test facility for hot fire static testing and early flight test.

## **5. Details of the proposed launcher.**

Many articles have been written on minimum cost design for launch vehicles.

A recurring theme is the "big dumb rocket", big relative to the payload size, and dumb as in simple. Our first vehicle design embraces these concepts and is a simple 3 stage pressure fed launcher using room temperature dense peroxide/hydrocarbon propellants. This vehicle will be small enough to handle by humans without assistance. In the mid to late 70's the existing computer makers could not envision a market where the little toy computer like the Heathkit H8 and Altair computers could have any impact on their market. They were mere toys. This is how many in the traditional aerospace environment view Nanosats, yet we are right on the cusp, organizations are now starting to do real missions and make real money with these "Toys". If one can provide affordable launch this trend will really accelerate. If you use the traditional aerospace concepts to develop a Nanosat launcher you will end up with a MicroVAX, not an Apple II. The goal here is to develop an Apple II, ie a low tech launcher that uses advances in material and electronics to build something the traditional aerospace organizations would view as a toy. One example, the third stage thrust vector uses tiny servos with custom titanium gears, digital communication, built in self-test with force and position feedback. In a traditional aerospace environment these actuators would be \$50K each. Yet these are high end robot servos produced in the 10's of thousands and available off the shelf for \$110

### **5.1. Tanks and Structures.**

Unreasonable has negotiated a joint venture/development agreement with Microcosm/Scorpius Space Launch systems to develop peroxide compatible composite tanks. Microcosm/SSLCS is a well-known defense and SBIR house with extensive experience and connections in the space launch community. This relationship gives Unreasonable access to extremely lightweight structures and tanks.

### **5.2. Propulsion**

Unreasonable is the first group to ever fire a regenerative cooled liquid rocket motor built with modern 3D additive manufacturing. We intend to use this technology to develop all of our motors and mechanical systems. Our first generation of 3D printed motor has in excess of 25 minutes of firing time and has exceeded all our expectations.

### **5.3. Avionics**

In most aerospace electronics systems the cases, cabling and connector weight exceeds the active electronics weight. Using modern electronics capabilities we reduce the vehicle avionics to a single light weight unit. Unreasonable Rocket has previously demonstrated success building and flying integrated avionics systems of this type.

### **5.4. Launch Platform Concepts**

For regulatory purposes the launch vehicle must be launched far from any population area. This can be done with either a boat or an aircraft. Determining the correct approach is a trade study that is still to be completed.

#### **5.4.1. Sea Launch**

The vehicle will be built and integrated in the factory. It will then be installed into a sealed container. This container will be transported to the launch site on a offshore fishing vessel, the sealed launcher will be attached to a balancing weight and set in the water, the vessel will then retreat to a safe distance and command the launch.

#### **5.4.2. Air Launch**

The vehicle will be mounted below a Cessna Caravan and flown out to sea. It will then be dropped under parachute and launched after the Caravan has established the necessary clearance. This can be done with very little modification to the Caravan as the Caravan already has structural hard points to mount amphibian floats and the ground clearance to have a belly pod on unimproved runways. (The founder is a licensed A/P aircraft mechanic and has experience with this sort of modification)

### **5.5. Regulation**

Regulatory compliance costs, have significant hardware side effects. The range safety systems on traditional launch vehicles cost more than we are planning to charge for a full launch, and weigh more than our payload. Unreasonable has experience with FAA permits and a good working relationship with a number of FAA personnel. Recognizing FAA compliance in the design phase of the vehicle has allowed Unreasonable to create a unique solution that minimizes overall cost. The launch will be at sea and first stage will launch far enough away from third parties to have our radius of potential harm constrained by physics. Our second and third stages are light weight composite structures incapable of surviving high-speed flight in the atmosphere. This greatly simplifies the verification process needed for regulatory compliance. We are familiar with the FAA AST office and have discussed this regulatory launch concept with the FAA AST chief engineer and found general agreement as to the validity of this approach.

## 6. Risks

The primary risk is technical. Can we actually do what we have proposed for the costs our business model proposes? Unreasonable Rocket has fired rockets from 50 to 25,000 lb thrust, with 9 different propellant combinations. We have built experimental tanks with structural efficiencies /mass fractions as good as any aerospace pressure vessel. We have built and flown guided controlled liquid rocket vehicles. We have flown said vehicles 5 or more times in a single day with an operating team of three or less.

## 7. Financial highlights.

Income K\$	2013	2014	2015	2016	2016
Revenue	\$0	\$1,200	\$4,000	\$8,000	\$10,000
COGS	\$305	\$540	\$853	\$1,670	\$2,150
Labor and Operating Expenses	\$333	\$473	\$613	\$903	\$903
EBITA	(\$638)	\$187	\$2,534	\$5,427	\$6,947

Cash Flow K\$	2013	2014	2015	2016	2016
Operating Net Income(Loss)	(638)	187	2,534	5,427	6,947
Investment Proceeds	1,200	0	0	0	0
Founder Contribution	150	150	0	0	0
Purchase Fixed Assets	(550)	(200)	(100)	(100)	(100)
Taxes	0	(21)	(1,081)	(2,386)	(3,072)
Starting Cash	50	212	328	1,681	4,622
Ending Cash	212	328	1,681	4,622	8,397

## 8. Funding needs and offering

We are looking for funding on the order of \$1.2M 100% of the funds will be used for capital equipment and direct operations. The founder will continue to contribute at least 150K/yr to the operation and draw no income until the organization is cash flow positive. Pre money valuation is negotiable and somewhat dependent on specific terms and what of the founder assets will be transferred into the created corporation. (License agreements, Machine tools, propellant storage facilities, developed IP, existing hardware etc..) This valuation could be in the range of \$2.5M to \$10M