NASA Solicitation JSC-COTS-2

Full and Brief

IPO - Industry Proposal Outline

Redacted Version with Minor Corrections

Thomas Lee Elifritz
Director of Research

(Company Deleted)
(Company Deleted)

(Address Deleted)
(Address Deleted)
(Address Deleted)

NASA* - National Aeronautics and Space Administration*

COSTS - Commercial Orbital Space Transportation System – COTS Proposal

COTS IPO - Commercial Orbital Transportation Services - Industry Proposal Outline

This proposal is in response to NASA* Solicitation **JSC-COTS-2**, dated October 22, 2007, and due November 21, 2007.

* The terms 'contractor' and 'partner' are interchangeable in this proposal, and may change during the execution of the proposed contract. There will be no foreign participation in this proposal or contract.

* Contractors and partners listed in this proposal are for guidance only. No participation, partnerships, contracts or agreements of any kind are implied with any of the corporations or the individuals listed.

Section I

Executive Summary (Full)

The 'Big Six' Space Faring Nations

United States - Russia - Europe - Japan - China - India

The geopolitics of commercial orbital launch capabilities are well beyond the scope of this proposal, however, clearly there are a large number of nationally subsidized orbital launch vehicles already on the launch pad, and that number, as well as the average size of these vehicles, is expected to increase significantly in the very near future. China has just embarked on an ambitious launch vehicle complex construction project on Hainan Island, presumably to service its next generation of five meter (5 m) Long March 5 vehicles. Japan also presumably will eventually make the transition to five meter (5 m) cores with its new H-2B vehicle. Europe already possesses the world's premier heavy lift vehicle, the Ariane V, and Russia has a functional heavy lift launch vehicle in the Proton, and is currently engaged in ongoing collaborative commercial space launch projects involving the Zenit. The Soyuz and Progress are both necessary components of the ISS, and ultimately, these vehicles are expected to be augmented and replaced by the new kerosene powered Angara family of modular launch vehicles. Whether or not India jumps into the five meter (5 m) arena remains yet to be seen, but they already have two operational launch vehicles, the GSLV and PSLV, and are actively engaged in cryogenic upper stage engine development.

The **Mission** - Rendezvous and Docking With The ISS - International Space Station

Lunar missions are also well beyond the scope of this proposal, therefore, the defining task which all national and commercial space entities must ultimately achieve, is a stable orbit, and rendezvous and docking with the ISS, or some suitable commercial space station. This goal is well within existing EELV and TSTO capabilities, with their current operational costs of 80 to 120 million dollars per launch, however, development of new and more capable launch vehicles is well beyond financial abilities of most if not all of the nascent commercial space organizations - the COTS competitors.

The **Challenge** - Commercialization of the Space Transportation Industry – **COTS**

The challenge is to reduce **COSTS** to orbit, quantitatively measured in dollars per kilogram. Clearly the clustered and staged kerosene powered TSTO solution is a promising COTS avenue. Here I present the complementary alternative, a hydrogen powered single stage to orbit cryogenic rocket, constructed out of components of the soon to be retired space shuttle fleet, based upon existing contractual obligations, demonstrated as a single one off demonstration flight, with the possibility of two to eight additional development flights, in order to satisfy challenging NASA COTS requirements in the quickest and most robust possible manner, using mostly preexisting industry talent, and ultimately leading directly to a scalable, independent and profitable, commercial orbital space transportation system (**COSTS**) with a financially viable launch vehicle operational solution for space station service.

In essence this is a proposal to commercialize the **SSME** – the Space Shuttle Main Engines. The primary premise of this proposal is that a credible method of decreasing the **COSTS** of typical $100 million dollar launches, is via the increase of the usable payload mass with **SSTO** cores stages in orbit.

Background

My intellectual property corporation has pioneered an innovative and visionary approach to the commercialization of the space transportation industry, using existing space shuttle main engines (SSME) in single stage to orbit configuration (SSTO), for resupply missions involving the rendezvous and docking with the international space station (ISS). This vehicle is not designed to compete with existing evolved expendable launch vehicles - (EELV), existing Soyuz and COTS launch vehicle architectures, nor the numerous creative commercial COTS competitor launch vehicle designs, but rather to fill a gap between the high end and very expensive to operate ISS resupply infrastructure, and the existing COTS architecture and contract, which already has shown a great deal of promise.

The function of this new launch vehicle niche, is to satisfy the extremely strict set of requirements for orbital launch, rendezvous and resupply, while simultaneously driving the nascent commercial launch vehicle industry upwards into the level of quality and rigor they will require, if they are expected to succeed in any future competitive launch vehicle market. Creation of a single goal and destination in the very first launch of this vehicle, will enable the entire spectrum of low to high end COTS solutions to quickly identify and resolve the necessary requirements and procedures of orbital launch operations, in an environment which is less strictly codified by NASA requirements, and which may reduce the technological burdens they must overcome in order to proceed into future success. This proposal is thus designed to fill a commercial space flight gap, using existing assets, with an entirely new architectural paradigm, which has only recently come into existence.

This proposal is being submitted only because an existing COTS contract competitor failed, and the lack of any other available engines with the performance levels necessary for commercial orbital space flight operations, has opened up an entirely new and novel launch vehicle niche, which now may immediately be filled by SSMEs – space shuttle main engines. It is hoped that in addition to initiating an influx of commercial investment capital into the commercial space transportation industry, a project of this genre will produce enough scientific and technological maturity to facilitate the development of second generation reusable engine designs and innovative reusable engine retrieval techniques.

It must be noted that operations and procedures developed here may also be applied directly to the upper stages of future high end, mainstream, two stage to orbit (TSTO) EELV COTS solutions. Ground started space shuttle main engine (SSME) core stages are also not incompatible with large solid rocket booster (SRB) or other hydrocarbon liquid reusable booster (LRB) assistance, as long as the core stage and the engine itself can achieve a stable orbit.

Indeed, that is the crux of the problem. Launch costs are expected to be fixed at or around a price of $100 million dollars per low earth orbit mission for any foreseeable future, and it appears that the primary method of increasing customer value will be in the area of performance and capabilities.

In an era of flat or increasing launch costs, dramatic and innovative methods and techniques must be invoked by launch operators in order to increase customer value, such as more passengers per launch, more cargo per launch, increased propulsion performance, or increased payload and mission utility.

Given that low earth orbit missions are highly variable, the sweet spot in launch vehicle architecture is expected to be a moving target, and at some point in the development cycle, a commitment has to be made to a single goal and purpose. The NASA COTS program provides a convenient starting point in this process - ISS service, resupply and presumably reboost. This is the minimum COTS requirement.

The **Problem**

SSTO to the N1 Limit

(Insert Orbiter Screen Shot Here)

(Intellectual Property Work Previously Performed)

Geometric considerations of conventional launch vehicle architectures yields a simple design spectrum, ranging from the ideal single stage to orbit rocket at one extreme, on to booster assisted SSTO cores, then to TSTO EELV systems, on to clustered TSTO solutions, ultimately leading to a large multistaged and clustered solution such as the Russian N1.

In the real world of launch vehicle architectures, all available indicators and metrics indicate a general migration towards the N = 1 limit, as opposed to the N1 limit, that is, towards single stage to orbit (SSTO) space flight, booster augmented single stage to orbit space flight, and to multistage solutions with N < 3, and clustered solutions with N < 10.

By looking critically at these architectures individually, one arrives at the astonishing conclusion that in 1973, the United States already had in its possession, a fine launch vehicle architecture, consisting of a TSTO Saturn II vehicle, composed of clustered J-2s in the first stage (The Saturn S-II), and a single J-2 in the upper stage (Saturn IV-B), easily capable of delivering an upper stage and Apollo capsule to an ISS equivalent orbit. The proposed J-2X of the ESAS architecture will have roughly 50% increased thrust and improved efficiency over existing J-2 engines of the era. Were it not for the cost of the engines (roughly $25 million dollars), a vehicle of this nature would, even after 35 years, remain as an interim solution to ISS transport, given that ESAS plans also include ten meter (10 m) core stages.

However, the ESAS architecture is still in development, ten meter core stages and J-2X engines do not yet exist, and the J-2s of the Apollo era have been retired and mothballed. Remarkably, ground started high performance regenerative cryogenic engines do now exist, have not yet been retired and mothballed, and are available for immediate use – the space shuttle main engines (SSME). Use of these engines was originally examined by the ESAS committee, and determined to be too costly to air start and use in an expendable manner. The only credible architectural position for these engines, is in a ground started single stage to orbit configuration, where the engines and core stages are carried to orbit, or in booster assisted stage and a half configurations of the same design, considerably easing the fuel - vehicle mass ratios required for single stage to orbit (SSTO) space flight.

Clearly the single stage to orbit and booster assisted stage and a half to orbit solutions are a credible alternative to the nearly and fully expendable ESAS solutions. Clearly also the decision to terminate Saturn II development and retire and mothball the original Apollo era J-2 engines was a mistake. On top of these concerns lies the urgent need for near term ISS transport and reboost, and the reentry and recovery of large and heavy orbital payloads, including reusable engines from upper and core stages used for low earth orbit transport.

As will be clearly shown in the following, the N = 1 (SSTO) solution also offers immediate market opportunities, well beyond the simple commercial delivery and recovery of payloads in LEO. There are capitalization opportunities above and beyond the traditional venture capital approach to space flight development, and there is the prospect of a uniting aspect of this one fundamental goal within the aerospace engineering community. That goal is conventional liquid propulsion in manned space flight.

The Existent Launch Vehicle Architecture Spectrum

Low End

The low end of the launch vehicle architectural spectrum consists of the numerous COTS competitors, the nascent commercial space industry and suborbital operators, with their creative variety of modest, but generally underpowered and unproven launcher designs. The previous round of COTS solicitation included many designs which never made it into the competition, and yielded unique systems ranging from unmanned and automated craft on existing launchers, to robust two stage winged and manned craft and/or space planes.

Mid Range

The mid range of the launch vehicle architecture spectrum consists of existing and promising, but still developmental - kerosene powered, turbopump fed, clustered and multistage solutions, epitomized by the Russian Soyuz and SpaceX – the Falcon 9. It is also fully expected that many of the now existent low end COTS competitors will eventually migrate into this new launch vehicle paradigm, driving costs down dramatically. Indeed, the scenario that I will present here will ultimately become dependent upon many such simple and cost effective launch vehicle architectures for future operational support.

High End

The high end of the launch vehicle spectrum consists of the many existing EELVs. Atlas V, Delta IV, including the Ariane V, H-2A, Long March and GSLV, and also commercial geosynchronous satellite launch operations using the Proton and the Zenit. All of these launch vehicle systems are intrinsically capable of delivering an upper stage and a medium sized and massed payload to low earth orbit (LEO).

Ultra High End

The ultra high end of orbital space operations consists of our existing nationally funded infrastructure – the ISS, STS, and the new, expensive and costly – Ares I. This is a unique and highly specialized set of assets, which may be immediately applied to the problem of commercial orbital space transportation system (COSTS) development.

Realities

Liquid powered launch vehicles have the lowest costs.
Smallest launch vehicles have the highest costs.
SRB assistance increases payload and costs.
Staging increases payload and costs.

Rationale

Complementary with existing midrange COTS solution.
Does not compete with numerous low end COTS solutions.
Does not compete with numerous high end EELV solutions.
Derived from proven high end components and technology.

Analysis (Intellectual Property Work Previously Performed)

Results

100-10-1 Rule

Payload fractions for typical idealized launch vehicles may be expressed in an easy order of magnitude manner known as the 100-10-1 rule, which reads as follows - 100 parts of fuel are required for 10 parts of vehicle to deliver 1 part of payload. This varies across fuels and architecture, but starkly delineates the problems facing orbital launch - the extreme gravity of the planet Earth.

In order to increase customer value in terms of dollars per kilogram, the entire rocket body and engine itself must become marketable payload, which is the primary motivation for single stage to orbit launch of large, rigid and pressurizable, cryogenic core stages into low Earth orbit (LEO), and indeed, also the upper stages of large modern liquid powered two stage to orbit (TSTO) launch vehicles – the EELVs. Along with the commercialization of high performance cryogenic and hydrocarbon based space flight, the concept of incorporating the launch vehicle into the mission in its entirety is my fundamental tenet.

Payload Fractions – System Elements

Launch Vehicle – Engine (Space Shuttle Main Engine)
Orbital Vehicle - Core Stage (Cryogenic Tankage and Plumbing)
Reentry Vehicle - Nose Cone and Aero Shield (Payload Fairing/Shroud)

Clearly the payload fractions, volumes and masses can be greatly improved with SSTO launch, dramatically increasing performance and capabilities of $100 million dollar launch vehicle missions.

Launch Vehicle Architecture Result

SSME - Space Shuttle Main Engine
SSTO - Single Stage To Orbit
RLV - Reusable Launch Vehicle

Vehicle Mission Architecture Result

CELLS - Closed Environmental Living and Life Support

Resupply
Habitats
Residuals
Consumables

Earth Science
Space Science
Space Tourism
Space Solar Power

(Insert Orbiter Screen Shot Here)

National Assets

STS - Space Transportation System (assets soon to be retired.)

ISS - International Space Station
EELV - Evolved Expendable Launch Vehicles
SSME - Space Shuttle Main Engines
COTS - Commercial Orbital Transportation Services
NASA – National Aeronautics and Space Administration

National Participation

ULA* - United Launch Alliance* - Personnel and Service
USA* - United Space Alliance* - Personnel and Service
NASA* - National Aeronautics and Space Administration* - Funding

Industry Participation

(Insert) - Critical Enabling Technologies Partner

Pratt & Whitney* (P&W) – Propulsion Contractor
The Boeing Company* – Structures Contractor

(Insert) – Integration Partner
(Insert) – Launch Partner
(Insert) – Mission Partner

Ground Infrastructure

Florida – Kennedy Space Center - Space Florida*
Wisconsin - Port Washington – Wisconsin Aerospace Authority*
Bahamas - Shallow Water Payload Recovery (or any number of other possibilities)

Business Plan

Development Phase - One Launch Per Year
Operational Phase - One Launch Per Month
Commercial Phase - One Launch Per Week

Technical Approach

Design
Salvage
Manufacture
Integrate
Test
Launch
Mission Control

Initial Mission – Payload Launch, Rendezvous, Docking, Transfer, Reentry and Recovery*

Vehicle Design

Critical Problems

SSME Starting System*
SSME Auxiliary Power Unit*
SSME Valve/Gimbal Hydraulics*

Volatile (OMS) Orbital Maneuvering System (Volatile)*
Nonvolatile (OMS) Orbital Maneuvering System (Nominal)*

Critical Solutions

Fuel Cell Power*
Auxiliary Power Unit*
Electric Hydraulic Valve and Gimbal Actuation*

Auxiliary Power Unit Venting*
Cryogenic (OMS) Orbital Maneuvering System*
Post Launch Active Volatile Venting and System Repressurization*

System Components

Forward Reentry Vehicle

Retro Escape Package
Nose Cone Aero Shield

Attitude Control System
Launch Avionics
Flight Avionics
Batteries
Parachutes
Airbags
Landing

Docking Node
Payload Capsule
Payload Interface

Nose Cone Aero Shield Interface
Blast Shield
Cryogenic Tank Docking Interface

(Insert Orbiter Screen Shot Here)

Center Orbital Vehicle

Stretched Upper Stage
Attachment Points

Fueling System
Draining System
Purging System
Venting System
Pressurization System

Antiicing System*
Deicing System*

(Insert Orbiter Screen Shot Here)

Propulsion Structure

Aft Shroud
Aft Structure
Thrust Structure

Fuel Cell System*
Auxiliary Power Unit*
Electric Hydraulic System*

Space Shuttle Main Engine

Gimbaling, Plumbing, Valves and Residuals*
Pressurization System*
Starting System*

Consumables

Vehicle Payload Integration
Fueling System
Launch Pad

Launch Operations
Flight Operations

Mission Control

Launch Avionics
Flight Avionics

Volatile Orbital Maneuvering (Volatile)*
Nonvolatile Orbital Maneuvering (Nominal)*

Sun Shade (Passive Thermal)
Thermal Radiators (Active Thermal)

Batteries (Electrical)
Solar Panels

Robotic Arms (Mechanical)
Docking Nodes

Space Suits (Environmental)
Inflatable Habitats

Training
Simulation
Research and Development

Second Generation Engine Development (Pratt & Whitney*)**

Channel Wall Nozzle Technology (Volvo*)**

IPD - Integrated Propulsion Demonstrator**

Deep Throttling Capability**

* - Critical Mission Enabling Technologies

** - Future Mission Enabling Technologies

(Insert Orbiter Screen Shot Here)

Section II
Business Plan (Full)

B1. Company Information

A. Business Strategy

The participant shall describe the core aspects of its business strategy that will enable it to be successful in this market.

The core aspect of the business is to leverage the payload fraction of any launch vehicle architecture by design, in order to reduce launch costs by an order of magnitude over existing systems, and to create new markets well beyond basic COTS requirements, by delivering the nose cone, core stage and engine of the launch vehicle to orbit, in single stage to orbit configuration, booster assisted only if necessary.

B. Market

The participant shall define and describe the market to which it will provide products and services, including size, growth rate, target customers, and needs of these customers. The market can include customers other than NASA. Where appropriate, the market can be segmented into smaller sections for clearer analysis.

This proposal only establishes the NASA COTS proposal contract requirements as its initial market.

In addition to providing rigid and reboostable mounting space for solar power satellites and other space facility operators, the author intends to capitalize upon the initial launch itself, primarily via media productions such as three dimensional simulation and gaming, feature length films and high definition television, celebrity guest entertainment, speaking engagements and music. A vast market exists for astronomy, science and space exploration, given the necessary dynamic leadership. I am that leader.

C. Products and Services

The participant shall describe in a product roadmap the attributes of the products and services that it will provide to its targeted market and the timing for the introduction of these products and services.

This proposal establishes the goal of an initial flight attempt during the fiscal years 2010 through 2012.

D. Competitor Analysis

The participant shall describe the strengths and weaknesses of competitors in the chosen markets.

This proposal intends to be cooperative to the competitors in the existing markets, since the goal of this proposal is the final commercialization of the space transportation industry in low earth orbit (LEO). This launch vehicle architecture is designed to encourage rather than compete with the participants.

E. Marketing and Sales

The participant shall describe the plan for marketing and selling company products and services to targeted markets.

If you build it, they will come. What I intend to do is sensationalize space flight with a single launch.

F. Governance Structure

The participant shall provide information on the decision-making structure that impacts the business' continuation in future years. For public companies, this will include financial-return expectations. For private companies, this will include the composition of the board of directors as well as an explanation of corporate covenants that impact the decision-making process.

The corporation is specifically organized to allow intellectual and financial partners and participants to sit on the board of directors. The director of the board wishes this endeavor to be cooperative, and will assert no ultimate control of the business direction. The corporation is set up as 100 percentage shares of ownership, and the author claims a single share – all of them. The director wishes to trade and sell these shares to participants and investors in the endeavor of single stage to orbit cryogenic space flight.

G. Management Team

The participant shall identify its top level management team and key personnel for this effort, including a description of the reporting structure, biographical information, history of relevant experience and business ventures, and professional references for each.

The author of this proposal is a private citizen of the United States of America, owning a registered intellectual property corporation in the State of Wisconsin, which he intends to invest in a COTS effort.

H. Finance

The participant shall provide a financial plan that is consistent with Sections A through G listed above. The participant shall describe future financing events required to achieve positive cash flow including the timing, amount, structure and sources. The participant shall also describe any other material information that will impact future financing events, including but not limited to litigation, convertible debt provisions, sale-lease back covenants, and preferred stock terms.

The proposal contract is self explanatory, the author intends to attempt single stage to orbit space flight for a full contract value of approximately $174 million dollars, using an initial 10 percent payment of $17.4 million dollars for feasibility and development studies, critical enabling technologies research and the design work required for a single successful launch, rendezvous and reentry mission attempt.

The participant shall discuss the amount and phasing by fiscal year of funding necessary from NASA to execute the financial plan. Recognizing the funding allocated to a participant is solely at NASA's discretion, the participant shall describe the sensitivity and impacts to their financial plan should the amount or phasing offered by NASA be more or less than proposed.

Fiscal Year 2008 – Twenty Percent (20%) of the Contract Value - $34.8 Million Dollars

Fiscal Year 2009 – Forty Percent (40%) of the Contract Value - $69.6 Million Dollars

Fiscal Year 2010 – Forty Percent (40%) of the Contract Value - $69.6 Million Dollars

Fiscal Year 2011 – None

Fiscal Year 2012 – None

There are no contract sensitivities beyond the failure of the proposal, contract or vehicle demonstration.

The following annotated statements consistent with the financial plan described above shall be provided in Appendix 2: Supplemental Business Data:

1) Historical income statement (prior three years or life of the company, whichever is shorter)

2) Historical sources and uses of cash (prior three years or life of the company, whichever is shorter)

3) Historical balance sheets (prior three years or life of the company, whichever is shorter)

4) Historical statements of stockholder's equity (prior three years or life of the company, whichever is shorter

5) Historical financing events including notations explaining material terms that impact valuation or future financing events

(Company Information Deleted) is an intellectual property corporation, which solely represents the intellectual property interests of its director - Thomas Lee Elifritz, and has no previous or historical financial activity - being a purely intellectual endeavor.

6) Pro forma income statement (looking forward five years)

7) Pro forma sources and uses of cash (looking forward five years)

8) Pro forma balance sheet (looking forward five years)

9) Pro forma statements of stockholder's equity (looking forward five years)

10) Future financing supporting documentation (i.e., signed term sheets, letters of commitment or interest, investor contact information, etc.)

For annotated statements 6) Pro forma income statement and 7) Pro forma sources and uses of cash, the NASA COTS phase 1 funding shall be treated as a source of cash from financing and shall not be treated as revenue, as other income or as a net against R and D expenses. NASA COTS phase 2 funding shall be treated as revenue.

B2. COTS Development and Demonstration Plan

A. Plan and Schedule

The participant shall provide a plan and schedule for developing and demonstrating the capability(ies). Include a discussion of programmatic risks and strategies to mitigate each risk.

The proposal allows for a single initial launch attempt during the fiscal years 2010 through 2012. Facilitation of this goal requires six months of model and design verification and six months of design before a decision to proceed can be assessed. After a decision to proceed is made, two additional years are required for hardware fabrication, assuming that space shuttle main engines will not be available until fiscal year 2011. A full year will be invested in an initial demonstration flight, and after a successful demonstration flight occurs, another year of operational development before a second flight. This takes the program through the fiscal year 2012, which effectively makes it a five year program.

B. Resources

The participant shall describe key resources such as personnel, facilities and other assets, including intellectual property currently owned and yet to be obtained. The use and/or need of government resources as described in Section 4.9 of this announcement shall be provided in this section of the proposal.

The proposal contract requires the use of existing space shuttle main engines on an existing space shuttle main engine maintenance contract, and an existing Ares I upper stage development contract.

In order for early satisfaction of the proposal contract, the author may require the use of both United Launch Alliance assets and services and United Space Alliance assets and services located at the cape.

C. Teaming Arrangements

The participant shall describe teaming arrangements including respective roles and contributions to the project. A list of all partners and suppliers shall include name, address, country of incorporation, and contact name and phone number. Provide a brief description of any previous experiences working with these partners and suppliers. If foreign participation is included in the proposal, the participant shall describe the critical elements of the foreign content, an assessment of supplier risks, and any alternatives or mitigation of the identified risks.

The teaming arrangements have been discussed in the summary, and consist of launch vehicle architect, a critical enabling technologies partner, an integration contractor, and launch contractor and a mission contractor, in addition to the two primary propulsion and structures contractors, Pratt and Whitney* and Boeing*. The author of this proposal is a private citizen of the United States of America, possessing a dormant intellectual property corporation registered in the State of Wisconsin, and has no prior work history with the preferred named and unnamed partners* and contractors* mentioned in this proposal.

D. Performance Milestones

The participant shall provide a proposed schedule of performance milestones for the Capability A, B, and/or C cargo demonstration including descriptive title, objective success criteria, rationale, and planned achievement dates (month and year). Milestones should represent the progress of significant technical and business development events in the demonstration program. At least one milestone per calendar quarter should be proposed. The milestones described here shall also be included within the proposed SAA submitted in Appendix 1 of the proposal with payment amounts left blank. Upon selection of a participant, NASA will negotiate *specific payment amounts for the identified milestones. A separate schedule of milestones shall be provided for the Capability D, Crew Transportation, if proposed.*

Proposal contract milestones by quarter and fiscal year are as follows :

2008 – Analysis and Design

- 1/08 – Proposal and Contract Acceptance
- 2/08 – Initial Propulsion Modeling and Analysis
- 3/08 – Initial Structures Modeling and Analysis
- 4/08 – Initial Integrated Design Verification – Decision to Proceed

2009 – Design and Manufacture

- 1/09 – Propulsion Structure
- 2/09 – Cryogenic Core Stage
- 3/09 – Nose Cone Reentry Vehicle
- 4/09 – Launch Pad, Mission Control and Payload

2010 – Manufacture, Integration and Test - SSME Availability

- 1/10 – Propulsion Structure
- 2/10 – Cryogenic Core Stage
- 3/10 – Nose Cone Reentry Vehicle
- 4/10 – Launch Pad, Payload and Mission Control

2011 – SSME Availability - Integration, Test and Initial Demonstration Flight

- 1/11 – Propulsion Structure
- 2/11 – Cryogenic Core Stage
- 3/11 – Nose Cone Reentry Vehicle
- 4/11 – Launch Pad, Payload, Mission Control and Launch

2012 – Initial Development Flights and Operational Procedures Development

- 1/12 – Propulsion Structure
- 2/12 – Cryogenic Core Stage
- 3/12 – Nose Cone and Reentry Vehicle
- 4/12 – Launch Pad, Payload, Mission Control and Launch

B3. COTS Operational Readiness Plan

The participant shall describe their approach to offer operational COTS services including the most likely, best case, and worst case operational readiness date, with assumptions.

This proposal offers two limiting approaches to contract satisfaction and operational readiness - the small business approach, and the large corporation approach, acknowledging that the actual final result may fall somewhere between these two extreme limiting cases. The small business approach assumes minimal involvement with NASA and its traditional suppliers and contractors, beyond the necessary involvement of the primary propulsion and structures contractors, Pratt and Whitney* and Boeing*. The large corporation approach assumes the maximal involvement with NASA and its traditional contractors and suppliers, in particular, United Space Alliance* and United Launch Alliance*.

The large corporation approach yields a contract satisfaction and operational readiness on the early side of the contract window, running from fiscal years 2010 through 2012, and the small business approach yields contract satisfaction and operational readiness dates near the late side of the contract window.

Best case scenarios deliver an initial test flight in fiscal year 2010 based upon the assumption of NASA and industry cooperation, and worst case scenarios deliver an initial test flight in the fiscal year 2012.

B4. Compliance

The participant shall describe compliance with eligibility requirements and applicable federal laws, regulations, and policies specified in sections 4.2 and 4.3. Participants that intend to rely on Russian suppliers for their COTS system shall explain how they would provide service capability after December 31, 2011, when the relief from the ISNA prohibition expires.

The author of this proposal is a citizen of the United States of America, in possession of a dormant intellectual property corporation registered in the State of Wisconsin, and has a vested interest in the welfare of the nation. Clearly the author intends to operate within the existing laws which govern any citizen or corporation, and any constitutional protections afforded to citizens of the United States.

B5. Cost and Price Information

The participant shall complete the following cost and price templates and provide them in Appendix 2 of the proposal,

Template C1 - Proposed Government Services, Facilities or Equipment

(Insert)

SSME - Space Shuttle Main Engines, KSC SLC Launch Pad and Range

Template C2 - Total Cost by System

(Insert)

Critical Enabling Technologies **Contract** - $17.4 Million Dollars

SSME Purchase -	$60 Million Per **Engine** (estimated, cost was not provided by NASA)
SSME Service -	$20 Million Per **Mission**
Core Stage -	$40 Million Per **Vehicle**
Integration -	$20 Million Per **Payload**
Launch -	$20 Million Per **Launch**
Total -	$177.4 Million **Dollars**

Template C3 - Phased Cost by Function

(Insert)

Critical Enabling Technologies Contract	- $17.4 Million Dollars
Decision to Proceed	- $34.8 Million Dollars
Initial Mission Demonstration	- $174.0 Million Dollars

Template C4 - Projected Operational Prices for Capabilities A, B, C

(Insert)

$100 Million Dollars Per Mission (Costs are flat, capabilities increasing over time)

Template C5 - Projected Operational Prices for Capability D

(Insert)

$100 Million Dollars Per Mission (costs are flat, capabilities increasing over time)

The information provided in the templates shall be consistent with the financial information requested in Section 5.2.3.B.1.H.

Section III

Technical Approach (Full)

This section shall describe the participant's proposed approach for their system concept, performance specifications, mission compatibility, development, manufacturing, test and verification, ISS certification, human rating certification, technical risks, safety, and mission assurance. Participants are asked to propose concepts that comply with the ISS interface requirements and satisfy as many of the performance goals as possible discussed in Section 3.0 of this announcement. Where those ISS interface requirements and/or performance goals cannot be satisfied, the proposal shall clearly articulate the limitations where and why they cannot be met. Innovations and efficiencies should be discussed throughout this section where appropriate. The subsections of the technical section are as follows:

T1. System Concept and Summary of Performance

The participant shall describe the space transportation system architecture, capabilities, features, system & performance specifications, and concept of operations for the targeted capabilities. Include technical description of the Phase 1 demonstration plan.

This commercial orbital space transportation system (COSTS) consists of a launch vehicle architecture composed of space shuttle main engines (SSME) in simple single stage to orbit (SSTO) configuration. The launch vehicle architecture consists of two components, the core stage, and a nose cone aero shield. Each component will function independently as orbital rendezvous vehicles, and additionally, the core stage will dock with the space station, deliver and retrieve payloads, and reboost using residual fuel, and the nose cone aero shield is heat protected, and can function as a large volume payload reentry vehicle, and emergency lifeboat for space station rescue and evacuation, with primarily water landings. It is expected that future manned variations of this same design will incorporate booster augmentation, and scale into payload capacities expected for modern commercial orbital space transportation systems.

T2. Mission Compatibility and Performance Analysis

The participant shall describe the space transportation system's compatibility with the targeted COTS Service Reference Mission (SRM) and associated requirements described in the COTS ISS Service Reference Document (CI-SRD) and the applicable COTS ISS Interface Requirements Document (IRDs), SSP 50808 and/or SSP 50832. Include discussion of the variances and technical work required to transition from the Phase 1 Demonstration project to the Phase 2 fully operational space transportation service for the ISS.

This basic launch vehicle architecture is expected to evolve into a fully NASA COTS compatible commercial orbital space transportation system (COSTS), at a well known and quantifiable fixed cost. Since the actual cost of operation of this system is unknown at this time, this contract is for the fixed cost of a single demonstration mission, which pending future financing, must remain at its full value.

T3. Development

The participant shall describe the elements of the system that are either already operational or commercially available and elements that are under development or to be developed, including an indication of the Technology Readiness Level (TRL) for each of those elements. Information associated with TRL definitions is provided in the COTS website Technical Library.

Clearly space shuttle main engines exist, are operational, and technologically ready for the first attempt at single stage to orbit space flight. Delta IV common booster cores exist, are operational, but do not yet have the structural efficiency for single stage to orbit space flight, as they are too heavy. Much preliminary work has already been performed on the Ares I upper stage, which does not yet exist, and is not in the necessary configuration for ground launch, but already approaches the structural efficiency necessary for single stage to orbit space flight. It is this author's assertion that the structural efficiencies necessary for SSTO space flight are now technologically achievable in friction stir welded Al-Li alloys.

This author's contribution is to note that the geometry of the nose cone aero shield is of the shape necessary for aerodynamic reentry, and also fortuitously of the geometry necessary for the eventual return of the expensive and reusable space shuttle main engines from orbit – a shipping container. Although initially extra payload deliverable to the space station is somewhat limited, it is enough to demonstrate the capabilities of such a system. Human rating is possible, and with modest hydrocarbon booster augmentation it is expected that such an architecture could evolve into a fully manned system. A primary limitation to human rating is the 67% throttle limit of the SSME, and terminal acceleration, which, depending sensitively on the actual flight profile, can be quite high - in the range of eight gees. This limitation may be overcome in the short term by water cushioned seats, but ultimately will benefit with second generation reusable engine designs, channel wall nozzles and deep throttling capabilities.

For development elements, describe work completed to date including modeling results, prototypes, sub-component tests or any other relevant work pertaining to the proposed system. Also describe the technical approach for bringing the concept in its current state to a full scale prototype system ready for demonstration flights to the orbital test bed.

The launch vehicle design is a clean sheet design already benefiting from existing Ares I upper stage development work, which allows for quick implementation from off the shelf components and shuttle salvaged hardware. The technical approach is design, salvage, manufacture, integrate, test and launch, across the primary elements of the vehicle - propulsion, structures, systems and initial launch mission.

T4. Manufacturing

The participant shall describe the approach for manufacturing the elements of the space transportation system in support of flight demonstration(s).

The author of this proposal has already selected primary integration contractors, with complete latitude in the integration, test and launch of the vehicle. The propulsion and structures contractors are fixed.

T5. Test and Verification

The participant shall describe the approach for testing and verifying the performance of the space transportation system before initial operational capability.

The SSME flight model will be calibrated against known NASA flight data from over 350 flights. Solution closure reduces to a simple exercise in mass of the system required to perform the mission.

T6. COTS ISS Certification and Orbital Test Bed Integration

The participant shall describe the proposed approach for verifying and certifying that their COTS system can safely visit the ISS orbital test bed. Identify any ISS visiting vehicle requirements in the ISS interface requirements (i.e. SSP 50808 and/or SSP 50832) identified in Section 3.0 of this announcement that the participant proposes to deviate from and the rationale for each. The participant shall describe the COTS ISS integration impacts to NASA including hardware/software design and operations (such as pre-flight installation of docking targets or communications equipment). If an alternative orbital test bed is proposed, the participant shall describe how it will simulate the vehicle interfaces described in the ISS IRDs (SSP 50808 and/or SSP 50832), its limitations, and how it will be used in the demonstrations.

The design of this vehicle as two free flying elements, allows for all aspects of the loiter, rendezvous, approach, docking, payload transfer and departure to be fully characterized, independent of the ISS.

T7. COTS Human Rating Certification (Capability D only)

This content applies only to participants proposing the Capability D demonstration. The participant shall describe the proposed approach for certifying that the COTS system meets the requirements for flight of NASA crew. Identify any NASA Human Rating requirements the participant proposes to deviate from and the rationale for each. (Note: Although highly desirable, participants are not required to be NASA human-rated prior to flying a commercial crew.)

There is virtually no way to certify an eight gee terminal acceleration, you just have to prepare for it. Unless a method is discovered of lowering the throttle stop on the SSME, boosters may be required.

This proposal defers to a well positioned COTS competitor and EELV operators, for manned support in the initial stages of operational development. The entire thrust of this mission is to unite existing elements of STS, ISS, EELV and Ares, with an existing COTS contract already under development.

T8. Technical Risks

Describe the technical risks associated with the effort and include the risk level (low, medium, or high) along with a strategy to mitigate each risk.

At the top of the risk pyramid sits the ultimate goal of this proposal - single stage to orbit space flight. The primary barrier to cryogenic SSTO space flight is the performance of the engine, which in the case of the SSME is fixed, and the structural efficiency, rigidity and thermal behavior of the cryogenic core stage, given the aggressive fight profiles inherent to high performance engines. In this particular case, the author has a viable 'Plan B', in event of a failure to close a SSTO mass performance solution, in order to prevent the collapse of the program because of the failure of the solution. That 'Plan B' is to augment the liftoff thrust of the core stack with modest hydrocarbon based boosters, which in this case resemble something which already exist : the SpaceX - Falcon 1 and 9 first stages - small, lightweight hydrocarbon boosters. Development of single stage to orbit performance specifications can therefore proceed without the anxiety of a catastrophic failure of the program, from fundamental technical issues related to single stage to orbit space flight, and the associated stigma of this endeavor. All other aspects and issues of this launch vehicle architecture may be easily solved by straightforward engineering.

(*The following paragraph was deleted from the original proposal as a test for the review committee.*)

Complementary to mass as a dynamical metric for launch vehicle performance is acceleration. Most high performance cryogenic engines have throttle limits that dictate final terminal acceleration levels, and the core stages and engines have mechanical and structural limits which restrict their performance. Fundamental problems in rocket science revolve around pushing these limits upwards for efficiency, or engineering around those limits via deeper engine throttling capabilities or higher structural efficiencies through pressurization of the core stage. Multi-engine cluster configurations allow these problems to be overcome by sequential engine shutdown at the expense of mass efficiency, which improves safety by providing a measure of engine out capabilities, demonstrating the tightly coupled synergy between the scientific nature of the technical problems of launch vehicle design, and the final engineering solutions. Thus the need for hydrocarbon booster augmentation is implicit with any SSTO development program.

T9. Safety and Mission Assurance

The participant shall describe the approach for safety (range, ground, flight, etc.), reliability, maintainability, supportability, quality, software assurance, and risk management. The discussion may include S&MA organization including subcontractors, processes, tasks and products. If the participant plans to operate on a NASA facility, the participant shall describe how they plan to meet NASA facility safety requirements as described in the NASA Facility Safety Requirements document provided in the COTS website Technical Library.

A first launch demonstration of an entirely new launch vehicle design from Cape Canaveral, with potentially millions of live viewers, in a historically significant event, is undoubtedly problematic.

The primary concern is that debris falls be limited to the launch site in the event of catastrophic failure, or limited to the oceans, in the event of premature or unanticipated deorbit and reentry of the vehicles.

Section II
Business Plan (Brief)

The first attempt at single stage to orbit (SSTO) cryogenic space flight will by itself be a monumental and historic event, and many will reject this idea at first glance, claim it is impossible, or ridicule it.

For such a project to proceed into quick success, requires a leadership able only to withstand the severely harsh punishment of natural laws. Since no such leader exists, I have accepted that challenge.

B1 - **Company Information**

The author and director is a self taught naturalist with a solid post Sputnik era education, possessing a very early training in machine shop, metal forming and welding technologies, and has been actively engaged and involved in the pursuit of pure and applied scientific knowledge of a significant nature, across a wide variety of interdisciplinary fields and domains, within the life sciences, earth sciences, space sciences and the natural sciences.

(Company Information Deleted), is a dormant corporation registered in the State of Wisconsin, in the United States of America (USA), as a commercial entity representing the intellectual property of its sole director – Thomas Lee Elifritz, the author of this development proposal, and director of this developmental effort. This proposal itself, upon its acceptance, now effectively represents the published intellectual property of the author.

This proposal is also evidence of credibility in launch vehicle architecture, since booster augmentation will easily close the mass performance solution for SSTO space flight of the ground started SSME cores into orbit. This proposal is an attempt to commercialize high performance, turbopump fed, reusable, ground started, cryogenic engines, which already exist, and may easily be pressed into commercial unmanned service, allowing second generation reusable engine development to proceed, independent of political direction.

B2 - **COTS Development and Demonstration Plan**

The plan is simple. Take existing assets, contracts and some future contract offerings, and convert them into a new rocket, consisting of a ground started space shuttle main engine, complete with auxiliary power, pressurization and starting system, a structurally sufficient cryogenic stage, and a nose cone fitted as a docking and reentry test article, and launch it to the international space station. The large reservoir of engines virtually ensures that the contract can be completed satisfactorily through the year 2016. The launch attempt itself will draw worldwide attention, and will be an almost immediate source of unconventional marketing and promotional revenues, and a business case can easily be made for complete reimbursement of development funds with active revenue streams on the very first launch.

B3 - **COTS Operational Readiness Plan**

Clearly such a direct and simple launch vehicle architecture may be declared operational upon the safe return, recovery and reuse of the first intact and working space shuttle main engine from orbit.

B4 – **Compliance**

The contract will be considered out of compliance if the success criteria are not met, or if the initial demonstration flight undergoes catastrophic loss of vehicle, or fails to reach orbit or rendezvous.

B5 - **Cost and Price Information**

Initial Contract Costs

Critical Enabling Technologies **Contract** - $17.4 Million Dollars

Initial Demonstration Flight Costs

SSME Purchase -	$60 Million Per **Engine** (estimated, no cost was provided by NASA)
SSME Service -	$20 Million Per **Mission**
Core Stage -	$40 Million Per **Vehicle**
Integration -	$20 Million Per **Payload**
Launch -	$20 Million Per **Launch**
Total -	$177.4 Million **Dollars**

(Already we're $3.4 million dollars over budget!)

External Funding Required – $3.4 Million Dollars

Typical Initial Developmental Launch COSTS - $100 Million Dollars Per Typical Mission (Flat)

Typical Second Generation Launch Vehicle Development Budget - $1.74 Billion Dollars (Golden)

Section III

Technical Approach (Brief)

T1 - **System Concept and Summary of Performance**

This launch vehicle system and performance is severely constrained by engine design.

T2 - **Mission Compatibility and Performance Analysis**

This vehicle must be flown off the pad at the maximum rated SSME thrust of 109% power.

T3 – **Development**

The mass to performance solution must be closed to allow single stage to orbit operation.

T4 – **Manufacturing**

The establishment of a Midwest manufacturing base will augment existing capabilities.

T5 - **Test and Verification**

Test and verification will be performed by the integration, launch and mission contractors.

T6 - **COTS ISS Certification and Orbital Test Bed Integration**

All COTS capabilities will be demonstrated on orbit before any actual ISS rendezvous.

T7 - **COTS Human Rating Certification** (Capability D only)

Terminal acceleration is too high for normal human flight with this vehicle, thus human rating will be deferred until second generation reusable engines are available. However, passenger flights are survivable in the flight profiles expected for such a vehicle design, which virtually ensures that passengers will eventually be flown on this particular vehicle.

T8 - **Technical Risks**

The primary technical risk involves closing the mass performance solution for single stage to orbit (SSTO) space flight. An upper stage powered by an SSME already comes very close to the solution.

T9 - **Safety and Mission Assurance**

Flight profiles are somewhat lofted, so there is potential for onshore debris falls. However, cryogenic fuels in aluminum alloys are quite volatile, and toxic volatiles will be avoided. The greatest potential for danger lies in the massive SSME main block and turbines, and, of course, collision with the ISS. Flight avionics and COTS mission capabilities are thoroughly vetted on orbit before ISS operations.

Appendix I

Proposed Space Act Agreement (Brief)

COSTS

The Golden Rule

Multiply your costs by 10.

In accordance with the launch vehicle architectural philosophy set forth in the above document, the $174 million dollar NASA COTS contract, if awarded, shall be distributed to the principles of this proposal, with (1) one percent being set aside for the principle (The Director), of the (10) ten percent set aside for the critical enabling technologies contractor (you may insert contractor name here), of the (100) one hundred percent set aside for the launch vehicle principles, Pratt and Whitney* and Boeing*. The principle portion of the contract itself will evenly be split between (P&W) Pratt and Whitney*, for an extension on the (SSME) Space Shuttle Main Engine maintenance contract, and the delivery of a functional (SSME) space shuttle main engine for the initial demonstration flight, and to Boeing*, for the delivery of a modified and stretched or reduced (Ares I/Delta IV) type booster stage for the initial demonstration flight, which occurs soon after STS retirement.

The Launch Vehicle Principles

Thomas Lee Elifritz - Director

(Insert) - Critical Enabling Technologies Partner

Pratt and Whitney - Rocketdyne* - Space Shuttle Main Engine Contractor
The Boeing Company* - Upper Stage Hardware Contractor

(Insert) – Integration Partner
(Insert) – Launch Partner
(Insert) – Mission Partner

The role of small businesses in this proposal will be the payloads portion of these vehicles, the setup and formation of space operations corporations, which can interact cooperatively with the nascent orbital launch and payload industry, with an existing COTS contractor, and with the principles of the presumably burgeoning future market of commercial and national high end and foreign upper stage equipment operators, and including, of course, the National Aeronautics and Space Administration - **NASA**.

Appendix 2

Supplemental Business Data (Brief)

Historical income statement (prior three years or life of the company, whichever is shorter)

Historical sources and uses of cash (prior three years or life of the company, whichever shorter)

Historical balance sheets (prior three years or life of the company, whichever is shorter)

Historical statements of stockholder's equity (prior three years or life of the company, whichever is shorter)

Historical financing events including notations explaining material terms that impact valuation or future financing events

(Company Information Deleted) is an intellectual property corporation, solely representing the intellectual property interests of its **Director** - Thomas Lee Elifritz, and has no previous or historical financial activity - being a purely intellectual endeavor.

Articles of Incorporation

Article 5

(Company Information Deleted) shall consist of 100 percentage shares of ownership, belonging to Thomas Lee Elifritz – Director of Research.

Any or all of the percentage shares of (Company Information Deleted) may be sold or traded as capital shares, at a price determined by the market.

Article 10

The board of directors of (Company Information Deleted) shall consist of owners of percentage shares.

Pro forma income statement (looking forward five years)

Pro forma sources and uses of cash (looking forward five years)

Pro forma balance sheet (looking forward five years)

Pro forma statements of stockholder's equity (looking forward five years)

Future financing supporting documentation (i.e., signed term sheets, letters of commitment or interest, investor contact information, etc.)

Bigelow Aerospace* Proposal :

$760 Million Dollars For Eight Possible Development Launches

$100 Million Dollar Possible Down Payment

IPO - Industry Proposal Outline (Brief) - November 21, 2007 – February 2, 2008

Deal : Stock Trade - 20% (Critical Enabling Technologies, Integration, Launch or Mission)
Principle offers up to an additional 19% for IPO and industry or small business participation.

Preferred Primary Propulsion Contractor – Pratt and Whitney* – West Palm Beach, Florida
Preferred Primary Structures Contractor – The Boeing Company* – Chicago, Illinois

Small Business Approach

Preferred Critical Enabling Technologies Partner

Orbitec* – Orbital Technologies Corporation* - Madison, Wisconsin - Eric Rice*

Preferred Integration Partner

Orion Propulsion, Inc.* – Madison, Alabama - Tim Pickens*

Preferred Launch Partner

SpaceX* – Space Exploration Technologies* - El Segundo, California - Elon Musk*

Preferred Mission Partner

Bigelow Aerospace* – Las Vegas, Nevada - Robert Bigelow*

Large Corporation Approach

Preferred Critical Enabling Technologies Partners

Orbitec* – Orbital Technologies Corporation* - Madison Wisconsin - Eric Rice*
Orion Propulsion* – Madison, Alabama – Tim Pickens*

Preferred Integration Partners

Pratt and Whitney* – West Palm Beach, Florida
The Boeing Company – Chicago, Illinois

Preferred Launch Partner

United Launch Alliance* – Denver, Colorado

Preferred Mission Partner

United Space Alliance* – Houston, Texas

* - For guidance only. No participation, partnerships, contracts or agreements of any kind are implied with any of the corporations or the individuals listed in this COTS proposal.

List of Acronyms

IPO – Industry Proposal Outline

USA – United States of America

NASA – National Aeronautics and Space Administration

JSC – Johnson Space Center
KSC – Kennedy Space Center
SLC – Space Launch Complex

STS – Space Transportation System – Space Shuttle
ISS – International Space Station

USA – United Space Alliance
ULA – United Launch Alliance

COTS – Commercial Orbital Transportation System
COSTS – Commercial Orbital Space Transportation System

SSME – Space Shuttle Main Engine
SSTO – Single Stage To Orbit
RLV – Reusable Launch Vehicle

LEO – Low Earth Orbit
OMS - Orbital Maneuvering System
CELLS - Closed Environmental Living and Life Support

ELV – Expendable Launch Vehicle
TSTO – Two Stage To Orbit
EELV – Evolved Expendable Launch Vehicle

VSE – Vision For Space Exploration
ESAS – Exploration Systems Architecture Study

SRB – Solid Rocket Booster
LRB – Liquid Reusable Booster