# SPACE BILLETS

## How to Fund Manned Lunar Missions with Current NASA Budget

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Douglas G. Thorpe[1],
Co-Founder: http://theusaparty.com
Member: Space Propulsion Synergy Team: http://spacepropulsion.org

## Abstract

**This is a companion paper to a series[i] of papers by the Space Propulsion Synergy Team that are entitled, "*Affordability Advantages in Integrating the Aircraft and Space Launch Operations*[ii]." In that companion paper, we show how 20,000 lb payloads or 3 astronauts may be delivered to Low Earth Orbit (LEO) at a marginal cost of less than $2M at a very high flight rate of 250 flights per year. Herein a method is provided to establish commercial space markets that will provide extremely low cost access to Low Earth Orbits as well as lunar missions and beyond. The world-wide commercial space industry is only a $2B market that consists of only 26 launches per year by several launch service providers. The desire for a high success rate in a low frequency market all but eliminates major innovations. Such a tiny market and limited opportunity also all but eliminates a good business case for an entrepreneur to pitch to investors for a new launch vehicle. To make matters worse, non-commercial (government) space programs are funded by Cost Plus 9% Fixed Fee, which encourages greater spending and discourages innovations. To cultivate a robust space industry that will eventually reduce the dependence upon government funding, we propose the US government establish a guarantee flight rate system we refer to as Space Billets. The Space Billets would not alter the Supply-Demand curve with an artificial price ceiling, but merely guarantee a large flight rate (250 to 750 flights per year) if ANY launch service providers could meet the price target of $20M per 10 tons (or 3 astronauts) to LEO. We expand the definition of Space Billets to fund manned missions to the moon and beyond. We show that the investment of $3.6B per year for 10 years in Space Billets would not only provide 200 astronauts on the moon, but remove all large space debris from earth's orbit. It is hoped that once a launch service provider can meet the price targets, commercial customers (space tourists, solar satellites, etc.) would utilize the bulk of the guarantee flight rate; (why should NASA send a dozen astronauts to the moon if space tourism is sending five dozen?). Space Billets not utilized by commercial users could be utilized by NASA to deliver propellants and spacecraft into orbit for manned missions to the Moon and beyond. Congressional support for NASA should increase because ANY American company located in any state could find investors and develop their own launch vehicle and secure any number of space billets for themselves. This is a no risk proposal to our leaders, if no company is willing and able to fulfill the price targets, nothing is spent.**

**Nomenclature:**
LOX – Liquid Oxygen
LEO - Low Earth Orbit
GTO – Geostationary Transfer Orbit
GEO – Geosynchronous Orbit
TLI – Trans Lunar Injection Orbit
OTV – Orbital Transfer Vehicle

## BACKGROUND

The Commercial Space Industry has failed to expand beyond the $2B per year mark because government launches are so much more profitable, especially with cost plus ~9% contracts. As you can imagine, Cost plus contracts provide the contractors with an incentive to make the project as expensive as possible to obtain a larger profit margin (the 9%). In addition, the government overseers have an incentive to have as large of a project as possible to increase their pay grade.

1 Space Propulsion Synergy Team and AIAA Member

If entrepreneurs and new businesses are not entering into an industry, there is usually little innovation and the price of service will not significantly decrease. To most entrepreneurs, the space launch industry is a terrible business investment opportunity. When compared to the commercial airline passenger market, the space launch service market is a tiny niche market. The commercial airline market is valued at over $5,000 Billion per year from scores of providers who take over 642 million passengers on 8.9 million airline flights each year[iii]. By contrast, the space launch service market is valued at only $2B by less than a dozen providers worldwide who fight over ~28 commercial launches world-wide per year and who have transported only 543[iv] people to EVER go into space.

The second problem with an entrepreneur entering is the cost of the payload (the satellite) can be an order of magnitude more than launch service. Thus, price of launch service is a much lower factor than long term-high success rate. But the cost of launch service and cost of a satellite have a negative feedback causation; as it becomes more difficult to obtain a ride on one of the 28 launches per year, satellite manufactures spend more time and expense testing the satellites to be sure they will function in space. If the cost of obtaining a ride into space goes down while the availability goes up, satellite providers will be able to launch two cheap redundant satellites (e.g., the GPS constellation) rather than one very expensive satellite that cannot fail.

Meanwhile a mere $2B commercial launch service market is derived from only 26 world-wide commercial launches per year while there were only ~75 total (commercial & government) launches world-wide per year for the last decade. Breaking into the commercial launch service market is extremely difficult due to the desire of customers wanting a long-term, multi-flight track record of successes before they will go with a new launch service provider. As a result of the very small market and very few commercial launches, it is **extremely difficult** for a private company to raise investment capital and this results in very few service providers (mostly of major aerospace firms) and causes those aerospace companies to repeatedly return to the government for development funding as well as their main customer. Unfortunately, going to the government for development funding allows the government to dictate who can compete and which design gets additional funding, which has not always been the best technology or best design **for the long-term**. Even in government space programs, the desire to eliminate risk and the lack of innovation in the commercial industry has resulted in designers relying on 50's and 60's space technologies. What is more depressing is the fact that 100's of technical papers are presented each year on new aerospace technologies that will not have a chance to ever be developed due to the lack of opportunities.

Innovation and new companies entering into the space industry is becoming extremely rare. A visit to an ever shrinking exhibition at the AIAA-JPC should provide the proof that funding from the federal government is very limited and all the major aerospace players are chasing the same dollars via the next grandiose aerospace program. It should be depressing to all but the most optimistic aerospace engineer that the federal government has a long list of cancelled programs and that there is little chance, if any, of introducing and maturing that new innovative propulsion system. We believe that the proposed funding program will provide a vehicle for new innovation, new enthusiasm, and more funding to a space industry that must stop looking back 40 years ago as its golden years.

## Prior Art

Previous papers, such as "*A Rocket a Day*" by Walker[v], have shown that IF the flight rate was increased, the cost of each launch vehicle or mission would be reduced. Walker expounds how the world's first mass produced rocket, Germany's V-2 ballistic missile, had a marginal cost of only $13,000 and they produced over 6,000 rockets during war time conditions with slave labor. Presentations by Gleason[vi] have expounded the cost effectiveness of orbital LOX depots using high flight rates. In this paper we approach these subjects from the government perspective by proposing that IF the government would establish long-term markets with very high flight rates with Not-To-Exceed prices, commercial ventures would be created to fill those markets with incredible savings to the government.

We propose **NASA** and the **Air Force** establish a **large, permanent market** for the **commercial launch service business** by setting aside a large annual investment for the next 50 years of $5B per year for what we call "**Space Billets**." A Space Billet was originally coined to only mean a stay at a Space Hotel (from the housing of soldiers during the Revolutionary War), but as this paper progressed we expanded **Space Billets to now mean any fixed contract with a guaranteed market over a long time in the Space Industry**. NASA and the Air Force should also establish a **sub-orbital launch service market** by paying $2M for the removal of each of the 2,200 large space debris objects currently in orbit about the earth. NASA and the Air Force should also establish a **commercial space hotel market** by setting aside a large annual investment of $1B per year by paying $2M per week for each government visitor to a certified American space hotel for 500 man-weeks **(50 additional Space Billets)** per year.

## SPACE BILLETS

We define a Space Billet as 10 tons of useful material transported from the earth's surface to Low Earth Orbit (LEO), but a Space Billet can also represent material to GEO, Lunar orbit, Mars orbit, or even astronauts at a lower weight requirement according to the chart below. A Space Billet may also represent ten man-weeks at a certified space hotel or 0.26 week on a lunar base. The maximum rate paid for LOX to LEO is $1,000 per pound while the maximum rate paid for spacecraft and hardware is as much as $1,500 per pound.

Figure 1: Proposed Space Billets Values

| SPACE BILLETS - $20M Value each | | | |
|---|---|---|---|
| Category | Amount | Units | $/lb |
| Earth to Low Earth Orbit (LEO) basic payload (LOX) | 10 | ton | $ 1,000.00 |
| Earth to Low Earth Orbit (LEO) spacecraft/satellite payload | 6.67 | ton | $ 1,500.00 |
| Earth to Low Earth Orbit (LEO) back to Earth - Astronauts | 3 | each | n/a |
| Earth to Geosynchronous Transfer Orbit (GTO) | 4.22 | ton | $ 2,372.29 |
| Earth to Trans-Lunar Injection Orbit | 3.85 | ton | $ 2,600.00 |
| Earth to Mars Orbit | 2.49 | ton | $ 4,020.62 |
| LEO to Geosynchronous Transfer Orbit (GTO) | 7.29 | ton | $ 1,372.29 |
| LEO to Trans-Lunar Injection Orbit | 6.25 | ton | $ 1,600.00 |
| LEO to Mars Orbit | 3.31 | ton | $ 3,020.62 |
| Accommodations at Space Hotel | 10 | man-week | n/a |
| Accommodations at Lunar Hotel (min. 200 man-week/yr) | 0.26 | man-week | n/a |
| Space Debris Removal >2kg size | 10 | pieces | n/a |

To provide some comparisons on the value of a proposed Space Billet:

- A Saturn V class mission that delivers 100,000 lb of payload from earth to Trans-Lunar Injection orbit or 260,000 lb to LEO would be worth $260M via 13 Space Billets.
- Bigelow BA330 space complex module has a stated lease rate of $25M/18 man-weeks[vii] or 14 man-weeks per Space Billet equivalent.
- The ISS costs $525M per 10 man week vs $20M for the proposed Space Billets; in other words 26.25 people could stay in a Space Hotel via Space Billets vs 1 person staying the same 10 weeks in the ISS.

We advocate that the US government create a commercial launch service market by paying ANY American company a fixed fee not to exceed $1,000 per pound for placing useful payloads from the government into LEO. At a rate of $1,000 per pound, each 10 ton Space Billet would be worth $20M. By allotting $5B per year for Space Billets ($3B from NASA and $2B from the Air Force), we would guarantee 250 American commercial launches per year. 250 launches of 10 tons each would amount up to 5,000,000 lb of useful material or up to 750 astronauts into LEO each year; however, if NO company wants to launch payloads for $1,000/lb than no money is spent by the government. Upon successful delivery of their first space billet, a start-up company or new launch vehicle will receive $20M plus a one-time award of $100M to partially offset their development expenses.

### Congress and NASA should set bold goals with long-term, guaranteed markets and let aerospace companies determine how to accomplish those goals.

Congress and NASA should set bold goals, such as sending 200 astronauts to the moon over the next 10 years and sending hundreds of astronauts and space tourists to several space hotels for 500 to 2,500 man-weeks per year, and let private enterprise determine how to accomplish those goals. Congress and NASA shouldn't be in the business of designing and developing rockets; they should only be involved with determining **where** we are going to explore, **how many missions or people are going**, and **what are we going to do once we get there**.

### What are Space Billets and Why are They so Special?

We advocate the use of Space Billets instead of Cost-Plus Contracts. Space Billets are firm, fixed contracts that NASA should utilize in conjunction with establishing guaranteed flight rates.

- A Space Billet is a firm, fixed *pay-upon-completion* contract that will replace the current *cost plus 9% fixed fee* contract instrument that NASA usually utilizes.

- The Basic Space Billet is 10 tons of useful payload at $1,000 per lb (or 3 astronauts) transported from ground to Low Earth Orbit – **a Basic Space Billet is worth $20 million**.
- The Space Billet plan guarantees a market rate over a long time so businesses can make a commercial business case and obtain investment funding.
- We propose a market rate of 150 to 350 Space Billets per year - $3B to $7B per year.
- If in-space propulsion technology is not improved, Liquid Oxygen (LOX) will make up 70% of Space Billets for payloads transported beyond Low Earth Orbit, i.e., the moon or geostationary orbit.
- Space Billets takes the design and development of launch vehicles, lunar landers, and other equipment out of the hands of NASA and the politicians (because NASA simply sets a goal of delivering astronauts to the moon, not how to accomplish that goal) and places it in the hands of businesses, who are going to find the cheapest method of accomplishing those different tasks.
- Space Billets will allow **ANY** commercial American company to deliver goods and astronauts not only to low earth orbit, but to the moon and beyond.
- Space Billets doesn't develop and spend nearly $3B per year just to maintain an expensive space station just for a few astronauts, instead it **guarantees** that at least 52 visitors will spend 10 weeks at a **commercial space hotel** per year (at $1,040M per year) for the next 5 years if a commercial company wants to provide one or more to NASA's specifications.
- Space Billets doesn't develop a vehicle to land on the moon, but instead it guarantees a market to transport at least 20 visitors **to the moon's surface** over 5 missions per year for 5 years if a commercial company wants to provide those services.
- Space Billets doesn't develop a rocket to put things into orbit, but instead it provides a guaranteed market of 150 to 350 missions per year for 5 years at a fixed, low price that can be used by the government or purchased by private companies.

Instead of major aerospace contracts going to the same large aerospace companies, any American company in ANY congressional district can reserve a Space Billet. Space Billets and the commercial aerospace markets they create, will enable us to do all of these things at nearly the same amount of funding currently going to NASA.

## How it works

Rather than NASA (and Congress) designing a vehicle and trying to find a mission for it; NASA would merely define MARKETS and any American company could obtain their own development funding via investors to fill those markets.

For example: NASA declares that it wishes to perform **5 manned missions to the moon per year** for the next 10 years.

NASA will establish and allocate 100's of Space Billets for:

- earth-to-LEO missions,
- LEO space hotel / way station
- LEO-to-TLI (Trans-Lunar-Injection) orbit missions,
- Lunar orbit to Lunar Surface missions
- Lunar base (including moon buggy!).

It would be up to commercial ventures to develop and deploy the hardware (with their own funding) that would fulfill these missions. The commercial companies will develop and deploy the hardware with their own funding because they know that they will make more money with Space Billets over time than they would with Cost Plus contracts.

## What is Possible with $3.56B in Space Billets per Year for 10 Years?

In this section, we investigate what would be possible by spending $35.6B (1,780 Space Billets) over 10 years. Over a 10 year period, this funding would accomplish the following:

- $ 4,300M: Remove ALL (~2,150) large space debris from orbit
  - 1 mission/day for 8.6 years
- $ 4,870M: 730 astronauts and Gov. tourists transferred to LEO
- $10,400M: House 520 Astronauts and Gov. tourists in a space hotel for 10 weeks each
- $ 5,600M: Transfer 210 astronauts from LEO & Land on the moon
- $10,400M: House 210 astronauts & govt. tourists in Lunar Hotel for 10 weeks each.
  - $82.86M per astronaut on the moon for 10 weeks

In like manner, a further investment of $5B per year for 10 years in Space Billets could be utilized to:

- $50,880M: House 210 astronauts in floating space stations on Venus
  - $242.3M per astronaut at Venus

Again, **Space Billets does not directly fund development costs it only provides guarantee markets for businesses and entrepreneurs to go out and find development funding**.

## But why should the big aerospace companies support Space Billets

Because **they can make more profit than the Cost Plus 9% contracts**.
The same $3.56B as shown above would yield only $320.4M profit via Cost Plus 9% contract but in a large market rate where companies in the Space Industry can develop innovative hardware that have extremely low marginal rate, much more profit can be made.
Example 1:

- In an accompanying paper on Hybrid Supersonic/Suborbital Aircraft (AIAA 2014-3651), we show that it may be possible transport 10 tons of payload into Low Earth Orbit at a marginal cost of less than $1M (at 250 missions/year) with a fully re-usable upper stage that is air launched from a large aircraft fleet.
    - Since 10 ton payload to LEO = 1 Space Billet which is worth $20M so gross profit is greater than 95%

Example 2:

- Suppose the same 10 ton payload was transported from LEO to TLI orbit via momentum tether
    - 10 ton payload from LEO to TLI = 1.6 Space Billets (from Figure 1). 1.6 Space Billets = $32M. A momentum tether or some other non-chemical in-space propulsion may be able to propel the 10 tons from LEO to TLI without **any marginal cost** so gross profit could again be greater than 95%.

Example 3:

- Suppose the same 10 ton payload was transported from TLI orbit to Lunar surface via some unknown technology
    - 10 ton payload from TLI to Lunar surface = 2.4 Space Billets (from Figure 1). 2.4 Space Billets is worth $48M. Can a machine be built that can transport 50 ten-ton payloads from TLI to the lunar surface for $2.4B over a 10 year period and make a substantial profit?

Example 4:

- Suppose the same 10 ton payload is a partial section of lunar hotel for 4 astronauts
    - Lunar hotel for 20 astronauts * 10 weeks each = 52 Space Billets (from Figure 1). 52 Space Billets = $1.04B per year
    - Cost to transport 10 ton lunar hotel module from earth to lunar surface = $200M
    - Weight of Bigelow BA-330 module = 22 ton
    - Bigelow Aerospace website states that each BA-330 module holds four astronauts and leases for $25M for two months ($2.77M/week or $0.69M/man-week).
    - Bigelow Aerospace website also state that three BA-330 modules would be needed for a moon base; three BA-330 modules should lease for $2.08M/man-week + transportation to the moon for all 66 tons.
    - Transportation of 66 tons to the moon surface should be $1,320M as calculated above.
    - Since Space Billets is paying $5.2M/man-week, the transportation cost should be paid for (minus the lease rate) after 2.12 years with a **total gross profit of $4,920M for the ten year lease of the moon base**.

This section reveals the guaranteed markets created by this fictitious $3.56B per year budget and provides business cases for private businesses who want to go after these Space Billets. For Example, if a business wanted to get into the business of transferring people to orbit, they merely need to look in this section to see that the market for this line of work is 730 people transferred to LEO and back for $4.87B over a 10 year period. Another company should decide if they could make a profit by developing a re-usable lunar lander that must operate 50 times over 10 years at a gross income of ~$2.4B. Another company would need to determine if it can make money by producing oxygen from lunar soil and transferring the 4.35M lb of oxygen to lunar orbit for ~$3.5B or would it be cheaper to transport all propellants from earth.

**The best outcome from implementing a Space Billets program is**:

- That Space Billets will become obsolete for missions to LEO and even the moon in just a few years.
- That the owner of the Lunar Base informs NASA that Lunar Base Alpha is already booked with space tourists for most of next year, does NASA want them to launch a new lunar base?
- That politicians and the space industry will stop promoting a grand government launch vehicle or space station because "***it will create jobs!***" but instead, will start thinking about what will we do once we get there.
    - Boeing didn't start the 787 aircraft program to "***create more jobs***"
- That the American space program will once again become the technological innovator that it once was.

- That the American people will demand that NASA's funding is doubled so more Space Billets will ever more people to a space hotel or carry us to Venus and beyond.

The Space Billets would allow private enterprises to develop (with their own funding) the following:

1. Space Hotels
2. Low cost access to space (ground to LEO) at $1,000 per lb for simple payloads
3. Low cost access to space (ground to LEO to ground) at $20M for 3 people
4. An Orbital Transfer Vehicle (OTV); basically a re-usable, refillable, heavily insulated upper stage with reusable heat shield. OTV would plunge into air atmosphere to return to LEO.
5. A reusable Lunar Lander
6. Floating Space Stations with heat shield for Venus environment. Space Stations would plunge into Venus atmosphere upon entering orbit.
7. Sub-orbital launch vehicles that could spray 10,000's of pounds of water in front of space debris to cause that space debris to deorbit.
8. Sub-orbital launch vehicles that could also carry 100,000's of point-to-point passengers supersonically across the globe.
9. In-situ production of oxygen from Lunar soil and the transfer of that oxygen to lunar orbit via mass driver.

## Is $1,000 per pound to LEO or 250 launches per year possible?

What you really want to know is "*other than the Space Propulsion Synergy Team does anybody else think $1,000 per pound to LEO or 250 launches per year possible*?" During the May 2012 speech to Congress, Elon Musk of SpaceX stated that his launch vehicle could achieve a cost goal of $500 per pound. We do not need to reduce the reward to $500 per pound, but rather maintain the price at $1,000 per pound and after 22 years the value of money at $1,000 would be the same as $500 per pound today due to inflation.

## What is Useful Material?

More than half the useful material to LEO could be Liquid Oxygen (LOX) that is typically used as an oxidizer together with a fuel to propel useful material to other destinations via upper stage rockets. Useful material may also include fuel, satellites, probes, equipment, astronauts, etc. It will be up to NASA and the USAF to determine how they would utilize this potentially 3 million pounds of material in LEO and they would be free to offer these billets to whomever they choose.

## Where does the Space Billet Funding come from?

Currently, NASA is spending approximately $3.25B per year to just **support** (no new hardware!) the ISS operations & transportation and $1.75B to develop the SLS. The likelihood that an affordable, sustainable launch vehicle will be developed via the SLS program is not very likely due to the fact that very little is different from the Space Shuttle Program and the use of Cost Plus Contracts will insure that spending the most amount of money (in the name of safety, no doubt) will be the prime concern by the contractor instead of reducing cost via innovations. The SLS is so large that it can only be flown a few number of times (<12) per year or less than ~120 times over a 10 year period. Basic accounting states that ANY launch vehicle that costs multi-$billion and only flown for less than 120 times over a 10 year period WILL NOT be affordable or sustainable. In fact, amortization of the development cost will amount to $9M per flight for each $B spent during the development phase. For example, spending $10B over the next 5 years to fully develop the SLS will mean that each SLS launch will cost $90M just for the cost of money; no hardware!

## Why would Congress Support Space Billets?

Currently, most major NASA & USAF projects are won by the major aerospace firms who are located in just a few states; CA, WA, TX, OH, FL, VA, & AL. Space Billets would allow ANY American Company in ANY state to obtain the Space Billets; they just have to deliver LOX to LEO, or house astronauts, etc and they would get paid (no competitions). Furthermore, EXTREME EXCITEMENT for the US space program would occur in many congressional districts if we are sending people to the moon or sending civilians to a Space Hotel instead of buying seats on a Russia rocket. This excitement would reveal itself to NASA as additional funding. America's world standing would greatly increase as we send ambassadors (and government officials) from around the world to Space Hotels and maybe even to the moon.

## Maturity – Why should NASA trust Young Companies?

Why would NASA and USAF place so much trust in young, start-up companies with such expensive hardware and Astronaut lives? Quick answer; they wouldn't. While ANY company could attempt to transport

20,000 lb of LOX to LEO, only a company that has done so many times would be entrusted to transport space hardware to LEO and even more successful launches to transport human lives. As proof, SpaceX was allowed to dock to the International Space Station after less than 6 successful missions. The use of Space Billets, which permits 100's of launches a year would allow young companies to complete dozens of successful missions before NASA entrusts them with space hardware. NASA could offer many space billets to young companies to land several in-expensive probes on the lunar surface before NASA would permit one of them to land humans. As a result, mission assurance would be far greater than any of the Apollo missions.

As a result, young companies can quickly (and cheaply) get through the design and development process and start utilizing their hardware. Instead of spending $Billion studying and performing simulations of missions, young companies can quickly build hardware and start landing in-expensive probes on the moon.

## ORBITAL SPACE DEBRIS

Over 510,000 orbiting objects larger than 1 cm are observed and tracked at any one time, but only ~400 objects are operational (including the International Space Station). Of these half million objects 2,158 of them are over 2kg in size and make up 99.6% of the total orbiting debris mass. While there is a small chance of these larger objects contacting each other, but when they do, they cause 1,000's of smaller objects. According to Joe Carroll at the "Space Access 2009 - Panel on Orbital Debris", most debris is clustered in very narrow bands. The two tables shown below show 1,525 objects amount to 1,508 tons of debris located within four zones of inclinations. Removing one object every working day would still require 6.1 years and cost $500M per year assuming each mission costs $2M each.

96-103 degrees of inclination

| Country | Objects | Tons |
|---|---|---|
| US | 155 | 85 |
| US allies | 80 | 85 |
| Russian | 42 | 93 |
| China | 39 | 59 |
| Total | 316 | 322 |

| Country | Objects | Tons |
|---|---|---|
| 81-83 degrees of Inclination | | |
| >97% Russian | 739 | 817 |
| 69.9 to 74.1 degrees of Inclination | | |
| >95% Russian | 126 | 105 |
| Other Inclination | | |
| US | 218 | 105 |
| Russian | 126 | 159 |
| Total | 1,209 | 1,186 |

**Rationale for Space Debris Program**

Funding a pay for performance program that will require hundreds of launches per year over a long time will enable a private American company to establish a business case in order obtain investment capital for this endeavor without any development funding from the US Federal Government. In fact, the 2,150 large objects will require at least one mission per working day for the next 8.6 years. The space debris missions are in addition to the earth to LEO missions and would provide greater rationale for more than one company to develop a totally reusable launch vehicle.

**Secondary Rationale for Program**

According to (Campbell, 2000)[viii], *"Based on the number of objects in low-earth orbit, and using the Iridium satellite system as an example, if we assume that the replacement cost of one of the 66 satellites in the $3.450 billion system is roughly $50 million, then the total cost to LEO satellites from orbital debris is estimated to be roughly $40 million per year. Debris-related expenses that are on the order of tens of millions of dollars per year should be compared with estimates from the Orion study for debris removal. It estimated that eliminating debris in orbits 800 km in altitude within 3 years of operation would not exceed $200 million."*

## SUMMARY

We can obtain low cost access to space by providing launch markets and opportunities on which entrepreneurs can establish business cases by which they can obtain investment funding. Space Billets is a no lost, no risk policy; if NASA states that they will fund 250 missions per year via Space Billets and no one is willing and able to fulfill the requirements; they haven't lost any funding. However, if Space Billets are offered and several large American companies are able to make a profit, the entire industry and our nation as a whole will benefit. Space Billets have a target of $1,000 per pound to LEO, but we show in a companion paper that it is possible to deliver 20,000 lb payloads to low earth orbit for $2M or $100/lb if the flight rate was 100 missions per year.

The next step is for our political leaders including Congress and/or NASA to see the no risk potential or Space Billets and push for more research into this concept and eventually passage into law.

**This was the 3rd in our Series of 5 papers on Cheap Access to Space**

- Goal of this paper is to show the economic advantages of establishing long-term Space Markets with high flights rates and firm-fixed prices for payment for completion
- 2nd Goal was to show that Space Billets are more profitable to business and so we hope businesses advocate for their implementation
- 3rd Goal was to show how Space Billets are NO RISK to politicians and government leaders who advocate for their development & implementation
- Results were encouraging enough that more research should be devoted by NASA, Air Force, and Congressional leaders to develop and implement the Space Billets plan.
- It is our greatest desire for Space Billets to become obsolete within 10 years since commercial markets may demand more flights than Space Billets allocated and at a lower price.
- $1,000/lb to LEO was chosen at random. More research should be conducted to determine the optimum rate that will foster the commercialization of space.
- Please see: http://www.theusaparty.com/policy.html

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Providing peaceful solutions to divisive topics including Space Commercialization, Global Warming, Healthcare, Education, Immigration, Taxes, & Budget.

**http://Spacepropulsion.org**

Government, Industry, and Academia coming together to provide guidance to vehicle design via knowledge gained from lessons learned.

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[i] Douglas Thorpe, Russ Rhodes, John Robinson, "Affordability Advantages in Integrating the Aircraft and Space Launch Operations2", 50th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, Cleveland, OH, 30 July-August1, 2014, AIAA 2014-3651

[ii] Douglas Thorpe, Russ Rhodes, John Robinson, "Affordability Advantages in Integrating the Aircraft and Space Launch Operations", 48th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, Atlanta, Georgia, 30 July-August1, 2012, AIAA 2012-4155

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