

GAME THEORY ANALYSIS FOR THE  
SUBORBITAL REUSABLE LAUNCH VEHICLE RESEARCH MARKET

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When evaluating the emerging market for suborbital reusable launch vehicle (sRLV) research, it is helpful to use a well-established, academically-based framework to define the market. This paper models the sRLV research market with a game theory-based structure created by Adam M. Brandenburger and Barry J. Nalebuff in their book entitled “Co-opetition.” This framework could be helpful in determining strategic promotion of the long-term viability of the sRLV research market. This paper defines the components of the sRLV research market using the market structure constructs described in the Co-opetition text.

Abbreviations and Acronyms

AST	Office of Commercial Space Transportation
B&N	Brandenburger & Nalebuff
DOT	Department of Transportation
DT	Drop Towers
FAA	Federal Aviation Administration
FOP	Flight Opportunities Program
ISS	International Space Station
ITAR	International Traffic in Arms Regulation
Micro-g	microgravity
PARTS	Players, Added-value, Rules, Tactics, Scope
PTA	Parabolic Trajectory Aircraft
sRLV	Suborbital Reusable Launch Vehicle
SARG	Suborbital Application Researchers Group
SR	Sounding Rockets
US	United States
USG	United States Government
VG	Virgin Galactic

INTRODUCTION

The market for suborbital reusable research vehicles (sRLVs) has become increasingly relevant over the past few years as the American commercial space industry emerges. The success of the market for sRLVs is predicted to drive down prices, therefore making suborbital spaceflight more cost-effective. The ultimate aim of these vehicles is to give customers of all types the opportunity to access the space environment at a lower cost and with greater flexibility.

Potential customers for sRLV flights include researchers who are developing physical and biological processes in micro-g, collecting data from the Earth’s atmosphere, conducting astronomical observations, as well as aerospace test demonstrations. [Ref. 1] It is assumed that this type

of research demand comes from the university, governmental, and industry sectors.

In the context of this paper, the sRLV market provides two relevant products. The first is time in microgravity, ranging from one to five minutes. The second is access to launch and space environments. Therefore, entities that conduct sRLV research are primarily the purchasers of “time” in these environments.

Section 1 of this paper will describe the generic framework of market structure and relevant characteristics based on Brandenburger and Nalebuff’s (B&N) “Co-opetition.” [Ref. 2] In game theory, market dynamics are modeled as “games” with players, added value, rules, tactics (to influence perception) and scope (leading to the acronym PARTS).

Section 2 of this report applies the PARTS construct to the sRLV research market. The players are divided into categories of the central company (or, for our analysis, the sRLV research industry), customers, suppliers, competitors and complementors. Next, the ARTS<sup>1</sup> of the sRLV research market are identified.

Results of this analysis will be summarized in the final section of this report.

In this analysis, the focus will be on the entire sRLV research industry and not on any one specific company. This is done intentionally to avoid showing preference to any particular business model. However, specific companies may be mentioned to provide examples as needed. This is done merely to demonstrate the nature of the industry, whose players are constantly changing and evolving as a result of technological development and industry growth

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<sup>1</sup> The components of PARTS without the Players.

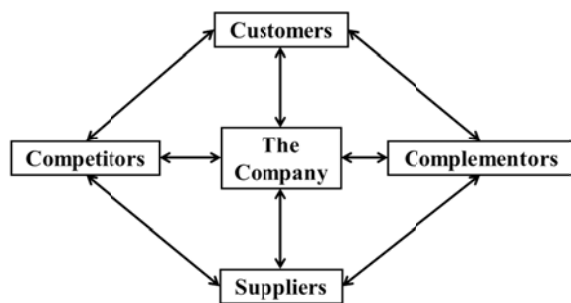
## 1. PARTS DESCRIPTION

A given market place is defined by the behavior of five elements: the players, added value, rules, tactics (to influence perception) and scope (given the acronym PARTS). This section will briefly describe each of these elements.

### 1.1 Players

The “players” in an industry or market include the company, the customers, the competitors, the suppliers, and the complementors. The relationship of these 5 groups to each other is called the Value Net [Ref 2] and is shown below in Figure 1.

**Figure 1. The Value Net [Ref. 12]**



### The Company

“The company” is featured as the central element and has the following characteristics:

- It produces a product that the customer wants.
- It engages in competition with others who can offer a similar product.
- It is supported by its suppliers who provide the goods necessary to conduct operations.
- It is complemented by sibling businesses whose success it mutually benefits from.

### Customers

Customers are those who exercise the buying power over the company. They include any entities that purchase the company’s services.

### Suppliers

Suppliers play a symmetric role to the customers and “are equal partners in creating value.” [Ref. 2] The supplier is to the company as the company is to the customer. This implies that the company derives the same utility from the supplier that the customer does from the company. This connection is crucial to the overall success of the firm.

### Competitors

A player is considered to be your competitor when a customer values your product less when they have your competitor’s product. [Ref. 2]

Competitors are businesses that are able to take customers from the central company because they offer similar products and services.

### Complementors

“[A] player is your complementor if customers value your product more when they have the other player’s product than when they have your product alone.” [Ref. 2] A classic example of complementors includes hot dog and mustard.

Competitors can also be complementors, as in the case of many antique shops co-located on a street, creating an “antique row” that attracts customers to their competitors as well as to themselves.

Competitors and complementors play opposite roles and are considered to be mirror-images of each other. They are bound to the company through the supplier. That is to say, the supplier is worse off supplying the company when it is supplying the competitor, and is better off supplying the company when it is also supplying the complementor.

### 1.2 Added Value

Added value refers to the benefit a firm generates when it enters a marketplace. This value does not exist before the entrance of the firm and is absent from the market if the firm exits. Each firm enters with its own unique added value.

Added value has the ability to determine the amount of power a particular firm will have when it enters. Determining added value may be unclear at first, but the affect it has on the marketplace can be profound. It can be achieved through monopoly power, trade-offs, and relationships.

Monopolies bring extensive amount of added value to a marketplace through their ability to be successful single-sellers of a unique and highly demanded product. The video-game company Nintendo is a good example of this. [Ref. 2] Nintendo earned its success through its ability to keep its hardware costs down. This, coupled with emphasis on high quality software, compounded the value Nintendo brought to the video-game market, giving it the ability to overtake all of its competitors.

Trade-offs occur in a competitive world where it is necessary to take in account the perspective of a customer in order to make the product more attractive to them. In other words, sometimes firms will have to

give up some opportunities to create new ones for their customers. This can be done through listening to customer demands and identifying where a firm can do a little to earn a lot.<sup>2</sup>

The added value of a relationship between players has the ability to bring a significant amount of leverage to any firm entering a marketplace. If a customer already feels comfortable with the company, whether through a personal relationship or a sound reputation, then the firm is certainly more likely to have more customers and visibility than a firm without pre-existing relationships. The familiarity a relationship brings may allow for expansion into all kinds of marketplaces. This kind of loyalty is what leads to the success of companies such as the Virgin Group, which has branched out into dozens of lines of businesses.

### 1.3 Rules

The rules of the game include regulations, hurdles, contracts, and industry norms that are in place in any given market. These can be seen as barriers to entry or advancement in a marketplace. Understanding the rules allows players the opportunity to strategize their actions.

Rules in the form of contracts enable customers and sellers to sustain steady business and foster loyalty. To the firms involved, this is seen as a beneficial relationship, but to new entrants in a marketplace, established contracts and relationships are a deterrent to serving a potential customer base. Government rules may include regulations on certain industries and technologies, as well as anti-trust laws.

### 1.4 Tactics

The tactics of the game are based on perceptions within the Value Net. Since each player perceives the game differently, it is necessary to establish, manage, and maintain perceptions so that they are advantageous to the central company involved. This may involve times of transparency or times of ambiguity for a given firm.

Establishing, maintaining, and managing perceptions may be achieved through credibility tests. This may

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<sup>2</sup> B&N reference Trans World Airlines' [Ref. 2, page 124] ability to significantly increase customer utility when they created more leg room in their "Comfort Class" by removing seats from their planes. TWA gave up the opportunity to seat more people in their cabin for the opportunity to attract more customers. Fortunately, it worked in their favor as satisfaction ratings for the airline soared.

be done through pricing schemes that show the customer that a firm has only their best interests at heart. Taking the time and exerting the effort to showcase dedication to a customer goes a long way.

Sometimes it is best for a firm to operate under a veil of secrecy. They do this by hiding information in order to maintain a positive image of themselves. An example of this includes complex pricing schemes that confuse the customer but benefit the firm.

It is important to note that tactics to ensure the betterment of a firm will always come with a trade-off. It is up to the firm to determine what kind of risks it is willing to take in the pursuit of its self-interest.

### 1.5 Scope

The scope of the game is an attempt to estimate the long-term viability of the players. This is done through establishing the commonalities one game may have to another. Determining these linkages allows for players to understand the value of their work. As an example, when a firm develops a superior technology, it may be in its interest to price it high so as not to disturb an incumbent in the market. Not disturbing them allows them to fall behind when the superior technology becomes increasingly popular. [Ref. 2] This is an example of how understanding the linkage an incumbent in the market may have to your game.

Linkages occur through all the aspects of PARTS. An important thing to remember is that there is always a larger game that every player must take into account.

## 2. SRLV RESEARCH MARKET VALUE NET

In this section, the game-theory structure of PARTS and the Value Net are used to describe the sRLV research market.

### 2.1 sRLV Research Market Players

#### sRLV Research Industry (in lieu of "The Company")

The companies in this part of the analysis include any launch vehicle provider who offers use of a sRLV for research purposes.<sup>3</sup> These include potential entrants such as Virgin Galactic, XCOR, Blue Origin, Masten Space Systems, UP Aerospace, and Whittinghall Aerospace. [Ref. 3]

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<sup>3</sup> Some potential sRLV launch providers, such as Virgin Galactic and XCOR, also offer the transportation of humans to microgravity for the purposes of space tourism. This aspect of sRLVs will not be discussed in this paper.

It is important to note that each company offers one or more unique options to conduct research on their sRLV. One option allows scientists and researchers to have the opportunity to fly with their experiments. Another option is a payload-only flight, with the addition of a research technician to monitor experiments.

Customers

The customer in this analysis can be broken into three groups: the United States government, private enterprise, and university researchers.

The USG buyer includes:

- NASA, who conducts numerous experiments in microgravity through the International Space Station (ISS) but may find the cost-effectiveness of sRLVs to be advantageous for some projects.
- The NASA Flight Opportunities Program (FOP), matching scientists and researchers with sRLV providers so they can conduct their experiments in the space environment.
- Department of Defense, whose operations in space is highly dependent on cutting edge technologies.

Private enterprise can include a wide array of entities looking to perform many types of research (including medical, biological, and astronomical) in space.

- The use of sRLVs to conduct medical and pharmaceutical research would be similar to the way medical research experiments are conducted in the ISS. If a particular research experiment needs a few minutes in microgravity, then sRLVs would be particularly advantageous to use.
- Defense contractors, especially those who specialize in remote sensing technologies, would have a new platform to perform their operations.

At the university level, entities such as the Suborbital Applications Researchers Group (SARG) exist to promote research for suborbital spaceflight. It is made up of member of universities including Princeton University, University of Colorado-Boulder, Johns Hopkins University and several others. It also includes organizations such as the Southwest Research Institute and X PRIZE Foundation.<sup>4</sup>

Members of SARG are conducting research and technology demonstrations in micro-g that require the capabilities that sRLVs provide. In fact, NASA recently awarded several member universities

<sup>4</sup><http://www.commercialspaceflight.org/programs/suborbital-applications-researchers-group/>

contracts to access suborbital space with the promise to match them with a sRLV provider.<sup>5</sup> In the past, these universities have also procured private funding to perform microgravity research.

Competitors

In the market for sRLV research, competition is not achieved as a result of several businesses with a homogenous service vying for the same customer. Instead, sRLVs compete with non-launch vehicle technologies that achieve microgravity, including drop towers (DT), parabolic trajectory aircraft (PTA), and sounding rockets (SR).<sup>6</sup>

One of the key aspects these different technologies compete on is variations in the time they offer in microgravity. Drop towers offer 1-10 seconds. Parabolic trajectory aircraft offer 20-40 seconds of micro-g per parabola (there can be dozens of parabola per flight). Sounding rockets can offer up to 20 minutes in microgravity. In comparison, sRLVs offer 1-5 minutes of microgravity.

The unique carrying capacity of a competitor's technology is another distinguishing factor between the various competing technologies. In general, sounding rockets can only carry small payloads. Drop towers can take small to medium sized payloads (the size of an experiment rack). This leaves parabolic trajectory aircraft and sRLVs at a size advantage through their ability to take small to large-sized payloads (person sized).

The table below summarizes the time and size capabilities of the different competing technologies.

	<b>Time in Micro-g</b>	<b>Payload Size</b>
<b>Sounding Rockets</b>	Up to 20 minutes	Small (70 cm in diameter)
<b>Drop Towers</b>	1-10 seconds	Small to Medium (4-5 cubic feet)
<b>Parabolic Trajectory Aircraft</b>	20-40 seconds per parabola	Small to Large (person size)
<b>sRLVs</b>	1-5 minutes	Small to Large

<sup>5</sup><http://www.parabolicarc.com/2012/07/02/nasa-selects-14-technologies-for-development-on-commercial-suborbital-flights/>

<sup>6</sup> It is important to note that it is difficult to determine if these technologies are considered to be substitutes to each other without calculating the Cross Price Elasticity of Demand. This paper, however, will assume that they have a positive CPED and are therefore considered substitute products.

NASA is the main provider of drop tower and sounding rocket services in the US, but international entities have entered the marketplace. ZARM at Bremen University in Germany and the MGLAB of Japan offer drop tower access in the world community. [Ref. 1]

However, there are some aspects of the sRLV research market in which drop towers and sounding rockets are unable to compete. For example, since DT and SR do not allow for humans to accompany the experiments, some sRLV firms would only have to compete with PTA companies such as Zero Gravity Corporation for a customer who desires human services in micro-g.

Therefore, DT and SR entities such as ZARM and MGLAB may only be competitors to the payload-only option of sRLV services.

### Suppliers

The suppliers for sRLV operators include a wide array of firms dealing in mechanical and machining equipment, composite materials for fuselages, bulk and sheet metals, solid and liquid propellant, and electronics equipment providers for avionics. [Ref. 4]

Popular suppliers in the industry include McMaster-Carr, a mechanical components provider, and Air-liquide, a propellant provider. Scaled Composites, for example, provides fuselages for companies such as VG as well as SpaceX.

### Complementors

Potential complementors for the sRLV research market include spaceports, space traffic control, and spacesuit providers.

In operating a sRLV or any other kind of spacecraft, a spaceport is essential. sRLVs cannot launch or land without the spaceport and its support staff. Likewise, a spaceport serves no purpose if no vehicle operates there. As a consumer, you would be at a loss if you purchased time in microgravity, but were unable to access it. Major spaceports currently operating in the US include Kodiak Launch Complex, Florida Spaceport, Cecil Field, Mid-Atlantic Regional Spaceport, Spaceport America, Oklahoma Spaceport, Mojave Air & Space Port, and California Spaceport.

In addition, space traffic control along with guidance systems built specifically for the spacecraft are also considered complementors, because of their uniqueness to the commercial space industry and to any particular spacecraft.

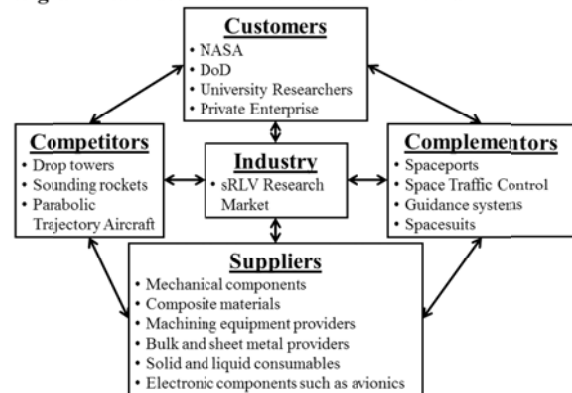
In flights with humans onboard, spacesuits may be required. Therefore, spacesuit manufacturers and

designers would also play a complementary role to the sRLV research market.

Players that are not listed in the Value Net but do have a role in the operation of this market include entities such as the Federal Aviation Administration who serve as the regulator as well as the provider of launch and reentry permits. Air traffic controllers also play a role in ensuring the safety of the spacecraft so as to prevent mid-air collisions with other aircraft.

Figure 2 below shows the Value Net for the sRLV research market described above.

**Figure 2. The sRLV Research Market Value Net**



## 2.2 sRLV Research Market Added Value

As mentioned above, currently existing incumbents in the sRLV research market include DT, SR, and PTA firms (including NASA). When the first sRLV firm enters, it will have to combat an already established (albeit small) sRLV research market. In order for a sRLV firm to attract enough demand to sustain itself, it is necessary to determine the added value they bring to the industry (the “A” in “PARTS”).

In the already existing market for suborbital research, the entrance of sRLV firms would bring added values in the areas of (1) increased capacity, (2) user friendliness, (3) cost-effectiveness, (4) reusability and (5) amenities.

Increased capacity (in comparison to sounding rockets and drop towers) on the spacecraft opens up the market for a new kind of consumer to enter. This consumer does not have to worry about the size of his/her experiment and may even be willing to pay more because of the space they need. Increased capacity also allows for more experiments to be taken on board the flight as well, so instead of just one or two, several experiments can be performed simultaneously. This is an improvement from the sounding rockets and drop towers competitors, where

experiments must be relatively small, unmanned, and performed one at a time.

User friendliness in the case of sRLVs refers to the amount of automation required of an experiment when a human can accompany it to space. Currently, in order to use SR and DT, payloads have to be engineered so that they can be fully automated. This involves intensive technical expertise and increased costs in addition to purchasing a place on the DT or SR. The introduction of humans to monitor the missions would eliminate costs incurred for automated operations.

Cost-effectiveness of sRLVs represents a significant cost reduction in comparison to NASA's technologies. Virgin Galactic is likely to charge \$200,000 for a ride on its vehicle.<sup>7</sup> Potential entrant, XCOR, advertises a \$95,000 ticket.<sup>8</sup> This is a drastically reduced price compared NASA's sounding rockets, the average cost for which is approximately \$1 million.<sup>9</sup>

Reusability is a trend of the private sector that moves away from the use of expendable to reusable launch vehicles. This new technology has the potential to drastically stimulate space innovation. No sRLV is in commercial operation at the moment. Therefore, the entrance of one provides the opportunity for cheaper access to micro-g that is conducted more frequently and with relative ease.

Amenities, such as customer service, are a unique aspect that companies such as VG offer. For example, the Virgin Group has already established itself as a successful provider of airline and cell phone services. Their ability to engage their customer through the ticketing, billing, and in-flight processes is an advantage that is currently unseen in the CST industry. Increased emphasis on the customer is always seen as always advantageous to any firm trying to gain a loyal customer base.

### 2.3 sRLV Research Market Rules

For any sRLV firm looking to enter to the sRLV research market, it is necessary to understand the rules in place that may affect their entry and behavior. The rules that sRLVs will have to deal with include (1) contracting and brand loyalty and (2) regulation such as licensing, ITAR and FAR.

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<sup>7</sup> This number was used by determining the price VG advertises for a space tourist as given on their website: <http://www.virinalgalactic.com/booking/>

<sup>8</sup> <http://www.xcor.com/contact/ticket.php>

<sup>9</sup> <http://www.thespacereview.com/article/1228/1>

(1) Since the customer-base for sRLV research is highly concentrated and has very few powerful buyers (the USG is likely to be the most powerful buyer [Ref. 4]), any sort of contract or loyalty to a particular company would be an immediate hindrance to the competitiveness of the market. In 2011, the NASA FOP selected seven companies to provide access to suborbital space.<sup>10</sup> In doing so, NASA found itself simultaneously enabling the industry as well as constricting its size and limiting it in scope. This paradoxical role occurs as the result of the strength NASA exercises as a client to these firms. The ability for NASA to constrain the market to a few companies creates a substantial barrier to entry for other potential newcomers.

(2) FAA AST requires all commercial spacecraft to be licensed for launch and reentry operations. All reusable spacecraft must undergo FAA inspections and must complete the following<sup>11</sup>:

- Pre-application consultation
- Policy review
- Safety review
- Payload review
- Financial responsibility determination
- Environmental review
- Post-license compliance monitoring

The International Traffic in Arms Regulations (ITAR) imposes restrictions on all defense-related objects exported and imported through the United States. Technology affiliated with launch vehicles is considered sensitive and must be safeguarded under ITAR control. Commercial spacecraft are not exempt from these regulations.<sup>12</sup> ITAR has a reputation to be a hindrance to the advancement of the aerospace industry. A potential challenge this may impose to sRLV is its ability to prevent international actors in the form of researchers or private firms from acquiring permission to use American sRLVs.

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<sup>10</sup> Companies selected include Virgin, XCOR, Armadillo, Near Space, Whittinghill, UP Aerospace, and Masten Space Systems. <https://flightopportunities.nasa.gov/blog/2011/08/10/nasa-selects-seven-firms-provide-near-space-flight-services/>

<sup>11</sup> [http://www.faa.gov/about/office\\_org/headquarters\\_offices/ast/licenses\\_permits/launch\\_reentry/#reusable](http://www.faa.gov/about/office_org/headquarters_offices/ast/licenses_permits/launch_reentry/#reusable)

<sup>12</sup> As evidenced by the experience of firms such as Bigelow Aerospace who have conducted operations abroad.

Other rules that can potentially limit government procurement of services that sRLVs provide include Federal Acquisition Regulations, Other Transactional Authority and the Acquisition Management System. Since the USG is the dominant customer, the contracting terms that will be imposed will be predominately determined by these acquisition regulations.

#### 2.4 sRLV Research Market Tactics

In order to develop an effective strategy for the advancement of sRLVs, it is necessary to for the firms involved to establish a positive perception of the marketplace and maintain it to their favor.

Launch operators want their product perceived in such a way that their customers feel like they are at a loss without it. They want to offer a differentiated and unique product that is unsurpassed in quality and inimitable in design. They also want to maintain a reputation of safety, reliability, reusability, and cost-effectiveness. In order to achieve this, firms can be proactive to demonstrate these aspects of their operations.

In order to achieve inimitability, issues of intellectual property become a factor. Patents place limits on the rate at which technical information can be acquired between firms, but are also seen as a challenge to innovation. However, in this industry, since sRLVs compete with non-launch vehicles, patent concerns may not necessarily be as problematic as a market where the products are homogenous and IP protection more relevant. However, between sRLVs, IP issues may emerge due to the similarity of their products and services.

In the case of safety, firms can adhere to and even exceed safety regulations. This is done through compliance with safety inspectors and guidelines administered by the FAA. This garners approval from the regulators and would result in positive public perception of the firm's operations. In the case that accidents occur, it is important for firms to employ a well-crafted communications plan to demonstrate their dedication to public safety.

For reliability, public product demonstrations are essential. Reliability will be fostered through adherence to scheduled operation of the spacecraft to prove to its customers that sRLV firms have the capacity to effectively provide suborbital flight opportunities. This means operating on a regular basis, keeping in contact with the customer, and maintaining a healthy relationship with complementors, suppliers, and even competitors.

Reusability can also be proven by flight operations. Since the reusable aspect of launch vehicles is new to the industry, it is crucial for sRLV firms to prove that their product is true to its design. This means there must be much focus on keeping the product design relevant and useful. The industry must also be transparent and open to discussion about product innovation.

Public signaling must be performed effectively to affect the perception of sRLV firms. Advertising must target customer desires by proving that sRLV research is superior to any other form of suborbital research performed.

Customers must also manage their perceptions of the marketplace to ensure the services they receive maximize their utility. They must insist that prices they pay are fair for the services they receive, and that sRLV providers recognize their importance as buyers.

To receive the best price, buyers must be cognizant of pricing schemes around them. Pricing for sRLVs may be sensitive to fuel cost, spaceport availability, location, schedule, payload size, etc. As a customer, it is necessary to make sure that they are being offered suborbital services at the advertised cost. It is not out of the question for a customer to request the firm to showcase their credibility. This can be done by comparing prices side by side or requesting exclusive contracts.

#### 2.5 sRLV Research Market Scope

In evaluating the scope of the game, it is important to determine any linkages or relationships the current game has to other games. The scope of the sRLV research market can be identified through linkages with new technologies and applications, safety, new customers, orbital markets, and between players.

Relationships created with other industries may take the form of an innovation externality that is created from a high-tech industry. Given the high capital level required and the necessity to cut costs for the future, efforts to manage costs and technologies will increase. As new entrants make their way into the marketplace, new ideas and applications for existing technologies will result. Consequently, an innovation externality is likely to occur through the emergence of new applications. These new applications may make their way into other industries, reaching a new customer-base who had not been initially targeted. The most evident example of this is through the creation of the market for civilian use of GPS which began as a military-only operation. sRLVs have the opportunity to create these linkages because they

move away from the status quo that has dictated NASA and DoD operations for these past fifty years.

Another way that the sRLV market is linked with other industries is through safety procedures, rules, and regulations. The sRLV industry falls under regulation by the FAA and thereby falls under the oversight of the Department of Transportation. The DOT imposes guidelines on the automotive and aviation industry as well. This creates a relationship between commercial space, aviation, automotive and other modes of transportation which will likely result in the need for increased collaboration and communication between them all.

Demonstration of sRLV technologies' capability and utility may entice the late majority and laggard segments of the scientific community to join the marketplace, become potential players, expand the market and grow the industry.

The success of suborbital firms also advances the orbital industry. Improved technologies by way of test demonstrations occurring on sRLV flights may result in increased efficiencies in the orbital realm, making possible for new technologies to emerge. Current orbital projects that may benefit from sRLV success include the Sierra Nevada Corp's Dream Chaser and Bigelow Aerospace with their inflatable space station.

The increasing number of relationships between existing firms showcases the expansionary power of the sRLV market. A recent joint venture between Scaled Composites, SpaceX, and Dynetics called Stratolaunch, formed in 2011 by Microsoft co-founder Paul Allen, is indicative of the growth of collaboration in the industry, leading to newer ideas and technologies. Scaled is most famous for supplying the White Knight mothership and SpaceShip series for VG. This success of this venture is indicative of market strength. Identifying the linkage between these firms allows us to understand the size and concentration of the market.

### CONCLUSIONS

This paper used a game theory construct developed by Adam B. Brandenburger and Barry J. Nalebuff to model the sRLV research market. The framework involves five components: players, added value, rules, tactics (perceptions), and scope.

The current players in the sRLV research market (company, customers, suppliers, complementors, suppliers) were identified and defined by the Value Net.

The added value emphasized aspects of user friendliness, cost efficiency, reusability, and amenities including customer service.

Predominantly, sRLV research market rules include contract terms which result in brand loyalty and regulatory hurdles of licensing, export control and acquisition.

Tactics that are employed to meet customer expectations help establish, maintain, and manage a positive perception that an emerging industry needs to attract more players.

The scope of the sRLV research market includes relationships between other industries, with potential players, with other markets, and with existing players.

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â€œGame Theory is a study of conflict between thoughtful and potentiality deceitful opponents. This may make it sound like the game theory is a branch of psychology rather than mathematics. Not so: because the players are assumed to be perfectly rational, game theory admits of precise analysis. Game Theory is therefore a rigorous branch of mathematical logic that underlines real conflict among (not always rational) humans.â€ In this book, Brandenburger and Nalebuff use game theory to develop a set of guidelines that will â€œmake it easier to explain the reasoning behind a proposed strategy.â€ The games that they use as analogies do not involve sports with their zero-sum outcomes; instead, they consider a variety of games that allow for mutual benefit, as well as harm, for the players. They use the term co-opetition, which is consistent with their message that cooperation pays off in some situations, competition in others. They encourage readers to think about not only how to play the game, but also how to change the