

A BUSINESS MODEL CANVAS FOR GOVERNMENT PURCHASES OF COMMERCIAL SATELLITE COMMUNICATIONS

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ABSTRACT

The traditional model for government purchases of satellite communications has been the development and operations of satellites by a government agency or department (e.g. NASA, Department of Defense etc.), or the direct lease of services from commercial vendors. This traditional model has two major shortfalls: the government generally has long development cycles, which lead to higher priced systems with somewhat older technologies; the lease of commercial services are timely and cost effective, but do not meet many of the unique government mission needs. As budgets get tighter, and the commercial sector advances ahead of the government in the development of new ideas and technologies in Satellite Communications, new acquisition paradigms need to be developed for effective and efficient purchase of these capabilities in support of military and civilian missions. However the lack of a business model framework that would guide this exploration has severely limited business innovation in this area. We propose a business model framework, based on the Osterwalder et al (2009) Business Model Canvas, and similar to the business model re-invention framework proposed by Johnson, Christensen and Kagermann (2008). In our framework we treat both government and industry as integral parts of a joint business model, that separates out government and industry responsibilities, as well as costs and profits respectively, but allows us to see each element of the business model in relation to each other, and guides us in building the foundations for a successful government-industry partnership in new and innovative ways. We will present the overall framework, the business model canvas, and a few examples of how it would be used in a brainstorming setting to identify new ideas and approaches.

I. INTRODUCTION

Satellite communications has been a real success story of technologies that were initially created almost exclusively for government use that were transitioned successfully into the commercial marketplace and are now widely available to everyone. The success of the transition is such, that now commercial users of satellite communications are the majority, with government use accounting for only a small portion of the overall market. Furthermore, even government users now rely heavily on commercial satellites to provide service worldwide. For example, in [6] we see that the US Department of Defense now leases from commercial providers 90% of its overall satellite communications capacity. There are two very different models for satellite communications development that have emerged over the past few decades: The government model where satellite communications technologies are created through a centralized government run program office that is responsible for developing uniquely tailored capabilities to specific government missions such as military or space exploration. And the commercial model, where capabilities are developed based on forecasting of the market demand over the next decade, creating capabilities that are generic enough to attract the largest user base possible, in relatively short time to market. The government model creates cutting edge capabilities that push the technological envelope, but at much higher price and relatively long timelines, with typical programs in the United States taking more than a decade to deliver a satellite on orbit, at a cost that is considerably higher than the commercial market. But when the capability is delivered it includes all the attributes that the government mission requires, such as security, or jamming resistance. However, the long timelines create a lag in the technology that is delivered, where technology that was cutting edge 10 years ago when the program was initiated, is now often superseded by more recent technological breakthroughs. The commercial model on the other hand is much less aggressive in the technologies it pursues, relying on more proven techniques and an incremental, rather a revolutionary development approach. But it can deliver capability on orbit in less than 3 years at a much lower price. This gives commercial providers the opportunity to incorporate newer technologies at much lower risk. The drawback is that many of the unique government needs are not included in these designs, since government users are now a small minority of the overall market.

With declining government budgets in the US and worldwide, the question has been raised in multiple forums of how can governments capitalize on the commercial model of delivering capability quicker and cheaper and incorporating at the same time the government unique attributes needed for specific government missions. Several

approaches have been proposed such as bulk leasing, government hosted payloads on commercial satellites, public private partnerships etc. All of these envision some sort of partnership between government and industry that is quite different from the traditional approach of either hiring industry to develop a specialized capability, or simply leasing whatever the commercial industry has to offer off the open market. Industry and government find themselves now in unexplored territory, with little understanding of how the business relationship between them should be setup, or how to evaluate proposed approaches from a cost benefit perspective to both parties. In this paper we will provide a framework that captures the unique attributes of these new partnerships between government and industry, and provides for a way to communicate and evaluate the main elements of a proposed business model in a way that captures all of the essential elements of the relationship and highlights all the relationships between these elements. The framework will also provide for the ability to view all the interdependencies among elements of the business model, as well as its impact on the underlying financial viability for both industry and the government and allow one to understand and assess tradeoffs between different aspects of a proposed business model.

II. BUSINESS MODELS

First we must understand what we mean by the term business model. It's a term used every day in business by both industry and the government, but with very little consensus of what it actually means. In a recent survey of business model literature in [3] they looked at all the different ways that business models are defined and used, and concluded that scholars do not agree on a definition, with research on this topic generally conducted in silos and focused on the specific phenomenology of particular interest, and not on generalizing their approach into a unified theory and set of definitions. They also noted that while there is no consensus in the field, the field itself has exploded since 1995, when only a handful of articles mentioning business models as a term were published in academic and non-academic journals. But since then that number has been growing exponentially to the point of having about 200 academic articles published in 2010, and over a thousand articles in non-academic journals on the topic of business models. They did however find some common ground across different approaches. Their conclusion is that the business model, whatever that means to respective researchers and practitioners, is emerging as a new unit of analysis; business models attempt to explain from a holistic viewpoint how firms conduct business in specific settings; all

relevant organizational activities need to be captured as part of a successful business model; and finally business models attempt to explain how value is created and captured within an organization.

For our purposes we selected a few recent papers that have been most influential in the field that set a framework for defining and capturing a business model. First we start with [2] that have offered a good definition for a business model, which we can build upon for our purposes. They define a business model as a set of four interlocking elements that taken together create and deliver value: Customer Value Proposition, Profit Formula, Key Resources, and Key Processes. It is these four elements and more importantly the relationships between these four elements that differentiate one firm from the next. While this definition is great in capturing the key aspects of what a business model is, and can be used to create the narrative that describes a specific business model, it does not help us visualize a specific business model in an easy, holistic and comprehensible way. This is where the authors in [1] have offered an approach that has become popular recently, in the development of what they term a “Business Model Canvas”, seen in figure 1. Their approach is to create a generic “canvas” that can be used as a graphical tool to capture the most salient elements of a business model and help us identify and represent the relationships between these elements in a holistic and systematic way. These authors have also developed an iPad-based tool that can help a business team to use the canvas in real time to capture a business model and communicate it internally to the team as well as externally to third parties. The approach follows in general the definition of Johnson, Christensen and Kagermann (2008), but breaks it down to few additional elements that highlight in more detail some of the important aspects of a particular business model. The canvas is laid out as a set of building blocks, where each one is used to capture the unique attributes of the respective building block of the business model and at the same time help us visualize the relationships between the building blocks themselves and how they relate to each other. Central to the approach is the value proposition, which is surrounded by a number of key building blocks that should highlight how each one of them is related to the central value proposition block. The blocks of the canvas are:

- Value Proposition
- Key Partners
- Key activities
- Key Resources
- Customer segments (what are the different customer groups to be targeted)

- Customer Relationships (e.g. self service, dedicated service, online help desk etc)
- Channels (how is the product or service provided, e.g. online versus brick and mortar store)
- Cost structure
- Revenue streams

The Business Model Canvas

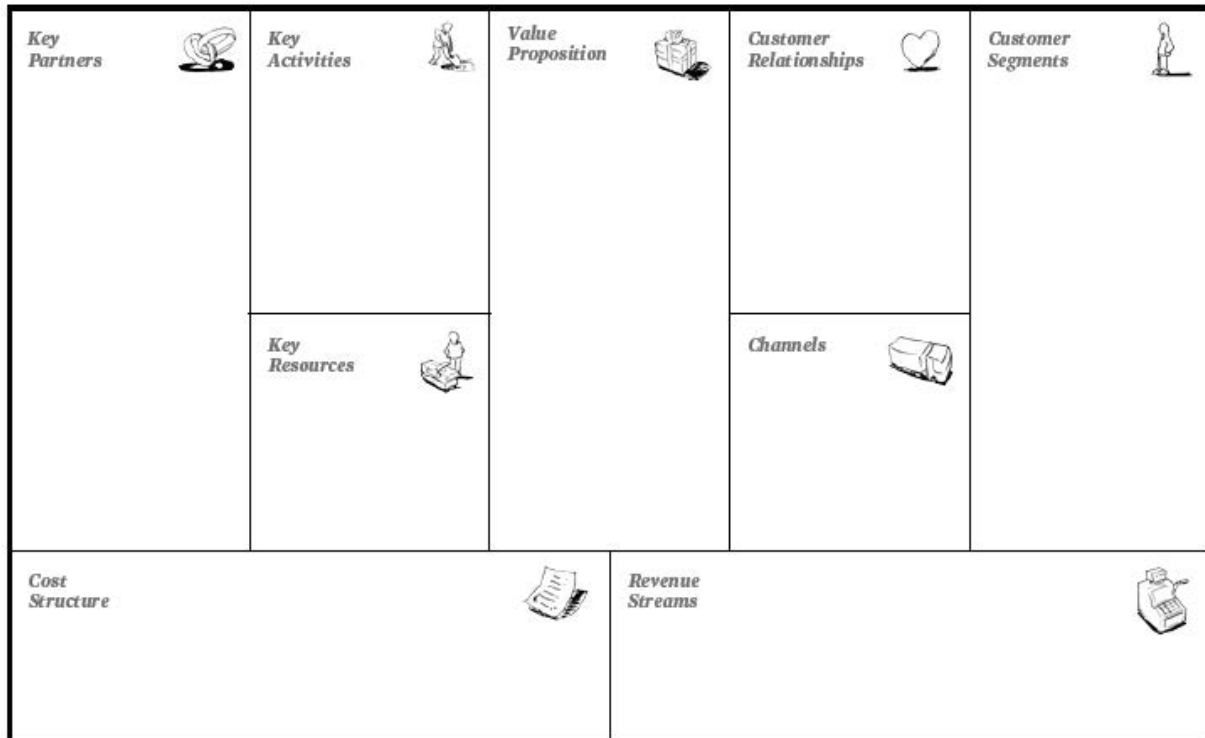


Figure 1. The Business model canvas from Osterwalder, Pigneur and Smith (2009)

This approach is now becoming popular with teams that are defining a firm's business strategy, capturing their value proposition and identifying the method and means by which they plan to provide it. However, for our purposes it has a few disadvantages:

- It is industry centric. In other words a commercial provider would use this to identify their business strategy in general, but it does not capture the special partnership we envision between government and industry

- The approach is focused on consumer businesses, and does not capture the unique needs, relationships and environment of a government user
- It helps us understand the profit equation for industry, but not how it relates to the cost equation for the government and the associated cost tradeoffs the government needs to make
- It does not provide a mechanism to tradeoff risk between industry and the government, nor does it highlight which aspects of the business model affect which components of cost and risk.
- It does not address inherent legal limitations of government contracting and how they relate to the rest of the model

Despite these shortfalls, it does provide a good starting point for developing a more tailored business model approach to our problem area.

III. THE JOINT GOVERNMENT-INDUSTRY BUSINESS MODEL CANVAS

We first need to recognize some key tenets regarding the type of business model we pursuing. These tenets will guide us into developing the right kind of building blocks, and help us highlight the appropriate elements of the kind of industry and government partnership we envision:

- It's a Joint Business model. In other words, the canvas should convey the message that as a partnership, both industry and government will be allocated a part of the overall business model. Each will have primary responsibility for different building blocks of the model, but the business model itself will be the sum of all of the activities that industry and government partners contribute to endeavor overall
- It's a model with multiple industry and government partners. Satellite communications is a complex endeavor, with different companies contributing different parties of the overall system. So while one company may be responsible for the satellite, it's a different entity that is responsible for the launch and yet a different one responsible for the operations of the satellite. Similarly, in the government it usually involves several different organizations that need to come together to represent the users, provide the programmatic oversight, conduct the testing and technical assessment of the capability etc. So this complexity should be highlighted in the model itself.

- It should include discussion of the stakeholders and the intended Architecture it fits in. An added complexity in such a partnership is that when the government is involved, there is usually a large number of stakeholders that need to be addressed that may not necessarily be directly served by the capability being purchased, but nonetheless may have a say in the approach that is followed. Also usually when the government is involved, the question often arises of how this capability fits into the larger infrastructure the government is responsible for and how we can ensure that it will integrate and work seamlessly within that infrastructure. Often industry refers to the government “Architecture”, i.e. the larger network it is intended to be integrated into, although there can be multiple architectures such as the network, security, management etc. And it is often that stakeholders and the underlying architecture are intertwined in complex relationships.
- There should be a way to test if it’s in the best interest of both the government and industry. However, we build the model both industry and government should obtain value from the transaction. For industry that is in the form of profit, for the government in the form of expected cost versus benefit. We need a way to be able to allocate expenses and profits to include the cost of risks both for industry and government and develop a test to evaluate if the partnership will provide adequate value to both parties.
- The focus of the canvas should be on the user value proposition, which is owned by both industry and government. This is a central point of the partnership, that if the intended users, whether it’s the general public or warfighters in a tactical theatre, if they are not satisfied with the capability developed then both the government and industry essentially lose. For the government it’s in the form of political costs and waste of taxpayer money, for industry it’s in the form of reduced future profits and potentially a tarnished image and brand.
- Market effects should be part of the model. In general for any business model there are assumptions and expectations about the current and future state of the market that are embedded into the model. With a large government purchase it’s even more pronounced since the size and nature of the purchase could affect the entire market as a whole. So for example if a government purchases a very large chunk of satellite bandwidth in a certain region, that capacity is constrained, it may drive up the prices in that region. So there needs to be a building block that estimates and addresses these effects. Additionally things that affect

the industry interactions, like choice of proprietary solutions that form barriers to entry for other firms and reduce competition, should also be captured here.

- It should include a method of graphically representing how core elements of the model affect both the cost and the profit side of the partnership. Note that in figure 2 (our modified business model canvas) we do not represent this, but it is illustrated in the example of figure 3.

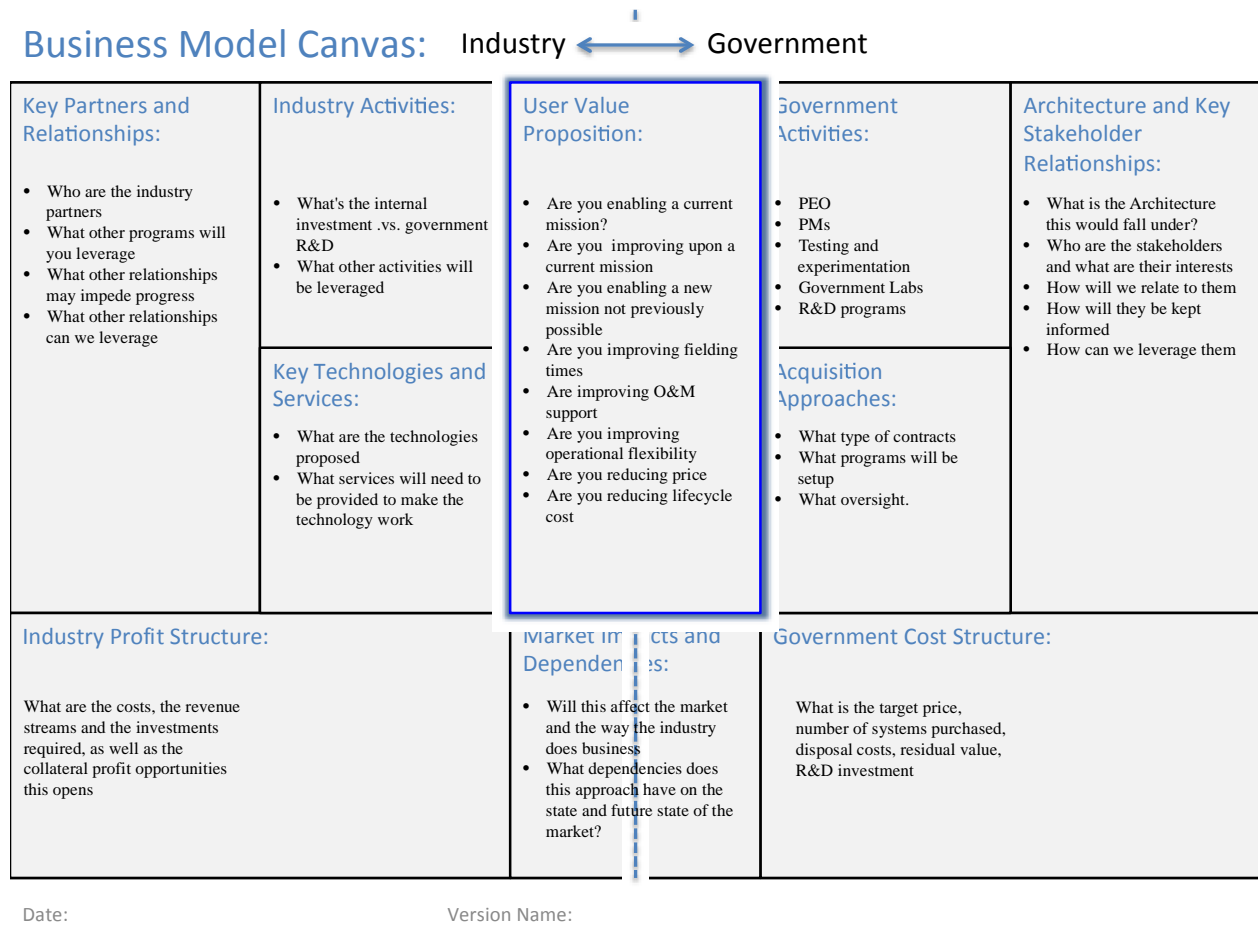


Figure 2. The Joint Industry-Government Business Model Canvas

An example of the proposed canvas is shown in figure 2. As discussed above, half of the model is “owned” by industry and the other half by the government. The value proposition and the market effects are split between industry and government as it relates to both. The building blocks proposed are as follows:

- Central is the user value proposition. The value proposition can either be enabling or facilitating a type of mission, improved support, reduced costs, reduced fielding times, improved Operations and Maintenance (O&M) or a combination of any these elements
- Key partners and relationships. Since satellite communications require large number of industry partners to come together, as well as other government programs that can be leveraged or that may be a risk to our development due to direct competition for budget resources. The choice of these partnerships is crucial as they can significantly drive risk and costs. A list of potential areas that different partners could be responsible for are:
 - Satellite Bus
 - Payload
 - Launch
 - Terminals
 - Networking and services across the system
 - Operations and Maintenance
- Industry activities. Here we will identify what other key industry activities we will leverage. It could be Internal Research and Development (IR&D) activities; standards development by industry consortiums; support to other commercial or government customers that industry will leverage; any other activity, any of the industrial partners will leverage and that will not be paid for directly by the government.
- Key technologies and services. Here we list the core set of technologies or services that we will incorporate into the systems. So for example its High Capacity Ka-Band satellite with routing services on board and steerable beams. Or it could be a set of services like end-to-end service lease with terminals provided, and operations and maintenance support included.
- Government Activities. Most government programs, and especially in the United States, requires several government offices and agencies to be involved. So it could involve several Program Executive Offices (PEOs) spanning multiple Program Management offices. There will probably be testing and experimentation support from a third agency. In the US often Federally Funded Research and Development Centers (FFRDCs) or government labs could be involved and help the government provide technical support. It should include all of the related government activities such as satellite programs or

leases, terminal developers, satellite control systems, satellite operators or whatever is needed to complete the system and successfully deliver a set of services to the end user.

- Acquisition approaches. The government has several acquisition approaches it can choose from such as cost plus contracts or fixed fee and each one has a different set of ramifications for risk, cost and schedule. Some of these require authorization from government bodies. This needs to be part of any business model discussion as it can drive several other decisions on the canvas.
- Architecture and Stakeholders. As mentioned in the previous section, most often than not any SATCOM service purchased will have to fit into a larger network. So for example for a US military application it would have to fit into the Global Information Grid, as well as within the rest of the system a particular unit is equipped with. There are specific aspects of networking, information security, management systems that the purchased capability will need to interface and be compatible with. These drive additional stakeholders other than the acquisition community participants identified in the government activities block discussed above. Other stakeholders could be from regulatory agencies or it could be representatives of the end users. All of these should be accounted for and a plan developed to communicate with them, understand and respond to their interests and leverage them when possible. How we choose to interact with some of these stakeholders may drive other decisions on the canvas.
- Market impacts and dependencies. Here we would summarize any assumptions we make about the market and any effects we expect to have on the market itself due to the size or location of purchase, new technology developed etc.
- Industry profit structure. For the partnership to work for industry, profits scaled by the firms Internal Rate of Return (IRR) should be larger than the cost of acquiring the opportunity plus any IR&D costs the firm has put into this. The IRR reflects not only the expected rate of return for an endeavor to be worth spending the capital to pursue for a given firm, but also includes an estimate of the financial risk associated with the project. We can use this concept to check out potential tradeoffs such as how much IR&D versus what price, what is the value of the residual IP for the firm, are there any collateral profit opportunities from this partnership like offering service on the government paid payload to third country government, how much risk can we allocated to the firm before the proposition becomes unprofitable etc. etc. More details on this will be presented in the next section.

- Government cost structure. Traditionally government costing has been conducted as purely an estimate of future costs, without any consideration of the financial risk for the government, or an estimated dollar value of the capability when it becomes available in the future. However, recently several governments have developed an equivalent concept to the IRR called the Public Sector Discount Rate (PDSR), used to make public project investment decisions in countries such as in the UK and Australia (See [4]). This is used to capture not only the cost of capital, but also the cost of risk to the project. The PDSR is used to scale the cost estimate by the expected risk of the entire project completing successfully on budget and on time. More on this in the next section. So the cost structure should include all the costs associated with the project, including that of the space segment, launch, terminals, ground stations and operations and maintenance. However, it should also include all the secondary costs associated with government projects such as cost of oversight, certification costs, cost of integration onto aircraft and vehicles and disposal costs of the system. We should also subtract any residual value remaining at the end. So for example if some of the terminals of the system after a decade of use will be re-allocated to another government agency or sold on the open market, this residual value should be accounted for. More details on this in the next section.

So in each of these blocks the intent is not to capture all of the information, but identify the key drivers and the salient points of the business model. The intent is to use this as a starting point to understand the tradeoffs. Once we have the key drivers, we then start exploring the relationships between the drivers, how each one of them drives the cost and profit model, and what additional key elements we would have to add to the business model to mitigate any potential negative effects some of these drivers may have on each other. So for example if we have specified that we want the industry partner to take on more of the risk of the technical development since they may be better than the government in managing that, we may see that the profit structure does not incentivize the industry partner to spend their own IR&D dollars to develop parts of the technology, because the Intellectual Property (IP) is owned by the government and does not allow them to capture additional profits from other customers. So we can mitigate this in several ways, either allow them to keep parts of the IP, or pay a higher price for the capability in extra lease costs or equipment purchase costs, or it may be that you would need to purchase higher quantities of terminals to make it worthwhile. These are the types of tradeoffs that the model will allow you to look at. Now, once we have the key drivers, and we understand the underlying assumptions and tradeoffs, as well as the associated

dependencies, we can then take each block and put down all of the additional details that will take the business model and turn it into a business plan.

Central in the whole discussion is the financial conditions under which it is worthwhile for both industry and the government to enter such a partnership. In the next section we will develop an example set of equations of how one could put this together. Obviously every project and every different government agency may have different implementation details that would modify some of the equations, but we present these as an example and starting point to further tailor the profit and cost discussion to the particulars of the project at hand.

IV. INDUSTRY PROFIT

We now have to define what we mean by the industry profit equation. As a general principle, firms will invest money and expect a rate of return that is commensurate with the amount of risk they are undertaking. At a minimum a firm will demand the risk free rate (which often taken as the Treasury bond rate) plus a “risk premium” for the project itself. This risk premium may include technical risks, risk that the market will change in unpredictable ways, risk that the firm will not be able to deliver due to internal issues, and so on and so forth. The sum of these two risks is usually referred to as the Internal Rate of Return IRR [4]. There are other ways of defining the IRR, and multiple ways of calculating it for specific projects, and this is beyond the scope of this paper. But we will accept the IRR as an indicator of risk, which will demand higher profits from the firm to cover the risk of investing capital into the project. The capital a firm would invest in a SATCOM partnership like this could be of two different kinds: capital to capture the opportunity, such as proposal costs, or upfront investment costs in equipment and resources; and the other is the IR&D conducted by the firm, in the form of the value of Intellectual Property (IP) it will contribute to the partnership. As a general rule of thumb a firm will not offer up IP if it does not retain ownership of it, unless the government is willing to compensate the firm for the full value of the IP, or the firm is allowed to freely use that IP in other ventures and there is adequate profit opportunity by the use of the IP. So the investment a firm is willing to make now in cost to capture the opportunity and IR&D it invests, must be less or equal to the expected future profits translated into current dollars using the IRR as the “expected” interest rate of the investment. The equation is shown in equation [1]

$$(Cost_{Opportunity} + IR\&D) \leq \sum_{i=1}^n \frac{N_t^i (Price_t^i - cost_t^i) + N_s^i (Price_s^i - cost_s^i) + n_l^i * Price_{lease}^i - Cost_{operations}^i}{(1+IRR)^i} + \frac{Value_{Residual}^f + Value_{IP} + Value_{other}}{(1+IRR)^n} \quad [1]$$

The left hand side is the current investment the firm would have to make. The right hand side (often referred to as the Net Present Value or NPV) has three distinct elements: 1) the profits from the sale of space and/or terminal assets 2) The profits from leasing or operating and maintaining any assets by the firm itself during the lifetime of the partnership. 3) Any residual value to the firm itself, such as residual value of equipment, or the value of the IP developed during the partnership that it can use to pursue other profits. Or any other value it can obtain from the partnership such opening new markets, or developing its brand image. The superscript i represents the year of the partnership that the costs or the cash flows that will be realized from year one to year n. So $price_s^i$ and $price_t^i$ is the price the government pays for space and terminal assets at year i respectively; $cost_s^i$ and $cost_t^i$ is the cost of those assets respectively; N_s^i and N_t^i is the number of space and terminal assets the government buys at year i respectively; n^i is the amount of leases the government purchases at year i (although one could foresee this be broken out into satellite capacity leases and terminal leases or other equipment leases); $Price_{lease}^i$ is the lease price at year i; $Cost_{operations}^i$ is the total costs of operations the firm incurs at year i; and finally the three value terms at the end of the equation is the residual value of equipment, the value of any IP the firm retains use of, and any other value such as branding or new markets that the firm can obtain from the partnership all calculated at year n. The term $(1+IRR)^i$ is the return at year i that the firm expects based on the calculated IRR, and all cash flows are summed from year one to final year n where the partnership is assumed dissolved (except for the residual value terms that are calculated simply at year n assuming that these values can only be realized at the end of the partnership. This is a simplifying assumption that could easily be modified but that is beyond the scope of this discussion).

We now can use this as a guide to understand the drivers of what would entice a firm join such a partnership with the government (one could envision multiple firms as well, in which case you would have one equation per firm). So for example if you are requiring the government to own all the IP from the partnership, then the residual value of the IP goes to zero, so the firm will have to be compensated in some other way, for example lowering the IRR by lowering risk for the firm with the use of low risk contracting, or increasing the price paid, or offering some other

residual value like guaranteed contracts with additional other government partners or agencies. Or maybe the amount of purchases would need to be higher to make it profitable. Or the length of the contract (years n) would have to be extended. There are a large number of ways you can conduct tradeoffs based this simple approach and maintain good visibility into what they are and what they mean. Note that this is not intended to be a budget quality tool, but a first order approximation to understand the types of tradeoffs. Additionally we can now identify specific key elements of the business model in the canvas blocks and draw arrows to point to specific elements of the profit equation that they affect negatively or positively and seek out other business model elements we can use to compensate on the same or other terms. More on this will be presented in a subsequent section.

IV. GOVERNMENT COST

Equivalently, as industry will not enter into a partnership without it being in its best financial interest, so does the government have a certain interest in using its taxpayer's money in the best way possible. The problem has traditionally been in defining what this "best" use of money really means. Since profit is not a driver, one may assume that the amount of social benefit it derives should be the driver. However, putting "social benefit" in monetary terms has always been difficult. The other issue with this approach is that it disregards the fact that governments have (or at least should have) limited budgets, so any expense in purchasing one "socially beneficial" service or product means that less of another service or product will not be purchased. While defining the monetary value of a given product or service is beyond the scope of this paper, we will assume that the government has a method of budgeting how much a given SATCOM service and/or set of products is worth by defining it in its budget allocation. Another issue is that usually governments make the argument that the discount rate for pricing the time value of money should be the same for all projects since overall the government budget averages all risks across all projects [4]. However, this would indicate if we have two projects that have the same "social benefit" then one with much higher risk would have the same preference as the lower risk one. In our case in particular, we may have two potential partnerships for delivering SATCOM services to the government at slightly different prices, but at different levels of risk. In this case, how would one price the risk to identify the acceptable difference in price one is willing to pay for lower risk? Or put in a different way, is there an equivalent for the government of the IRR approach where it can price risk and the opportunity cost of using its capital. Some approaches in the literature [5] have proposed a "social opportunity cost of capital" or "social rate of time preference". One approach that has gained

traction in several countries is the Public Sector Discount Rate (PDSR) ([4], [5]). This is equivalent to the IRR as it represents the risk as an equivalent demanded “interest rate” when calculating the cost benefit of a given project, and allows for a direct comparison on a monetary basis between projects with different risk levels. At a minimum the PDSR for a risk free project is usually taken as the Treasury bond rate. In other words if the government were using the funds spent for this project to either repurchase treasury bonds or not sell additional treasury bonds, it would be able to gain the bond rate in funds it can use to fund other projects. So the value of the project should be at least as much as the cost of the project plus the amount of interest it would have saved. But now we assumed that the project is risk free. We know however of several government projects that either never complete due to technical or political difficulties, or that overrun on their budget and schedule. If this risk was taken into account at the initial decision point of the project, then a different project may have been chosen, so the government now will forgo the extra capital it could have used elsewhere. This is where the PDSR comes in, to account for both these two terms. There are many ways PDSR is calculated. Sometimes it’s a heuristic number based on historical rates or risk and budget overruns. In [5] we see a method that a weighted average cost of capital method is used into a capital asset pricing model, and uses standard values of risk premiums for different types of projects, e.g. transportation versus telecommunication. The general agreement is that higher tech projects would have a higher PDSR, so SATCOM projects would be on the higher end of the scale. A more detailed analysis of how PDSR would be calculated for a SATCOM partnership is beyond the scope of this paper, but suffice it to say that there are methods we can calculate it and incorporate risk of either the project itself, or the historical risk associated with the particular agency or program office undertaking the project.

So in general the project will be in the governments best interest if the value of the capability when it is fielded is greater the cost minus any leftover residual value (for example reusing terminals for another agency or reselling them to another country) once you take out any disposal costs associate with decommissioning of the system. To get the value over the entire lifetime of the system you would translate all the costs incurred at each year i to the final year of operation n , by using the PDSR as the “social rate of time preference” in some sense.

$$Value_{capability} \geq \sum_{i=1}^n (1 + PSDR)^i * [R\&D^i + N_t^i * Price_t^i + N_s^i * Price_s^i + n_l^i * Price_{lease}^i + O\&M^i + Cost_{oversight}^i + Cost_{integration}^i + Cost_{Test\&Cert}^i] + (1 + PSDR)^n * [Cost_{disposal} - Value_{Residual}^G] \quad [2]$$

In equation [2] we see the detailed breakdown. The right hand side can be viewed as the government equivalent of the NPV, but in this case it is the Net Future Costs (NFC) the government will incur during the project. Some of the terms in equation [2] are the same as in equation [1]. The ones that are different are the $R\&D^i$ which are the R&D costs incurred at year i ; $O\&M^i$ is the operations and maintenance costs incurred at year i ; $Cost_{oversight}^i$ is the cost of oversight at year i ; $Cost_{integration}^i$ is the cost to integrate terminals our ground stations equipment into platforms such as aircraft and vehicles (which in some cases can be very significant) at year i ; $Cost_{test\&cert}^i$ is the cost at year i of any government testing and or certifications that often government agencies require. $Cost_{disposal}$ is any disposal costs of the system such as dismantling ground stations, or any hazardous materials in terminals or infrastructure; and finally $Value_{residual}^G$ is any residual value the government can get from either re-using some of the equipment elsewhere, or by outright selling it at the end of lifetime. Note that this is different that $Value_{residual}^f$ in equation [1] that the firm can get from selling any equipment it has in its possession at the end of the partnership. The costs incurred at year i are all summed from year 1 to year n .

We can now use this to guide for making tradeoffs as to what would be in the governments' best interest to meet its value target, adjusted for risk, by trading terms within equation [2] but also across equation [2] and equation [1]. So for example, we said for equation one we might have to assign the IP to the contractor to make the profit equation work for the firm. But now the government may worry that if some aspects of the systems are proprietary it may lead to higher prices in the future due to decreased competition. So depending on how the government thinks it will affect the prices it may negotiate the integration costs, which is what often locks the government into a specific solution, to be allocated to the firm as cost of capturing the opportunity. Or maybe negotiate the O&M into the contract as the firm's responsibility. Or maybe the terminal price will rise, but the overall risk is lower so the PDSR will drop, thus reducing the right hand side of the equation. When looking at any of these tradeoffs, one must be careful to take into account how each tradeoff will affect each other term of each equation, or how it will affect terms across the equations. This is where the market block also comes in. For the example of IP we used, this has effects in the market by raising the barriers to entry for new firms to compete. However there other ways of

enforcing standards and interfaces at appropriate locations in the design, that may allow firms to compete on systems elements where performance is critical, while still lowering the barrier to entry for new entrants competing for these government contracts. For example, we may want firms to compete on the modem design, but the antenna due to the integration costs has to be standard, so we standardize the antenna Size weight and power, fittings and the interface to the antenna, and let firms compete on the rest of the system. So we have to carefully consider how changes in the market, profit and costs blocks affect each other, and tailor each one in ways that makes it beneficial to all parties to participate into the partnership.

V. EXAMPLE: HOSTED PAYLOAD

We will use a completely hypothetical example to illustrate how one would use this concept. We envision the use of the canvas on large whiteboard, so the limited real estate on this page make it seem crowded even for this simple example. However one could choose to create several of these for different aspects, or reduce the number of relationships depicted on the canvas. The main point of this is to highlight the main relationships and how they drive cost elements in an easy to see graphical manner, that would then allow you to take the equations and make the more quantitative tradeoffs to see how one could modify this to optimize both industry profit and government cost.

So let's assume the business model we want to capture and brainstorm on is a partnership for a government built payload hosted on a commercial satellite built and operated by a commercial industry. Let us also assume that the government lab that designed the payload also builds the payload, while the commercial provider has the responsibility of integrating it. Let us also assume that the capability provided is a communications capability for users that already have terminals and that are used on similar satellites, and that they can be used without any modification. So let's start populating the blocks:

- The key partners here are assumed to be the satellite builder and operator, we assume there is an international launch partner to further reduce costs, and the government lab that build the satellite
- The industry activities are building and operating the satellite, and integrating the payload. Let us also assume that the integration fees are included in the hosting price.

- We assume that the key technologies used here are the payload developed by the government lab, but we will also assume that there is a standard well known payload interface on the satellite that the government lab can easily design to, and that this further lowers costs.
- Government activities are the program office that manages the project, and the government lab that has technical oversight of the project. Let us also assume (for simplicity's sake) that the government lab is already paid for from unrelated R&D funds, and uses these to pay for its participation to the project
- The acquisition contracting approach used here is assumed to be a fixed costs contract to lower risk.
- The architecture is assumed to be an existing one, with users already owning and having the terminals integrated into their terminals. So stakeholders are these users.
- We assume this is a small one-time project, and that the commercial satellite provider has already pre-sold all of its capacity, and that there are no real market dependencies. However if, for example, the satellite provider is dependent in getting enough subscribers to sign up in order to get to launch, then that would be a market dependency we would capture.
- The industry profit formula is now much simpler, since most of the terms dropped out. If we wanted however to explore for example how much the contractor would be willing to drop the price if we gave them residual capacity on our payload, we would could add that value into the model. Note also here that the cost of the capturing the opportunity is the actual value of the unused real estate on the satellite.
- In the government costs we just have the R&D costs, and the price times the number of systems purchased which is one. We also include the cost of oversight and integration. But we have assumed those to be zero, we just include them for illustration of potential tradeoffs later in this section.

The completed canvas is shown in figure 3.

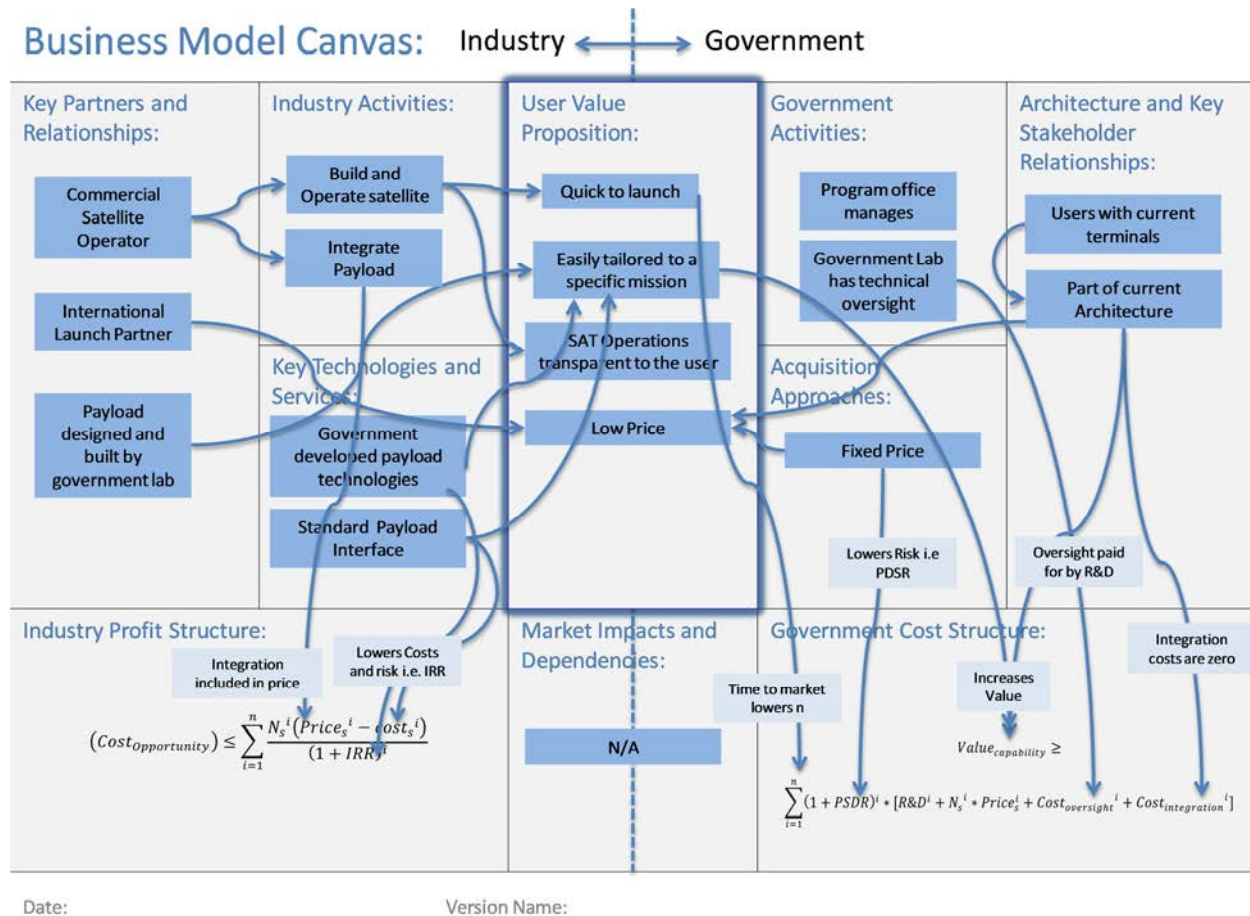


Figure 3. The Business Model Canvas for a Hosted Payload Partnership

Here we use dark blue to depict the elements in each block, arrows to show relationships between block elements and light blue boxes that explain how block elements affect cost elements. Note that all relationships here are depicted to be positive. In other words, a blue arrow indicates that the starting block influences the receiving block in a positive or at most neutral way. We could have negative effects potentially by using red arrows, or light red boxes, but for the sake of simplicity we chose an example that this would not be needed. But one could complicate their graphical nomenclature as much or as little as they need to. So for example, we depict that the choice of commercial satellite operator drives the choice of industry activities to have a commercial entity build and operate, the satellite and integrate the payload. This now makes it quicker to launch. The choice of a government lab to design the payload means that we can tailor the payload to the operational mission. The fact that we are tying into an existing architecture and using existing terminals, as well as the fact we are using an international low cost launch

partner helps lower the costs. Also to easily tailor the capability to the mission we would need a standard interface on the bus for hosted payloads, so maybe that is what drove us to this specific satellite builder. You can envision many ways one can setup and tradeoff these relationships. But the main point is that now you can envision how these relationships are setup, and how you can add or change them to make the business mode more complete. For the elements that affect costs we have arrows depicting that with a note in a light blue box of how the price is affected. So for example the fact that this is part of an existing deployed architecture, and that the capability is easily tailorable to the users' needs, drives up the overall value to the government. The quick time to launch drives down the exponent n , which has a significant impact on cost. The fixed price contract significantly lowers financial risk, so it lowers PDSR. Similar arguments can be made for the rest of the relationships depicted in figure 3. Now, if for example we were trying to look at different alternatives, and one was based on new terminals that were not integrated on platforms, but had a price advantage and lower risk for the hosted payload, we could now compare the two and see how risk and cost elements would compare against the overall value gained from the project, and at the same time see if the proposition is still profitable to the industry partner. It would also allow us to move cost terms around in what if scenarios, and even help us identify incentives that could tip the balance on both sides in favor of the project.

VI. CONCLUSIONS

In this paper we presented a method to capture a joint business model for a joint government-industry partnership to deliver satellite communications in support of government missions. We first presented what a “business model” in general means to the larger community, and then chose the two related definitions in [1] and [2]. We then took the framework in [1] and extended it for a joint government industry partnership, and in particular for satellite communications. However the existing model did not adequately address the tradeoffs between industry and government in their NPV and NFC (Net Future Costs) respectively, as well as how to allocate and tradeoff risk between the partners and across different alternatives so we developed a first order approximation for the NPV and NCF and established a quantitative criterion for successfully setting up the partnership and a methodology to tradeoff cost and profit elements. Finally we showed how the canvas can be used to brainstorm and capture a hypothetical hosted payload business model, and showed how we can depict relationships between the elements of the model and with the cost elements themselves. While we recognize there are some difficulties in the framework

such as estimating IRR and PSDR for different types of partnerships, as well as the value of a given capability to the government. However, we did present a few ideas of how we can start looking at these and how these can become topics of future research. While the estimates we developed here are not budget quality estimates that can be used to make final project decisions, they are useful to guide teams in the early discovery process of how to think about these types of partnerships in some quantitative sense, and capture their thoughts on how the elements of the partnership would relate to each other in a way that allows them to visualize and quickly estimate impacts of trades on cost drivers for both industry and the government. While this is not how traditionally these partnerships have been setup, this approach allows for new integrative negotiation approaches between industry and government to find common ground and setup mutually beneficial partnerships. Also note that while this study was performed for satellite communications types of projects in particular, there is nothing that prevents it from being easily extended into other areas of government-industry partnerships in general. Throughout this paper we have avoided using the commonly used term “Private Public Partnerships” (PPPs) as this sometimes has specific connotations that may limit ones imagination. But in essence this can become a canvas for assessing and capturing business model for PPPs, which a topic of growing interest in this climate of declining budgets worldwide.

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