Questioning NRO's Costly Assumptions about the Industrial Base

Issue: The National Reconnaissance Office (NRO) buys intelligence satellites faster than necessary to meet mission requirements in an effort to stabilize the industrial base. Its assumptions about how fast it needs to buy satellites in order to achieve industrial base stability have not been sufficiently scrutinized. A thorough review of these assumptions may reveal the potential for billions of dollars in savings over the next decade.

Scope Note: This report is part of a larger HPSCI study on Intelligence major systems acquisition, which was published to the Intelligence Community in July 2014. The larger study scrutinized the Intelligence Community's acquisition practices in terms of its ability to think architecturally and to strike a reasonable balance among cost, performance, schedule and risk. It included several case studies of individual satellite programs, which informed this overarching issue paper on industrial base assumptions.

Background: The market for US intelligence satellites lacks the efficiencies common to typical commercial markets. There is generally only one buyer (the NRO), and once a satellite has been selected for a particular mission, there are strong barriers to entry for competitors. This is because the NRO generally believes it is too technically risky to switch contractors once one has built expertise on a highly complex and vertically integrated satellite program. Further, NRO acquisition practices tend to reinforce this non-competitive situation, as described below.

NRO chooses the quantity and frequency of its satellite purchases using two considerations: (1) constellation replenishment plans based on mission need, using a methodology known as functional availability[1]; and (2) industrial base considerations. There is often tension between these two considerations. Functional availability is used to forecast the constellation's performance and risk relative to intelligence mission need, and the industrial base is considered to ensure it will be able to supply the satellites when NRO needs them.

NRO often buys satellites at a faster pace than required for functional availability in order to keep its space industrial base strong.[2] NRO makes various assumptions about which factors affect the health of the industrial base. Many of these assumptions are informed by the prime contractor, who tells NRO how often it needs to produce a satellite to keep its workforce in place and its subcontractors on sound financial footing. However, NRO lacks sufficient visibility into industry to thoroughly verify these assumptions, and they have not been externally verified. If NRO plans to continue buying satellites faster than it strictly needs them to meet mission requirements, its assumptions about the industrial base should be verified.

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[1] The probability that a satellite constellation will perform its mission as a function of time.

[2] There is also a widely-held perception among overseers that functional availability forecasts are too conservative.

Unverified Assumptions Lead to Excess Satellites

NRO assumes it must buy satellites at a relatively fast pace because a slower pace would lead to an increased cost per satellite. Slower production paces can also increase technical risk, but much of the increased risk is priced into the higher unit cost. Unless the higher cost of slower production exceeds the cost of an excess satellite, the assumption that slower paces are too costly is flawed. It may be true that cost performance is degraded when the Government has to pay extra for the same capability because it stretched the production pace. But the additional unit cost that results from a slower production pace needs to be weighed against the total cost of excess satellites.

Example 1: Buying Extra Satellites in the Name of Better Cost Performance
NRO's Cost Analysis Improvement Group (CAIG) built a model to prove the case for transitioning to an evolutionary acquisition strategy (buying satellites at a fixed schedule to satisfy the mission requirement and provide industrial base stability). When it ran a hypothetical test case (based on a particular satellite program) through the model, the CAIG identified the following options for how to schedule satellite purchases over a number of years:

	Centers	Total # of Satellites	Cost per Satellite	Total Cost
Based on Need	2.4 years	8	~$1.25 B	~$10.0 B
Optimize the Industrial Base	1.6 years	13	~$1.18 B	~$14.5 B
"Balanced Solution"	2.0 years	10	~$1.18 B	~$11.8 B
Delta b/w "Balanced Solution" and Need	(0.4 years)	2	~($0.07 B)	~+$1.8 B

*Number of satellites and all costs are representative for classification reasons, but proportions are real

NRO used this result to illustrate that the best approach in this example would be a "balanced solution." Its argument is that this option provides better cost performance because the cost per satellite is about $0.07 billion less than buying based on need. While it is true that the unit cost performance of the "balanced solution" is better than buying based on need, the total cost is about $1.8 billion greater. It would also lead to NRO paying to launch two more satellites than it needed at an additional cost of about $0.7 billion.[3] Therefore, **NRO's "balanced solution" would lead to buying two more satellites than it needed at an additional cost of ~$2.5 billion.**

NRO may argue that the additional cost is justified by reduced technical risk. Excess satellites provide insurance against malfunction or launch failure. However, the benefit of this extra insurance is dubious because functional availability already accounts for these risks. NRO also argues that a closer to optimal production pace for industry may reduce the risk of manufacturing defects that cause functional problems. However, reduced manufacturing risk needs to be quantified along with cost in order to justify paying extra for it.

The higher unit cost associated with purchasing based on need already reflects those increased risk factors the prime contractor considers relevant. For example, it reflects supplier instability and the need for additional testing. The extra cost of the "balanced solution" in this example (~$2.5 billion) is about 20 percent more than the total cost based on need.[4] To justify this, NRO would need to quantify any risk factors beyond those already considered by the prime contractor and demonstrate that eliminating these factors warrants a 20 percent increase in total cost.

This particular satellite program has very rarely experienced significant failures on orbit, and the failure rate of NRO satellites in general is extremely low. This is a credit to both NRO and its industry partners, but it also partially reflects NRO's organizational aversion to risk. NRO weighs risk differently than cost, so it is difficult to do a direct comparison between an incremental cost increase and incremental risk increase. However, if NRO were to explicitly weigh risk against cost in this example, it may decide that a slower production pace is ideal despite its risk aversion. There is an opportunity cost to buying excess satellites, especially in a time of flat or declining budgets, and NRO should consider whether there are better investments.

Example 2: Restarting a Satellite Program

One of the few well-documented cases of the cost of production gaps (the most extreme version of a slowed production pace) can be used to illustrate the flawed assumption that slower production is invariably costlier than excess capacity. After the failure of a replacement architecture for a particular type of satellite, the Government directed the prime contractor for the old satellite program to restart its production line. NRO invested about $1.8 billion[5] in non-recurring engineering to restore the program to its previous capability. This is the kind of restart cost NRO is trying to avoid by preventing slower production and gaps. Therefore, it can be used as a very conservative case study of weighing the cost of restarting a program after a production gap against the cost of excess capacity.

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[3] Based on a HPSCI estimate in lieu of an NRO integrated launch cost
[4] ~$12.9 billion including launch
[5] This is a representative number for classification reasons.

The below table shows the costs of the two satellites produced after the re-start (including start-up costs) and the notional estimated cost of a third satellite, which was under careful consideration, but was never produced.

	Start-up Cost	**Total Cost**
Satellite 1	~$1.2 B	~$3.5 B
Satellite 2	~$0.6 B	~$3.2 B
Subtotal (Satellites 1/2)	*~$1.8 B*	*~$6.7 B*
Satellite 3 (estimated)	n/a	~$3.3 B
Total (Satellites 1/2/3)	*~$1.8 B*	*~$10 B*

*Number of satellites and all costs are representative for classification reasons, but proportions are real

NRO generally buys this type of satellite faster than necessary to meet mission requirements. Since these satellites consistently well exceed their design lives, fewer of them will be required for functional availability in a given time period.

Let us assume that the third satellite after the re-start had been built instead of moving on to the next generation, and that three satellites were purchased in a time window for which only two satellites were required. In this scenario, the Government would have spent a total of about $10 billion instead of meeting the requirement at a total cost of about $6.7 billion. **Therefore, the cost of producing an extra satellite in this example (~ $3.3 billion) is almost twice the start-up cost (~ $1.8 billion).**

It is understandable that NRO would want to avoid paying ~$1.8 billion to restart a cold production line, but this cost has to be weighed against the cost of producing an extra satellite to support the industrial base. The above example illustrates that as costly as an actual and severe production gap was, it was less costly than purchasing an extra satellite.

Here too NRO could argue that buying an extra satellite is justified because it reduces the risk associated with production gaps. However, the cost of an additional satellite in percentage terms seems much higher than any reasonable estimate of the increased risk from a production gap. The extra cost in this hypothetical example (~$3.3 billion) is 49 percent more than the cost of meeting the requirement. Even a very conservative estimate of increased risk from slowing the production pace would not likely approach 49 percent.

Slow Production Pace Issues

NRO assumes that satellite production at slower than industry's optimal pace imposes additional costs and drives up risk. The assumed additional costs fall into two main categories: inefficiencies from prime contractors spreading their workforces too thin, and subcontractor instability due to inconsistent work.

Prime Contractor Workforce Issues

Prime contractors argue that if slowed production leads to any gaps, engineers will have to move on to other work, resulting in lost expertise. This will lead to inefficiencies because new engineers will have to be brought up to speed on the program.

Prime contractors make many assumptions about the inflexibility of their workforces, which the Government generally accepts. However, there have been no known studies about workforce flexibility in the intelligence satellite industry. Presumably, contractors would benefit from studying ways to increase the flexibility of their engineers (e.g. cross-training, rotations, incentives to return to programs within their expertise). Funding stability is always a concern with government contracts, so it would behoove contractors to mitigate the risk of less than ideal production paces.

Subcontractor Instability & Dependence on Specialized Parts

Prime contractors also argue that some of their mission-unique suppliers will go out of business if there is too much time between satellite purchases. Some of the critical parts provided by third or fourth tier contractors are single-source and there is no commercial market for them. NRO depends on these suppliers because it requires many specialized parts, and they depend on NRO to stay in business.

NRO knows who these specialized single-source suppliers are because it maintains a database of critical parts and works with the Air Force and NASA to stabilize critical suppliers who are struggling. However, there is often only one supplier simply because the market does not support more than one, not because the part is so specialized that only one supplier *can* produce it. Therefore, if one supplier exits the market due to reduced work from a slower production pace, the work could be shifted to another supplier at some cost or acquired by the prime contractor.

It is unclear how many third and fourth tier subcontractors are at risk of being put out of business by slower production paces. Here too the Government and prime contractors seem to make untested assumptions about the prevalence of this problem but real market research is rare.

Preliminary results from the Department of Commerce's ongoing "Space Industrial Base" survey suggest that the number and fragility of these mission-unique suppliers may be exaggerated.

The Need for Standardization: The mutual dependence between NRO and small specialized suppliers creates inefficiencies that could be avoided if NRO used more standardized parts. The market for parts would likely be much more efficient if NRO was willing to relax some of its most stringent requirements to allow for a standard commercial space part providing, notionally, the 80 percent solution instead of a highly specialized part providing the 100 percent solution. And for the parts that really do need to be specialized for NRO, some level of standardization among NRO programs would at least grow the market for these parts. If NRO could use more commercial parts, or at least more standardized parts, it could reduce its exposure to the fragility of small specialized suppliers.

The Space Universal Modular Architecture (SUMO) group within ODNI has been trying to build support for standardized satellite interfaces, which is at least a step in the right direction. However, SUMO has received little buy-in from the IC despite a business case based on Aerospace Corporation modeling that projects $18.8 billion in savings over 17 years. Standardization of interfaces and components may require some up-front investment but the potential long-term savings are significant.

Evaluation

Government assumptions about the cost of slower production paces are mostly based on information from prime contractors. The NRO CAIG also runs models such as the one used to support evolutionary acquisition (mentioned above), but these are based on historical data that reflect the same dynamic between prime contractors and NRO. The Government does not independently verify that the ideal production paces indicated by contractors are correct. These production pace rules of thumb may be ideal for industry but not for the Government. Given that the contractor has an incentive to convey the need for a fast production pace, it is vital that the Government does its own check.

The Defense Contract Audit Agency (DCAA) audits NRO satellite contracts but it generally focuses on the prime contractor and major subcontractors. DCAA only audits small suppliers if specifically asked, and has more difficulty validating sole-source prices. DCAA does not make judgments on production pacing unless the prime contractor's proposal specifically identifies price points for different pacing options. However, NRO requests for proposals rarely include different pacing options, so DCAA generally does not have the opportunity to validate the cost of slower paces.

The most promising effort the Committee has seen so far to check Government assumptions about the industrial base is the Department of Commerce's "Space Industrial Base Deep Dive." The Air Force requested the study to improve its business intelligence on space programs, and NASA and NRO became co-sponsors. The survey, which includes classified NRO programs, is ongoing but has already yielded valuable information by identifying trends in the industry and mapping out interdependencies with social network diagrams. However, the Committee has not seen a plan for how NRO will use the data when the study is complete.

The Department of Commerce study has the potential to shed some light on NRO's assumptions about production paces, if it is used correctly. In particular, it could help NRO assess whether its prime contractors are accurately representing the dependencies and fragility of their subcontractors. If this study fails to help the IC check its assumptions, ODNI could commission a more tailored study to be performed by an FFRDC or other independent organization.

Unverified assumptions about the industrial base may be particularly costly for the Intelligence Community because:

- It is subject to less oversight than unclassified programs, whose major acquisitions are reviewed by organizations like GAO and the Defense Contract Management Agency.

- There is limited competition among contractors because most major contracts are sole-source.

Therefore, the burden should be on the ODNI and NRO to take additional steps in ensuring their assumptions are correct and they are not paying more than necessary to meet requirements.

Slowing production paces in the examples above, and for many other NRO programs, could yield significant cost savings. Some may argue that the potential cost savings are not worth even a small increase in risk. However, in a time of flat or declining budgets, NRO's extreme risk aversion should be revisited. If it cannot justify buying excess capacity to avoid a relatively small increase in risk, it should slow the pace at which it buys satellites.

Recommendations

Recommendation #1: ODNI should verify NRO's assumptions about production paces and the industrial base. Instead of relying on information from prime contractors and running models that aggregate historical information, NRO should have its assumptions externally verified.

> ***Recommendation #1a:*** NRO and ODNI should create a plan for using the Department of Commerce data to verify assumptions.

Recommendation #1b: ODNI should start exploring alternative studies to verify assumptions in case the Department of Commerce results are inadequate.

Recommendation #2: NRO should include multiple paces in all requests for proposals on new satellite block buys.[6] The specified paces should include one based solely on functional availability to establish a baseline for cost comparisons. DCAA and NRO should both scrutinize the price differences of the various pacing options.

Recommendation #3: NRO should justify to ODNI and Congress how it chooses the pace of its satellite acquisitions. NRO should be specifically required to demonstrate during the acquisition process that it weighed the estimated additional cost of a slower production pace against the cost of excess satellites.[7] If NRO requests excess satellites, it should either have to show that the cost of the excess satellite is lower than anticipated additional cost from a slower production pace or that the cost of the excess satellite is necessary to reduce risk. (The risk would need to be quantified in terms of dollars).

Recommendation #4: Prime contractors should be required to notify NRO of any single-source suppliers it uses. NRO should consider modifying requirements when these single-source parts are identified such that a standard commercial part could be used instead of a specialized part. NRO should build this flexibility into its prime contracts upfront.

Recommendation #5: ODNI should develop a plan on how to encourage more standardization of components and parts on IC satellites. It should also include a strategy for implementing and securing funding for the standardization of interfaces through the Space Universal Modular Architecture.

[6] This may delay proposals slightly and/or cause a small cost increase but it will likely be insignificant compared to potential overall savings.
[7] Proprietary data may need to be redacted for source selection sensitive contracts.

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