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America's Space Program - What's Ahead?

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Integrating Scientific Payloads in a Commercial Launch Market

by
Kevin M. Berry

Abstract

Scientific and research payloads are fundamentally different from commercial satellites. This paper presents an integration model to accommodate the special needs of R&D, science, and first time payloads in a launch market which is being developed mostly for commercial communications satellites. The model is supported by actual examples of process changes implemented in the Space Shuttle program.

Introduction

Lockheed Martin Space Operations is responsible for representing the Shuttle launch processing community to payload users. Over the past seven years, the focus of Shuttle flights has changed from commercial payloads to scientific missions and R&D of International Space Station hardware and procedures. The high volume of payloads flown, their widely varying complexity, and the changing budgetary picture has allowed the individuals involved to develop a model of the ideal process for handling these unique missions.

While NASA is refocusing on "better, faster, cheaper" science missions, the launch industry is busily planning for the inexpensive launch of hundreds of small communications satellites. Cheap launches will be a boon for the science community, but the integration process for the two kinds of payloads is vastly different.

This paper will:

- Explain the differences between commercial and scientific payload processing
- Define the goal for the ideal process
- Present the characteristics of a good integration process
- Show successful examples from the Shuttle program's efforts

This paper was prepared to satisfy the curiosity of the author. While information was obtained from LMSO and NASA management and employees, all conclusions and opinions are solely those of the author.

Opportunities for Flight

The supply of relatively inexpensive launch slots available over the next ten years looks very favorable for the scientific community. The ongoing Shuttle program, the possible advent of the X-34 (or its international cousins), and the rebirth of small launcher development to support the personal communications industry will provide opportunities for cheap spaceflight.

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However, there is more to space flight than finding a slot on a booster. There are real, fundamental differences between commercial payloads and science missions. One time or first time payloads, even if commercial in nature, often resemble science missions because the hardware may still be under development during the launch integration cycle.

Differences Between Commercial and Scientific Payloads

The difference may be simply stated: Commercial customers want *stability* and *simplicity*. Scientific and R&D customers want *flexibility* and *support*. This basic difference in mindset, stability vs. flexibility, is the root cause of many problems for both types of customers in any launch market.

A repetitive commercial customer both desires a stable interface, and provides one. This is true for hardware, software, and personnel. They want minimum interference from the launching organization during off line payload buildup, and only request special or nonscheduled support for serious contingencies.

Customers flying R&D, scientific, or first time payloads are usually in a “seeking” mode. The launch site must first provide education, and help the customer know what to ask for. Their hardware and software design is often in flux during the planning process. In offline buildup, they often find design problems, fabrication errors, or faulty test procedures. Also, due to the complexity and nature of today’s science missions, the first time that they can characterize the “as built” performance of communications, power or cryogenic systems is at the launch site after final assembly. In some cases, this characterization cannot be done until just before launch.

In the area of operations and planning the same differences are found. The commercial flyer accurately knows the duration and support needed for each operation before arrival, through previous experience. The noncommercial customer often is still doing initial planning for integrated operations after they arrive at the launch base. This requires the launch base host to scramble around, arranging for special tools, access platforms, skilled technicians, or laboratory support.

Goal Statement for the Integration Process

The launching organization will provide an integration process to all customers, commercial or scientific, that:

- *Minimizes cost*
- *Maximizes customer control of their processing*
- *Clearly communicates the musts, wants and desires of both parties*
- *Encourages standardized interfaces while accommodating legitimate variances or no-impact nonstandard requirements*

Characteristics of an Ideal Integration Process

There are four specific characteristics that can be used to evaluate this process: linkage, cost control, flexibility, and level of support.

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Linkage is made up of two elements: communication and feedback. The first element, communication, means that requirements must be well thought out by the initiator, documented clearly, explained to the launch site, and implemented correctly. Likewise, constraints that the launch community puts on the payload customer must be transmitted and understood. The second element, feedback, means that the status of implementation and variances noticed must be systematically returned to the initiator.

These interactive connections between requirements and processes are necessary to allow the integration process to “learn” from the as run timelines, problems, and enhancements. The goal of a tightly linked system is for the initiator and implementer to always understand the who, what, when, why, where and how for any requirement. Both parties must also understand how each requirement fits into the “big picture,” so issues and variances can be resolved.

Cost control and crisp accounting are one key to successor failure in marketing launch services to the scientific community. Each standard service used by the customer must be rigidly defined and priced. This allows the user, who typically is working on a tight budget, to accurately understand future expenses. Agreements must be reached before the hardware flow for “preplanned contingencies” such as a launch scrub/payload refurbishment, extremely late access due to a last minute failure, or off-line laboratory support. The goal is to minimize retroactive analysis of costs for unplanned or misunderstood operations.

When a unique service is requested, real costs must be predicted and captured. This assures the customer that they are being fairly treated, and allows the integrator to ask the key question, “should this service be added as a new standard feature, or discouraged from future use?”

Flexibility by both the launch provider and the payload customer greatly increases the ease of integration. The launch base must realize that, by their nature, scientific, R&D or first time payloads are prone to failures, problems during assembly, and changing requirements. The customer’s staff is probably also new to the process. Since the booster contractor has often seen dozens, if not hundreds, of payloads come and go, they have an intuitive feel for the readiness of the payload and payload customer to launch.

The customers must realize that launching rockets is not, by any means, a science. Complex variables of weather, staffing, hardware problems, range schedules, and budget set the odds of a launch occurring on time. If the customer understands this early in the design process, and sorts out their requirements into the classic formula of “musts, wants and desires,” they can prevent many conflicts and issues before they arise. The classic error common to new spacecraft is that the builder doesn’t think about launch base processing until they arrive at the site!

Support, even more than cost, is the yardstick that decides whether any customer comes back for a second ride. The important thing for a launch site integrator to remember is that level of support is a perception, not a metric. Payload customers can view a disastrous flow in a positive light, if they feel that they were treated honestly, with respect, and that the integrator went “above and beyond” the written agreements. Conversely, a flow that made every schedule milestone, had no hardware failures, and launched on time can be overshadowed by a climate of hostility and arrogance. The key to a successful integration process is to do the “above and beyond” tasks while charging only for items that the customer should have anticipated, and that caused a real launch base impact.

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Space Shuttle Transition from Commercial to R&D Payloads

The Space Shuttle program has gone through several transitions that show the differences between commercial and scientific payloads. Before the Challenger disaster, NASA was relying on commercial missions to pay for most launches, while flying some science flights. In the massive changes that followed the investigations, it was decided that the Shuttle was more appropriate as a booster for scientific missions. The SDI and International Space Station programs created a large number of R&D payloads.

Recognizing that the post Challenger integration process was unwieldy and too long, NASA formed a team to look at the Payload Integration process and template. Over several years, the team shortened the template by nearly four months. A new class of payloads was created to specifically support R&D efforts. These are being integrated using the “better, faster, cheaper” model. “Freeze points” were created to try to penalize late changes with additional overhead and approvals.

A second wave of improvement efforts is being driven by two factors: budget decreases and TQM. With reduced budget naturally comes an examination of processes to eliminate “non-value added” work. To facilitate their TQM efforts, NASA implemented a version of the Integrated Product Team concept. Both of these efforts have added efficiency from the payload customer’s standpoint.

While the efforts to shorten the template and perform the integration process more quickly have been successful, a strain has been placed on both the design agencies and launch site. Problems arise because the payload customers and NASA integrators find it difficult to identify requirements early enough to avoid impacts to the downstream process. The launch site has responded with their own efforts to find ways to absorb changes later without impacts. These efforts have met with some success. Over the last year, the total hours expended to absorb these changes has remained the same, even though the number of late changes has doubled.

The lessons learned from this activity can be summarized as follows:

- The “Freeze Point” concept worked, but late changes need to be categorized as to the reason for being late. Human error is unavoidable, but mistakes due to the process must be used to improve it.
- The large infrastructure of the Shuttle program allows deep support to the payload customer, if communications difficulties can be overcome.
- There is no real ability to perform the kind of cost accounting, to an individual payload level, that would allow the preceding model to be implemented. The upcoming efforts to “privatize” the Shuttle program may provide some opportunities to work on this.

Conclusion

The launch market is going to become more competitive and overcrowded over the next ten years. Customer service will be a key deciding factor in acquiring market share. The model presented in this paper, if effectively implemented, will provide the flexibility and support needed for science missions, while preserving the stability and cost control needed for commercial satellites. The influx of new boosters and ongoing commercialization should provide the R&D community a “brave new world” of cheap, quick launches. Systems and attitudes to support a smooth integration process must be built in from the start.