

Aesop's Guide to Space Acquisition

Glimpses of Past and Future

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10 United States Code (U.S.C.) § 2273—Policy regarding assured access to space: national security payloads, establishes the requirement for the President to ensure our access to space.

(a) Policy—It is the policy of the United States for the President to undertake actions appropriate to ensure, to the maximum extent practicable, that the United States has the capabilities necessary to launch and insert United States national security payloads into space whenever such payloads are needed in space.

The United States and the world are witnessing a transformation of space. More countries are reaching space, or trying to, crowding it more and more. Years of satellite launches, collisions and anti-satellite weapons testing have left lots of junk and debris. Although we have never faced a situation where wars on Earth have escalated into space, there is a potential to do so. Through all events, the president must assure access to space.

Although the thrust of Section 2273 is to assure payload launch, the authors believe the broader picture includes acquiring the needed assets (e.g., navigation, weather, communication, and reconnaissance), launching them, and ensuring their continued viability and vitality on orbit. This requires a combination of National Security Space (NSS) architecture and smart space acquisition. This paper addresses the latter.

Bottom Line Up Front (BLUF)? Space acquisition needs long-haul, cost-effective solutions to increasingly difficult challenges. We may wish advances in space were like the birth of Athena, born full grown, complete with armor, directly from her father Zeus' head—the reason she is associated with wisdom. Unfortunately, that is not the case with space advances. A more reasonable model is suggested by Aesop's fable of the tortoise and the hare: Slow but steady wins the race—in this case, the space race. This approach has served us well for several decades. Given the transformational upheaval expected in the next century, we need all the tools we can get in our space acquisition toolbox (i.e., new developments, evolution of existing systems, and augmentation with commercial and non-space assets) and a whole new way of perceiving our space systems as an Enterprise.

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Table 1. Evolution of Thor to Delta II

Rocket	Height	Circumference	Mass	Payload	Success Rate
Thor	19.76 m	2.44 m	49,590 kg	1,000 kg (Ballistic)	76%
Delta	19.76 m	2.44 m	49,590 kg	45 kg (LEO)	92%
Delta II	38.2 - 39 m	2.44 m	151,700 - 231,870 kg	2,700 - 6,100 kg (LEO) 900 - 2,170 kg (GTO)	99%

Note: Data from Wikipedia, June 4, 2014.

George Santayana offers wisdom to guide us: “Progress, far from consisting in change, depends on retentiveness. . . . Those who cannot remember the past are condemned to repeat it.” Although we may strive for breakthroughs, we need to bridge them with incremental advances and evolution of current architectures.

Slow But Steady Wins the Race

Delta Launch Vehicles: We got out of the blocks late in the space race, with the 1957 Soviet launch of the Sputnik satellite providing a wakeup call. Our beginnings were not auspicious. The Vanguard Program had three successes in 11 launches (a 27 percent success rate); total combined payload of less than 34 kilograms (kg)—about 75 pounds—to orbit. Delta was a different story. (See Table 1, above).

The current Delta IV has a single payload launch capability of 22,560 kg to Low Earth Orbit (LEO), 644 times the lift of all Vanguard launches combined, and a 96 percent success rate. Delta IV did not leap forth full grown from the heads of scientists and engineers but evolved from prior Deltas back to the Thor ballistic missile. Delta was the “D” version of Thor.

Mater Artium Necessitas

For those not familiar with Latin, that phrase from William Horma’s book *Vulgaria* (1519) translates as “Necessity is the Mother of Invention.” Applying that rule to space acquisition is how we develop new solutions or take degraded or useless assets and breathe new life into them.

Space has become exponentially more useful since the 1957 Soviet launch. Utility has grown by leaps and bounds, but each new “out of the box” program usually comes with daunting cost, schedule and software risks. In contrast, steady evolution of existing systems, progressive incorporation of new technologies, and incremental exploitation frequently can provide cost-effective solutions for meeting new requirements or unknown needs. Give people control over a process or system and they will come up with ingenious ways to improve it. On the commercial front, additional uses devised for Velcro, Post-Its and Vicks have demonstrated inventiveness and creativity.

Discoverer/Corona/Gambit: The beginning of space reconnaissance was inauspicious—12 successive failures before the first film bucket of photographic surveillance of the Soviet Union was retrieved from space. It turns out space development is

difficult. A national commitment supported dedicated scientists and engineers through dark days, but “slow but steady” in all parts of the program—satellites, operations, and data exploitation—won the race, and that success marked the beginning of the end of the Cold War. Improvements continued across programs. The high-resolution Gambit program, designed for low-Earth orbit, was given a second engine burn to fly at a higher orbit for part of the mission.

“The Schoolhouse Gang”: Gen. Bernard Schriever set up the organization to build the first Intercontinental Ballistic Missile and intelligence satellites. (“Schoolhouse” comes from the organization’s first residence, a former Catholic boys school in a suburb of Los Angeles.) Schriever created a streamlined program management model that led to the great advancements in space technology that protected this nation.

The satellites evolved over time as two things happened. First, the technology and requirements evolved. Second, the operators, working with the engineers in the factory, learned what the system was capable of doing and learned new ways of using it. A satellite once was left in the wrong orbit by a launch vehicle. At first the satellite was considered useless. But the team created a plan to use the system and found an area of requirements previously unmet. On another occasion, a satellite was nearly out of life and the team used some of the remaining fuel to invert the satellite, flying it “upside down” for years, capturing valuable information. The original Hexagon photoreconnaissance satellite, designed to fly 30 days, was by the end of the program (Block IV) incentivized to fly for a year.

Time and again space operators, their partners in the factory team, and Soldiers, Sailors, Airmen and Marines have shown an ability to use the various parts and aspects of the systems to create new ways of exploiting those systems:

- **Global Positioning System (GPS):** The GPS mission was to develop a precise timing system to improve navigational accuracy worldwide. Originally intended to be a navigation satellite for the nuclear triad, its value as a precise time-distribution system succeeded at the Enterprise level beyond all expectations. “Although the first thing that comes to mind about GPS is navigation, GPS is ubiquitous, even reaching into areas such as banking and investments, through computer clock synchronization. Wikipedia lists a myriad of civilian

applications for GPS (i.e., clock synchronization, cellular telephony, disaster relief and emergency services, geofencing, geotagging, GPS aircraft tracking, GPS tours, mapmaking, navigation, phasor measurements, robotics, recreation, surveying, tectonics, telematics, fleet tracking)." ("An Immodest Proposal," John Krieger, p. 26, *Defense AT&L*, September-October 2012)

- **Milstar:** The original system developers would never have guessed that a few Marines would figure out that Milstar, originally designed to survive a nuclear blast and still provide secure communications for the National Command Authorities (NCA), also could be used to transfer tactical digital data necessary to keep the Marines in the fight.
- **Kepler:** NASA's Kepler Space Observatory looked for distortions in space that could be caused by a new planet. It found 962 possible planets before two reaction wheels failed and it was unable to maintain stability. Engineers found a way to add pressure from the sun to provide the required stability, allowing a "doomed" mission to continue.

These examples show the critical nature of program office, corporate and personnel continuity, knowledge and memory.

The Enterprise

Space: the final frontier . . .

Many will remember the introductory words from the "Star Trek" television series. For those personally involved in space

domains (air, land, sea, space, cyber). Gen. William L. Shelton, then commander of Air Force Space Command, posited that we need to be "reducing costs through cost-effective resilient architectures . . ." (Global Warfare Symposium, Nov. 17, 2011).

In 1707, the Royal Navy lost several ships and more than 1,000 men off Sicily because navigators could not accurately determine their positions. The British Government passed the Longitude Act providing 20,000 pounds for developing a simple method to measure longitude accurately. John Harrison won the competition in 1765, culminating 35 years of developing a chronometer accurate to 5 seconds. Time was the key.

During the early days of GPS, as program manager Brad Parkinson arrived late for a review, someone commented, "Have you ever noticed how all our meetings start 15 minutes late?" Without hesitation, Parkinson responded, "Yes, but precisely 15 minutes late."

Parkinson focused his team on mission, not hardware, by posting goals in the program office's hallway; Enterprise goals, not satellite goals:

- Drop 5 bombs into a single hole.
- Build a receiver for \$10,000.
- Build a receiver that could be carried on a person's back into combat.

(Consider how outlandish the last two seem today, in view of the current cost and size of GPS receivers.)

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acquisition, they may have been a contributing factor. However, the Enterprise that we discuss here is not the USS *Enterprise* (NCC-1701) but a large, difficult undertaking that requires the commitment of extensive resources (e.g., dollars, personnel and time). Big-picture, Enterprise-level solutions are hard to develop requirements for, to budget for, to justify to Congress, to contract, to design, to build, and to deploy—but may be the solutions that we need the most.

The major advocate for Enterprise solutions is that Soldier, Sailor, Airman or Marine with iPad in hand, who calls out for a complete Enterprise-level solution. If we could give the warfighters what they need, we could save lives. There is a critical need to build the most effective combat-capable space force at the Enterprise level, not the system level. We need a space force that cuts across programs, stovepipes, Services, communities (U.S. Government, commercial, and international) and

GPS is an example of an Enterprise-level solution. While the technical design solution was to move atomic clock accuracy to space for easier signal distribution, from the start the satellite was meant to be "dumb." The "brains" of the system were in the control and user segments. The focus of the program was on the total cost of ownership, with source-selection criteria and award-fee criteria for design to life-cycle cost. The program was not just a satellite program; it was Enterprise architecture.

The Air Force and other space acquirers have an opportunity to optimize existing assets, with some augmentation for new technologies, and to use space to exploit new user requirements, even unknown future capabilities. Space can be a platform for the Internet, and all the opportunities that the Internet and the applications summon to mind. The Space-Based Infrared System, for instance, might be a major node

in a system that includes drones, fighters, ships and other assets that would make it even more capable of exploitation by multiple users. Milstar and Advanced Extremely High Frequency could be seen as space servers in an Enterprise-wide network. A broader perspective would be to see the Defense Meteorological Satellite Program as part of a weather Internet app being exploited by multiple users for multiple applications.

The Path Forward

We look forward to a stronger space force able to meet the challenges of the next 100 years; a space force able to protect commercial interests (in Navy parlance, “freedom of the seas”); a space force able to deter an adversary from contemplating offensive operations in space; a space force able to maintain universal freedom in space.

Common Operating Picture (COP): We need to build a COP as we prepare for the 22nd century. Between now and then, what we can say with certainty is that the next quarter-century will see the advent of the following:

- Commodity contracting for space
- Commercial management of government satellites and constellations
- Performance-based logistics (PBL) and contractor logistics support (CLS)
- “Outsourcing”—mission acquisition as services, not products
- Re-establishment of “Defense Enterprise Programs”

(We must leave the discussions of COP and acquisition transformation to another day.)

Tomorrow’s Success and Today’s Innovation

Is there more innovation to be had? Absolutely. Think accepting launches at successful satellite placement, not liftoff. Think eliminating chemical-based launch vehicles, using other concepts for satellite launch, like electromagnets—a technology almost a century old. Both the Navy and the Army are developing electromagnetic technology for launching projectiles. Think on-orbit PBL, refueling and repairing satellites, a la Lockheed’s 1958 Astrotug. Think of the benefits of the last



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- Cross-domain Enterprise architecture and Enterprise-level solutions
- Embedded resilience
- Mixed government and commercial (assets and approaches)
- Hosted payload acceleration
- Dynamic retasking of national collectors
- An international team approach to greater resilience
- Sharing data across stovepipes, Services, agencies and borders
- Assured access to space and quick launch

Acquisition Transformation: We need to carefully consider how to acquire space assets, including adapting to changes driven by commercial space providers that could serve us well. Candidates include:

- Better Buying Power
- Adapting cost and performance incentives to true motivators
- Multiyear contracting, block buys, and economic order quantity (EOQ)
- Capturing the learning curve—continuous product/process improvement
- Government payloads on commercial satellites

two (e.g., launch on demand, greater reliability, safer, cheaper, less pollution). We must do “smart innovation,” making leaps when we can, and incremental improvement when we can’t.

Grand strategy requires grand vision. For space, our grand vision has been set by 10 U.S.C. § 2273—policy regarding assured access to space: national security payloads, as we described it in the introduction. The way to fulfill that grand strategy is to carefully build on what we as a nation already have accomplished in space acquisition.

One final thought, provided by Bernard of Chartres, “*nanos gigantum humeris insidentes*”—“We are dwarfs standing on the shoulders of giants.” When you stand on the shoulders of the likes of Gen. Bernard Schriever, that is not such a bad place to be. For the next 100 years, we can build upon the outstanding space systems that are our inheritance—incrementally, at lower cost, with less risk—if we apply proven lessons learned. Given the challenging task of restructuring our NSS architecture to meet the increasingly demanding environment of the next 100 years, we can’t afford the luxury of getting sidetracked by endless rounds of viewgraph engineering, of unfulfilled promises. 

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