Cubesat Communications: From Traditional Communications Design to Evolved Emerging Space Need

Erik J. Eliasen
SSC Space US, eeliasen@sscspace.com

ABSTRACT

Access to space is becoming a reality to a broader global community of students, scientists, and entrepreneurs. The CubeSat industry is furthering this access to space by standardizing affordable components/subsystem boards. Standards provide for clarity in design, repeatability, and risk reduction.

Standards and Requirements are often seen as opposing forces. The challenge is multi-fold in that: traditional spacecraft communications development is usually a mission ops function and the spacecraft design decides the ground capability. However, when standards are set for the ground segment, the spacecraft designers will utilize pre-qualified radios.

Commercial ground network providers have a unique opportunity to set the stage in the implementation of standards and advance the CubeSat community towards a more desired end state where the space segments are harmonized on the ground by providing flexible, adaptable, and taskable resources on an as-needed basis.

This paper will focus on an acceptable risk mindset to emerge spacecraft operations from a traditional requirements mindset to a more customer focused need.

THE OLD AND THE NEW

The transformation of Satellite Operations (SATOPS) has been on the horizon for quite some time. To understand the transformation, we must define what is “traditional” and what is “the new”. When describing the characteristics of “traditional satellite operations” most people recognize phrases of “60 years of space exploration”, “space is expensive”, and “space is hard”, or ideas founded around process-based requirements in hierarchical organizations. Many traditional space interested organizations perpetuate the status quo, tend to resist change, and fear disruption.

Disruption threatens the traditional status quo. It does this primarily by new entrants and nimble competitors who bring different business models to SATOPS. In the new space environment, companies are focusing on product and service lines of business, not single programs burdened with the overhead of the company.

WHAT ARE COMMERCIAL SPACE SERVICES?

In commercial markets, businesses understand the concept that "value is subjective". This concept means the customer decides where and how to spend money to achieve the value they seek. Said another way: a $10 bill has no value until you trade it for a seat in a movie theater or buy a slice of pizza and a beer after the movie. What this concept does for SATOPS is to provide many options across multiple disciplines that may previously been unknown or unavailable when a requirements documents was authored. Commercial companies serve their customers with an application in either people or products. In an environment where multiple providers are competing for business continuously, my "killer app" idea will still see the light of day and stand on its own merit. Ultimately, it's only if the application is downloaded, will I truly know I created value in the eyes of the customer. This idea, stated more eloquently by Austrian economist F.A. Hayek, goes like this, "Insofar as an economy is market oriented, the ultimate determinate of "where money goes" – that is, of where resources, including labor, go; where the course of productive activity goes; where financing goes – is the detail in the pattern of consumer spending (including consumers' decisions on how much, how long, and in which specific forms). Consumers' decisions ultimately determine where capital and labor "go" and what their values are in alternative uses.

In 1776, Adam Smith described an idealized economic process where individual economic activities not only benefit the self-interests of the individual, but also unwittingly benefit the holistic interests of society. Smith suggests that an economic actor who produces goods of the greatest value "intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention. Nor is it the worse for the society that it was no part of it." This description of the "Invisible Hand" has stood the test of time and shows how the free-market's economic order is an emergent, dynamic, bottom-up, and self-organizing process that no one controls. Essentially, order emerges within a complex adaptive economic system even though it is decentralized and leaderless. This is not exactly the same as the JCIDS process of today.

"FRESH THINKING" for SATOPS

Standards are published documents that establish specifications and procedures designed to ensure the reliability of the materials, products, methods, and/or services people use every day. Standards address a range of issues, including but not limited to, various protocols that help ensure product functionality and compatibility, facilitate interoperability and support consumer safety and public health.

Standards form the fundamental building blocks for product development by establishing consistent protocols that can be universally understood and adopted. This helps fuel compatibility and interoperability and simplifies product development, and speeds time-to-market. Standards also make it easier to understand and compare competing products. As standards are globally adopted and applied in many markets, they also fuel international trade. Standards are not arcane technicalities to be dealt with; rather they are the engines that facilitate access to data. A relevant point when the purpose of satellites is to gather and distribute data.

It is only through the use of standards that the requirements of interconnectivity and interoperability can be assured in a competitive environment. It is only through the application of standards that the credibility of new products and new markets can be verified. In summary, standards fuel the development and implementation of technologies that influence and transform the way we live, work and communicate. This is also true for the CubeSat Community.

When an organization buys a service, they are choosing to not invest in the infrastructure to receive the same result. New space entrants and service providers are able to focus on delivering Service Level Agreements across many customers. This allows rapid learning and efficiencies to optimize across multiple customer sets. This is an advantage to the service provider but also the buyer as well since they are able to focus resources on other aspects of the mission.

Standards drive interoperability and sharing. When organizations such as service providers participate with standards based organizations they are more competitive in the global marketplace. When organizations do not participate in standards, they must unnecessarily focus on establishing themselves as “better” than their competitors in areas where it may or may not matter.

WHERE DOES SATOPS EVOLVE?

One risk for SATOPS leaders is to jump on the latest technology and declare it a panacea for some, many, or all problems they are currently facing. However, I assert that technology is a necessary ingredient of the greater investment strategy, which will ultimately maximize the pace and efficiency of capability improvements.

A second risk for SATOPS leaders is to over-rely on process as a means to find best value. Instead, SATOPS leaders should focus on organizational culture shift, where more DARPA-like attitudes are embraced. This biological problem is historically harder to change than any technological problem.

SATOPS Leaders should participate in Standard Development Organizations. One good example for SATOPS is the Object Management Group (OMG). This non-profit is driven by vendors, users, academia, and government agencies to increase the interoperability of ground systems and segments.

In a free market there are buyers and sellers freely entering into contracts to achieve their goals. This type of economy encourages companies to embrace concepts that accelerate capabilities to remain competitive. Satellite owner operators should consider leasing available services and only design, build, buy, operate and maintain the "crown jewels" of their system. This is also true in today's DoD 5000 acquisition driven system. In this specific case of EGS, the buyer is AFSPC and the sellers are multiple commercial providers all engaging with the buyer continuously based on their state of the market offerings. This is drastically different than a single "winner take all" competition where the government is beholden to the winner.

Infrastructure, as stated earlier, is the physical representation of an economic actor's business decision. When satellite owner operators can dynamically plug into existing commercial ground networks, in the spirit of infrastructure as a service, like SSC's Universal Space Network, based on established standards efficiencies are immediately possible, since there is no unused/extra capacity cost.

SSC's Universal Space Network is a bright example of a dynamic and growing set of capabilities for customers of today and tomorrow.

SUMMARY

It is a fair statement to say that the SATOPS community is changing, enabled by new entrants, cubesats, culture shifts, and new standards. As such, the SATOPS community should participate in standards working groups and organizations because these standards will dictate global access to data and simultaneously influence the nature of technology. The best way for organizations to deal with disruption is to create it.