Space Warfighting Construct: Prototyping

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"Space is big. Really big. You won't believe how vastly, hugely, mindbogglingly big it is. I mean, you think it's a long way down the road to the chemist's but that's just peanuts to space.

Douglas Adams
The Hitchhiker's Guide to the Galaxy

Space is undergoing a period of great change, as the barriers to entry are lowering in every arena. Launch to any orbit is becoming more routine and feasible thanks to industry innovation, the rise of small- and cubesats, and the use of ESPA rings enabling "freight trains to GEO." With more regular rides to space, there is a concomitant rise in the capability for space qualification, technology validation and verification, and all types of experimentation in both the space and ground segments. The types of architectures that commercial and government agencies develop is being influenced because space is becoming more accessible. Whereas current architectures are designed to have four to six satellites perform a mission, in the future that same mission may be distributed among dozens, hundreds, or even thousands of satellites. This changing landscape is something of a double-edged sword for Space Situational Awareness (SSA): safety of flight becomes a heightened concern, but the opportunities for the entire community to innovate, prototype, and ultimately provide novel, robust solutions have never been greater.

"Space is a global commons…we have to strengthen our partnerships with like-minded space-faring nations and within the commercial sector and academia."

General John "Jay" Raymond
Commander, Air Force Space Command

The prototyping framework developed by the Space and Missile Systems Center (SMC) in conjunction with the Air Force Research Laboratory (AFRL) marks a turning point in the way the Air Force thinks about prototyping for space. We are moving beyond the realm of launching one experimental satellite every few years to a future enabled by ESPA rings and small satellites in which we have 40+ flight experiments going up in the next 4 years. We are also moving beyond the realm of thinking in terms of single systems for modeling and simulation, experimentation, and residual operations. In the very near future, the Space Operations Development Center (SpODC) will be a hub of activity for multi-system pre-flight modeling and simulation, training of space operators, and development of a wide range of tools for all facets of SSA and Command & Control. Key to the SpODC's central role both in the operational and experimental SSA architectures is its role as a data repository. This repository will be able to ingest data from all sensors and provide tailored information to meet the needs of all types of SSA customer. Within this prototyping framework, there are three types of opportunities for SSA innovators, whether traditional or non-traditional partners: Provide data through novel sensors, develop data analytics and visualization tools, and provide command and control solutions to synchronize this complex web of sensors and operators.

First, new sensors are needed to continue to track and maintain custody of all the objects in space. In addition to augmenting current capabilities in conjunction assessment, object identification, etc., these new sensors can be used

to gain valuable information about satellite anomalies: what happened, when it happened, and how it will affect other satellites. New phenomenologies are needed to gain a better understanding of these events – not just being able to detect something after-the-fact, but being able to understand why and predict those events in the future. Second, opportunities abound for new tools to make sense of the data that will be coming in not only from traditional (i.e., government) sources, but from these new sensors as well: processing algorithms, visualization capabilities, data validation and trust, fusion, and the ability to provide tailored information on needed timelines to the wide variety of space users. Third, a key piece of this new sensor- and data-rich SSA ecosystem will be synchronization of the various operational floors to enable seamless command and control of a highly dispersed architecture. Needed capabilities include automated tasking and scheduling to link commercial, international, and government sensors and operations centers.

To build this architecture we need to find nontraditional business models that move quickly. This means moving away from traditional DoD business practices that can take 10 years, beginning with MAJCOM capability needs and an analysis of alternatives, and then setting up a program of record to manage the acquisition of long-duration systems. Instead we plan to adapt DoD practices to a venture capitalist model that makes decisions on timescales of weeks-to-months, funds various options that show promise, and then decides a winner of competing systems. SSA and terrestrial weather are the initial focus of these accelerated efforts. A preliminary pilot in partnership with LightSpeed Innovations funded three prototypes in the realm of SSA, and a second pilot program with Catalyst Campus in Colorado Springs will bring weather capability to bear on a 12-month schedule. The Commercial Augmented Mission Operations (CAMO) effort will be looking to improve SSA and C2 mission operations by bringing capabilities that exist in the commercial world into the military world. Finally, the Space and Missiles Center Space Enterprise Consortium gives the military the flexibility to do almost any space-related prototyping of new and exciting capabilities: research and development, build, integration and testing, launch, and/or operations. These options all represent new ways of doing business and bringing more options to complete the missions of the government.

With the rapid changes that are coming in space, SSA will continue to be a challenge. Small satellites will continue to evolve in capability that will allow them greater mission utility. This will continue to provide continued work for everyone that works in space situational awareness. New efforts will need be undertaken and conquered in data analytics including visualization, modelling, and simulation. Continued work in new sensors on the ground and in space will create more data that will test our abilities to fuse data from multiple sources. Command and control endeavors will need continuous evaluation and evolution. It will take innovation, engineering, and changes in thinking to maintain safe flight for all parties interested in space.