The New Space Race

Paul D. Spudis
spudis@lpi.usra.edu
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Introduction

Recent media reports suggest that China is stepping up their program to send people to the Moon just as America appears to be standing down from it. This circumstance has re-awakened a long-standing debate about the geopolitical aspects of space travel and with it some questions. Are we in a race back to the Moon? Should we be? And if there is a "space race" today, what do we mean by the term? Is it a race of military dimensions or is such thinking just an artifact of the Cold War? What are the implications of a new space race?

Many in the space business purport to be unimpressed by the idea that China is going to the Moon and publicly invite them to waste money on such a stunt. "No big deal" seems to be the attitude – after all America did that over 30 years ago. NASA Administrator Charles Bolden recently professed to be unmoved by the possible future presence of a Chinese flag on the Moon, noting that there are already six American flags on the Moon.

Although it is not currently popular in this country to think about national interests and the competition of nations in space, others do not labor under this restriction. Our current human spaceflight effort, the International Space Station (ISS), has shown us both the benefits and drawbacks of cooperative projects. Soon, we will not have the ability to send crew to and from the ISS. But that's not a problem; the Russians have graciously agreed to transport us – at $50 million a pop. Look for that price to rise once the Shuttle is fully retired.

To understand whether there is a new space race or not, we must understand its history. Why would nations compete in space anyway? And if such competition occurs, how might it affect us? What should we have in space: Kumbaya or Starship Troopers? Or is the answer somewhere between the two?

Some History

People tend to think of Apollo and the race to the Moon when they hear the term "space race" but the race began with the October 1957 launch of a Russian satellite called Sputnik. The clear implication of this new Soviet satellite was that if they wanted to, they could lob a nuclear bomb at the United States. This situation led to near panic in America, with outraged demands that we technically catch up to the Soviets as quickly as possible and damn the cost.

The initial phases of the space race were not auspicious for America. In our publicized and televised launches, vehicles frequently blew up while the Soviets appeared to effortlessly achieve an endless series of headline-grabbing space "firsts." American officials working behind the scenes knew that we were not as far behind as it seemed but to reveal that knowledge was to disclose our national technical means of surveillance. So each new Soviet first was officially greeted with silence.

The Russians raised the stakes in the spring of 1961 with the launch of Yuri Gagarin, the first human in space. Although America followed a month later with Alan Shepard's ballistic hop, the new U.S. President, John F. Kennedy, wanted to issue a challenge, one carefully crafted to be beyond the existing capabilities of both the USA and the USSR, yet reachable by us (but not by them) over the course of a few years. A manned landing on the Moon was selected as the ideal target for such a race. Although no specific strategic goals on the Moon were identified, it was believed that the attainment of this difficult task would demonstrate the superiority of our open, pluralistic capitalist society in contrast to its closed, authoritarian, socialist opposite number.

The so-called "Moon race" of the 1960's was a Cold War exercise of soft power projection, meaning that no real military confrontation was part of it, but rather, it was a competition by non-lethal means to determine which country had the superior technology and by implication, the superior political and economic system. In short, it was largely a national propaganda struggle. Simultaneously, the two countries also engaged in a hard power struggle space race to develop ever-better systems to observe and monitor the military assets of the other. There was little public debate associated with this struggle, indeed, much of it was held in the deepest secrecy. But as the decade passed, military space systems became increasingly capable and extensive and largely replaced human intelligence assets for the estimation of our adversaries' strategic capabilities and intentions.

The United States went on to very publicly win the race to the Moon, giving rise to a flurry of rhetoric pronouncing everyone's peaceful intentions for outer space while the larger struggle continued to play out behind the scenes. NASA's replacement effort for the concluded Apollo program, the Space Shuttle project, promised to lower the costs of space travel by providing a reusable vehicle that would launch like a rocket and land like an airplane. Because of the need to fit under a tightly constrained budgetary envelope and for a variety of other technical reasons, the Shuttle did not live up to its promise as a low cost "truck" for space flight. However, the program resulted in a fleet of four operational spacecraft that flew over 120 missions over the course of its 30-year history.

Although widely cited in American space circles as a policy failure, the Shuttle had some interesting characteristics that led it to be considered a military threat by the USSR. One of the earliest missions of the Shuttle had its crew retrieve and repair an orbiting satellite (Solar Max). Later missions grappled balky satellites and returned them to Earth for refurbishment, repair and re-launch. This capability culminated with a series of Shuttle missions to the Hubble Space Telescope (HST), which conducted on-orbit servicing tasks ranging from literally fixing the worthless satellite (the first mission) to routine upgrading of sensors, replacement of solar arrays and main computers, and re-boosting the telescope to a higher orbit. The significance of these missions was that the HST is basically a strategic reconnaissance satellite: it looks up at the heavens rather than down at nuclear missile sites from orbit. The Hubble repair missions documented the value of being able to access orbital assets with people and equipment.

Another relatively unnoticed series of Shuttle missions demonstrated the value of advanced sensors. As a large, stable platform in orbit (the orbiting mass of the Shuttle is almost 100 mT), the Shuttle could fly very heavy, high-power payloads that smaller robotic satellites could not. The Shuttle Imaging Radar (SIR) was a synthetic aperture radar that could obtain images of the Earth from space by sending out radar pulses as an illuminating beam. It could thus image through cloud cover, day or night, all over the Earth. In a stunning realization, it was found that it could also image subsurface features; in particular, the SIR-A mission mapped ancient riverbeds buried beneath the sands of the western Sahara from space. The strategic implications of this were immense; as most land-based nuclear missiles are buried in silos, they cannot be hidden from account because of sensors like imaging radar.

The construction of the International Space Station (ISS) became the next frontier for strategic space. One of the most complex spacecraft ever made, it was designed to be launched in small pieces by the Shuttle without an end-to-end systems test on the ground and assembled on-orbit. It worked perfectly the first time it was activated. The building of the ISS documented that not only could people assemble complex machines in space, they could also repair, maintain and upgrade them as well. As the ISS nears completion, much complaint continues about its cost and supposed lack of value, yet even if we get nothing further from it as a research facility, it has already taught us invaluable lessons about the building and maintenance of large spacecraft in orbit.

These new Shuttle capabilities had significant policy implications for the Soviets. To them, it seemed that the Shuttle was a great leap forward in military space technology, not the "policy failure" bemoaned by American analysts. With its capabilities for on-orbit satellite servicing and as a platform for advanced sensors, the Shuttle became a threat that had to be countered. The USSR responded with their own space shuttle (*Buran*), which looked superficially very similar to ours. The *Challenger* accident showed that Shuttle was a highly vulnerable system in many respects; even as the Soviets developed *Buran*, the American military decided to withdraw from our Shuttle program.

During the 1990's, we saw a revolution in tactical space – the use of and reliance on space assets on the modern battlefield. The Global Positioning System (GPS) has made the transition to the consumer market, but it was originally designed to allow troops to instantly know their exact positions. A global network of communications satellites carries both voice and data, and interfaces to the partly space-based Internet (another innovation originally built for military technical research). The entire world is connected and plugged in and spacebridges are now key components of that connection. Fifty years after the beginning of the Space Age, we are now, more than ever, dependent upon our satellite assets.

Space and the national interest

Most people don't realize how the many satellites in various orbits around the Earth affect their lives. We rely on satellites to provide us with instantaneous global communications that impact almost everything we do. We use GPS to find out both where we are and where we are going. Weather stations in orbit monitor the globe, alerting us to coming storms so that their destructive effects can be minimized. Remote sensors in space map the land and sea, permitting us to understand the distribution of various properties and how they change with time. Other satellites look outward to the Sun, which controls the Earth's climate and "space weather" (which influences radio propagation.) No aspect of our lives is untouched by the satellites orbiting the Earth. In a real sense, they are the "Skynet" of the Terminator movies – they are our eyes (reconnaissance), ears (communications) and brains (GPS and Internet) in Earth orbit. Fortunately, they are not yet self-aware. But the people who operate them are.

All satellites are vulnerable. Components constantly break down and must be replaced. New technology makes existing facilities obsolete, requiring replacement, at high cost. A satellite must fit within and on the largest launch vehicle we have; satellites thus have a practical size limit, which in turn limits their capabilities and lifetime. Once a satellite stops working, it is abandoned and a replacement must be designed, launched and put into its proper orbit.

Satellite aging is normal and expected but satellites can also be catastrophically lost or disabled, either accidentally or deliberately. Encounters between objects in space tend to be at very high velocities. The ever-increasing amounts of debris and junk in orbit (e.g., pieces of old rockets and satellites) can hit functioning satellites and destroy them. NORAD carefully tracks the bigger pieces of junk and some spacecraft (e.g., ISS) can be maneuvered out of the path of oncoming debris, but smaller pieces (e.g., the size of a bolt or screw) cannot be tracked and if they collide with a critical part, it can cripple a satellite.

It has long been recognized that satellites are extremely vulnerable to attack and anti-satellite warfare (ASAT) is another possible cause of failure. Both the US and the USSR experimented with ASAT warfare during the Cold War. Although it sounds exotic, ASAT merely takes advantage of the fragility of these spacecraft to render them inoperative. This can be done with remote affecters like lasers to "blind" optical sensors. The simplest ASAT weapon is kinetic, i.e., an impactor. By intercepting a satellite with a projectile at high relative velocity, the satellite is rapidly and easily rendered worthless.

Despite the fact that the destruction of satellites is relatively easy, it has seldom happened by accident and never as an act of war. Although most space assets are extremely vulnerable, they are left alone because they are not easy to get to. Some orbiting spacecraft occupy low Earth orbit (LEO) and are accessible to interceptors, but many valuable strategic assets are in the much higher orbits of middle Earth orbit (MEO) 3000 to 35000 km and geosynchronous Earth orbit (GEO) 35786 km. Such orbits are difficult to reach and require long transit times and complex orbital maneuvers which quickly reveal themselves and their purpose to ground-based tracking.

In 1998, a communications satellite was left in a useless transfer orbit after a booster failure. Engineers at Hughes (the makers of the satellite) devised a clever scheme to send the satellite to GEO using a gravity assist from the Moon. This was the world's first "commercial" flight to the Moon and it saved the expensive satellite for its planned use. One aspect of this rescue is seldom mentioned but attracted the attention of military space watchers everywhere. This satellite approached GEO from an unobserved (and at least partly unobservable) direction. Most trips to GEO travel from LEO upwards; this one came down from the Moon, a direction not ordinarily monitored by tracking systems. This mission dramatically illustrated the importance of what is called "situational awareness" in space.

Our current model of operations in space is well established. Satellites must be self-contained and operated until dead, then completely replaced – a template of design, build, launch, operate, and abandon. With few exceptions, we are not able to access satellites to repair or upgrade them. Sometimes favorable conditions allow us to be clever and rescue an asset that had been written off, but the system is not designed for such operation. The current spaceflight paradigm is a use and throwaway culture. Yet thirty years of experience with the Shuttle program has shown us that such is not the case by necessity. What is missing is the ability to get people and servicing machines to the various satellites in all their myriad locations: LEO is easy, but MEO and GEO cannot be accessed with existing space systems. Yet from the experience of Shuttle and ISS, we know that if they could, a revolution in the way spaceflight is approached might be possible.

The Vision for Space Exploration and its implications

The Vision for Space Exploration (the Vision, or VSE,) announced by President Bush in January 2004, called for returning the Shuttle to flight after the Columbia accident, completion of the International Space Station, a human return to the Moon and eventually voyages to Mars and other destinations. This proposal was subsequently endorsed by two different Congresses (in 2005 and 2008) under the control of different parties; both authorizations passed with large bipartisan majorities. The preface to the founding VSE document states that the new policy is undertaken to serve national "security, economic and scientific interests."

Subsequent statements and writings elaborated on the purpose of the VSE. Despite concerted efforts to distort its meaning, the goal of lunar return was not to repeat Apollo but to create a long-term, sustained human presence in space by learning to use the material and energy resources of the Moon. The VSE was to be implemented under existing and anticipated budgetary constraints; the guidance given to NASA for this aspect of the mission was to stretch timetables if money became short. The idea was to create this new system with small, incremental, yet cumulative steps.

The intellectual underpinnings of the VSE began to be undermined by NASA almost immediately. The Exploration Systems Architecture Study (ESAS) made lunar return an Apollo redux, with the development of a large, 150-mT-payload heavy lift vehicle becoming the centerpiece and *sine qua non* of human spaceflight beyond LEO. An ambitious program to establish an early robotic presence to prospect for resources on the Moon was cancelled, along with the incremental approach outlined by the Vision. Thus, the Moon became a distant goal, with first arrival of humans occurring well after 2020, if then. NASA had chosen something familiar, an architecture very similar to Apollo with little effort made to develop reusable, refuelable spacecraft (although the Altair lander used LOX-hydrogen, so in principle, it could be modified for refueling).

In short, the purpose of returning to the Moon, i.e., to create a sustainable human presence based on the use of lunar resources, got lost in the ESAS shuffle. Lunar return became synonymous with "Apollo on Steroids" and heavy-lift rocket building while ESAS (Constellation) became synonymous with the VSE. Project Constellation, the agency project to develop the new Orion spacecraft and Ares I and Ares V launch vehicles, was a costly, throw-away space system that got us to the Moon with considerable capability, but with little or no thought given to planned surface objectives or activities. The idea of finding and learning to use the resources of the Moon became an experiment slated for the manifest of some future mission, not the primary driver or objective of lunar return. Lunar Reconnaissance Orbiter is currently mapping the Moon and sending us data on the extent and nature of lunar resources, but no lander missions are planned to follow up on its findings. The ingenuity of an incremental program was lost and we created no new capability in space.

The goal of the VSE is to create the capability to live ON the Moon and OFF its local resources with the goals of self-sufficiency and sustainability, including the production of propellant and refueling of cislunar transport vehicles. A system that is able to routinely go to and from the lunar surface is also able to access any other point in cislunar space. We can eventually export lunar propellant to fueling depots throughout cislunar space, where most of our space assets reside. In short, by going to the Moon, we create a new and qualitatively different capability for space access, a “transcontinental railroad” in space. Such a system would completely transform the paradigm of spaceflight. We would develop serviceable satellites, not ones designed to be abandoned after use. We could create extensible, upgradeable systems, not “use and discard.” The ability to transport people and machines throughout cislunar space permits the construction of distributed instead of self-contained systems. Such space assets are more flexible, more capable and more easily defended than conventional ones.

The key to this new paradigm is to *learn* if it is possible to use lunar and space resources to create new capabilities and if so, how difficult it might be. Despite years of academic study, no one has demonstrated resource extraction on the Moon. There is nothing in the physics and chemistry of the materials of the Moon that suggests it is not possible, but we simply do not know how difficult it is or what practical problems might arise. This is why resource utilization is an appropriate goal for the federal space program. As a high-risk engineering research and development project, it is difficult for the private sector to raise the necessary capital to understand the magnitude of the problem. The VSE was conceived to let NASA answer these questions and begin the process of creating a permanent cislunar transportation infrastructure.

So where do we stand with the creation of such system? Is such a change in paradigm desirable? Are we still in a “space race” or is that an obsolete concept? The answers to some of these questions are not at all obvious. We must consider them fully, as this information is available to all space faring nations to adopt and adapt for their own uses.

A new space race

The race to the Moon of the 1960’s was an exercise in “soft power” projection. We raced the Soviets to the Moon to demonstrate the superiority of our technology, not only to them, but also to the uncommitted and watching world. The landing of Apollo 11 in July 1969 was by any reckoning a huge win for United States and the success of Apollo gave us technical credibility for the Cold War endgame. Fifteen years after the moon landing, President Reagan advocated the development of a missile defense shield, the so-called Strategic Defense Initiative (SDI). Although disparaged by many in the West as unattainable, this program was taken very seriously by the Soviets. I believe that this was largely because the United States had already succeeded in accomplishing a very difficult technical task (the lunar landing) that the Soviet Union had not accomplished. Thus, the Soviets saw SDI as not only possible, but likely and its advent would render their entire nuclear strategic capability useless in an instant.

In this interpretation, the Apollo program achieved not only its literal objective of landing a man on the Moon (propaganda, soft power) but also its more abstract objective of intimidating our Soviet adversary (technical surprise, hard power). Thus, Apollo played a key role in the end of the Cold War, one far in excess of what many scholars believe. Similarly, our two follow-on programs of Shuttle and Station, although fraught with technical issues and deficiencies as tools of exploration, had significant success in pointing the way towards a new paradigm for space. That new path involves getting people and machines to satellite assets in space for construction, servicing, extension and repair. Through the experience of ISS construction, we now know it is possible to assemble very large systems in space from smaller pieces, and we know how to approach such a problem. Mastery of these skills suggests that the construction of new, large distributed systems for communications, surveillance, and other tasks is possible. These new space systems would be much more capable and enabling than existing ones.

Warfare in space is not as depicted in science-fiction movies, with flying saucers blasting lasers at speeding spaceships. The real threat from active space warfare is denial of assets and access. Communications satellites are silenced, reconnaissance satellites are blinded, and GPS constellations made inoperative. This completely disrupts command and control and forces reliance on terrestrially based systems. Force projection and coordination becomes more difficult, cumbersome and slower.

Recently, China tested an ASAT weapon in space, indicating that they fully understand the military benefits of hard space power. But they also have an interest in the Moon, probably for "soft power" projection ("Flags-and-Footprints") at some level. Sending astronauts beyond low Earth orbit is a statement of their technical equality with the United States, as among space faring nations, only we have done this in the past. So it is likely that the Chinese see a manned lunar mission as a propaganda coup. However, we cannot rule out the possibility that they also understand the Moon's strategic value, as described above. They tend to take a long view, spanning decades, not the short-term view that America favors. Thus, although their initial plans for human lunar missions do not feature resource utilization, they know the technical literature as well as we do and know that such use is possible and enabling. They are also aware of the value of the Moon as a "backdoor" to approach other levels of cislunar space, as the rescue of the Hughes communications satellite demonstrated.

The struggle for soft power projection in space has not ended. If space resource extraction and commerce is possible, a significant question emerges – What societal paradigm shall prevail in this new economy? Many New Space advocates assume that free markets and capitalism is the obvious organizing principle of space commerce, but others might not agree. For example, to China, a government-corporatist oligarchy, the benefits of a pluralistic, free market system are not obvious. Moreover, respect for contract law, a fundamental reason why Western capitalism is successful while its implementation in the developing world has had mixed results, does not exist in China. So what shall the organizing principle of society be in the new commerce of space resources: rule of law or authoritarian oligarchy? An American win in this new race for space does not guarantee that free markets will prevail, but an American loss could ensure that free markets would never emerge on this new frontier.

Why are we going to the Moon?

In one of his early speeches defending the Apollo program, President John F. Kennedy laid out the reasons that America had to go the Moon. Among the many ideas that he articulated, one stood out. He said, "whatever men shall undertake, *free* men must fully share." This was a classic expression of American exceptionalism, that idea that we must explore new frontiers not to establish an empire, but to ensure that our political and economic system prevails, a system that has created the most freedom and the largest amount of new wealth in the hands of the greatest number of people in the history of the world. This is a statement of both soft and hard power projection; by leading the world into space, we guarantee that space does not become the private domain of powers who view humanity as cogs in their ideological machine, rather than as individuals to be valued and protected.

The Vision was created to extend human reach beyond its current limit of low Earth orbit. It made the Moon the first destination because it has the material and energy resources needed to create a true space faring system. Recent data from the Moon show that it is even richer in resource potential than we had thought; both abundant water and near-permanent sunlight is available at selected areas near the poles. We go to the Moon to learn how to extract and use those resources to create a space transportation system that can routinely access all of cislunar space with both machines and people. Such a system is the logical next step in both space security and commerce. This goal for NASA makes the agency relevant to important national interests. A return to the Moon for resource utilization contributes to national security and economic interests as well as scientific ones.

There is indeed a new space race. It is just as important and vital to our country's future as the original one, if not as widely perceived and appreciated. It consists of a struggle with both hard and soft power. The hard power aspect is to confront the ability of other nations to deny us access to our vital satellite assets of cislunar space. The soft power aspect is a question: how shall society be organized in space? Both issues are equally important and both are addressed by lunar return. Will space be a sanctuary for science and PR stunts or will it be a true frontier with scientists and pilots, but also miners, technicians, entrepreneurs and settlers? The decisions made now will decide the fate of space for generations. The choice is clear; we cannot afford to relinquish our foothold in space and abandon the Vision for Space Exploration.