The Deployment of Economic Assets within the Earth-Moon System

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The author argues in favor of the economic development of space by focussing attention on the commercial and military exploitation of the Moon, analogous to the development of the American frontier.

Key Words: Space, Earth, Moon, Space Shuttle, Single Stage To Orbit Vrhicles, Ballistic Missiles.

Space is beckoning us toward its expanding frontiers in scientific exploration, economic development and defense. Just as in the frontier days of the North American continent, where two distinct areas – the Eastern Seaboard of the United States to the Mississippi River Valley, and the West Coast of the United States – dominated the economic development of the American frontier, so the economic development of the earth and the moon will dominate the history of the Twenty-first Century.

The moon, 240,000 miles distant, dominates the night sky. The object of an intense competition between the U.S. and Soviet Union during the 1960s, the moon is once again becoming the focal point of a competition, this time in the economic development of space. Nearly thirty years have passed since Neil Armstrong became the first man to set foot on the moon on July 20, 1969. Those years have set the stage for a new energy and focus for its development.

Low-Cost Access to Space

The rapid development of low-cost access into space is creating a railroad for opening the space frontier, and setting the stage for the economic exploitation of the moon. This revolution of low-cost transportation into space, breaking the price barrier of $10,000 per pound for low earth orbit, has its origins in the Single Stage To Orbit

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program championed by Vice President Dan Quayle,[2] the reusable two-stage rockets being developed that emulate the economics of Single Stage To Orbit, the Pegasus and other rockets launched from aircraft, and the new expendable launch vehicles being developed that use simpler and faster launch procedures. These new rocket designs and processes for space launches, based on maximizing efficiency of rocket design and economics of operation, will cut the cost of space launches by large fractions, and eventually by orders of magnitude.[3] And as we start to measure space launch procedures in days rather than months, we will begin to see space open up for business.

In addition, the development of hypersonic vehicles, high atmospheric transit vehicles, and spaceplanes capable of touching the fringes of space from the earth and going into low earth orbit,[4] representing a new class of space vehicles that build on the approach to space we took under President Eisenhower which gave us the X-15 and prepared the way for the X-20[5] (later cancelled by Defense Secretary Robert McNamara), will extend the coming revolution in space transportation. These new vehicles will be far more economical in design and operation than our current generation of space launchers of "throw away" rockets and "expendable launch vehicles" that are derived from long-range ballistic missiles. Like a Single Stage To Orbit rocket, these new vehicles will offer improved maneuverability, flexibility of basing, ease of operation, and greater availability than our current space launchers. For example, a personal computer in a portable trailer made up the launch control facility for the DC-X testbed Single Stage To Orbit: its launch control center

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[2] Vice President Dan Quayle's briefing and support for Single Stage To Orbit are reproduced in: Daniel O. Graham, "Preface", *The Journal of Practical Applications in Space*, Volume IV, No. 4, Summer 1993, pp. 1-8. The Single Stage To Orbit is explained at length in the same issue in "The SSX - A True Spaceship" by Max Hunter, "Technology Readiness Review of the Space Ship Experimental (SSX) by Steve Hōeser, "Reliable Low Cost Space Transportation' by Jess Sponable, "The SSTO vs the NLV" by Robert C. Richardson lll and "Designing for Routine Space Access" hy William A. Gaubatz.

[3] A thorough, non-technical history of tbe Single Stage To Orbit and its potential is to be found in: G. Harry Stine, *Halfway to Anywhere*, M. Evans and Company, 1996.

[4] Richard Cook, [review1 "Spaceflight in the Era of Aerospace Planes." *The Journal of Practica1 Applications in Space*, Volume VI, No. 2, Winter 1995, pp. 193-194. See also: D. Ashford, "The Potential of Spaceplanes," *The Journal of Praetical Applications in Space*, Volume VI, No. 3, Spring 1995, pp. 213-265.

[5] Walter J. Boyne, *Beyond the Wild Blue*, St. Martin's Press, 1997, pp. 268-269.

required just two people instead of the hundreds for Apollo 13. These new vehicles will not depend upon the launch schedule of an overbooked Space Shuttle or Cape Canaveral. They will be fully reusable vehicles, economical in operation, and possessing an operational robustness (engine out capability) more like an aircraft than a ballistic missile. They will not require extensive launch ranges near a seacoast for safety, but will be able to operate inland. Spaceports other than at Cape Canaveral and Vandenberg will become a reality in our lifetime. These new space vehicles will have flexibility in entering space and at a much lower cost compared to the Space Shuttle.

Economic Potential of the Space Industry

Space is a growing industry with satellite manufacturers, satellite receiver vendors, space-based information users, communication networks, and commercial space launchers. It is more than a multibillion dollar industry and international in scope. The booming growth in satellite communication, observation, and navigation services illustrates the economic potential of space. Our use of space today, dominated by the telecommunications industry and defense, will be dwarfed by other applications and industries that are just beginning to appear. Space tourism is just around the corner.[6] This vast potential will expand as man finds new roles in space.[7]

The rapid development of low-cost transportation into space will benefit our use of space for defense. We have used space for defense since the 1960s with reconnaissance and weather forecasting satellites, and more recently with military communications and GPS navigation satellites. Space also offers unparalleled advantages as a point of deployment for a defense against long-range ballistic missiles. We can overcome our total vulnerability to attack from long-range ballistic missiles by deploying interceptors and high energy lasers in space to destroy long-range ballistic missiles and their warheads.

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[6] T. F. Rogers, "Space Tourism, The Perspective from Japan and Some Implications for the United States" *The Journal of Practical Applications in Space*, Volume IV, No. 2, Winter 1995, pp. 109-149.

[7] Ivan Bekey, "The Coming Space Intustrial Revolution: An Optimist's Scenario", *Space Energy and Transportation*, Volume 1. No. 2, 1996, pp. 119-131.

Military Significance

A ballistic missile defense that is based in space will be the most effective defense possible against long-range ballistic missiles.[8] It will have the capability to intercept ballistic missiles in their boost phase, which is the time when a ballistic missile is most vulnerable. A boosting missile has a large target profile which is easily visible under stress. A space-based missile defense will be able to intercept a ballistic missile over its whole trajectory in space. A space-based missile defense will also have global coverage and be predeployed. It will be on duty twenty-four hours a day. In addition, the long lines of sight and lack of atmospheric interference make it a prime location for high energy lasers, the fastest technology available to intercept and destroy ballistic missiles.

A space-based ballistic missile defense will bring the line of battle right to the theater of operation of the long-range ballistic missiles. We will increasingly look to space as the main theater of operation against them. Deployment of a ballistic missile defense in space will also strengthen our ability to protect our military and commercial satellites in space. It will help energize the commercial development of space by creating a demand for flexible, innovative, and low cost access into space.

A clear vision for the economic development of the earth-moon system will increase the effectiveness of the assets we use to develop space. Interplanetary probes, scientific and military observation satellites, and communication satellites will continue to extend into space. But for ventures like the International Space Station, rebuilt Space Shuttle, and other plans for the development of space, we need a clear vision as to our priorities. It will cost billions of dollars to develop space. How we spend those billions will determine our return.

What should be our strategy for developing space? Should we continue with an approach of business as usual, building a series of satellite constellations in low and medium earth orbit and launching

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[8] Space as the new theater of war is argued by G. Harry Stine, in *Confrontation in Space*, Prentice-Hall, 1981, pp. 1-10. Space as a base for ballistic missile defense is explained in Lt. Gen. Daniel O. Graham, in *High Frontier*, The Heritage Fonndation, 1982, p. 18. The use of space for ballistic missile defense is also presented by Robert Jastrow in *How To Make Nuclear Wars Obsolete*, Little, Brown and Company 1985, pp. 40-43.

unmanned probes? But if we continue as we have been doing we will fail to recognize the opportunities we have before us. It will continue the monopolies that have propped up the artificial cost barrier to space. It will perpetuate the overregulation and bureaucracy that could strangle our development of space. It would not permit a free market approach to space, nor will it protect the interest of government in developing space for defense. Will the International Space Station and Space Shuttle open up the economic potential of space? The International Space Station and Space Shuttle, often thought of as "ultimate" goals or achievements, are only stepping stones. Where shall we find our vision for the economic development of space? Shall we turn to aerospace giants like Boeing or Lockheed Martin? But the interests of large corporations are to preserve their market dominance and avoid open competition. The industrial giants of today will not necessarily survive as giants for another fifty years. We need boldness and innovation to open up the frontier of space, not the constraints of accounting and regulation. We need to free and equip the hands of progress.

Our vision for developing space will come from the military use of space, and from our history of opening the American frontier, which is founded in the free enterprise system and property rights of the individual. In classical military strategy, positions of higher altitude – higher ground – are sought. The military use of space calls for obtaining progressively higher points of advantage for defense, and for the maneuver of forces. Control of higher ground - mountainous or hilly terrain – is generally sought in ground operations. In the 20th century, control of the air – a higher ground than any hill or mountain - is now viewed as a practical necessity for ground operations. For which reason, in the 20th century we have developed air forces to control the higher ground. In the 1991 Persian Gulf War, the Air War under General Horner preceded and supported General Schwartzkopf's ground campaign. The Gulf War was also the first war to extensively use satellites in space.[9] America took the high ground of air and space before attacking on land. Whether from the perspective of an artillery officer, infantry

[9] John Hutt Cuuningham, "The Role of Satellites in the Gulf War," *The Journal of Practical Applications in Space*, Volume 2, No. 3, Spring 1991, pp. 43-69.

commander, or air squadron leader, the military development of space calls for such a policy.

Significance of the Moon

The moon stands at the highest point of the earth-moon system, dominating it. Development of the moon for defense would support U.S. defense of geosynchronous (22,300 miles above the earth) and super synchronous orbital assets. In addition to its altitude, the moon offers a large resource base for military use of space. Economic development of the moon will make available an independent center of economic supply for space defense.

Technically, in terms of the gravity well of the earth-moon system, the lunar libration points (L1-L5 where there is close gravitational equilibrium between the earth and moon) are at the top of the earth-moon system.[10] The lunar libration points offer a greater potential military advantage than the moon, especially for the interrogation and interception of space vehicles with kinetic energy weapons. But their potential is limited by supply and logistics. The lunar libration points may be thought of as frontier outposts to be taken and held to protect the growth of economic activity within the earth-moon system. The military use of the moon offers far greater potential. For it will be from the moon that we can supply and sustain military positions at the lunar libration points.

During the 1800s, two distinct areas – the Eastern Seaboard to the Mississippi River Valley, and the West Coast – dominated our economic development of the frontier. The development of these two distinct regions resulted in our building a transportation and communication system that spanned the North America continent from East to West. The Pony Express, telegraph, and railroad, going beyond our natural trade routes found in the great river valleys of the Ohio and Mississippi, forged new connections tying us together as a country. The golden spike joining the Union Pacific to the Central Pacific Railroad in 1869 brought together new market forces, expanded the flow of trade with the Orient, and opened up the

[10] For a discussion of the military valne of the lunar libratiou points see John M. Collins, *Military Space Forces*, Pergamon-Brassey, 1989, pp. 20, 25. & 47. Additional discussion of the gravity well and lunar libration points is to be found in G. Harry Stine, *Confrontation in Space*, Prentice-Hall, 1981, pp. 56-62.

Midwest and Great American Desert as frontiers for settlement. Immigrants from the Old World found their homes in the New World.[11]

Likewise, any power developing the moon first, rather than looking to the evolutionary deployment of satellites deeper into space, will put itself in a far stronger position to economically and militarily dominate the earth-moon system. While space between the earth-moon system does not contain the natural resources of the Great American Desert – broadly defined as that vast region from west of the Mississippi River to the West Coast where teeming millions now live – the advantages to be gained from developing space between the earth and the moon, which could hold solar power satellites transmitting power to the earth, hotels for tourism, space stations for industrial processes as well as our telecommunications and navigation network satellites of today, will be more readily obtained through trade between the earth and the moon than by any other means.

The moon's gravity, at one sixth of the earth's, will enhance efforts to economically develop the earth-moon system. In the not so distant future, the transmission to earth of energy collected from solar power satellites, the development of a fusion power economy, mining and manufacturing on the moon, and tourism in space will rival and exceed the space telecommunications industry in economic impact. These new industries will either be based on, or connected to the moon. Others have noted the advantages of using the moon as a staging area for the construction of large solar power satellites, and for the launching of interplanetary expeditions.[12] The initial investment for developing the moon will be more than repaid in long-term economic returns. The production of energy, special goods and industrial materials from the economic development of the moon will find its largest market on the earth, and commercial activity on

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[11] An analogy for the economic development of space is presented in G. Harry Stine, *Confrontation in Space*, Prentice-Hall, 1981. pp. 54-55.

[12] See: Philip Chapman, "Reviving Spaceflight," *The Journal of Practical Applications in Space*, Volume VI, No. 1, Fall 1994, pp. 1-54; David G. Stephenson, "There's Gold in Them Thar Lunar Highlands," *The Journal of Practical Applications in Space*. Volume IV, No. 2. Winter 1993, pp. 137-143; and John P. Wetzel and Stewart W. Johnson, "Engineering and Construction Challenges for a Lunar Solar Power System and Base," in the same issue, pp. 145-155.

the moon will be destined for markets on earth. The moon's lesser gravity and lack of atmosphere intrinsically favor the flow of trade from the moon to the earth, rather than from the earth to the moon.

The moon is an economic and geographic frontier waiting for development. It is a resource ripe for development in scientific observation, energy, mining, and industrial processes. The key to our strategy for developing space will be found in developing the moon as an independent center of economic activity where private property rights are respected and protected. By focusing economic development on the moon, we will be writing the history and storybook for developing civilization. Our future lies in space. It is our manifest destiny.

Why International Theater Missile Defense Is Still A Challenge Rather Than A Reality

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A number of factors which have been alleged to influence the attitude of Governments towards investment in Missile Defense are reviewed. These include the relationshIp to the original Strategic Defense Initiative, the absence of an agreed threat, desired reductions in defense spending, uncertainty in the capabilities of projected defenses and the influence of the ABM Treaty. Recommendations are made for actions which will have to be taken before allies are likely to overcome their reluctance to get more actively involved in Missile Defense activities.

Key Words: Theater Missile Defense (TMD), ABM Treaty, Strategic MIssile Defense (SDI), Cold War, Helsinki Agreement

A question that merits thoughtful attention is why international participation in Theater Missile Defense (TMD) remains such a contentious subject. No nations other than America and Israel have yet made missile defense a high priority issue, nor have they been prepared to invest substantially in the acquisition of equipment. Yet despite this reluctance to acknowledge the growing missile threat, some of America's allies continue to support the United States in peacekeeping and crisis reduction activities by deploying troops to trouble spots all over the World. It seems odd that nations are willing to expose their forces to possible hostile action, without making adequate provision for effective missile defense.

There has been so much publicity given to the extensive proliferation of missile and unconventional warhead technology[1,2,3,4,5] that no Government could now use the excuse that it was unaware of the ever increasing risk. One possible explanation is that allies believe that the U.S will provide TMD for all participants in a multinational force, even though, as yet, the U.S. is still unable to provide any effective protection for it's own forces.[6] Other explanations that have been advanced to explain allied reluctance to become heavily involved in TMD include: the lack of full agreement on what constitutes the