# Is U.S. Losing the Space Race to China?

## Synopsis of the New Book, ***StarTram: The New Race to Space***

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The very high cost of launching payloads into space using rockets has kept the brakes on a major space race among technically advanced countries. This is about to radically change, and America needs to recognize what is going to happen and act accordingly. Currently, rocket launch into Low Earth Orbit (LEO) costs roughly $5,000 per pound. Why are launch costs so high? First is the fact that the payloads are typically only about 3% of the rockets' lift-off weight. For example, Saturn V, the rocket launch system for the Apollo Moon Landings, weighed 3400 tons at lift-off, but could only deliver about 120 tons of payload to LEO (3.5%), and much smaller amounts to the Moon. So with each launch, one throws away 97% of the rocket's take-off weight, much of it very complex and expensive machinery, which ends up as space junk in orbit, junk on ocean floors, or pollutants in the atmosphere. It's like delivering a refrigerator by helicopter, which crashes after the delivery.

It is 44 years since Neil Armstrong stepped out onto the Moon, the giant step for mankind into space. What has happened since then? A series of small steps creeping further out into the solar system – Rovers on Mars,

the Hubble Telescope, the Voyager, Cassini, Galileo and other robotic probe missions, and various orbiting space stations, of which the International Space Station (ISS) is the last survivor. All of these small steps have provided glimpses of the wonders of space, of which we have experienced only a tiny portion. It is very frustrating. By now, 44 years after the Apollo landing, humans should be living on the Moon and Mars, exploring the sub-surface oceans on Europa and other moons for new forms of life, beaming clean power down to Earth and completely protecting it from asteroid and comet impacts, imaging planets in other solar systems to detect intelligent life, mining asteroids for resources, and countless other new and wonderful things.

But we can't do these wonderful things as long as we are constrained by rocket launch into space. We cannot launch the massive amounts of spacecraft and payloads that are required – it is just too expensive. We cannot afford it and the situation is not going to change. For 40 years, we have tried to bring down the cost of rocket launch, but the results have been essentially zero. Marginal cost reductions have been achieved, but the cost is still far too great. Dead rocket systems litter the landscape – NASP, Titan, Space Shuttle, etc. All have failed to cut cost.

To achieve much lower launch costs we need an entirely new way to launch payloads into space. We need to replace the very expensive

rockets launch system with our proposed electro-magnetic launch system, whose design and technology are described in our recently published book: *StarTram, A New Race to Space*. In contrast to rockets, StarTram launch keeps all of its expensive equipment on the ground, to be used over and over for thousands of launches. Amortizing the facility cost over many launches greatly reduces cost per launch. Second, unlike rocket launch, where the weight of the rocket structure and propellant is 20 to 30 times greater than the weight of the payload, in Maglev Launch, the reverse is true, with the weight of the payload being 5 to 10 times greater than the weight of the container that carries it into space. Using electro-magnetic launch, the cost into LEO could be lowered to about $25 per pound, which is 200 times cheaper than rocket launch. The cost of electrical energy to accelerate the Maglev spacecraft to orbital speed of 18,000 mph is trivially small, only about 50 cents per pound. The balance of $24.50 per pound of payload covers the amortized cost of the Maglev launch facility, operating costs, personnel, cost of the payload container, and maintenance. Maglev launch will open many major and very important new opportunities in space, that are not possible now because of the high cost of rocket launch.

Since superconducting Maglev technology forms the basis for the StarTram system, let us backtrack a little and talk about it. Maglev vehicles equipped with superconducting magnets are magnetically

levitated and propelled above a guideway of ordinary aluminum loops without contact, subject only to air drag and very small electrical losses in the guideway loops. Superconducting Maglev was invented by American scientists Powell and Danby in 1966. In spite of this, the U.S. has opted to pass on this form of high-speed land transportation. Other countries, however, have developed and built magnetically levitated trains. These countries are Japan, Germany, China, and South Korea. The U.S. came close to having a Maglev system, thanks to the efforts of the late Senator Daniel Moynihan. In the end though, the airline and automobile lobbies managed to kill it. The Japanese Railways used the Powell & Danby inventions (the inventors had only U.S. patents), did the needed R&D, and built their Maglev system. On Japan's Maglev guideway at Yamanashi, Maglev vehicles have traveled at speeds of 361 mph in the atmosphere, carrying many thousands of passengers safely and reliably. Japan plans to extend the Yamanashi guideway to become a 300 mile Maglev route between Tokyo and Osaka that will transport 100,000 passengers daily with a trip time of 1 hour. The ironic part of the story is that Japanese are today actively marketing the American-invented Japanese commercialized Maglev system for the Washington - New York corridor. An American company, Northeast Maglev, is assisting Japanese Railway Central with their marketing efforts. Northeast Maglev has assembled an Advisory Board composed of high-level former U.S. government officials.

The next step in the evolution of Maglev to electro-magnetic space launch is the Vactrain. In simple terms, Vactrain is a Maglev train operating inside an evacuated, air-free, tube or tunnel. Since there is no air inside the evacuated tube, there is no aerodynamic drag, and consequently no real speed limit. Rocket pioneer Robert Goddard was the first to explore the concept in the 1910's. His inventions were patented in 1945 by his wife, who found the designs after Goddard's death. Since then, there have been numerous paper studies of the concept. In the 1970s, Robert Salter of the RAND Corporation published many papers on the Vactrain concept. He designed a Vactrain system running from Washington, DC to Massachusetts and pointed out the many environmental advantages of evacuated tube travel. As there is no air drag, the vehicle inside the tube or tunnel could be accelerated to orbital speed of 8 kilometers per second, equivalent to 18,000 mph in British units.

Once the Maglev vehicles are able to achieve orbital speeds and operate in an evacuated tube or tunnel, the next step is to use them for space launch. One could construct an evacuated tube or tunnel on the side of a high mountain, and shoot the vehicle out of the tube at orbital velocity to reach earth orbit. This is the basis of StarTram Gen-1 system. The vehicle would coast up to the selected altitude, e.g., 500 kilometers, at

which point a small rocket burn would put the spacecraft into a circular orbit. At the mountain top, the launch tube will point upward at a desired angle of about 10 degrees. Launching from a mountaintop is desirable because the air there is much lower in density than at sea level. Consequently, when the vehicle enters the atmosphere, the aerodynamic drag and heating are greatly reduced. Also, preventing backflow of the ambient atmosphere into the evacuated launch tube, which opens when the vehicle exits the tube, is easier at lower atmospheric pressure.

As stated earlier, StarTram launch is about 100 times cheaper than conventional rockets. StarTram's cheaper access to space makes many new space activities practical, that were prohibitively expensive using rocket launch. The new opportunities for mankind are incredible. Probably foremost, we can realize the dream of abundant clean energy without burning fossil fuels, or creating nuclear waste. We can generate enormous amounts of electrical energy in orbit using solar power satellites and beam it down to Earth, to be distributed by our existing electrical grids. The beamed energy is 100% pollution free, does not emit greenhouse gases, and will be unlimited and low in cost.

As with Maglev ground transport, America seems to be sitting on the sidelines and risks letting other counties take the lead in Maglev space launch, to reap its economic benefits. StarTram launch will be a multi-

trillion dollar per year industry. With all the potential benefits, why has America not rushed to develop this technology? The major obstacle is the existing rocket industry, a multi-billion dollar establishment. Whenever a new technology threatens to "step on the rice bowls" of the existing one, there is great resistance to it. History is full of examples. After inventing the light bulb in 1897, Thomas Edison wanted to bring electric light into Manhattan. Did the gas-light industry welcome electric light? They certainly did not. They had a whole infrastructure in place to provide gas-light: factories to produce clean-burning gas, huge gas storage facilities, miles of underground piping leading to each house, etc. All of this was threatened by Edison. In the end, electricity did win out, but it was a very hard fight.

StarTram launch will not eliminate rockets; only the heavy lift rockets that put spacecraft and their payloads into Earth orbit. With the great expansion in space activities as a result of cheaper launch cost, there will still be a need for rockets, for situations where StarTram is not available. These are rockets to go from Earth orbit to destinations beyond Earth, and rockets for return to Earth, etc.

So which country is likely to claim the prize to change the world for the better? If we "connect the dots" that country is China. Why China? First, China already has a fully operational revenue-producing Maglev

train operating on a 31 kilometer track between the Shanghai Airport and the City Center. Second, since 2002, China has been working on the Vactrain, i.e., Maglev trains that operate in an evacuated tube. As noted earlier, there have been many paper studies of Vactrain, but the Chinese are the first to commit to bring the Vactrain to reality. In 2002 China assembled a team of scientists and engineers at the Chinese National Traction Laboratory of the Southwest Jiaotong University to develop, design, test, and build the Vactrain system. The *China Information Center* (www.china.org.cn) reported on January 30, 2010 that the new technology can be put into operation in 2020. The design speed of their Vactrain is 622 mph. This is far below the limit for Maglev trains in vacuum tunnels. Dr. Zhang Yaoping, one of the scientists in the Vactrain program, believes that the speed limit of evacuated tube Maglev trains will be close to orbital speed. Clearly, the Chinese Vactrain system provides a solid technology base for electro-magnetic space launch, should they proceed in that direction. And why not? Once they decide to use Vactrain for space launch, there are two requirements they must meet, both of which are readily resolved. First, they must build the Vactrain track on a suitable mountain slope, the higher the better. The Chinese have many sites to choose from in southwest China, several with unpopulated regions that extend hundreds of kilometers downrange from the launch site. The second requirement is to build a system that prevents the flow of atmospheric air into the

evacuated tube, when the tube end opens to let the high speed spacecraft exit the tube. Both requirements can be met by straight-forward engineering, with no breakthroughs needed. After meeting these engineering requirements (it would be surprising if they weren't already working on them), the Chinese would have what we call the StarTram Gen-1system that can launch 100's of thousands of tons of payloads into orbit annually, at a cost per pound that is 1/100$^{th}$ of that using rockets.

Where does the U.S. stand? Before you can build the StarTram launch system, you need Maglev and then Maglev in a vacuum tube, which is Vactrain. America does not have a Maglev system. Although American scientists invented superconducting Maglev, it was built in Japan and not in the U.S.A. So what does U.S. have? We have good ideas, and smart people that want to work on StarTram, but there is little national will for anything new and bold. Our companies are very risk-adverse. They want to bet on sure things that provide fast earnings, preferably in the next quarter. On the government side, our Congress is politically paralyzed, and unable to do much of significance. So Maglev transport and space launch, which will be the major technologies in the coming decades, are languishing in the U.S., while other countries are pushing ahead.

Moreover, there are very important national security implications of the StarTram launch. While Maglev ground transport does not have military uses, the same cannot be said of StarTram. Once a country develops StarTram launch to do good things for mankind, there is also its "Evil Twin" lurking in the shadows. A space-based weapon system, proposed in the 1950's and studied by many, including the USAF, is the kinetic energy kill system, generally called the "Rods from God." These Rods are simply very heavy tungsten cylinders, about the size of telephone poles. They weigh about 8 tons each and re-enter the Earth at near-orbital speed, with an equivalent explosive power of 40 tons of TNT upon impact with its target on Earth. The reason this weapon system has remained on paper, until now, is that putting the heavy Rods in orbit is too costly. With rocket launch, the cost to orbit a single Rod is about $80 million. For a robust weapon system, the number of Rods needed is at least 10,000. Using rockets, the launch cost would be close to a trillion dollars. With StarTram launch, these costs become much less, on the order of 10 billion dollars, equivalent to about 5 days of U.S. defense budget. The Rods from God can be directed against any military base, airport, seaport, and manufacturing facility. Warplanes, ships, tanks, armored and unarmored vehicles, radar stations, missile silos, computer and communication networks, the labor of decades – all gone in a few hours. And here's the kicker: Developing this system

does not violate the Outer Space Treaty or the Anti-Ballistic Missile Treaty.