

NovAtel in the Space Elevator

GPS Technology helps drive the future of space commerce and travel



Figure 1: A NovAtel GPS-702-GG antenna guides the USST's elevator cab up the ribbon at the 2007 X-Prize Cup

Photo Credit: Mark Boots, USST

Introduction: The Space Elevator

Imagine an elevator that goes into space! Climbing on a ribbon tethered to the Earth, an elevator cab would climb upwards for 22,000 miles to its final destination into outer space. Novatel's receiver and antenna technology was utilized by the University of Saskatchewan's Space Team (USST) to show the world the Space Elevator is no longer a science fiction concept.

By providing everyday access to the solar system, the Space Elevator would open new travel and commerce opportunities. The Elevator could also potentially replace expensive shuttles and rockets, cutting the cost of transporting people and cargo into space by as much as 1/100.

The Technology Behind the Concept

While the Space Elevator concept sounds futuristic, The Spaceward Foundation, the organization behind Elevator: 2010, says full-scale work on the elevator will begin in 2010 and could carry its first payload by 2020. The elevator will consist of a thin ribbon, or tether, anchored to a base on Earth and to a counterweight in space. As the

planet rotates, the counterweight will rotate with it, ensuring the ribbon remains taut.

The ribbon will be made out of carbon nanotubes. To form carbon nanotubes, carbon molecules attach together in a circular, tube formation. When processed, the nanotube is thinner than a sheet of paper, but stronger



Figure 2: USST's prototype climber

Photo Credit: Mark Boots, USST

than stainless steel.

The 'climber', a type of elevator cab will travel up and down the tether, carrying cargo or personnel into space. The climber is powered by photo voltaic panels, similar to solar panels, mounted to the bottom of the climber. The panels are a constant-voltage current source, which deliver an electric current to the climber's drive train system. A laser on the ground would direct a beam at the panels.

NASA's Centennial Challenges

In order to encourage new advances in technology, NASA provides funding through the Centennial Challenges program. Rather than awarding grants for future work, NASA offers prize money for organizations and academic institutions to build technology that meets certain requirements. The Spaceward Foundation's Elevator: 2010 is among these Centennial Challenges.

The University of Saskatchewan's Space Team

The USST is one of the 22 competitors that entered the Elevator: 2010 competition last year at the X-Prize cup. The teams had to create a climber that would scale a ribbon suspended 110 meters up on a crane. The USST was the only team entered who competed with a working laser power beaming system and sent the



Figure 3: Members of the USST team attach the climber to the ribbon

Photo Credit: Mark Boots, USST



Figure 4: The USST team with their first prize Elevator: 2010 entry

Photo Credit: Mark Boots, USST

climber up the ribbon powered only by the laser beam. To deliver power to the climber, a laser is directed at the panels on the bottom of the climber.

A Differential GPS (DGPS) system is used to keep the laser pointing at the solar panels, in the case of the climber moving while traveling up the ribbon. It is crucial for the team to maintain sub-centimetre accuracy from the DGPS system, to keep the laser beam centered on the climber. A NovAtel ANT-532-C antenna is attached to the climber's platform frame to track the movement of the climber as it ascends. If the cab shifts, the laser too must shift to keep the cab

climbing steadily. A NovAtel GPS-702-GG antenna is on the ground. The antenna on the car, relays positioning information to the base station.

A NovAtel OEMV[®]-2 L1/L2 receiver on the ground, allows the crew to change the direction of the beam. The receiver is set to make RT-2[®] corrections and NovAtel's Waypoint[™] RTKNav software is used to determine a vector between the base station and the climber.

The USST team's laser powered prototype worked exactly as planned, climbing the ribbon in 1.86m/s, setting four world records and placing first in the competition. Unfortunately, this time was just short

of NASA's 2m/s criteria to win the \$500,000.00 grand prize. According to Mark Boots, VP Engineering for the project "The results were simultaneously a tremendous achievement and a frustrating disappointment". The team is entering the X-Prize cup again in 2008 and will be focusing on incrementally improving the technology that the team has already developed. Lessons learned in the 2007 competition will be built upon so that they can rise to the top again in 2008.

Summary

Keeping the University of Saskatchewan's Space Team's elevator cab on its ribbon calls for sub-centimetre accuracy. With NovAtel's leading edge OEM GPS technology on board, the USST came in first at the 2007 stage of Elevator: 2010, a NASA Centennial Challenge at the X-Prize cup. The USST team set four world records and climbed its ribbon in 1.86 m/s.