Space Elevator Transportation System

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Personal Prolog

This is an Architecture Note. It is the opinion of ISEC's Chief Architect. It represents an effort to document ISEC's ongoing science and engineering discussions, and is one of many to be published over time. Most importantly, it is a sincere effort to be the diary, or the chronicle, of the multitude of our technical considerations as we progress; along the pathway developing the Space Elevator.

Michael A. Fitzgerald

Background

In early June, the Chief Architect approached NSS's Dave Dresser about a more collaborative relationship between NSS and ISEC. One of the outcomes was Dave suggesting we connect with Rod Pyle at ad Astra & get an article into the coming edition.

This is the result of that suggestion

Space Elevators seen as part of a "Galactic Harbour"

Reliable, safe, clean, and efficient access to space; without debris, within a permanent transportation infrastructure. The International Space Elevator Consortium has been investigating the technology challenges of achieving space access without rockets. It is called a Space Elevator. This Space Elevator lifts cargo into space like any elevator you have seen in any building. The elevator cable is called a "tether" while the elevator car is called a "climber". The upper end of the tether, an Apex Anchor is counterweight; 100,000 kilometers up there, held in place by the combination of 1) centripetal/centrifugal forces generated by attachment to a spinning earth; and 2) the reduced force of gravity at the higher altitude. This transportation capability is close at hand.

At the ISDC Conference in Los Angeles in May 2018, the International Space Elevator Consortium (ISEC) discussed the viability of building the Space Elevator Transportation System. ISEC sees the Transportation System supporting the space industries that will be burgeoning on orbit by mid-century; companies that will be servicing and repairing operating satellites, managing small orbital factories, supporting interplanetary flights, and delivering power & unique materials to a crowded Earth.

The Space Elevator will eventually replace heavy lift rockets and become the primary pathway to space. Each system is seen to have 14 Climbers each carrying up to 20 tons to Geosynchronous orbit and beyond. The Climbers move along a Tether that will be longer and stronger than any elevator cable ever made.

Since discussed years ago in science fiction like Arthur C. Clarke's "*Space Odyssey- 3001*" critics have pointed at the challenges; dismissing the benefits. But in the last few years things

have changed. Announcements regarding materials with high tensile strength convinced many that the tether challenge could be met. ISEC reported that the Elevator could by solidly simulated; an essential tool for engineers. Unique engineering approaches like multi-stage elevator construction also provided validity to the feasibility of building the Elevator. The Space Elevator team from Japan have published their intent to construct an Elevator. Most recently, China announced their intent to have an operational Space Elevator by 2045.

ISEC brought forward the concept of regions in space logistically supported by the Elevator and coined that approach as the Galactic Harbour Architecture. The Space Elevator has left science fiction. This could be the story of this century.

The Galactic Harbour 's Destiny

The Architecture will be the transportation and commerce foundation for a growing Earth population; estimated to exceed 11 billion by 2060. To support such a population; power, products, and resources in general must be found and developed. A robust permanent transportation system is needed to support the search and the developments; much as the transcontinental railroads fueled development in the 19th century, and container shipping was the foundation of the 20th century explosion in global commerce. The Galactic Harbour is an active construct, and people "get it". The Elevator will support daily departures; tons of cargo up to orbit and daily arrivals of products from space. ISEC has set out to socialize the concept and its technology maturation efforts with industry and academia.

The Space Elevator Transportation System is the main channel in the Galactic Harbour. Using that transportation support, on-orbit businesses will locate themselves near this flow; depending on it for services, spare parts, and customers. The GEO Belt is already flourishing with hundreds of commercial and

government satellites. These satellites can be repaired, rebuilt, refueled, and reprogrammed inside the Elevator's GEO Region; solar power generation systems will be assembled; gravity-free research and experimentation will be conducted; and interplanetary journeys will be launched using spacecraft assembled in factories within the Space Elevator's GEO Region. Some governments have signaled to get started. Japan's Basic Space Law – passed in 2008 - established Space Solar Power as a national goal. China matched this with their 2015 roadmap for sizable power delivery from space by 2050. This date coincides with the first operational date of China's Space Elevator in 2045. Things are becoming obvious.

The Galactic Harbour is the first stop to everywhere

A Space Elevator is a permanent space transportation infrastructure. It is composed of an Earth Port where cargo is received, Climbers for carrying up to 20 tons cargo each, Tethers on which the Climbers move up and down. At the geosynchronous altitude is the GEO Node. This is the region where the business services and factories will operate. Further up, the Tether is attached to the APEX Anchor; keeping the Tether taut and stable for efficient operations.

One of the principle thrusts towards an operational Space Elevator is its customer utilization. Today's forward-thinking companies can see their commercial space projects within the Galactic Harbour. The Galactic Harbour is the unification of transportation and enterprise; operations that move customer payloads from earth to space destinations (the customer's places of business).

The cargo enters the Galactic Harbour at the Earth Port where it is placed inside Climbers which proceed up the Elevator's Tether with cargo inside; much as any elevator car in any building might carry passengers or cargo to the upper floors. The exact point of

delivery is possible most anywhere, per the customer's desires. A primary destination is likely a region near geosynchronous altitude where a great deal of Space business is currently active; the Elevator's GEO Node Region.

The operating concept encompasses two Tether Termini on the ocean surface near the Earth Port's central operating platform (where incoming and outgoing ships, helicopters and airplanes operate – handling cargo, as well as housing crews and support services). The Elevator operates from the Earth Port, stretching up to include tethers, climbers and other elevator system elements out to the Apex Anchors; 100,000 kilometers above the Earth Port. Products and payloads for space delivery enter the Galactic Harbour at the Earth Port and exit at the GEO region, or the Apex region or at another point along the Tether.

Any release point above the GEO Node could be used as an energetic departure point for travel elsewhere. Departure energy is derived from the angular speed (centripetal force), the diminished strength of Earth's gravity, and the increased effect of gravity from elsewhere in our galactic locale ➔ the Moon, Mars, the asteroid belt, an intergalactic trek, or the sun.

Eventually, the Apex Anchor will use its high energy location to launch interplanetary flights; and receive the returning flights. The Apex is unique. It's position at the far end of the Tether provides incredibly efficient impetus to spacecraft destined to Mars, the resource rich asteroids, or any other undiscovered necessities. These Apex departing space craft are "tossed" toward their destinations; mankind's destiny. The Galactic Harbour is, indeed, the first stop to everywhere.

Because we must

The Space Elevator will be built, because it must be built. The operating elevator will be the core of mankind's capability to survive

to the next century. It is the source of tomorrow's clean energy. It is the source of tomorrow's food and water. It is the route to travel to other planets, efficiently … and more. Perhaps most importantly the Space Elevator opens the road, it opens the Heavens; it opens the way. It will, as the poet cites, allow us to truly '**slip the surly bonds of Earth**'. It is our responsibility to do so.

"Oh! I have slipped the surly bonds of Earth
And danced the skies on laughter-silvered wings;
Sunward I've climbed, and joined the tumbling mirth of sun-split clouds, — and done a hundred things You have not dreamed of

This starts a poem by John Gillespie Magee on his dreams of flight; written in the middle of the 20th century. It seems that it also portrays our dreams of space travel by the middle of the 21st century.

The Space Elevator will be a transformational transportation system. It will move objects, systems, material and (eventually) people from the Earth to Space. The Space Elevator will be incredibly more efficient than today's launch systems leaving the deep and strong gravity well of Earth.

The Space Elevator will be safe. It will be environmentally friendly, and most importantly, it will enable a wide range of activities in Space. Because of the Space Elevator, we will do today's Space missions better than ever before. It will enable us to do missions in Space that have only been dreamt of. ISEC's goal is to show how space elevator effectiveness for future missions can lead towards galactic destinations. By understanding this new revolutionary capability; we will be able to go wherever we wish.

In closing

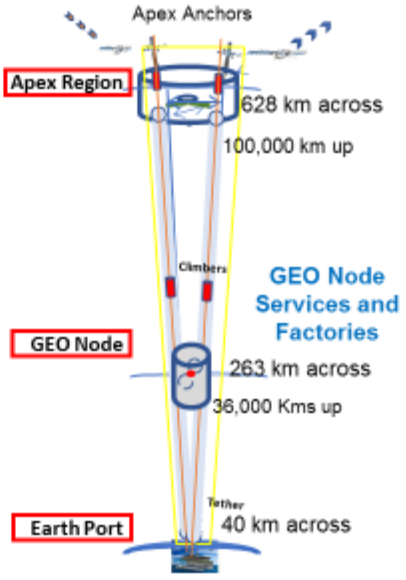
I hope they see us coming!
More to come

Fitzer

The Space Elevator Architecture

What we see is magnificent: ➔ large regions in Space, dedicated to operating the new & revolutionary space access transportation system.

Businesses will flourish on-orbit, satellites will be repaired and refueled; "gravity-free" research & experiments will be conducted, systems of solar power generation will be assembled; and interplanetary journeys will be launched -- using spacecraft built in factories near the Space Elevator.



Galactic Harbour - The Unifying Vision

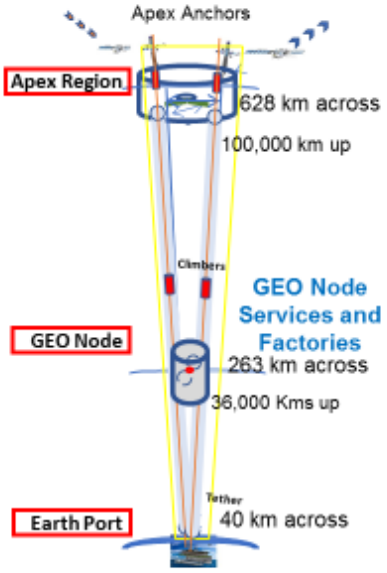
Space Elevator Basics

1. Space Elevator Transportation System is the 'main channel' in the Galactic Harbour.

- ***Apex Region***
  - ***Mars and Lunar Destinations***
- ***GEO Node -***
  - ***Satellite Services & Factories***
- ***Earth Port***
  - ***Payloads received***
- ***Climbers***
  - ***Payloads delivered within the Harbour***

2. Businesses flourish as part of the Space Elevator Enterprise System

- ***Business support to Operational Satellites***
- ***Interplanetary Efforts within reach***
- ***Power and Products delivered to Earth***
- ***Research***



Galactic Harbour - The Unifying Vision