

**FINAL**

# Space Elevator Architecture

## Architecture Note #32

### ***Testing a Megaproject***

*Now that we know what a Galactic Harbour is ...  
How do we test it, and see if it works?*

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## **Personal Prolog**

This is an Architecture Note. It is the opinion of the Chief Architect. It represents an effort to document ongoing science and engineering discussions. It 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

### **We are certain, the Galactic Harbour can be built but ...**

I remember it well. It was October 1973 and I was in front of the TV watching the Oakland A's and the New York Mets in the World Series. I was also assembling the crib for our first child. Kathy was asleep. She needed to be ready. It was only a couple weeks until Brian would arrive. The World Series ended (Oakland won), and I was pushing the complete and operative crib down the hall to the "baby's room". All was well ... until ... It didn't fit through the door into the room! I knew I could assemble it; but ...ah, the lessons of life!!

In a similar way - Yes, we are certain that a Galactic Harbour can be built. We have our way for building each and every piece of it. Yet ... A quick review of the ISEC Position Paper # 2014-1 – "Space Elevator Architecture and Roadmaps" reveals the scope of testing:

- The Earth Port - 4 Major Demonstrations
- Tether Segment - 13 Major Demonstrations
- Tether Climber - 8 Major Demonstrations
- Apex Region - 9 Major Demonstrations
- HQ / POC - 4 Major Demonstrations

In addition to these 38 major demonstrations, the testing activity in the GEO Region will be immense. The GEO Region has been defined since the 2014 report, and must be active prior to the deployment of the Seed Tether. The GEO Region will be home to a fleet of test support MicroSats and CubeSats supporting the deployment and Limited Operations activity cited in the ISEC sequence discussion. (See Architecture Notes #6,7,8).

## **Test Taxonomy – can you count that high?**

Each of the 38 Major Demonstrations will be large and complex. Many of the tests will be conducted in orbit, mostly at GEO. Some will be conducted at LEO to enhance observation from ground sensing. Some will be conducted in the debris zone (for obvious reasons) and some will be conducted in the environmental zone. It is likely that a number of tests will be conducted with high flying weather balloons.

But the real scope of testing is revealed when we understand that each of the 38 major demonstrations sits atop a taxonomy of other testing; component testing, risk reduction tests, internal interface testing, hardware in the loop testing, software in the loop testing, failure mode and effects testing, test data collection checks. I would estimate that three to four thousand tests and retests will be conducted, and easily one third of that number will be field tests or on-orbit tests. We probably ought to figure out that number.

### **Testing for alternate engineering validation**

As long as we are thinking about numbers, remember that in some of the segments there will be alternate engineering approaches being considered. Those considerations will require testing for the sake of comparing one alternative with another. This is especially true for integration testing; such as the classic “thread testing”. Thread testing is needed to confirm that the various segments can operate together, AND when one segment must change its operation (e.g. slowdown); the other segments must accommodate. Those tests are exciting!!

### **Testing for the unknown unknowns**

Within the simple rule of life - “We don’t know what we don’t know – we have a lot of work to do. We will have test failures that are not understood. We will have “random successes” that will haunt us for months. We Must be sure that our various simulators are simulating the same thing we are testing.

## **FINAL**

### **Where are we going to test?**

Here is a topic that will occupy our politician and diplomatic friends for a long time. I speak from experience. I figure we need to do a lot of the field testing over the ocean; probably the Pacific. Wherever our test range is – it must be accessible for the monitoring and management of the test events. It must be safe. Assets must be available to respond to tests gone awry and to recover assets for analysis. The logistics of managing the test range when multiple tests are underway ... will be interesting.

### **In Closing**

There is more to say but, you get it. I did not intend to answer questions with this note. Rather, I wanted the team to start thinking about it. As stated above, I don't know what I don't know. More to come. 😊

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