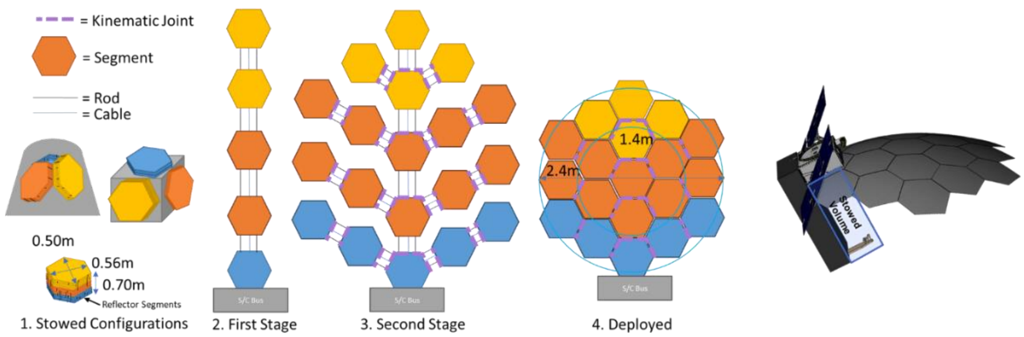
Let It Go Written Spec

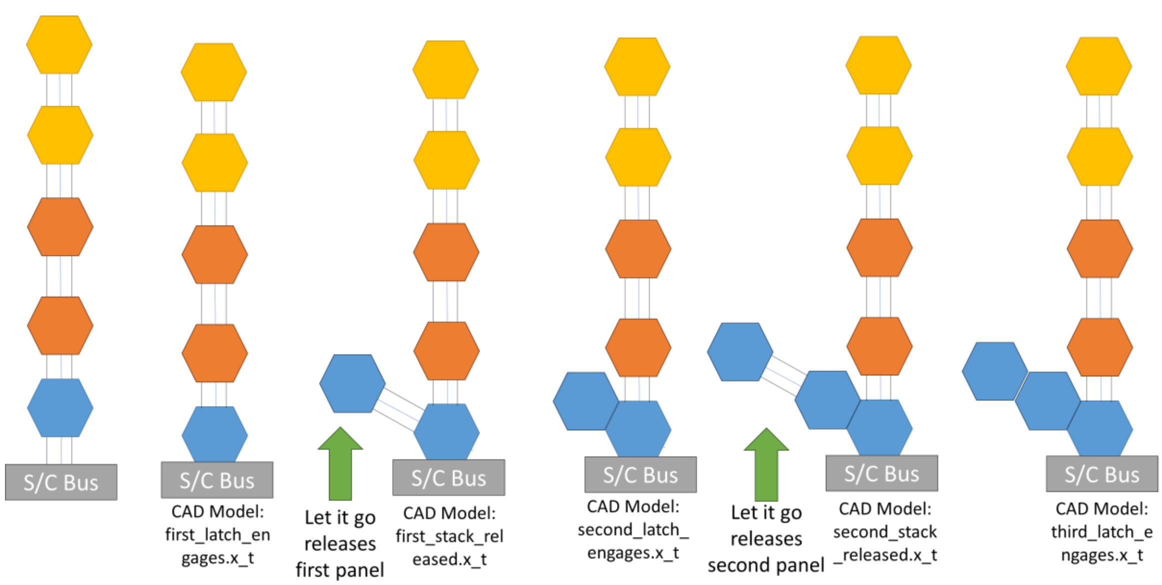
<table>
<tr><td>Challenge Title:</td><td>Let It Go: (After Latching)</td></tr>
<tr><td rowspan="3">Challenge Summary:</td><td>Brief overview of the challenge context and goals.
Our goal is to provide a synchronized deployment for an antenna. One of the key challenges is ensuring we have a device that will release the next panel, after the prior panel is deployed.</td></tr>
<tr><td>Key problem(s) to be solved or system(s) to be designed.
Your goal is to design a mechanism that will release the next hexagon in the stack of hexagons after the previous one latches. This will allow us to have a sequenced deployment.</td></tr>
<tr><td>High-level requirements, assumptions and/or constraints.
Your design must work with the one of the winning latch designs from the prior challenge (Lets Connect). It must also work with the provided backing structure model, and not penetrate the parabolic surface.</td></tr>
<tr><td>Background:</td><td>In space, there's a growing need to build large, precise structures like antennas, booms and telescopes. These structures are too big to fit inside a rocket during launch, so we need a way to deploy them once they reach their orbit.

One idea for deployment is the Starburst architecture, which uses high strain rods to deploy and cables to pull the different parts together after launch. In our last prize challenge on this topic (Positive Connections), we asked participants to design a latching mechanism, that would latch the hexagons after the cable pulls them together. This new challenge will build on the previous results. The goal is to design a mechanism that will release the next hexagon in the series after latching.

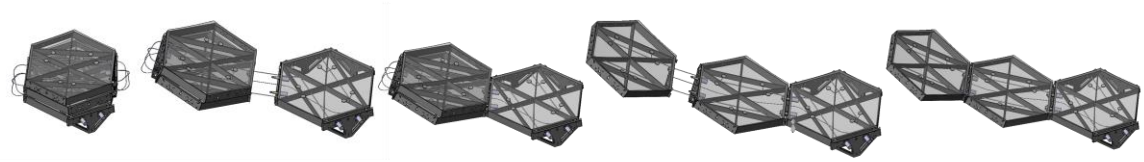
Our key example is an Earth observing antenna. The antenna's segments are stacked neatly on top of each other, taking up a compact space (1). After launch, the segments are released from their locked positions, and a set of high strain rods deploy the system into an initial configuration (2). Each element is aligned correctly by two high strain rods, so they can be pulled together. Once the antenna opens up, the cables start retracting, gradually pulling in each segment until they form the final deployed shape (3). The segments are precisely located relative to each other using special joints, with an accuracy of around 20 microns, and held in place by the tension in the cables. (4) Upon fully deploying, the latching mechanism from the “Positive Connections” challenge locks the segments together. The overall surface alignment has a root mean squared (RMS) error of approximately 60 microns. Check out the image below for a visual representation of how the antenna transforms from a packed state to a fully deployed state.</td></tr>
</table>



Initially, all the hexagons are stored in a stack. One of the challenges we have realized in our prototyping efforts over the last year, is that we can't just release all the hexagons at once. The result is too dynamic and they may collide with each other! Therefore, our goal is to have a system that will release the hexagons in the stack one at a time, after the previous hexagon is deployed and no longer moving. The goal of this challenge is to design a mechanism that will release the next hexagon after the latch engages, allowing steps 2 and 3 in the figure above to occur in smaller steps. See the second image below (updated), with arrows where the "let it go" system will release the next panel after each deployment.



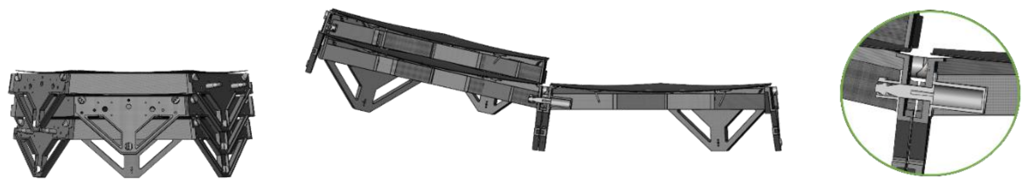
Your goal is to create a mechanism (the "let it go system" which will release the next hexagon after the latch engages. This will then allow our hexagon deployment to be sequenced, consisting of release, deploy, latch... which then triggers the next release, deploy, latch. This is where it connects to the previous GrabCad challenge. You can choose any of the 5 winning latch designs as a starting point for your design. The figure below highlights the deployment sequence in the CAD model. Each photo is a unique model file.



Challenge Details:

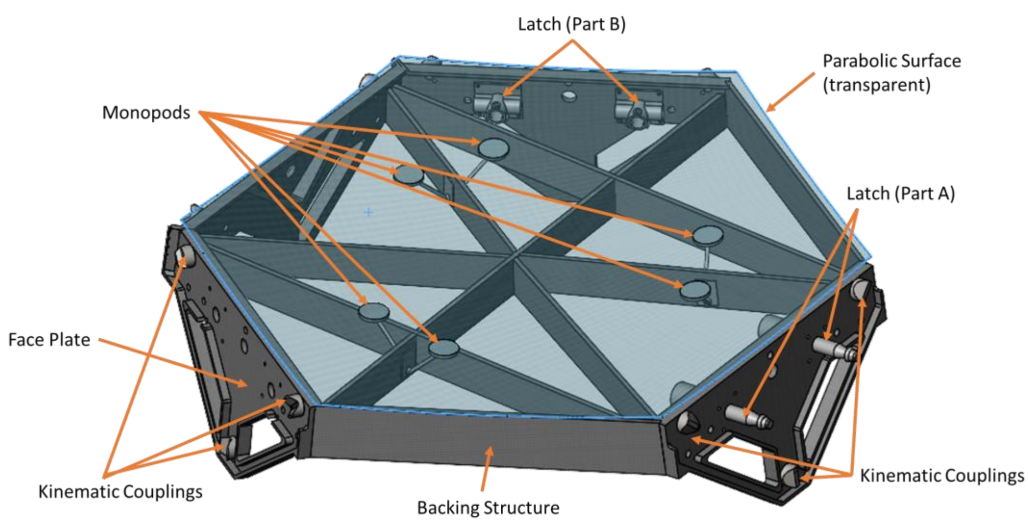
Detailed description of the problem to solve or system(s) to be designed.

The study "[Starburst: A Revolutionary Under-Constrained Adaptable Deployable Structure Architecture]" demonstrated a unique approach to deploying large antennas to much higher accuracies than ever before. The first system had all the segments release at once, but this created problems with the segments interfering with each other during deployment, except for very simple "Z-fold" stowing patterns. We want to sequentially deploy the segment after the prior segment latches to enable more complex deployments. CAD files of the current segments are provided with the Egyptian key design.



Only after the latch fully engages does the next panel release.

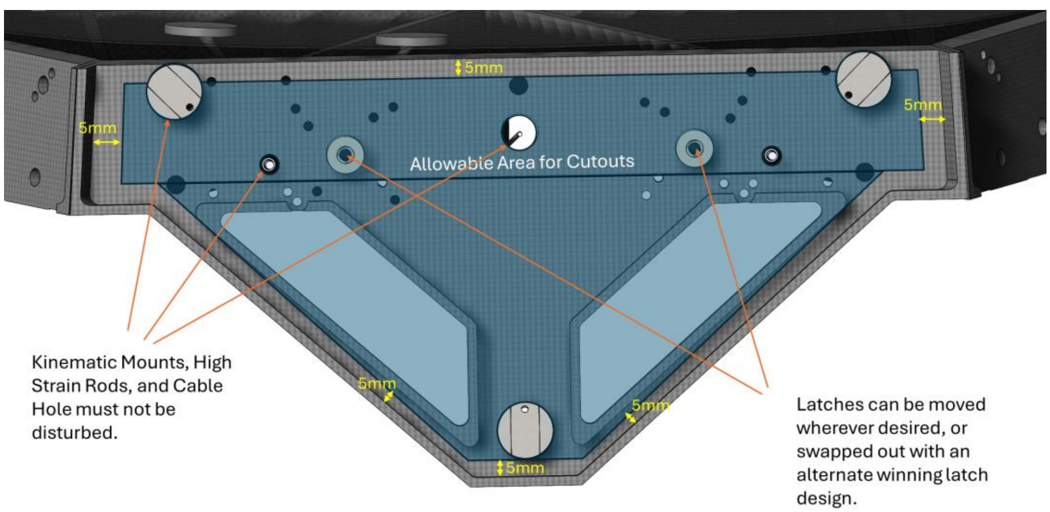
Below identify the key parts of a single hexagon which are useful for understanding the detailed requirements. Each hexagon consists of two key parts, backing structure which serves as the structural background, and a precision parabolic surface on top of the hexagon. The backing structure and precision surface are connected with a set of monopods. On the backing structure, there are face plates where it connects to other hexagons. On each face plate are three kinematic couplings, which connect each hexagon with each other with exactly 6 points of contact.



Detailed requirements, assumptions and/or constraints.

1. The release system must work with the existing latch systems as designed. It can be trigger by latch, or by the proximity of the two faces in how close they are together when latching.

2. It can be assumed that the latch produces 25N of force which can be used to trigger the next panel release, or that there is 25N of preload between the panel faces that can be used.
3. The release system must not interfere, contact or penetrate the kinematic couplings, monopods, or parabolic surface at any point before, during or after operation. It should hold on to the backing structure above the prior mount.
4. The release mechanism must not extend more than 60 mm from the backing structure when stowed, and after the panels are deployed can not extend above the parabolic surface. While additional holes and cutouts can be added to the backing structure, this may only be done in the middle 25 mm (in other words, it cannot remove the top 5mm or bottom 5 mm of backing structure material). See image below which clarifies areas that can be modified.



5. The system must be entirely self-contained, and not require any external power sources or signals to operate. It must be able to detect when the latch engages, and use this as the criteria to release the next panel.
6. Release mechanism components should weigh less than 1 kg (2.2lbs). It must work in the vacuum of space, and a variety of temperatures. The mechanism must be able to be triggered at any temperature between -10C to 60 C (14F to 140F) and survive temperatures ranging between -60C to 100C (-76F to 212F).
7. The system cannot be triggered without the latching components coming together. For example, high G-forces or shock loads that come with spacecraft launch should not trigger the release mechanism. Expect that the mechanism could see accelerations up to 250 G's. It can be assumed that each panel weighs 3 kg, plus

	the mass of the release mechanism. It can also be assumed that an external device holds all the panels together during launch, so your release device does not need to hold the mass of the entire stack of panels. It just needs to survive the 250 G launch load itself.
	Provide any available CAD models, data, or other references. See attached .x_t file of CAD (to be sent via JPL LFT) of the antenna system in the stowed and in the deployed state.

	Any key criteria that must be included in the submissions.
	Each entry is expected to include.
	1. CAD model of the release mechanism
	2. Rendered images showing the sequence of how the release device works.
	    a. Cross sections, especially annotated cross sections can be very helpful for the judges to understand how deployment mechanisms work.
	3. (Optional but encouraged) Animation showing the how when the panels latch the release device is triggered, and how the release device releases the next panel. Animations are extremely helpful in selecting the finalists.
	4. An explanation document in .pdf format
	    a. This document must include
	        i. How the release mechanism will work.
	        ii. Why an acceleration of 250G's will not accidentally trigger the device.
	        iii. That the device can operate at both -10C to 60 C, and survive temperatures between -60C to 100C.
	        iv. All written justification should be in one .pdf document.
	        v. Written justification should include a references/credit section, which includes:
	            1. Links to any CAD files used as a starting point.
	            2. Any ideas on GrabCAD or from other sources that inspired your concept. Includes ideas from the current challenge, and prior challenges, and anywhere else on GrabCAD. Be sure to list both the submission name and the username of the person who made the submission.
	            3. The GrabCAD community excels in collaboration so make sure to give credit to ideas and/or recommendations from other community members that have helped you mature your design as failure to do so may negatively impact scoring.
	                a. Hint, you must reference at least one of the latch designs from the "lets connect" challenge.
	            4. If relevant, any publications used to justify the design.
	5. (Optional but encouraged): Images of prototypes to help justify the design. Does not need to be a 3D printed prototype, but it can be. Also detailed analysis of

	device operation can be a substitute for prototyping (this can be included in the prototype above). Images of a prototype greatly help with judging criteria 2 and 8.
Submission Requirements:	*Required deliverables (CAD files, reports, images, etc.).* • *CAD Files used in model.* • *An image of your design, and images or animation of the deployment sequence (animations are strongly encouraged)*
	Accepted file formats. • STEP, IGS, X_T or native Solidworks files are acceptable for CAD. o If applicable, use a CAD file naming convention that makes it easy to determine how each file fits into the larger assembly. • Image files should be .jpg or .png • All animations should be compatible with embedding in Microsoft PowerPoint and separate viewing in Windows Media Player • Reports should be in .pdf format (can be saved from MS word to a .pdf). • If zipped, the file compression shall be compatible with Windows 10 and not require any special software to unzip.
	Page limits and file size limits. • Total size of all files combined should not exceed 250 MB • There is no page limit to the report.
	Any additional technical requirements not discussed earlier.
	Any non-monetary prizes or recognitions. The finalists will be listed on the GrabCAD websites. We also reserve the right to name honorable mention for concepts that did not place in the top 5, but we thought would have a special call out. Also, we will name an honorable mention to the top entry from a country not eligible to receive a cash prize (Type 1, 2, or 3 on the NASA Designated Countries List). This concept may or may not be on the finalist list.
Judging:	*Evaluation criteria and weighting factors (what you will base your judgment on).* 1. It is clear how the mechanism operates to release the next segment. — 20%

2. Mechanism operation appears to be robust and work repeatably.	20%
3. Design is shown to meet the physical constraints.	15%
4. Design provides confidence it will not unintentionally activate.	10%
5. Quality and fidelity of the 3D models and renderings.	10%
6. How innovative the concept is when compared to other submissions.	6%
7. Design is shown that it will activate with 25N of force or less	10%
8. Quality of thermal and structural analysis, giving confidence that design will survive launch and space environment.	6%
9. Feasibility of manufacturing, fabrication, and assembly of mechanism.	3%

Evaluation process and timeline.

There are two evaluation processes that will be occurring. First is evaluation of the ideas, and second is for the most referenced idea award:

A subset of the judges will review all the concepts to determine which concepts our finalists. Determination of finalist entries will be primarily based images an animations submitted, and judging the first six of the evaluation criteria. After finalists are selected, the judges will then review all the finalist entries in greater detail, including a detailed examination of the report. Finalist entries will be scored per the full evaluation criteria.

Finalists will be determined two weeks after the contest closes. Winners will be determined within three weeks after the finalists are announced (longer time period due to the holidays during the judging period.

For most referenced design/community member:

- Option 1 (most referenced design/challenge participant by the finalist entries)
  - This prize will go to the top two challenge participants/submissions in THIS challenge which are referenced by the most finalist entries in this challenge. References can be due to a design feature that you incorporated into your submission or direct feedback from another challenge participant that helped your submission.
    - Self-references to do not count. The must be from other participants.

	- The most referenced design does not need to be a finalist. - If one participant has multiple finalist entries, those finalist entries count as 1 reference instead of multiple. (I.e. maximum of one reference per participant). - Reference chains, will be include. For example, a Finalist references idea A, and idea A references idea B, id . Both idea A and idea B will get scores for being referenced (provided the rules above apply. Circular references will not be counted multiple times.).
About the NASA Sponsor:	*Jonathan Sauder*
	Jonathan Sauder is a mechatronics engineer at NASA's Jet Propulsion Laboratory who invents new deployable antennas and develops innovative spacecraft concepts. He also is a group lead in the technology infusion group