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Sustainable Telecommunications: A Portable, Solar-Powered Balloon for Remote Connectivity and Disaster Response

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Abstract

This project aims to develop a compact, cost-effective, and portable solar-powered telecommunications product. It is designed for situations where traditional communication infrastructure, such as radio towers or satellite stations, are impractical or unavailable. This includes remote locations with limited access to infrastructure and disaster-stricken areas where existing networks are often damaged or inaccessible, hindering communication. The product is intended to be tethered to the ground and operated for a limited duration, ranging from a day to a week. Its modular design allows for a customizable payload, making it adaptable to different communication needs. This solution offers an innovative and flexible approach for providing temporary or emergency telecommunications in challenging environments.

Keywords
Low Altitude Platform Station, Telecommunications Balloon

1. Introduction
This report outlines the reasoning for the need for a short-term low-altitude telecommunications (telecom) balloon as well as defining the gap in the market for the lack of a telecom balloon. Telecommunications is an integral part of communication in the modern day, it is no longer a tool of convenience but an extremely important component of everyday communications. Communication channels play a critical support role in operations such as surveying, land management, and search and rescue operations where timely and effective communication is of the greatest importance. Traditionally, telecom depends on constructed infrastructure that requires vast amounts of qualified people, time, and money to construct and set up for that region to have telecom services. Additionally, satellite communications have seen major advancements in servicing remote locations, and yet it has a lot of limitations and gaps in its services that limit its usage in extremely remote locations. Furthermore, the two services often face limitations when it comes to costs, deployment speed, and coverage. On the other hand, with the wireless revolution and the invention of the smartphone, telecommunications have become the forefront of critical infrastructure. By using effective ways of communication the world has become increasingly interdependent through globalization and the need for more connectivity rises daily.

1.1 Objectives

The objective of this project is to design a portable solar-powered telecommunication balloon that is tethered to the ground, can provide connection to a telecommunication tower, and has an operation duration of 1 to 7 days. The first phase would be gathering all the materials necessary for the project ensuring the quality and cost of the material chosen are up to standards for heavy weather constraints. Also meeting legal standards such as any small object floating in the air must be tethered to the ground and have red lights indicating its location for other airplanes to see and avoid. The solar panels would have to be somewhat flexible and lightweight to ensure easy storage access.

After everything is met to legal standards and the best materials have been chosen based on quality and cost. According to the research we have done so far the material of the balloon, particularly nylon and polyester, are the better options due to its strength to weight ratio. It is light and is much tougher to tear or pop than a regular balloon. Latex is another great material for the balloon; it's able to expand much more compared to other materials. Elasticity is important for our design because the balloon may have to adjust to accommodate more weight. After all the material is approved we can begin working on the prototype phase.

The second phase of this project would be to start working on a prototype that has the main components functioning providing portable satellite communication in rural areas for a certain period powered by flexible solar panels. The solar panels would have to generate enough energy to maintain reception for more than 24 hours. During the day the solar panels would have generated enough energy to keep it running during the night so it can provide maximum efficiency at all times. Any iterations to the project would be made to meet legal requirements and help the functionality of the project.

The last phase of the project would be to fix any technical errors with the design. Making sure the quality of the project is the best and the functionality is working precisely as intended. More improvements can be made but must only benefit the product or customers without going over budget or violating any requirements. The objectives will be met on time with the first phase being extensive with research but by the end of the semester, all of our parts should be placed and will begin construction of the project starting phase two, and phase three will be done towards the end of next semester. Our first short-term milestone would be placing the order for the correct material and our 2nd short-term milestone would be assembling all the parts and having the prototype functioning. Our last milestone would be getting the prototype to be finalized and perfected.

2. Literature Review

Amazon Project Kuiper is a collection of several thousands of satellites stationed in (LEO) low earth orbit. “Its mission is to bring fast, affordable broadband to unserved and underserved communities around the world” (Project Kuiper). Approximately three thousand satellites will occupy space within low orbit requiring a space shuttle to carry the satellites to the required altitude. Several parts of the United States and especially the world currently don’t have the infrastructure to support fiber optic services. These parts made it especially difficult to provide communication services needed for operations of any kind. Consumers from both the public and private sectors lack the access to communications that Amazon plans to fix with Project Kuiper.

OneWeb is a private business venture that plans to send several thousands of satellites in low earth orbit to expand the communications network globally. The communications network will allow the globe access to broadband internet thus requiring a large network of satellites to communicate with each other around Earth. Oneweb plans to “establish connectivity in rural and remote areas where it is most lacking” access to the communications network while providing alternative network services to fiber optics (Oneweb n.d.).

The low earth orbit satellites come with a plethora of risks that include collision concerns and the life expectancy of the satellites themselves. Multiple corporations have taken a keen interest and are months ahead of OneWeb with serious financial support and leverage. With low-orbit satellites becoming the primary objective within society today, these means of communication are dependent on equipment. The equipment is specialized to receive satellite networks but the service needs to be purchased and the account has to go through the setup process to enable access.
The mesh network created by low orbit satellites may ultimately resolve land limitations of fiber optics but remote and land battered regions will struggle to still utilize these networks. Natural disasters such as hurricanes, typhoons, and earthquakes ravage the electrical network thus rendering satellite communications. The telecommunications solar balloon isn’t dependent on the electrical grid and is self-sustaining, portable, and has the ability to expand the cellular network for life-saving communications and operations.

Remote locations receive no satellite communication making access to reception not achievable. With other products on the market providing different sources of communication either high altitude or handheld devices they all provide some sort of connection to a satellite. The Iridium Go! Creates reliable global connections and also provides hotspots anywhere in the world. This satellite communication device can put out 18 watts of power and provides a watertight hard case to protect the device from any harsh weather conditions and easy storage placement. Overcharging is a big issue as the device runs continuously but the solar panels have solved that issue.

“This solar panel has a Smart protective integrated circuit to avoid over discharging, overcharging, and over current”(Northern Access 2024). Some gaps in existing research would be the balloon aspect because we want to offer the best satellite reception. Our senior design project will address the gap of better satellite signals with a blimp to increase the altitude for better reception. Some existing knowledge we would like to build on would be the foldable solar panels as we want the solar panels to be flexible and easy to store without taking up excessive space. We would also like to build on the idea of the protective case that saves the device from harsh weather conditions. This would be particularly useful when the location that needs service is in a heavy rain storm or hurricane and needs immediate attention.

Effective communication is highly necessary and something everyone should have access to. Hughes Net provides high-speed internet services and satellite communication for rural areas. “Every Hughesnet plan offers speeds up to 100 MBPS and easy scheduling options to get you online no matter wherever you live”(Hughes Net 2024). They also offer mesh wifi nodes to enhance the performance of the service. Having smooth communication is vital to any area especially those who are in disastrous relief areas. Some gap in existing research is the wireless technology to provide a more responsive communication experience. Sometimes connection drops and cannot always ensure 100 mbps. Our design would expand on the wireless communication aspect focusing on satellite communication. We would need to find a stable connection, and maybe use a mesh network to start and progress further when the other components of the project are finished.

To further confirm the effectiveness and potential of the LAPS product, recent studies identify considerable benefits with portable balloon-integrated photovoltaic systems (BIPVS). These systems can successfully avoid the problem of shading that is characteristic of solar installations at ground level and are especially useful owing to their flexibility, portability, and negligible spatial requirement. The balloon's flexible spherical shape allows for optimal solar radiation harvesting, providing robust energy generation even under difficult urban conditions or crisis scenarios where traditional PV mounting is impossible (Zhang et al. 2023). Incorporating these flexible solar photovoltaic solutions is extremely aligned with the objectives of the LAPS project, demonstrating excellent potential for future scalability and efficiency.

Similarly to our own system, there have been attempts before to use passive lifts to provide telecommunications coverage in remote or underserved areas. The idea behind this is referred to as HAPS or high altitude platform stations. One such effort was done by Google via Project Loon. The system used a network of free-floating balloons that were placed in the stratosphere in order to provide internet access to a region. It also used solar panels to generate power and a learning algorithm that used wind data to help it navigate and maintain its position. The main issue was that the costs associated with it were too high; what Google was essentially trying to do was create an entire network of these balloons so that they could communicate with each other and a couple of ground stations. Ultimately, creating and maintaining the large amount of balloons was deemed unprofitable, and so, it was canceled in 2021 as a result.

Although there’s potential for this type of system, Google’s project was simply too ambitious (Kumar et al. 2020). Our design could fix the problems with this project by offering an overall much smaller solution. Not only would it be much less expensive to build and maintain, but it would also be more stable in that the balloon would be attached to the ground. It being on a much smaller scale means it can be much more portable and easier and quicker to set up. Alternatively, we could also integrate our system into the already existing telecommunication systems like cellular networks instead of building everything from scratch. Lastly, because our focus is on telecommunications and not on satellite-based services, this means power requirements are much lower, enabling our solar panels to serve effectively for the payload.

Continuing with the theme of using airborne platforms for communications, another similar idea that’s currently on the market is the Sceye HAPS project. Rather than using a balloon for its method of lift, it instead uses a blimp. The project is also large-scale focused and once again operates in the stratosphere, much like Project Loon. However, rather than distributing communications amongst multiple balloons like Project Loon, the Sceye blimp is supposed to be a multi-story building-sized, stationary, all-in-one system that provides internet and communication access to a targeted area (Sceye Inc. 2022). It essentially would work as a middle-man service by connecting to a satellite or far away station and then linking it to a customer on the ground. The blimp also incorporates solar panels into its system to provide power, just like ours.

However, the project suffers from the same issues that Project Loon encountered, and in some cases even more so. Because of the massive scale of the blimp, the problems that Project Loon faced are even more exacerbated; as a result, it's even more costly and impractical to use in situations where a temporary solution is required. The large cost of maintaining, storing, and purchasing the balloon means only companies can really afford this. We could address this gap by offering this to regular customers or small organizations, like surveyors or researchers. And unlike the blimp, our design wouldn't require some kind of autonomous program to maintain its position and altitude because it would be tethered to the ground. Another consideration that we need to make is the fact that helium is a gas that requires constant refill as "Helium has been shown to have a high rate of diffusion" (Tedesco S. A. 2022). Lastly, the federal regulations involved in flying at high altitudes are much more strict than being located a couple hundred feet in the air.

3. Expectations
The product can be introduced as an open-sourced project that allows and encourages subject matter experts and hobbyists alike to innovate and create iterative design improvements. Using open-source platforms like Thingiverse, GrabCAD, or Github allows the product to adopt a distributed manufacturing approach where vendors could add the product to their catalog and fabricate components based on their local demand. This encourages the use of lean manufacturing techniques such as JIT manufacturing since the distributed manufacturers would have less pressure to fulfill compared to that of a centralized manufacturer for the product thus reducing lead times are a result. Additionally, the consideration of the product having modular components reinforces the interchangeable components that can be attached and replaced on the product, allowing for any entity to manufacture the parts needed for the product consequently ensuring the continuity of the supply for the product. Meanwhile, there is a need to collaborate with local telecommunication providers and emergency response agencies to strengthen the continuity of coverage that the product provides in the case of an emergency.

These strategic partnerships are critical to the continuous improvement of the LAPS service as there is a need for an agile feedback loop from end users to inform the need for design refinements, improving durability and serviceability over the service cycle of the product. By executing these steps there will be a reduction in the risk of supply chain disruptions and reduce the need for single vendors or suppliers for a single region as well as enhance rapid deployment capabilities that can provide tremendous value to disaster-stricken areas or people needing telecom services in remote locations. Wireless mesh networks are particularly suitable for disaster situations because they are highly interoperable, broadband-supporting, and fault tolerant, thus being good alternatives to traditional terrestrial communication infrastructure that collapses during large-scale crises (Portmann and Pirzada 2009). As such, a mesh network system was chosen for this product, and in the future, can be further scaled for a more extensive coverage.

4. Methods
The design will focus on creating a low-altitude platform station (LAPS) that must meet several functionality requirements:

- Provide temporary network coverage.
- Deployed easily and within an hour.
- Operate continuously without maintenance.
- Be self-sustaining and airborne for an extended period, while remaining stable in various types of weather conditions.
- Accommodate an interchangeable payload (such as a mesh network module, radio repeater, camera, etc.).
- Comply with FAA regulations, including signal lights, tethering requirements, and a rapid deflation device (ECFR n.d.).

Additionally, it must meet several key performance needs:

- Having a coverage area of about 5km^2.
- Compact when stowed away and easily airdropped by emergency relief planes.
- Maintain an altitude of about 100-500 feet.
- Have an operational duration of a day to a week.
- Power itself and other devices via solar panels.
- Have a payload capacity of close or up to 1 kg.
- Survive the effects of UV and temperatures ranging from -10°C to 50°C.

Ultimately this system will be composed of two main parts: a spherical balloon and a payload box. Figure 4 outlines what the overall final product may look like. The balloon is about 2.5 meters in diameter and made of latex, which will allow it to be lightweight and elastic. It will be inflated with a small helium canister and connected to a polystyrene box via a hook. The box is 22x22x18 cm in dimension, and that will house and protect the onboard electronics. An example of the box is showcased in Figure 1, and a see through example is presented in Figure 2. All of this will be connected via a tethered cable that will be marked with reflective strips every 15 meters and securely fastened with metal ground anchors.

Per regulations, the balloon is also equipped with an LED strobe for visibility at night and a mechanical striker system that will puncture the balloon in the event of a tether failure. The exterior of the payload will be wrapped in foil to protect against electromagnetic interference and four mini solar panels will cover each side to provide power to all the various components. These components will include two rechargeable batteries, a control module for power management, a LoRa mesh node module with an external antenna, and the aforementioned LED strobe light. All of this will be housed within a 3D-printed plastic tray, as seen in Figure 3. Besides the battery, control module, and light, the tray and components within the payload can be easily modified based on the customer's needs. The current mesh node will work as a demonstration to show the feasibility of using this platform but could be swapped out for a cellular network module or even an environmental sensor for weather data collection. When not in use, the product can be easily stowed compactly. The balloon will be tucked away and the whole system can be wrapped in a protective cover to prevent damage. The helium canister will need to be either stored separately or attached to the payload temporarily with velcro sleeves.

One consideration that should be taken into account is that the system relies on helium, which is a finite resource and may affect deployment frequency. An alternative, hydrogen can be used, but "to safely use hydrogen-enriched natural gas, the knowledge on the explosion hazards of these mixed gaseous fuels is of great importance" (Miao et al. 2020). The risk of a tether failure is also a possibility, as stress or abrasion could weaken it over time, therefore it should be made out of a high-strength material and undergo regular inspections. Lastly, external factors like rough weather and physical strikes pose a risk for this system. High winds or lightning strikes can disrupt operations entirely, while birds, drones, or planes can compromise the balloon or tether. The mentioned situations can also create potential hazards for others, so it's important to mitigate these risks.

To ensure that the system remains functional throughout its lifetime, some testing must still be done before deployment. The tether would undergo a stress test to see how it would fair in the environment. The balloon itself could be tethered at a low altitude and without a payload to see how well it retains helium over a long time, how it fairs in different types of weather, and its temperature resistance. The deflation device needs to be evaluated to ensure that it activates immediately upon release of the tethers. Furthermore, the batteries will lose their state of charge throughout their lifetime at a 1-5% loss each month depending on usage therefore a simulated battery test must be done (Oyang et al. 2023). Lastly, the solar panels will need to be tested to see how efficient they are in low-light conditions, and the batteries will need to be put through multiple charge and discharge cycles to observe how well they perform long-term and in different temperature conditions as well.

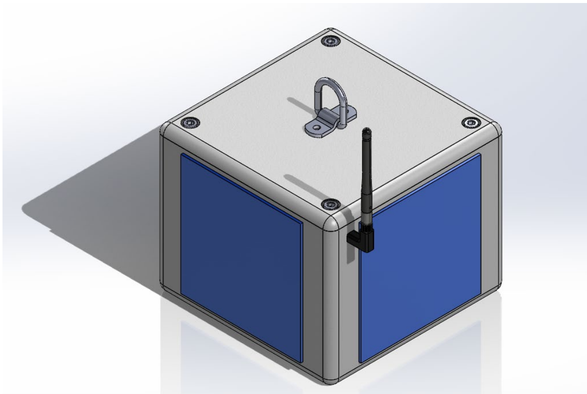

Figure 1. Exterior view of payload

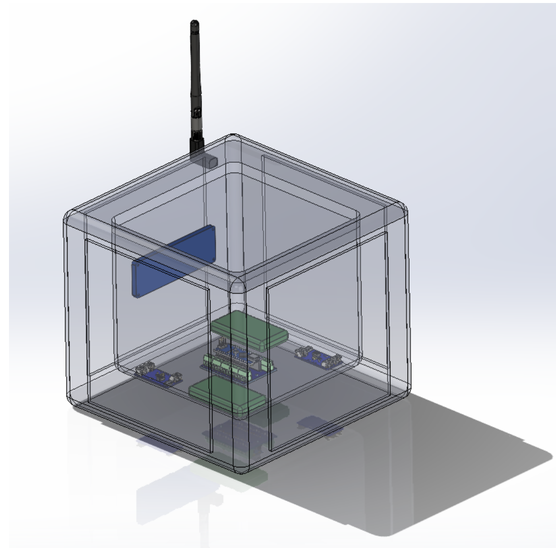

Figure 2. Interior view of payload

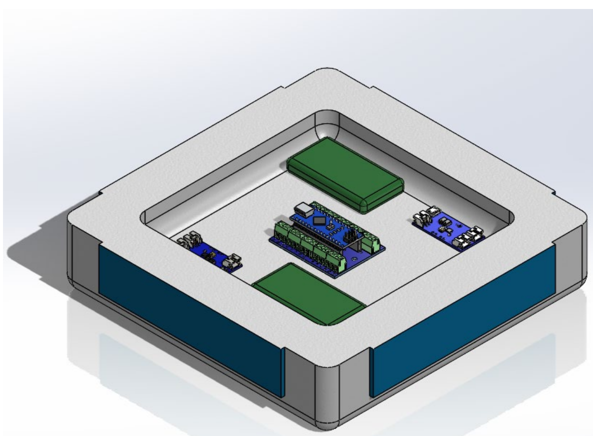

Figure 3. Payload's electronic components

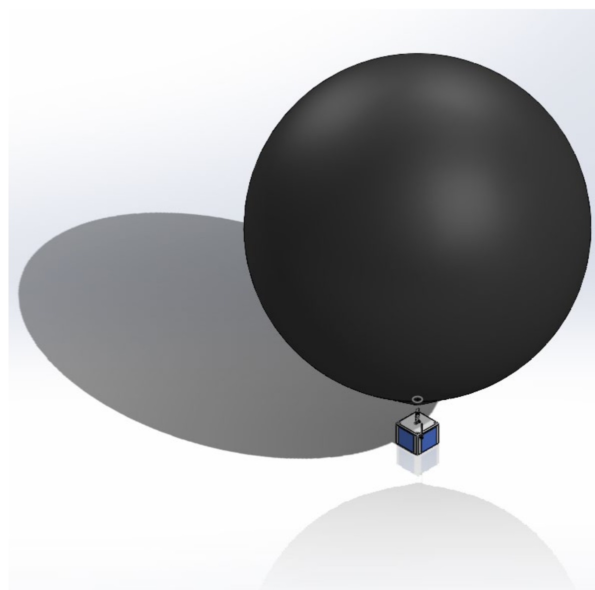

Figure 4. Balloon to payload scale

5. Data Collection

The dimensions of the balloon are 8 feet (or 2.4384 meter) in diameter, and we can determine the total volume and total lifting force generated by the helium inside.

Part	Weight (g)
Battery	48.2
Lora mesh unit	11.1
Solar controller adapter	18.9
Micro-fans	6.0
Latex balloon	211.5
Solar panel	17.3
Styrofoam box	149.6

V = $\frac{4}{3}\pi r^3$
V = $\frac{4}{3}\pi(1.2192)^3 = 7.594m^3 = 7594$ L

Next, we can use the fluid density of helium, the acceleration due to gravity, and volume to determine total buoyant force.
$F_b = 0.17 * 9.81 * 7.594 = 12.66\ N$ or about 1200 gram total lifting force

The weight of helium inside the balloon is:
0.1785*759.4 = 135.553
Knowing that the balloon weighs 211.5 grams, the max weight the balloon can lift is:
1200-135.553-211.5 = 852.947 grams

6. Results and Discussion

The calculation demonstrates that the solar-powered communications balloon effectively meets the specified requirements of the project. The total lifting capacity of the helium-filled balloon is approximately 852.947 grams after taking into consideration the balloon material and weight of helium. With the total weight of all electronics and duplicates coming to 357.2 grams, the design offers ample space in terms of the lifting capacity, thus ensuring that it will be safe and stable to use. Power analysis had shown that with four solar panels, the system generates about 14.85 Wh/day sufficient to ensure an uninterrupted run of the LoRa mesh device, which consumes merely 0.91692 Wh/day. The two 3000mAh batteries would hence under no sun power be able to last operations for approximately 24.2 days, much higher than the requisite one week. Additive manufacturing is proposed for specific parts, like the electronics tray and tether mounts, based on its strength of customization, prototyping in terms of speed, and flexibility in general, greatly enhancing system flexibility and maintainability (Tangren 1980).

6.1 Numerical Results

Power demand:
5.5V*0.135A = 0.7425W per panel
There are four panels providing 0.7425W * 4 = 2.97W
They would be wired in series equating to 5.5V*4 = 22V
Under the assumption that there are at least 5 hours of sunlight the panels would generate 2.97W*5 = 14.85Wh/day

Power is running on two 3000mah batteries at 3.7V.
3.7V*3Ah= 11.1Wh

Two batteries would equate to 11.1*2=22.2Wh

The lora mesh unit requires 4.245V at 0.009A which equates to 0.038205W for power consumption.
Assuming the unit is being used 24/7, thats 0.38205W×24 hrs= 0.91692 Wh/day

This means that without solar and constant use, we will have 22.2Wh/0.91692Wh/day = 24.2 days of use on battery life only.

Total weight:

Determining the weight of duplicate units is important to determine the overall weight of the product.

Two batteries equates to 48.2g * 2 = 96.4g
Two micro-fans equates to 6g * 2 = 12g
Four solar panels equates to 17.3g * 4 = 69.2g

Given the total weight of the duplicates we're able to determine the following result:

$$11.1 + 18.9 + 149.6 + 96.4 + 12 + 69.2 = 357.2$$

852.947 - 357.2 = 495.747g

Given the results, we're able to determine that the total weight of the components is less than the available lift force generated by the helium inside the balloon.

6.2 Proposed Improvements

While the two major components – that being the balloon and payload box – are created using traditional manufacturing methods, several components in the system can be created with additive manufacturing. Specifically the electronics tray, attachment hook, and the tether mounts. These components will be modeled and created via a plastic material extrusion (MEX) process. This will allow for the parts to be flexible, lightweight, and easily customizable. This is especially important for the internal tray because it must accommodate different payload configurations. The additional benefit of using additive manufacturing is that this would allow for easy prototyping, as opposed to traditional machining or injection molding.

The components would be made out of ABS/ASA or PA6-CF, rather than PLA. The reason is that the material must be able to withstand UV radiation, mechanical stresses, or weather changes and not degrade. A study found that although these materials are rather durable, coating them in a weather resistant material decreased the failure strain by 32.1% (Afshar and Wood 2020). Annealing should be taken as a post-process step for both the tether and hook mounts because it can help prevent layer separation when under load. Although these two parts will be made of plastic, they could be substituted for 3D printed titanium components, since it's a relatively lightweight metal that would also reduce the chance of failure. All of these parts can be quickly swapped without needing a full system overhaul and since they will be made of recyclable plastic, their environmental impact is minimized. While helium is preferred due to its inert nature and safety advantages, it is a finite and increasingly scarce resource. This presents long-term sustainability concerns, especially for scalable or high-frequency deployment applications (Wilkinson & Gerth 2024). As such, this concern should be addressed through the use of another gas, such as hydrogen; however, safety measures must be incorporated in order to mitigate the flammability risks associated with hydrogen. A proposed mixture of helium and hydrogen could be used instead, which would not only change the ignition point, but also significantly increase the lift capacity. Overall, this approach offers a practical balance between performance and safety - increasing payload capability while reducing reliance on finite helium supplies.

6.3 Validation

Validation testing will also be conducted on the tether through stress and environmental testing, balloon helium retention, system function of the rapid deflation system, and solar panel efficiency in varied light conditions. Battery operation will be validated through conducting several cycles of charge and discharge in varying environmental conditions in order to determine reliability and endurance.

7. Conclusion

The low-altitude telecommunications platform station provides a new way to address the gaps in telecommunications infrastructure in remote and disaster-affected areas. This is a new approach that offers rapid deployment, modularity, additive manufacturing, and decentralized manufacturing, for emergency response services, rural communities, and commercial teams in remote areas. By utilizing additive manufacturing, and providing an open-sourced platform, the product's supply chain is extremely resilient since production is decentralized which reduces the dependency on a single manufacturer to fabricate the product. Furthermore, due to its open-sourced nature, the end users are encouraged to make iterative designs that would improve the overall product amongst engineers, service bureaus, and hobbyists alike. Looking past the technical and design advantages that the product provides, it also delivers a social and environmental benefit as well. Environmentally the product is self-sustaining with its solar-powered capabilities, as well as its internal parts are fully recyclable which establishes a minimal environmental impact. Meanwhile, the product provides a great societal benefit as well, as it bridges the gaps in communication during an emergency which can allow for fast response, coordination, and rescue efforts. In conclusion, the LAPS product delivers a resilient and environmentally sound telecommunications solution, which the product has the potential to bridge communication gaps that would otherwise be infeasible. Therefore, ensuring that even the most remote locations and communities have access to the rest of the world in all circumstances.

References

Project Kuiper. About Amazon. Retrieved October 5, 2024, from https://www.aboutamazon.com/what-we-do/devices-services/project-kuiper

OneWeb. Eutelsat OneWeb. Retrieved October 5, 2024, from https://oneweb.net/about-us/responsible-space

Northern Access. (2024). Iridium go! Adventure Package W/ solar panel & case. NorthernAxcess Satellite Communications. https://www.northernaxcess.com/iridium-go-adventure-package-w-solar-panel-case

Hughes Net. ,How does satellite internet work? | hughesnet®. How Does Satellite Internet Work?, (2024). https://www.hughesnet.com/about-hughesnet-satellite-internet/how-satellite-internet-works

Kumar, D., Ponseelan, A. J., Prabha, D. D., Mathipurani, V. B., & Selvakrishna, S.,A study on Google Project Loon: Opportunities and challenges. International Journal of Emerging Trends in Information and Engineering (IJETIE), 6(3),.(2020). . Available at SSRN: https://ssrn.com/abstract=3565713

Sceye Inc. ,Sceye HAPS ascend to the stratosphere using renewable energy sources. Business Wire,(2022, June 22). . https://www.businesswire.com/news/home/20220614006039/en

ECFR :: 14 CFR part 101 -- moored balloons, kites, amateur rockets, and unmanned free balloons (far part 101). (n.d.). https://www.ecfr.gov/current/title-14/chapter-I/subchapter-F/part-101

Miao, H., Lu, L., & Huang, Z. ,Flammability limits of hydrogen-enriched natural gas. International Journal of Hydrogen Energy, 36(11), 6937–6947(2011). . https://doi.org/10.1016/j.ijhydene.2011.02.126

Tangren, D. Charles. (1980, August 1). Calculating Payload for a Tethered Balloon System. US Forest Service Research and Development. https://research.fs.usda.gov/srs

Afshar, A., & Wood, R. ,Development of weather-resistant 3D printed structures by multi-material additive manufacturing. MDPI,(2020, July 18). . https://www.mdpi.com/2504-477X/4/3/94

Tedesco, S. A. , Helium. Geology and Production of Helium and Associated Gases, 1–31, (2022). . https://doi.org/10.1016/b978-0-323-90988-4.00002-5

Ouyang, Q., & Chen, J. , Advanced model-based charging control for lithium-ion batteries. Springer Nature Singapore Springer,(2023). .

Person. (2006, December 13). Wireless Mesh Networks for public safety and disaster recovery applica. Taylor & Francis. https://www.taylorfrancis.com/chapters/edit/10.1201/9781420013542-23/wireless-mesh-networks-public-safety-disaster-recovery-applications-marius-portmann

Zhang, T., Qi, L., Zhang, Z., & Yan, J. , A portable balloon integrated photovoltaic system deployed at low altitude. ScienceDirect, (2024, November 5). . https://www.sciencedirect.com/science/article/pii/S036054422403500X

Wilkinson, S., & Gerth, F. ,A review of the sustainability of helium: An assessment of its past, present and a zero-carbon future. MDPI,(2024, October 23). . https://www.mdpi.com/3042-4658/1/1/6

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