

A Review Paper on Project “LOONS”

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I.INTRODUCTION

Many of us think of the Internet as a global community. But two-thirds of the world's population does not yet have Internet access. Project Loon is a network of balloons traveling on the edge of space, designed to connect people in rural and remote areas, help fill coverage gaps, and bring people back online after disasters. Project Loon balloons float in the stratosphere, twice as high as airplanes and the weather. They are carried around the Earth by winds and they can be steered by rising or descending to an altitude with winds moving in the desired direction. People connect to the balloon network using a special Internet antenna attached to their building. The signal bounces from balloon to balloon, then to the global Internet back on Earth.

Project Loon is a research and development project being developed by Google with the mission of providing Internet access to rural and remote areas. The project uses high-altitude balloons placed in the stratosphere at an altitude of about 20 km (12 mi) to create an aerial wireless network with up to 3G-like speeds. Because of the project's somewhat outlandish mission goals, Google dubbed it "Project Loon". Project Loon is a research and development project being developed by Google with the mission of providing Internet access to rural and remote areas. The project uses high-altitude balloons placed in the stratosphere at an altitude of about 20 mi (32 km) to create an aerial wireless network with up to 3G-like speeds. Because of the project's seemingly outlandish mission goals, Google dubbed it "Project Loon".

The balloons are maneuvered by adjusting their altitude to float to a wind layer after identifying the wind layer with the desired speed and direction using wind data from the National Oceanic and Atmospheric Administration (NOAA). Users of the service connect to the balloon network using a special Internet antenna attached to their building. The signal travels through the balloon network from balloon to balloon, then to a groundbased station connected to an Internet service provider (ISP), then onto the global Internet.

The system aims to bring Internet access to remote and rural areas poorly served by existing provisions, and to improve communication during natural disasters to affected regions. Key people involved in the project include Rich Devalue, chief technical architect, who is also an expert on wearable technology; Mike Cassidy, a project leader; and Cyrus Behroozi, a networking and telecommunication lead.

In the evolution of the Internet nowadays, some population of the world enjoys the benefits of the Internet. According to Google™, two-thirds of people on the earth, reliable Internet connection is still out of reach. To solve this global problem, Google™ developed an innovative project called the “LOON”, to provide broadband for free in rural and remote areas, as well as to improve communication during and after natural disasters or a humanitarian crisis. During a crisis, connectivity is really significant because information in itself is really lifesaving. Here the key concept is a set of high-altitude balloons ascends to the stratosphere and creates an aerial wireless network. The technology designed in the project could allow countries to avoid using expensive underground infrastructure.

II.LITERATURE SURVEY

2.1 HISTORY

Over the past few years, Google X has released a number of incredible projects, including Google Glass, Self Driving Cars, as well as other projects related to neural networks. Google X is Google's secret research and development lab that is headed by Sergey Brin himself. The division is rumored to house hundreds of projects related to futuristic technologies, which until now, we have only witnessed in movies and our wildest imaginations.

About ten years ago, no one would have predicted that smart phones would become such an integral part of how we lead our lives or that the internet would facilitate such a strong influence in educational transparency and cultural integration across multiple continents. An entire genre of jobs has erupted on the web over the last decade, many of which are based solely around spreading knowledge. YouTube, for example, has thousands of “how to” videos. With internet becoming available to millions of web secluded people, there will be a drastic surge of these videos.

Imagine how Wikipedia, Facebook, Twitter and other crowd sources websites would look after 4.5 billion more people go online and begin contributing. Recently, Google announced its newest endeavor: Project Loon. It hopes to enhance the web's influence by providing internet to everyone in the world through a series of hot air balloons with attached routers. When Google's chairman, Eric Schimdt announced in April that "For every person online, there are two who are not. By the end of the decade, everyone on Earth will be connected," no one would have guessed that this bold statement would be carried out by

Google X, the division in Google in charge of Project Loon.



Fig.2.1 History

In 2008, Google had considered contracting with or acquiring Space Data Corp., a company that sends balloons carrying small base stations about 20 miles (32 km) up in the air for providing connectivity to truckers and oil companies in the southern United States, but didn't do so[7]. Unofficial development on the project began in 2011 under incubation in Google X with a series of trial runs in California's Central Valley. The project was officially announced as a Google project on 14 June 2013[1].

On 16 June 2013, Google began a pilot experiment in New Zealand where about 30 balloons were launched in coordination with the Civil Aviation Authority from the Tekapo area in the South Island. About 50 local users in and around Christchurch and the Canterbury Region tested connections to the aerial network using special antennas[1]. After this initial trial, Google plans on sending up 300 balloons around the world at the 40th parallel south that would provide coverage to New Zealand, Australia, Chile, and Argentina. Google hopes to eventually have thousands of balloons flying in the stratosphere.



Fig.2.2 New Zealand

The Internet is one of the most transformative technologies of our lifetimes. But for 2 out of every 3 people on earth, a fast, affordable Internet connection is still out of reach. And this is far from being a solve problem. There are many terrestrial challenges to Internet connectivity—jungles, archipelagos, mountains. There are also major cost challenges. Right now, for example, in most of the countries in the southern hemisphere, the cost of an Internet connection is more than a month's income. Solving these problems isn't simply a question of time: it requires looking at the problem of access from new angles. So today we're unveiling our latest moonshot from Google[x]: balloon-powered Internet access.

2.2 RELATED WORK

2.2.1 The problems with today's internet services

- Many of us think of the Internet as a global community. But two-thirds of the world's population does not yet have Internet access. Project Loon is a network of balloons traveling on the edge of space, designed to connect people in rural and remote areas, help fill coverage gaps, and bring people back online after disasters.



Fig.2.2.1. Problem with todays internet

2.2.2 MISSION OF PROJECT LOON

- No internet to the high speed internet for everyone.

- Many of the Indian as well as the small villages and the towns are unable to enjoy the benefits of the internet due to some or the other reasons.
- For this reason Google has launched the PROJECT LOON.

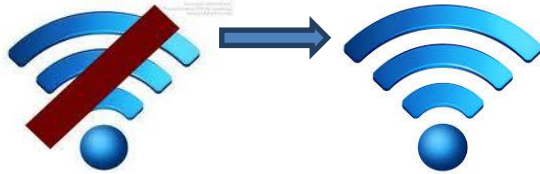


Fig.4.1 MISSION)

- Slow internet to fast:
- Sometimes even after having the internet the speed is a big issue.
- For this our aim is to bring the high speed internet.

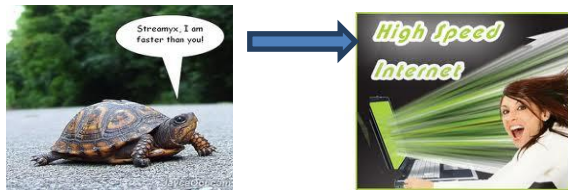


Fig.2.2.2. MISSION

2.2.3 LOON POWERED INTERNET



Fig 2.3.1 Balloon Powered Internet

Project Loon is a research project with a mission of providing Internet to people living over rural and remote areas by google. As the core object used in this project is balloons placed at high altitude of around 20 kms above the earth so its called Project Loon. The floating balloons shall connect each other to transfer the data from ISP to layman’s house and vice versa.

Key people involved in the project include Rich DeVaul, chief technical architect, who is also an expert on wearable technology; Cyrus Behroozi, who is networking and telecommunication lead; and Mike Cassidy, a project leader. The first person to connect to the “Google Balloon Internet” after the initial test balloons were launched into the stratosphere was a farmer in the town of Leeston, New Zealand. He was one of 50 people in the New Zealand area around Christchurch who agreed to be a pilot tester for Project Loon. The locals knew nothing about the secret project, but allowed Google to attach a basketball-sized receiver to an outside wall of their property in order to connect to the Internet. The receiver resembles a giant, bright-red Google map pin. The New Zealand farmer lived in a rural location that couldn’t get broadband access to

the Internet. He had used a satellite Internet service in 2009 but found that he sometimes had to pay over \$1000 per month for the service. The high-altitude balloons fly twice as high as airplanes, but below the range of satellites.



Fig.2.3.2 Hardware

The balloon envelopes are made by Raven Aerostar of polyethylene plastic about 3 mil or 0.076 mm (0.0030 in) thick, and stand 15 m (49 ft.) across and 12 m (39 ft.) tall when fully inflated. A small box weighing 10 kg (22 lb.) containing the balloon’s electronic equipment hangs underneath the inflated envelope. This box contains circuit boards that control the system, radio antennas to communicate with other balloons and with Internet antennae on the ground, and batteries to store solar power so the balloons can operate during the night. Each balloon’s electronics are powered by an array of solar panels that sit between the envelope and the hardware. In full sun, these panels produce 100 watts of power, sufficient to keep the unit running while also charging a battery for use at night. A parachute attached to the top of the envelope allows for a controlled descent and landing when a balloon is ready to be taken out of service. The ground stations are able to connect to the balloons beaming down the Internet when the balloons are in a 20 km (12 mi) radius. Some reports have called Google’s project the Google Balloon Internet.

3.1 SYSTEM ARCHITECTURE

❖ Dealing with the extreme conditions in the stratosphere:

The stratosphere presents unique engineering challenges: air pressure is 1% of that at sea level, temperatures hover around -50°C, and a thinner atmosphere offers less protection from the UV radiation and temperature swings caused by the sun’s rays. By carefully designing the balloon envelope to withstand these conditions, Project Loon is able to take advantage of the steady stratospheric winds, and remain well above weather events, wildlife and airplanes.



Fig.3.1 Balloon in stratosphere

❖ Electronics are on the balloon:

In addition to the specialized radios that provide Internet service to users on the ground, our balloons carry instruments to monitor the weather and the conditions around them, as well as a GPS to keep track of their flight patterns. The electronics are powered by solar panels, and excess power is stored in a rechargeable battery so service can continue during the night.

❖ Communication equipment on a balloon:

There are two main radio transceivers; one for balloon-to-balloon communications and another for balloon-to-ground communications. There is also a third backup radio that we use to communicate with the balloons if the others fail or go out of range.

❖ Will the Balloons Crash?

Each balloon is made of rugged polyethylene plastic. They use solar power to help remain aloft. The balloons float in the stratosphere, above rain and commercial aircraft, for example, and far below satellites. Of course they will crash.



Fig.3.2 Stratosphere

Google says each balloon includes a parachute to ensure a more controlled landing - not a crash, per se. The company adds that the balloons are designed to stay aloft for "100+ days." When a balloon is known to have reached its end of life or needs repair, controllers can arrange an orderly descent. Google has plans for designated Loon balloon collection points. Google has also suggested that the balloons and equipment on board can be re-used and recycled. Google will notify the appropriate authorities, such as air traffic controllers, during both launch and descent.

❖ The balloons from the ground:

In certain weather conditions, you may be able to see them from the ground. Most of the time they will be very difficult to see with the naked eye. As balloons launch during the initial pilot in Christchurch, they may be visible during ascent/descent, but it is unlikely more than one balloon will be visible at any given time.

❖ The Internet speed:

During our New Zealand pilot test, we expect Internet speed to be comparable to 3G.

❖ How does the Loon network interact with standard Wi-Fi networks?

Our balloons work only with specialized Loon Internet antennas, and are not compatible with standard Wi-Fi

networks. Our radios and antennas are designed to receive only Loon signals and filter out standard Wi-Fi³³, despite using similar frequencies. We do this to achieve high bandwidth over the long distances (20+ km) involved.

❖ How many people can one balloon serve?

Each balloon can provide coverage to a ground area about 40 km in diameter and hundreds of people can connect to each balloon at once.

❖ How are the balloons powered?

The equipment on the balloons is charged with solar panels. The balloon hardware contains a rechargeable battery to allow for night operation.

❖ What kind of spectrum will be used?

Loon uses unlicensed ISM spectrum at very low power to avoid interference. Because communication devices using the ISM bands must tolerate any interference from ISM equipment, unlicensed operations are typically permitted to use these bands, since unlicensed operation typically needs to be tolerant of interference from other devices anyway.

The ISM bands share allocations with unlicensed and licensed operations; however, due to the high likelihood of harmful interference, licensed use of the bands is typically low. In the United States of America, uses of the ISM bands are governed by Part 18 of the FCC rules[18].

❖ How do you preserve the security and integrity of data transmitted over the Loon network?

While transiting the balloon network, data is automatically encrypted. Also, only specialized Loon Internet antennas can access the Loon network.

❖ How are the movements of these balloons controlled?

The positioning of the Loon fleet is adjusted and controlled from Loon Mission Control, using a combination of automatic planning and human oversight. In addition, the individual balloon vehicles perform some automatic flight control functions, such as venting gas to prevent a burst or deploying a parachute in case the balloon envelope fails.

❖ How do I receive Internet service from the balloons?

Signals are transmitted from the balloons to a specialized Internet antenna mounted to the side of a home or workplace that use radio frequency technology.



Fig. 3.3 receiver

The Internet antenna is connected to a consumer grade router. Web traffic that travels through the balloon network is ultimately relayed to ground stations, where it's connected to pre-existing Internet infrastructure, like fiber cables and our local telecommunications partners.

❖ **How high do the balloons fly?**

We are flying in the stratosphere well above commercial air traffic and weather events, at around 18-27 km or 60,000 - 90,000 feet.

❖ **How long will a balloon stay up in the air?**

We've designed the balloons to be able to stay in the air for 100+ days at a time. During our initial tests, the flight durations will be shorter.

❖ **How will the balloons come down?**

We control the balloons by raising and lowering them to an altitude with winds in the direction we'd like them to travel. We plan to take our balloons down over safe recovery zones, and in the event of an unexpected landing all our balloons have parachutes to slow their descent and foam bottoms to cushion the landing.

❖ **How do you collect the balloons after they have landed?**

We track our balloons continuously in the air and note their location when they land. Ultimately, we plan to steer the balloons as they descend, so we can direct them to land in various collection points around the world.

❖ **Is there risk of airplanes hitting the balloons?**

Our balloons fly almost twice as high as commercial jetliners and so they pose no more of a risk than any of the other 70,000 weather balloons currently launched every year without incident. We coordinate with local air-traffic control when balloons are launched and when they descend.

3.2 How Loon is Designed



Fig.3.1 Design

The balloon envelope is the name for the inflatable part of the balloon. Project Loon's balloon envelopes are made from sheets of polyethylene plastic and stand fifteen meters wide by twelve meters tall when fully inflated.

They are specially constructed for use in super pressure balloons, which are longer-lasting than weather balloons

because they can withstand higher pressure from the air inside when the balloons reach float altitude. A parachute attached to the top of the envelope allows for a controlled descent and landing whenever a balloon is ready to be taken out of service.

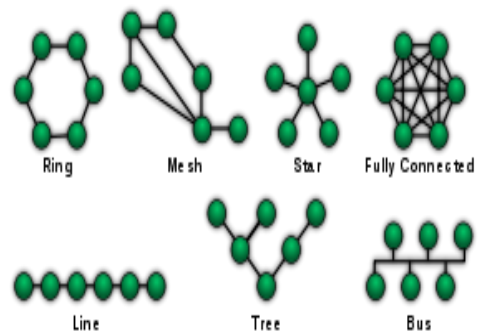


Fig.3.2 Balloon

4.1 INTERBALLOON NETWORK TOPOLOGIES:

Network topology is the arrangement of the various elements (links, nodes, etc.) of a computer or biological network. Essentially, it is the topological structure of a network, and may be depicted physically or logically. Physical topology refers to the placement of the network's various components, including device location and cable installation, while logical topology shows how data flows within a network, regardless of its physical design. Distances between nodes, physical interconnections, transmission rates, and/or signal types may differ between two networks, yet their topologies may be identical. For this project loon we are considering the 4 given topologies

1. SPANING TREE TOPOLOGY
2. HYBRID USING MESH AND STAR TOPOLOGIES
3. RING TOPOLOGY
4. DUAL RING TOPOLOGY



4.1.1 SPANINGTREE TOPOLOGY:

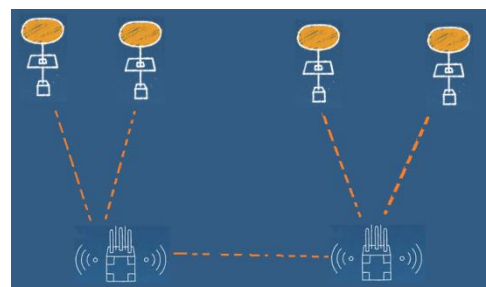


Fig .4.1 Spaning Tree Topology

In this topology we have the interconnection of the balloons and the base stations also. And thus there are some of the advantages and the disadvantages which are as follows:

<u>Advantages:</u>	<u>Disadvantages:</u>
1. Easy fault detection	1. Cost is high
2. System is robust	2. More no of base stations
3. Greater connectivity	3. There is no interconnectivity between two balloons

4.1.2 RING TOPOLOGY

In this topology we are having the ring of all the devices connected together. This creates the problem as, when one of the balloon is disconnected then we can not continue with the rest of the network. Some of the advantages and the disadvantages are discussed below:

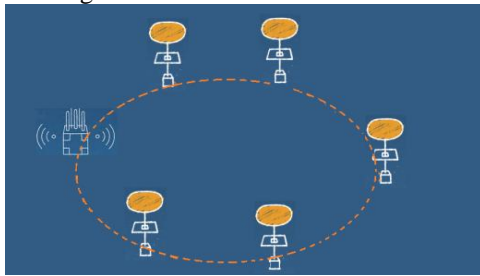


Fig .4.2 Ring Topology

<u>ADVANTAGES:</u>	<u>DISADVANTAGES:</u>
1. Fault detection is easy	1. System is not robust
2. Cost is low	2. Fault detection is difficult
3. No of base station is only 1	3.in case of failure difficult to rebuild.

4.1.3HYBRID USING MESH AND STAR TOPOLOGIES

In this topology we are having the combination of the star and the mesh and thus we could use the advantages of both the network but the disadvantages are also following the advantages thus the advantages and the disadvantages are as follows:

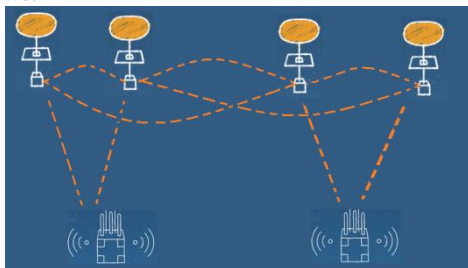


Fig .4.3 Hybrid Using Mesh and Star Topologies

<u>ADVANTAGES:</u>	<u>DISADVANTAGES:</u>
1. System is robust	1. System is expensive
2. Elimination of traffic problem	2. More no of base stations

3. Every message travels through the dedicated lines	3. Complex wireless connection
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4.1.4DUAL RING TOPOLOGY

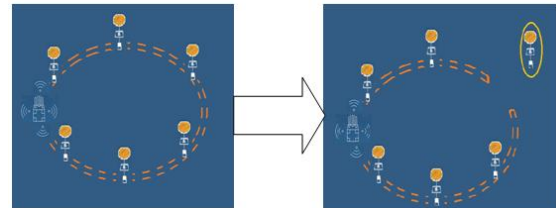


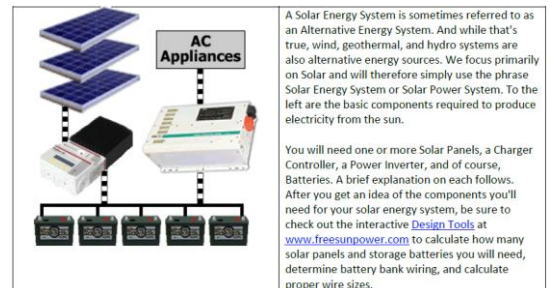
Fig.5.4 Dual Ring Topology

In this topology we are using the third line which we have kept for the backup and therefore when one of the balloon is disconnected then we can have the uninterrupted connectivity .thus the advantages are as shown below:

ADVANTAGES:

1. Comparatively low cost
2. System is robust
3. High connectivity
4. Fault detection and correction is easy


4.1.5 SOLAR POWER:




A Solar Energy System is sometimes referred to as an Alternative Energy System. And while that's true, wind, geothermal, and hydro systems are also alternative energy sources. We focus primarily on Solar and will therefore simply use the phrase Solar Energy System or Solar Power System. To the left are the basic components required to produce electricity from the sun.

You will need one or more Solar Panels, a Charger Controller, a Power Inverter, and of course, Batteries. A brief explanation on each follows. After you get an idea of the components you'll need for your solar energy system, be sure to check out the interactive [Design Tools](http://www.freesunpower.com) at www.freesunpower.com to calculate how many solar panels and storage batteries you will need, determine battery bank wiring, and calculate proper wire sizes.


The first component needed is one or more [Solar Panels](#). They supply the electricity and charge the batteries. A very small system could get away with a couple 240 watt panels but figure at least 4 to 8 for a small to medium system.




A [Charge Controller](#) is needed to prevent overcharging of the batteries. Proper charging will prevent damage and increase the life and performance of the batteries.



The [Power Inverter](#) is the heart of the system. It makes 120 volts AC from the 12 volts DC stored in the batteries. It can also charge the batteries if connected to a generator or the AC line.



Lightning Strikes can cause great damage to your solar power system and can be mitigated using [Surge Arrestors](#) in the design loop. Surge arrestors act like "clamps" in most cases. They go across the live wires with another wire going to ground. Normally they just sit there, but if the voltage goes above a certain level, they start to conduct, shorting the higher voltage to ground.



Last are the storage [Batteries](#). They store the electrical power in the form of a chemical reaction. Without storage you would only have power when the sun was shining or the generator was running.



CONCLUSION

5.1 INTRODUCTION

Over the past few years, Google X has released a number of incredible projects, including Google Glass, Self Driving Cars, as well as other projects related to neural networks. Google X is Google's secret research and development lab that is headed by Sergey Brin himself. The division is rumored to house hundreds of projects related to futuristic technologies, which until now, we have only witnessed in movies and our wildest imaginations.

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It hopes to enhance the web's influence by providing internet to everyone in the world through a series of hot air balloons with attached routers. When Google's chairman, Eric Schimdt announced in April that "For every person online, there are two who are not. By the end of the decade, everyone on Earth will be connected," no one would have guessed that this bold statement would be carried out by Google X, the division in Google in charge of Project Loon.

In 2008, Google had considered contracting with or acquiring Space Data Corp., a company that sends balloons carrying small base stations about 20 miles (32 km) up in the air for providing connectivity to truckers and oil companies in the southern United States, but didn't do so[7]. Unofficial development on the project began in 2011 under incubation in Google X with a series of trial runs in California's Central Valley.

The project was officially announced as a Google project on 14 June 2013[1]. On 16 June 2013, Google began a pilot experiment in New Zealand where about 30 balloons were launched in coordination with the Civil Aviation Authority from the Tekapo area in the South Island. About 50 local users in and around Christchurch and the Canterbury Region tested connections to the aerial network using special antennas[1].

After this initial trial, Google plans on sending up 300 balloons around the world at the 40th parallel south that would provide coverage to New Zealand, Australia, Chile, and Argentina. Google hopes to eventually have thousands of balloons flying in the stratosphere.

5.2 CONCLUSIONS

This revolutionary project can bring internet to everyone on this planet irrespective of their location. Complete world can be linked together. There is near about 75% comment is in the favor of project loons. so far as I think it would be great Success of this. Project in Future. And we hope balloons could become an option for connecting rural, remote, and underserved areas, and for helping with communications after natural disasters.

Information would never have been available at this ease in the history of this planet, everything just a couple of clicks away, from any corner of the world you are in. Education: There are millions of poor children all over the world who haven't even heard the word 'school.' Loon has the potential to become a school on the air for the under privileged. Medicine: Health and hygiene information can be made easily available to the people who haven't even heard of the word doctor Collaboration: Connecting with the remote countries and inaccessible terrains will no longer be impossible.

It'll eliminate the need to lay down cables in those areas, and live weather forecast reports in such areas would be of a great help to the locals there. Internet connectivity and communication become one of the basic needs in modern human daily life. An innovative and scalable idea like the Google™ Project Loon would aid and benefit remote areas of the world as well as population to reap the benefits of modern communications.

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