Internet Service to the Remote and Rural Regions by Cost-effective Loon Technology

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***Abstract*—At present, we seek the services of the internet service providers for connection to the global network. As a matter of fact, only one out of three throughout the world have internet accessibility. Rest of them still long for the connectivity to the global network. The most basic solution to this problem is to lay down the communication lines all over the world. As the cost incurred in laying down the communication lines is very high, emerging nations will not be able to afford the amount. So this isn't an optimal solution at all. A platform with high altitude is required to give the internet facility .For this, use of balloons was found by Google. This paper presents network of balloons. Internet service is provided to the rural as well as remote regions efficiently.**

Keywords— Solar panel; Envelope; Wind data; User Antenna; Balloons.

I. INTRODUCTION

Internet is a global interconnected network system designed to serve many users. It is networked with networks. While millions of them jump from 3G to 4G yet there are many people who cannot access the internet. It is found that the internet is an unattainable technology for every two in a group of three of the world's population[1].Hence, to avoid this problem we shall lay down the fiber cable connections to connect the people to the global system. Yet the cost incurred in it is so high that it is hardly possible for the developing nations to adopt this solution [1].In the skies Google was searching for the solution and they sprang up with an intellectual concept called balloon-powered internet access for everyone. This lead to 'LOON PROJECT'.

Network of balloons travelling in space is Loon Project, which connects people living in different regions, controls coverage and allows people to be online even after a disaster. These balloons floats very high in the Stratosphere. By winds around the earth they are carried along and are steered up or down to an altitude with winds moving in a particular direction. By special internet antenna in their house people connect to balloon network. Signal jumps from balloon to balloon and then to Earth's global internet [2].The balloons(loons) acts as a wireless station flying in the stratosphere. It has the range of almost 80km diameter and can serve hundreds of people in a given region.

Balloons are managed by setting the altitude to the specific stratosphere's wind layer. NOAA-National Oceanic and Atmospheric administration gives the desired information about the direction and speed.

Transceivers are connected to the balloons for interchanging the signals. Then joins global network with Internet Service Provider(ISP) or Long Term Evolution(LTE) [3].Performance matrices of Project Loon with cost as a parameter is low or affordable when compared to other methods. Its speed is higher or 3G equivalent while others show slightly higher speed. Users for the Loon project are comparatively more [13].When compared to wi-fi project loon is always more better. Eventhough it has its own pros and cons but pros overweight the cons [15].

II. HISTORY

Around ten years ago, nobody would have anticipated smart phones would turn out to be such a vital piece of how we lead our lives or that the internet has impacted strongly on our lives. Many jobs are now erupted on web. For example, 'how to' videos are more on YouTube.

Loon Project is taken care by Google X.In 2008,Google had considered contracting with or acquiring Space Data Corp., an enterprise which sends balloons wearing small base stations approximately twenty miles up inside the air for imparting connectivity to truckers and oil corporations in the southern United States, but didn't do so [4].Unofficial development on the commenced in 2011 beneath incubation in Google X with a series of trials runs in California'Cnetral Valley. The project turned into announced as a Google undertaking on 14 June 2013 [5][2].Different machine learning techniques are proposed in [11][12][16].

Google commenced a pilot experiment in New Zealand on 16 June 2013 where approximately thirty balloons were released in coordination with Civil Aviation Authority from Tekapo inside the South Island. About fifty local users in and round Christchurch and Canterbury region tested connections to the aerial network the use of unique antennas [5].After preliminary trail, Google planned on sending three hundred balloons around the sector at the fortieth parallel south that might provide coverage to New Zealand, Australia, Argentina, Chile.[2],The author Sunanda et al worked on segmentation techniques[7-10].

Project loon pursuits at dealing with the problem of lack of internet connectivity in rural, remote and underserved regions. It also specializes in providing the connectivity to the global network in case of herbal calamities as the balloons positioned some 15-20 kilometres above the sea level.

III. SYSTEM ARCHITECTURE

The architecture consists of the following component:

- Envelope
- Solar panel

- Control box

1) ***Envelope***
Balloon's inflatable part fig.1 A formed by polyethylene plastic [14] and are 0.076 mm thick. This makes up envelope of the balloon. At full inflation the balloon spans around 15mwide and 12 m height. They have lifetime of around 55 days and hence called super pressure balloons. As compared to conventional weather balloons they are long-lasting. If the balloon is to be pulled out of service, the gas inside should be released using custom air pump system. A parachute placed at the envelope's top is used when the balloons drops down quickly.[2].

2) ***Solar Panels***
Each unit's electronics are powered with solar panel array fig.1 Band is kept in between the hardware part and the envelope. They generate 100 Watt power in full sun and is enough for day and night.

3) ***Control Box***
10 kg box is hooked up under the balloon's envelope fig.1 C shows GPS, wi-fi circuits, batteries, computers based on Linux, and sensors. They keep a record of air temperatures, balloon's altitude and its circuit boards and speed for controlling the unit.

A. ***Dealing with extreme conditions in Stratosphere.***
There are few challenges in the stratosphere: compared to sea level the pressure of air is 1%,temperatures range to -50 °C, as the atmosphere is thinner it gives minor protection from the UV radiations and fluctuations is the temperature due to the rays of sun. Hence, by cautiously designing the balloon's envelope to face up these conditions, the project can profit from steady stratospheric winds and stay well above weather, wildlife and aircraft.

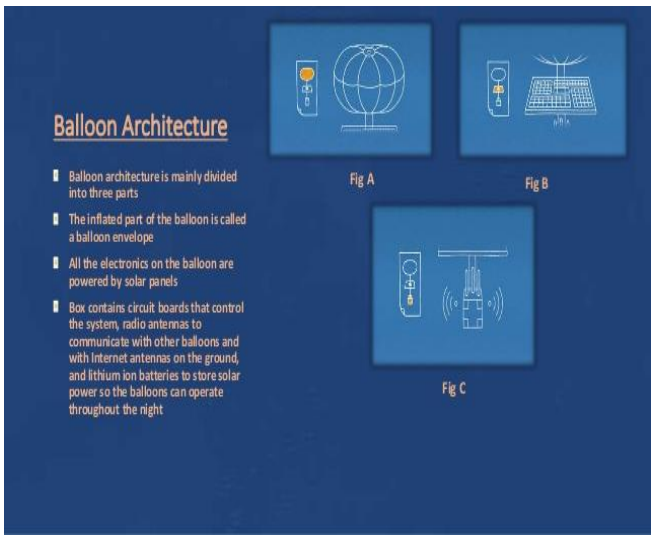

Fig.1. Architecture Diagram

B. Electronics on the Balloon
The inclusion of especial radio that gives Internet assistance to consumers on the deck ,our balloons holds equipment's to monitor the climate and state around itself also the GPS to stay on to path of their flight patterns the auto electronics are charged by solar plates and unresistant energy is deposited in a rejenuvate able battery so supply will be on even in the dark.[2]

C. Communication equipment on the Balloon
Two radio transceivers are present: first one for the communication between balloon to balloon and the second for balloon to ground communication. We also use a third backup radio to communicate with the balloons when the others fail or go out of range. [1]

D. Navigation of the Loon
The balloons move along the stratosphere by navigating the wind. Winds prefer to move in a specific direction at stratosphere (twice the range of aircraft travelling altitude), 20 km above the earth's surface. Stratosphere has different wind layers. Each layer varies in magnitude and direction. The inclusion of especial radio that gives Internet assistance to consumers on the deck ,our balloons holds equipment's to monitor the climate and state around itself also the Gps to stay on to path of their flight patterns the auto electronics are charged by solar plates and unhesitant energy is deposited in a rejenuvate able battery so supply will be on even in the dark. The balloons are made to raise or fall to the favoured altitude and circulate in desired path at the required speed with the aid of inflating or deflating the envelope using a air pump fixed within the setup. Actual lifestyles of balloons is estimated to be a hundred days but, we can replace it constantly once in 55 days for checking which avoids unexpected failures. By this the balloons can be kept updated. Within this period it flies approximately 3 instances across the globe. The excessive altitude affords many demanding situations to the loon like air pressure, extreme low temperature, less safety from UV(Ultra Violet) rays and the temperature swings. Yet it's miles in a position to conquer all those hurdles and withstand those conditions only by the suitable designing of balloon envelope. Hence, balloons are in a position to shape a huge conversation network in the stratosphere [3].

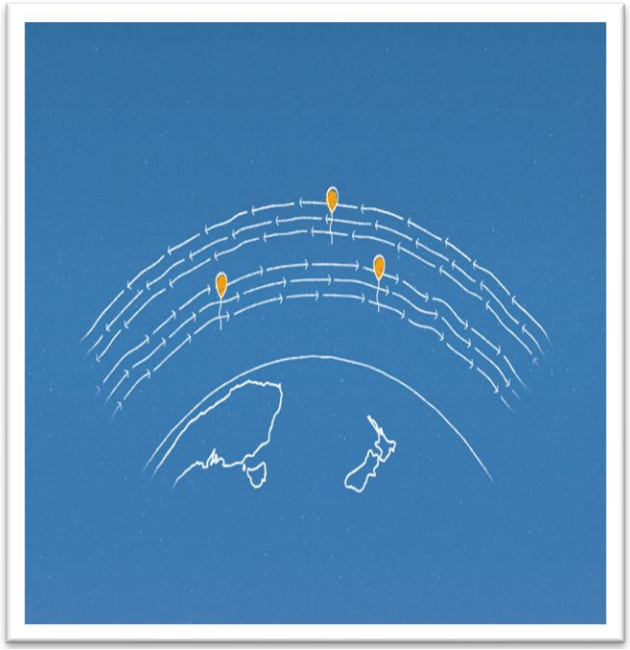

Fig.2. Navigation of the Loon in the Stratosphere[6].

E. Establishing the Network

The balloons shape a network of airborne hot spots. It can deliver internet access at speeds comparable to 3G over a wide area of around 1250 square kilometres. Special radiofrequency technology is used to communicate to ground stations. The project currently specifically uses ISM bands of 2.4 to 5.8 GHz.

Each unit of balloon has three transceivers for various purposes. The first is for balloon to communicate with the balloon and the second is for the balloon to communicate with the ground, while the other one is for the backup. In the control box the reflector plate placed between the antenna at the top and the radio at the bottom is fitted together and is used to create connection to the network. The head consists of two parts, called together as “patch antenna” which are used to receive the reflected signals from the plate and direct the signals. Those signals form the signals to be transmitted when coupled together. Users can use a basketball size antenna attached to their building to connect to the network. It is similar to a big bright red party balloon, and can be placed conveniently on their building anywhere. With the aid of this antenna the signals are sent and received. [2]

Fig.3. Network establishment with Loons [6]

When dealing with the design and architecture part we come across certain important questions which needs to be addressed are listed and explained. These are:

- Will the balloons crash?

Each balloon is made of rugged plastic polyethylene. Using solar power to help them stay aloft. The balloons, for instance, float in the stratosphere above rain and commercial aircraft, and far below satellites. Of course they are going to crash. Google says there's a parachute in every balloon 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." Controllers can arrange an orderly descent when a balloon is known to have reached its end of life or needs repair. Google has plans for collection points designated for Loon balloons. Google has also suggested reuse and recycling of the balloons and equipment on board. Google will notify relevant authorities, such as air traffic controllers, both during launch and during descent.

- Speed of Internet:

The Internet speed was comparable to 3 G during the New Zealand pilot test at Christchurch University held in June 2013. [3]

- How is the loon network interaction with the standard wi-fi network:

Our balloons only work with specialized Loon Internet antennas and do not support standard Wi-Fi networks. Though using similar frequencies, our radios and antennas are designed to receive only Loon signals and filter out standard Wi-Fi 33. We do this for achieving high bandwidth over the long distances involved (20 + km).

- How do you preserve the data transmission securely and with integrity over the Loon network?

  Automated encryption is done while the data is transferred and antennas which are specialized to loon network can assess it.

.What are the Way through which internet service is received from the balloon?

There are specialized internet antenna mounted to the side of a workplace or home with the help of radio frequency technology

- What is the range of the height over which balloons fly ?

Around 18-27 km or 60,000 - 90,000 feet above the ground in stratosphere where it is safe from commercial air traffic and weather events.

- What is the collection process of balloon after they have landed?

Continuous tracking of balloon is done when it's in air and note their local when they land. As it descends we steer it with proper plan, so they are directed to land around the world at various collection points.

- Is there risk of airplanes colliding with the balloons?

The high at which balloons fly is double of that of commercial airlines therefore there is no threat due to airplanes on the balloon over 70,000 weather balloons are launched without any incidents every year. The ascend and descend of the balloon is coordinated with local air traffic control.

- What are the designing steps for Loon?

Inflatable part of Loon is called the balloon envelope. These envelopes are made from polyethylene plastic sheets which are fifteen meters in breadth and twelve meters in height. To make them last long they are specially constructed for super pressure balloon. This is done so that the balloon can endure higher pressure from the air which is inside the Loon when float altitude is reached. When there is a need of a service of the Loon, a parachute mounted on the top of the envelope helps in controlled landing and descent.

Fig.5. Loon design

IV. ADVANTAGES AND DISADVANTAGES

For the sake of performance issues, we take into account the different topologies in which the balloons(loons) are interconnected.

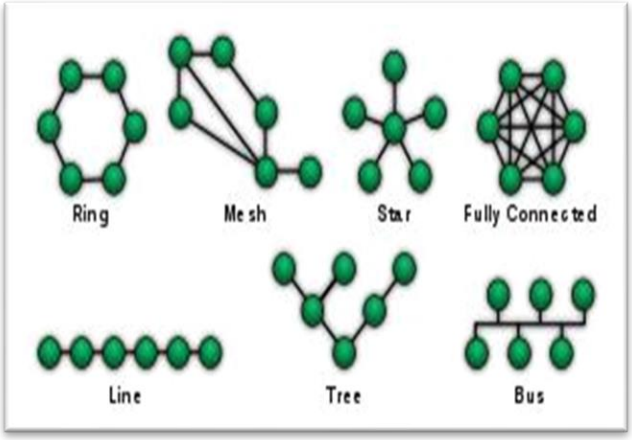

Fig.6. Different topologies

- Spanning tree topology:

Balloons and base stations are also interconnected In the topology above. Due to this there are some the advantages and the disadvantages to it which are as follows:

Advantages	Disadvantages
1. Fault detection is simple.	1. High cost.
2. System is robust.	2. More number of base stations.
3. Greater connectivity with the base stations.	3. Interconnectivity is zero.

- Ring Topology:

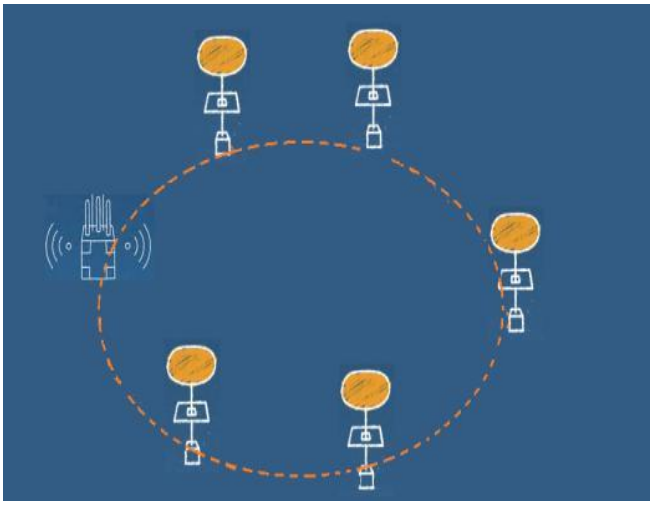

Fig.7. Ring topology

The topology above, there is the ring of all the devices connected together. This creates the problem as, when one of the balloon is disconnected then we cannot resume with the rest of the ring network. Some of the advantages and the disadvantages are discussed below:

Advantages	Disadvantages
1. Simple fault detection	1. System is not robust.
2. Cost is low.	2.Difficult to rebuild in case of failure.
3. Number of base station required is 1.	3. Connectivity is less compared to the spanning tree topology

- Hybrid using Mesh and Star topologies:

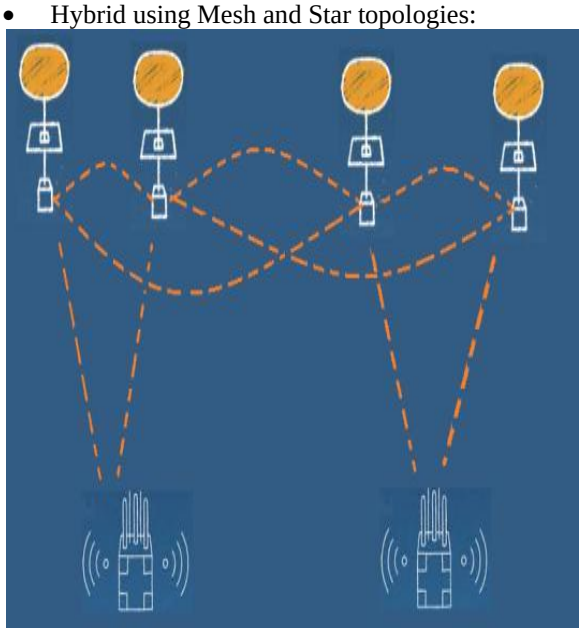

Fig.8. Hybrid using Mesh and Star topology.

The above topology have the star and the mesh [6] combined with each other so there are advantages and disadvantages of both topologies attached to it which are as follows:

Advantages	Disadvantages
1. System is robust.	1. It is expensive.
2. Problems related to traffic are removed.	2. More number of base stations.
3. Every message travels via a dedicated line.	3. Complex connections.

- Dual Ring topology:

In this topology[7] using the third line which we have kept for the backup and therefore when one of the balloons is disconnected then we can have the uninterrupted connectivity. Thus the advantages are as shown below:

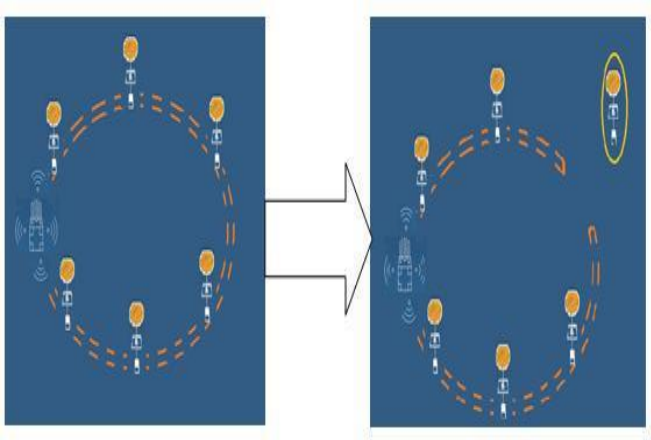

Fig.9.Dual Ring topology

balloon does not cause interruption in connectivity. Following are the advantages:

- Comparatively low cost.
- This is a robust system.
- High connectivity.
- Fault detection and correction is easy.

IV. CONCLUSION

The Internet is emerging as the basic necessity in daily life. While one part of the world is improving with the help of internet connection at a tremendous speed, about 2/3 of the population is not even able to access this. Google has been trying to fill this void with the 'Project Loon' and fix the problem with the broad band. Project loon is one of Google 's biggest idea. For an area of about 25 miles in diameter it acts as a wireless station. The technique of connecting mobile internet to billions of people using balloons may sound crazy but it could work. Google says, "It is highly experimental technology we have a long way to go."An inspiring effort is this innovative attempt by Google to provide links to rural areas and remote regions that deserve internet connection. The launch of 'Project Loon' also made balloons an option to provide cost-effective internet access everywhere, too.

Connecting to rural, remote and inaccessible terrains will no longer be impossible. People in rough terrains will get the weather forecast in advance which in turn will help them to escape the damage caused by any of the natural calamities. It also provides an optimal solution over the solution of laying down the fiber cables for the connectivity to the global system.

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