WIRELESS TECHNOLOGY- GOOGLE'S PROJECT LOON

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Abstract – As two-thirds of the world's population does not yet have internet access, "Google's Project Loon" – a network of balloons travelling on the edge of space – is designed to connect people in rural and remote areas, helping fill coverage gaps, and bringing people back online after natural disasters. Floating high in the stratosphere – twice as high as airplanes and the weather – the 'Project loon balloons' 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 network using a special internet antenna attached to their building. The signal bounces from balloon to balloon, which then provides a connection back down on earth. Each miniature blimp can provide connectivity to a ground area about 40 km in diameter at speeds comparable to 3G. For balloon-to-balloon and balloon-to-ground communications, the infrastructure use antennas equipped with specialized radio frequency technology.

I. INTRODUCTION

Project Loon is a research and development project being developed by X (formerly Google X) 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 18 km (11 mi) to create an aerial wireless network from 3G to 4G-LTE speeds. It was named Project Loon, since even Google itself found the idea of providing Internet access to the remaining 5 billion population unprecedented and "crazy."

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 ground-based 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 DeVaul, chief technical architect, who is also an expert on wearable technology; Mike Cassidy, a project leader; and Cyrus Behroozi, a networking and telecommunication lead.[1]

II. HISTORY

In 2008, Google 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.

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.

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.

In May 2014, Google X laboratories director, Astro Teller, announced that, rather than negotiate a section of bandwidth that was free for them worldwide, they would instead become a temporary base station that could be leased by the mobile operators of the country it was crossing over.

On 29 October 2015, Google agreed to partner with Indonesia's XL
Axiata, Indosat and Telkomsel to bring the

technology to the country in the hopes of connecting its 17,000 islands.

On 25 February 2016, Google started testing their auto launcher named "Chicken Little" at former naval station Roosevelt Roads located in Ceiba, Puerto Rico.

On September 5, 2016, a balloon was spotted over Newfoundland and Labrador, Canada.[3]

III. TECHNOLOGY

Project Loon is Google's pursuit to deploy a high-altitude balloon network operating in the stratosphere, at altitudes between 18 km and 25 km. Google asserts that this particular layer of the stratosphere is advantageous because of its relatively low wind speeds (e.g., wind speeds between 5 and 20 mph / 10 to 30 kmph) and minimal turbulence. Moreover, Google claims that it can model, with reasonable accuracy, the seasonal, longitudinal, and latitudinal variations in wind speeds within the 18–25 km stratospheric layer.

Given a reasonably accurate model of wind speeds within the 18–25 km band, Google claims that it can control the latitudinal and longitudinal position of high-altitude balloons by adjusting only the balloon's altitude. By adjusting the volume and density of the gas (e.g., helium, hydrogen, or another lighter-than-air compound) in the balloon, the balloon's variable buoyancy system is able to control the balloon's altitude. Google has additionally indicated that balloons may be constructed from various materials (e.g., metalized Mylar or BoPet) or a highly-flexible latex or rubber material (e.g., chloroprene).

Fig 1:Balloon in stratosphere

The balloon envelopes used in the project are made by Raven Aerostar, and are composed of polyethylene plastic about 0.076 mm (0.0030 in) thick. The balloons are super pressure balloons filled with helium, standing 15 m (49 ft.) across and 12 m (39 ft.) tall when fully inflated. They carry a custom air pump system dubbed the "Croce" that pumps in or releases air to ballast (provide stability to a vehicle or structure) the balloon and control its elevation. A small box weighing 10 kg (22 lb) containing each balloon's electronic equipment hangs underneath the inflated envelope. This box contains circuit boards that control the system, radio antennas and a Ubiquiti Networks 'Rocket M2' to communicate with other balloons and with Internet antennas 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, the panels produce 100 watts of power, which is sufficient to keep the unit running while also charging a battery for use at night.[6] The balloons typically have a maximum life of about 100 days, although Google claims that its tweaked design can enable them to stay aloft for closer to 200 days.[2]

IV.RELATED WORK

A. 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.[9]

V. 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.
- 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.

VI. OVERVIEW

Project Loon balloons travel around 20 km above the Earth's surface in the stratosphere. Winds in the stratosphere are generally steady and slow-moving at

between 5 and 20 mph, and each layer of wind varies in direction and magnitude. Project Loon uses software algorithms to determine where its balloons need to go, then moves each one into a layer of wind blowing in the right direction.

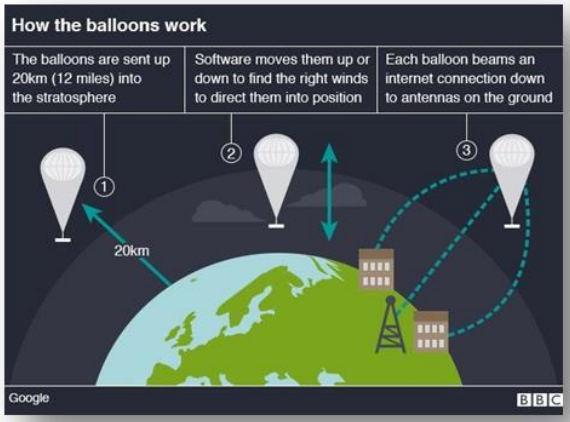

Fig 2:How loon works?

By moving with the wind, the balloons can be arranged to form one large communications network situated between 10 km and 60 km altitude on the edge of space, the stratosphere is named after the different strata, or layers, of wind within it. But the extreme altitude also presents unique engineering challenges:

1. Air pressure is 1% of that at sea level,
2. Temperatures hover around -50°C, and
3. A thinner atmosphere offers less protection from the UV radiation and temperature swings caused by the sun's rays.[7]

VII. 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.

❖ **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. 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. ϖ 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-Fi___33, 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. ϖ 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 lo0w 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 [8].

❖ **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 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. ϖ 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.

VIII. 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

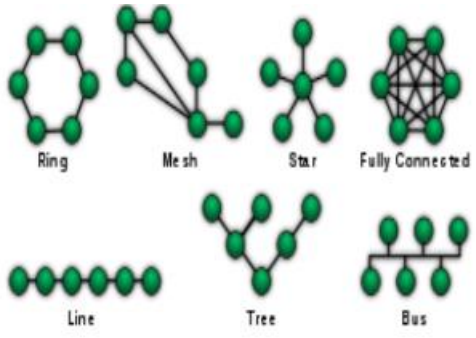

Fig 3: Different balloon Topologies

IX. ADVANTAGES

✓ The price of Internet data in many parts of the world continues to be unaffordable for the majority of global citizens.

✓ "Project Loon" will offer worldwide access to information to everyone, including those who today are beyond the geographic reach of the internet or can't afford it."

✓ Project Loon will guarantee this right by taking a practical approach to information delivery.

✓ Project Loon's near-term goal is to provide the entire world with broadcast data, Internet access for everyone.

✓Wireless connection to the Web available for free to every person in the world.

✓Project Loon will also offer a humanitarian communications system, relaying public service transmissions during emergencies in places where there is no access to conventional communications networks due to natural disasters or man-made restrictions on the free-flow of information.

✓Project Loon will use a network of balloons to transmit selected internet data – audio, video, text and applications – to any Wi-Fi-enabled device, including mobile phones, anywhere in the world.[2]

X. LIMITATIONS

- "Cost" was high as we have to take permission, buy antenna and fix it in home.
- "Maintenance" cost will be very high as the total equipment is very costly and complicated.[5]

XI. CONCLUSION

Although internet has become such a handy thing for people having access to internet that they roam about with it in their pockets, but this has been possible for those countries that can afford fibre optic cables for connectivity and therefore the bitter truth remains that nearly two-thirds of the world population do not yet have internet access. The Google[X] team has therefore taken an initiative to bridge this gap and make the world actually connected to one another by introducing Google's Project Loon.

This project has come along a long way with successful Pilot Test and also surpassing many environmental, engineering, political challenges (relating to use of airspace and radio frequencies) and now is seeking NASA's intervention for its success worldwide.

The project aims at : *"Forget the Internet, soon there will be OUTERNET"*

The success of this project would thereby make us talk about Outernet, may be, in the next one.

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