



## RTT TECHNOLOGY TOPIC June 2014 LTA LTE U

The March technology topic, The North to South Transition highlighted the shift in mobile broadband industry value from the northern to southern hemisphere.

[http://www.rtonline.com/tt/TT2014\\_003.pdf](http://www.rtonline.com/tt/TT2014_003.pdf)

We highlighted the requirement for lower delivery costs for these markets including rural and urban coverage, frustrated by the rising costs of sites including rental and administrative costs and security costs in rural areas.

In January 2013 we discussed the changing economics of the satellite sector and the impact this could potentially have over rural broadband delivery costs over the next five to ten years.

[http://www.rtonline.com/tt/TT2013\\_001.pdf](http://www.rtonline.com/tt/TT2013_001.pdf)

In this month's technology we look at two sub space alternatives, Google's Loon LTA (**L**ighter than **A**ir) project, Facebook and Google's drone proposals and possible LTE U (LTE in **U**ncensored spectrum) integration opportunities.

Read on

### **Hot Air, Hydrogen and Helium**

On June 4<sup>th</sup> 1783 Joseph and Jacques Montgolfier launched a paper lined silk hot air balloon from the market place at Annonay in France. It rose to over 6000 feet.

The French physicist Jacques Charles (1746-1823) and Nicolas Robert (1758-1820) made the first untethered ascension with a gas hydrogen balloon on December 1, 1783.

The following January a larger version of a Montgolfier balloon carried seven passengers to over 3000 feet above Lyon.

Hydrogen can be generated from natural gas or other hydrocarbons. It was described by Robert Boyle in 1671 as the reaction between iron filings and dilute acids and recognized as an element by Henry Cavendish in 1766 when he collected it over mercury and described it as "inflammable air from metals" (He thought that the gas originated from the metal rather than from the acid).

Helium was discovered by Pierre Janssen a French astronomer in 1868. He was observing a solar eclipse in India when he noticed the yellow spectral emission lines of the element.

In 1895, Sir William Ramsay managed to produce helium after treating cleveite, a uranium mineral, with mineral acids.

<http://www.universetoday.com/53563/who-discovered-helium/#ixzz2zc8ZjaNG>

Helium is a by-product of the gas industry formed by the decay of radioactive rocks in the earth's crust and accumulates in natural gas deposits.

<http://www.bbc.co.uk/news/magazine-24903034>

Hydrogen was used with mixed success in air ships. The crash of the R101 in October 1929 recorded in real time radio transmissions effectively put an end to its potential use by commercial airlines.

<http://www.bedfordshire.gov.uk/CommunityAndLiving/ArchivesAndRecordOffice/CommunityArchives/Shortstow/CausesOfTheR101Disaster.aspx>

Hydrogen is the lightest element on earth, helium is the second lightest.

Helium however has the significant advantage of not being flammable.

On 24<sup>th</sup> October 2012 Felix Baumgartner flew in a helium balloon to 24 miles (39 kilometres) and jumped out to break the sound barrier in a free fall descent.

<https://www.facebook.com/FelixBaumgartner>

Hot air, hydrogen and helium are all possible choices for producing flying base stations but helium is the safest and most effective.

### **The Google Loon Project – High on helium?**

<http://www.google.com/loon/how/>

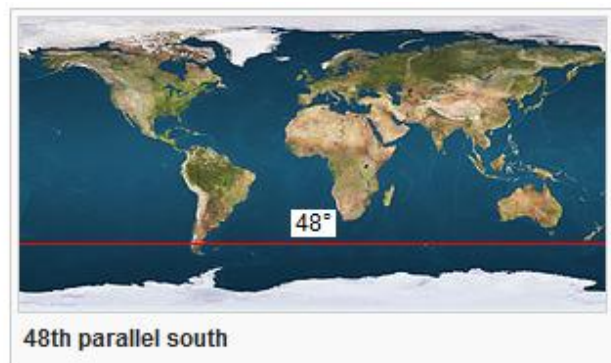
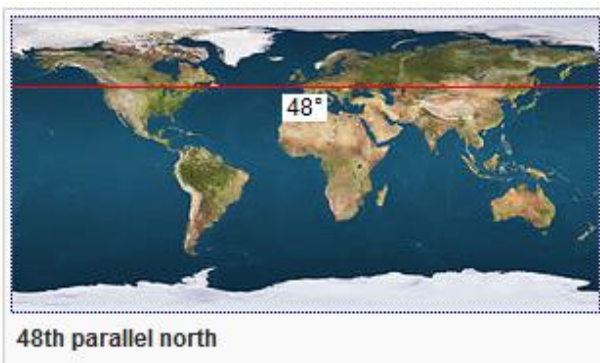
The concept of the Google Loon project is to launch helium balloons into the stratosphere at around 20 miles (100,000 feet). The height of the balloons can be altered by pumping air in or out of the balloons to change their density. As their altitude changes they catch different wind currents and can therefore be positioned to provide coverage as and where and when required.

The balloons take about 22 days to fly around the world typically blown at wind speeds of the order of 100 miles per hour and should be able to stay up for 100 days.

Each balloon has solar panels to run the RF transceiver, the air pump and a heater to stop the electronics freezing. The present stated position is that the air interface will be 2.4 and or 5 GHz Wi Fi though they could feasibly use 5 GHz LTE U. The LTE option would have the advantage of providing more closely controlled air to ground interference.

The images and graphics from the Google Loon web site show what a Loon balloon looks like and how coverage might be provided between the north and south 48<sup>th</sup> parallel.





Helium balloons could of course be used at other heights.

This could include the troposphere up to 36000 feet using the jet streams that are generally moving west to east in the northern hemisphere and east to west in the southern hemisphere at up to 200 miles per hour.

Civil Aviation authorities would however need to be reassured about how relatively low speed balloons could coexist with higher speed aircraft flying at a similar altitude. It would be disturbing to fly an aeroplane through a forest of giant slow moving condoms. A regime similar to the present regulatory control of weather balloons would probably be less than adequate.

<http://ukhas.org.uk/guides:faq>

Higher altitudes above the stratosphere include the mesosphere at up to 150,000 feet (28 miles), the thermosphere at above 50 miles and the exosphere, the boundary with space, at 300 miles.

The highest a gas balloon has flown to date is around 170,000 feet (32 miles) so thermospheric and exospheric altitude options are not presently feasible (and probably never will be).

By comparison the orbital height of an Iridium satellite is 485 miles. Iridium satellites travel at 17000 miles per hour in north to south polar 100 minute orbits. They are therefore different to balloons but share some of the same economic dynamics.

For example, the present generation Iridium satellites have lasted longer than expected with a lifetime of well over twice the design expectation. Both present and 'next' generation Iridium satellites successfully amortise delivery costs with other payloads including sensing systems.

The delivery economics of Project Loon will be similarly dependent on developing envelope materials that are sufficiently robust and resistant to damage including UV radiation in order to extend the flight time beyond present expectations, achieving further improvements in solar panel efficiency and developing high value hosted pay loads to offset launch and flight and system costs.

Helium is a finite resource and one of the few elements that escapes gravity and leaks away into space. Resources are being depleted by its use in party balloons. (Party spoiler alert).

It is used in the electronics industry in the manufacture of silicon wafers, for superconductors and by deep sea divers. It will become more costly over time.

For real time updates on the Google project go to

<https://plus.google.com/+ProjectLoon/posts>

### **Facebook Internet.org and the drone option – how high is the sky?**

<http://internet.org/>

Facebook have a similar low cost internet access initiative to Google though are studying the use of drone technology rather than balloons.

These are quasi stationary platforms (they go round in circles) flying at 65,000 feet to provide a city sized coverage footprint with medium population density. This is close to the lowest altitude for unregulated air space with relatively stable weather conditions most but not all of the time (thunderclouds can reach 60,000 feet). Future generation solar powered high altitude drones could stay on station for months or potentially years with their location precisely controlled.

The communication system could be a conventional microwave transceiver or free space optics (more power efficient but susceptible to weather fading).

[https://fbcdn-dragon-a.akamaihd.net/hphotos-ak-ash3/t39.2365-6/851574\\_611544752265540\\_1262758947\\_n.pdf](https://fbcdn-dragon-a.akamaihd.net/hphotos-ak-ash3/t39.2365-6/851574_611544752265540_1262758947_n.pdf)

### **The lessons from the R101... whatever the weather?**

Project Loon and the Facebook Internet project are admirable, exciting and potentially feasible options for delivering low cost internet access. It is of course not an either or choice and would be more convincing if the two options were integrated together rather than being separately promoted. Google's recent acquisition of drone maker Titan Aerospace suggests this might now happen. <http://titanaerospace.com/>. A new generation of airships also suggest that alternative delivery platforms might become available. <http://steffanlewis.com/blog/worlds-longest-aircraft-the-airlander-hav304-airship/>

But a final word of caution – the R101 disaster was caused by an unexpectedly severe rain storm over France which caused a fabric failure at the front end of the air ship. The weather and the resulting accident invalidated the economic business model for the commercial airship industry.

Eighty years later we are able to forecast the weather with greater accuracy and foresight but wind and rain and thunderstorms and typhoons and hurricanes are elements that remain outside of our control.

This is of course a definable risk statistically (ITU rain fading statistics for microwave links provide a starting point) but weather costs need to be fully factored in to Google's and Facebook's delivery cost calculations.

And best to avoid France when it's raining.

## **A review of Making Telecoms Work**

The impact of physical layer innovation on telecom delivery economics is discussed in detail in our 2012 book Making Telecoms Work.

The book has just had a very nice review in the IET Journal by Robert Wojcik.

[Read the review here](#)

Copies can be ordered here

<http://www.rttonline.com/bookshop.html>

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## **About RTT Technology Topics**

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[http://www.rttonline.com/tt/TT1998\\_008.pdf](http://www.rttonline.com/tt/TT1998_008.pdf)

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## **Contact RTT**

[RTT](#), the [Jane Zweig Group](#) and [The Mobile World](#) are presently working on a number of research and forecasting projects in the mobile broadband, two way radio, satellite and broadcasting industry.

If you would like more information on this work then please contact [geoff@rttonline.com](mailto:geoff@rttonline.com) 00 44 208 744 3163