

# THE HALO NETWORK A PROPOSED SYSTEM OF HIGH ALTITUDE LONG OPERATION NETWORK

T. Lincy Thangammal, B.E Computer Science and Engineering, Final Year, Panimalar Engineering College;  
Aiswarya, B.E Computer Science and Engineering, Final Year, SKR Engineering College

## Abstract

The High Altitude Long Operation (HALO) network is a wireless broadband metropolitan area network whose solitary hub is located in the stratosphere. The existing wireless broadband millimetre wave technology and our proposed HALO network technology using HALO aircraft with their corresponding architectures and principle of operation are presented in this paper. The equipment needed to perform the functions of this wireless broadband service will be evolutionary in nature, not revolutionary.

## Introduction

Many people from small children to cooperate people are with iPhones demanding for higher bandwidth. An electronic “information fabric” of a quilted character that includes terrestrial, atmospheric and space data communication layers will emerge that promises to link every digital information device on the planet. Communication infrastructures will be shared more efficiently to offer dramatic reductions in cost and enormous increase in effective data rates. The emergence of new technologies and manufacturing properties are affecting millimetre wireless wave and multimedia communication industries to pursue new wireless broadband communication services. The HALO network will offer ubiquitous access to any subscriber within a metropolitan area through a simple-to-install subscriber unit, each subscriber will be able to communicate at multi-megabit data rate per second. This network will be meld with connection oriented telephony networks. The HALO network will be steadily evolved at a pace with the emergence of data communications technology worldwide. It will be a universal wireless communication network solution. It will be deployed globally on a city-by-city basis.

## What is HALO?

The markets of broadband, wireless and multimedia network services are growing rapidly. Ingenious communications networks are being pioneered. The HALO Network Infrastructure is a simple and a convenient star topology with a single central hub. It can interface to existing networks through SONET and ATM.

It can also provide video conference links through standard (Integrated Services Digital Network) ISDN or T1 interface hardware. The HALO network will be located in the stratosphere at an altitude between wireless terrestrial and satellite networks

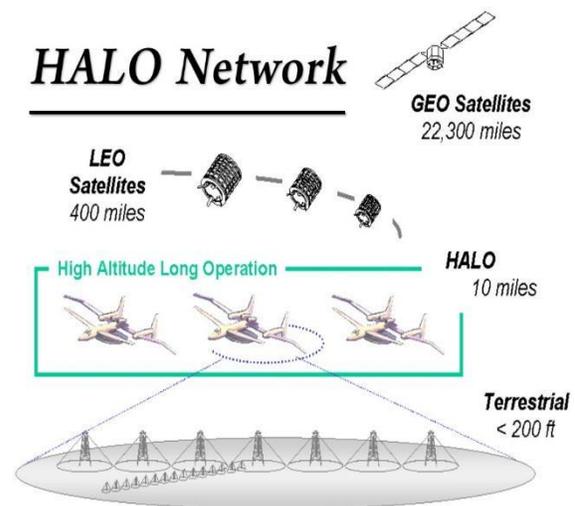
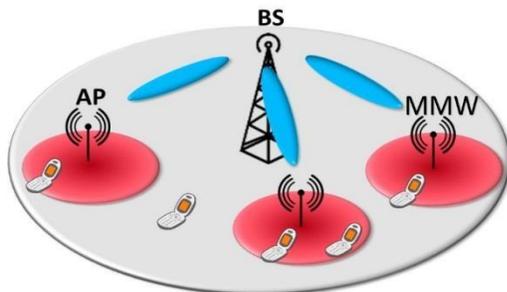


Figure 1. General HALO Location

The satellite networks being developed as well as proposed for operating at Low Earth Orbit (LEO), Medium Earth Orbit (MEO), High Earth Orbit (HEO) and Geosynchronous Earth Orbit (GEO) have the advantages such as free space like channels with Ricean fading and high look angles whereas the disadvantages include expensive high power user terminals, long propagation delays and stagnant performance growth. In contrast, the terrestrial wireless network has low cost low power user terminals, short propagation delays and good scalability of system capacity as its meritorious attributes and low look angles, multipath channels with Rayleigh fading and complex infrastructures follow as its de-meritorious attributes. The HALO network has the advantage of both these popular wireless communication services. It can operate as a backbone to link the physically separated Local Area Network (LAN) through frame relay adaptation or bridges and routers. In order to backhaul aggregated traffic, the HALO link's network provides many base stations that must be interlinked over microwaves or cables.

## Conventional Wavelength Wireless Services      Millimeter Wave Broadband Services

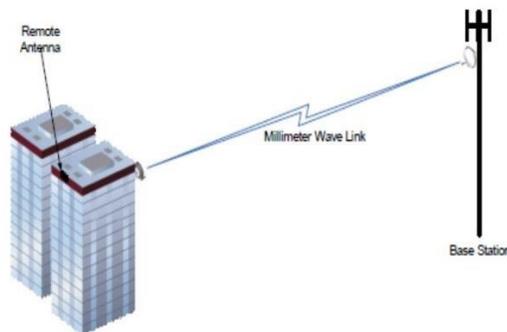
Millimetre waves generally corresponds to the radio spectrum between 30GHz to300GHz with wavelength varying from 1 to 10mm. Millimetre wave wireless technology presents the potential to offer bandwidth delivery comparable to that of fiber optics but the deployment of financial and logistic challenges are removed.



BS - Base Station  
AP – Access Point  
MMW-Multimegabit Millimeter Wave

**Figure 2. Broadband connectivity**

It generally corresponds to a few bands of spectrum near 38, 60 and 94GHz. Recent times have seen the uprising of 70GHz band and more comfortably the E-Band (90GHz) for the purpose of wireless communication in the public domain. Depending on atmospheric oxygen, humidity, fog and rain, the propagation characteristics of millimetre waves through the atmosphere varies. It is unlikely to be matched by any low frequency wireless technology.

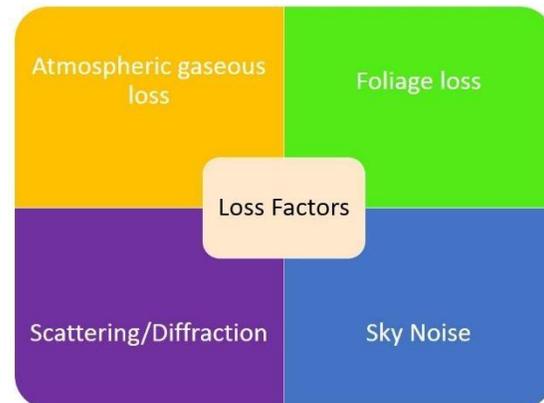


**Figure 3. Transmission through millimetre wave link**

As demanded by market needs, the availability of high amount of bandwidth enables the capability to scale the capacity of millimetre wave wireless links are provided.

Typical millimetre wave products are commonly available with spectral efficiency of 0.5 bits per hertz. The narrow beams of millimetre wave links allow for deployment of multiple independent links in close proximity. Other wireless technologies often reach their scalability limit due to cross interference.

## Loss Factors of Millimeter Wave Technology



**Figure 4. Loss factors in millimetre wave broadband communication**

### Atmospheric Flush Loss

Transmission losses occur when millimetre waves travelling though the atmosphere are absorbed by oxygen molecules, water vapour and other gaseous atmospheric particles. These losses are greater at certain frequencies. Absorption results in high attenuation at these frequencies of the signal, hence leading to a short propagation distance.

### Foliage Loss

Foliage losses are significant at millimetre wave frequencies and may be limiting propagation impairment in some cases. This loss occurs for frequencies in the range 200 to 95000MHz.

### Scattering/Diffraction

The signal still reaches the receiver via reflections from objects in proximity to the receiver or via diffraction or bending if Line Of Sight (LOS) path is nil between the transmitter and receiver. Like light waves the signals are subject more to shadowing and reflection. It provides less power at the receiver than specular reflected power.

## Sky Noise

The sky noise temperature acts as a function of frequency. The sky noise peaks at the millimeter wave gaseous resonance bands and this phenomenon affects the spectrum of millimeter waves. The noise entering the receiver from the antenna includes components of sky noise.

TABLE 1: Estimation of Loss Factors in dB scale

EFFECT	COMMENTS	SIGNAL LOSS(dB/km)
Oxygen	Sea Level	0.22
Humidity	100% at 30o C	1.8
Heavy Fog	10o C,1 gm/m <sup>3</sup>	3.2
Cloud Burst	25 mm/hr	10.7
Moderate Rain	4 mm/hr	2.6
Intense Rain	50 mm/hr	18.4

## Other Factors

Attenuation is caused by rain which results in power loss. As the dielectric constant of ice is much smaller than that of water, the scattering cross sections of snow flakes, ice needles and hail stone are considerably small. Fog is also expected to introduce noticeable path losses. Due to atmospheric windows the transparency decreases with increasing frequency.

## Proposed HALO System

### HALO Aircraft



Figure 5. HALO aircrafts hovering over metropolitan areas

The HALO aircraft is an aircraft designed to act as a very high altitude receiving and transmitting tower. It is also termed as a “flying-antenna”. It covers a metropolitan area and provides broadband telecommunication service at data rates upto 5Mbps to homes and upto 25Mbps to business uses. In each city, a single aircraft is maneuvered at about 52000 to 60000 feet, which takes it a lot higher than commercial planes. The aircraft will be able to service home and business uses over a wide coverage area of 60 miles. Three aircrafts will take turns, each with a pilot and co-pilot for a shift of 8 hours for each plane.

## Technical Specifications of The Aircraft

The HALO aircraft fuselage contains the Airborne Switching Node (ASN) which is the primary coolant loop and which provides power conditioning. It also performs packet switching and network management function. It is powered by a Direct Current (DC) supply of 40KW or higher. It gets aligned to a stabilized roll angle. The liquid cooled engine adds up to its advantageous low power and low cost. The HALO aircraft will fly above the metropolitan city in a circular habit of 5 to 8 nautical miles diameter. Station keeping is carried out by Global Position Satellite.



Figure 6. Proteus

## Architecture of the HALO Aircraft

The HALO aircraft, called the Proteus built in California by Scaled Composites. Powered by twin turbofan engines, a subsidiary of Wyman Gordon and is constructed to have an “efficient high-altitude linger”. It consists of a (18 feet Diameter) communication payload which houses the antennas and their interfaces.

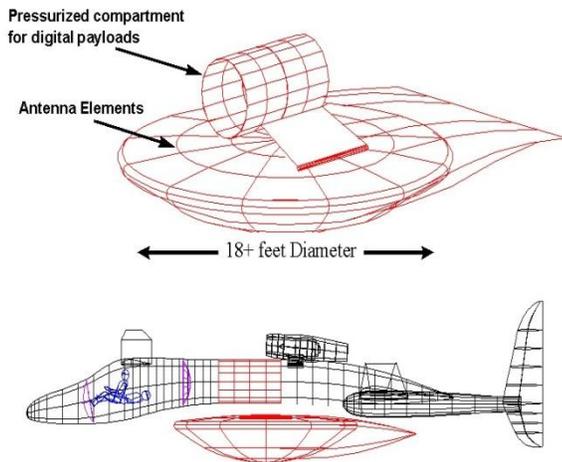


Figure 7. HALO aircraft with its communication pod

The payload bearing architecture of the HALO aircraft includes 2300 lb for the airborne elements of the HALO network distributed as 500 lb for the fuselage section using pylon, ASN and the pilots and 1800 lb for the suspended communications Pod. The pylon maintains the axis and angle of the communication payload with respect to terrestrial ground level. Extendible wings allow it to carry a range of payloads around 2000 pounds.

## Design of HALO Network

The HALO network offers ubiquitous access to any subscriber within a metropolitan area from the HALO aircraft. The aircraft will serve as the hub of the HALO network serving tens of thousands of customers. Each customer mounts a high gain antenna with small aperture, known as the premise equipment which tracks the HALO aircraft.

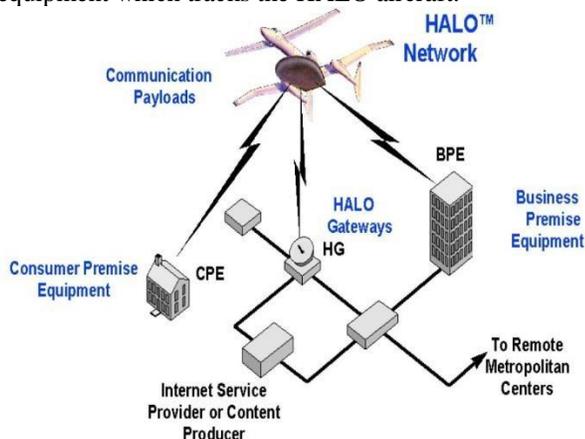


Figure 8. The HALO hub

If the premise is a home, it is known as Consumer Premise Equipment (CPE) and the premise of the dedicated business organization is known as Business Premise Equipment (BPE). They are operated by Internet Service Providers (ISPs). The HALO Gateway (HG) is directly connected to distant metropolitan area acting as a portal serving the entire network. It avails system wide access, allowing any subscriber to extend the communication to long distant lines. The CPE, BPE and HG have common functions and common designs, demonstrated in related forms by terrestrial 38 GHz and 28 GHz vendors. The data rates are more than 99.7% , planned to be reach the maximum upto 99.9%. The Minimum Look Angle (MLA) will be higher than 20 degree typically. Such a high look angle has been chosen to ensure that the antenna of each subscriber's premise equipment would have access to a solid angle swept by the settling HALO aircraft.

## Concept of Operation

The HALO network use a high-gain antenna that automatically tracks the HALO aircraft at first. Secondly, the modulating signals conveyed through the air by millimeter waves are extracted. Then the extracted signals are converted to digital data. Next data communications interfaces are provided. Finally, the data is routed to the respected equipment connected to the premise equipment.

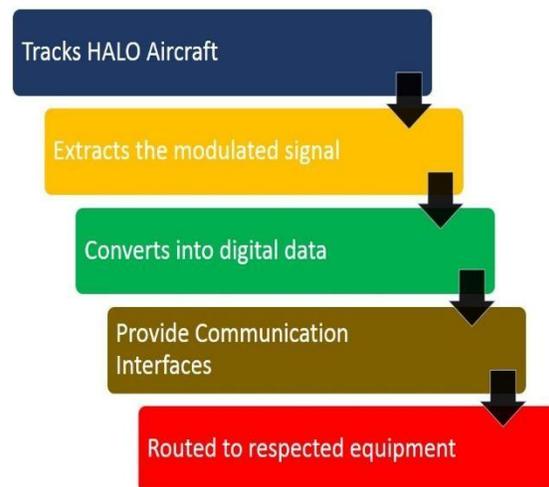


Figure 9. Operational Process in the HALO Network

An array of narrow beam antennas on the HALO aircraft are used by the HALO network to form multiple cells on the ground. Each cell covers a small geographic area of about 3 to 4 square miles. The wide bandwidths and narrow bandwidths within each beam or cell are achieved by using Multi-mega bit Millimeter Waves (MMW) frequencies. Small cells are used to achieve Small aperture antennas. The HALO aircraft can easily carry one hundred dish antennas to create one hundred or more cells throughout the service area. By the utilization of



lensed antennas, wider beams are created by combining beams through each lens aperture. Multiple beams can be formed by each compound lens with multiple feeds behind each lens. A minimum capacity of one full-duplex channel is available per cell by assuming 850 MHz of spectrum. This capacity can be shared by multiple users in an efficient manner by the use of Asynchronous Transfer Mode (ATM) technology with over the air dynamic bandwidth allocation. Communication payload consists of MMW transceivers, pilot tone transmitter, SONET multiplexers, high speed modems, packet switch hardware and software and associated ancillary hardware such as power supplies and processors.

## Conclusion

The sine quanon of HALO network is the ability to combine the merits of satellite network and terrestrial network. It has multi-ferrous functions in terms of low cost, low power and less space consuming with greater advantages. The advent of HALO Network is a boon, not only to our society, but also to our entire universe. Though it is used in California, the days are not too far away to

reach India. An era of inexpensive bandwidth has begun which will transform the nature of commerce.

## References

1. "Broadband wireless services from HALO aircraft" by J. Martin and N. Collela, Dallas, TX, Nov 1997
2. "HALO: A broadband wireless metropolitan area network" by I. F. Akyildiz, X. Wang and N. Colella
3. "Establishing wireless communication services" by G. Djuknic et al., Mag., Sep 1997
4. "High Altitude Long Operation" by Lindstrand, 2007
5. "Proceedings of workshops on High Altitude Platform Systems" WHAPS 05, Athens, Greece, September 2005 6. "The role of high altitude platforms beyond 3G network" by S. Karapantazis and F. N. Pavlidou, 7(1), 2-3, 2005