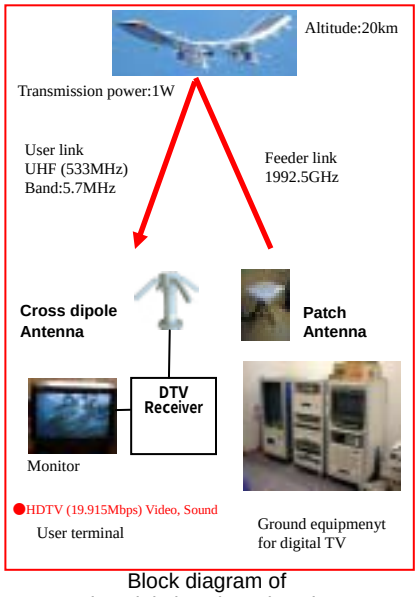
Space Japan Milestone

The world's first success communications signal relay in the stratosphere

Unmanned solar-powered plane
"Pathfinder Plus"

Rising over Kauai Island



Block diagram of
the Digital TV broadcasting

Digital television signal
relayed through stratosphere

Communications Research Laboratory

Communications Research Laboratory (CRL) carried out a stratospheric relay experiment for communications and broadcasting signals using the unmanned solar-powered plane "Pathfinder Plus" loaded transponder developed by CRL. This was done in collaboration with Telecommunications Advancement organization (TAO), AeroVironment, Skytower and NASA.

Background

The CRL and TAO began developing telecommunications and broadcasting systems based on the stratospheric platform, and have contributed to standardization for such organization as International Telecommunications Union (ITU).

Stratospheric platform means the flying object that stay at a predetermined height at altitude of approximately 20 km above the ground in the stratosphere. It should be very useful for future telecommunications and the broadcasting infrastructure. Several thousands of transmission or relay stations are used for terrestrial television networks in Japan. However, it is possible to replace these with six stratospheric platforms, if the lowest elevation angle for broadcasting services is assumed to be 5 degrees and the radius of coverage reaches about 200 km.

Large scale airships and solar-powered planes are perceived as strong candidates for stratospheric flight, even though only the later is being used at present. The Pathfinder Plus is an unmanned solar-powered plane that was developed for NASA's ERAST(Environmental Research Aircraft and Sensor Technology) by Aerovironment. It was the first in the world to fly at 24 km in the stratosphere though it was restricted to flying during the daytime. It is actually only a single wing that is 36.3 m in length and 3.4 m in width.

We carried out and established the telecommunications and broadcasting relay in the stratosphere using the Pathfinder Plus loaded transponder developed by CRL. This experiment was the world's first advanced communications and broadcasting signal relay with stratospheric transponder. Three flights were done to achieve this over the U.S. Navy's Pacific Missile Range Facility (PMRF) on the Hawai'i islands of Kaua'i. The first flight (24 June) involved digital television broadcasting. Voice, video, and Internet access using a third-generation mobile handy phone terminal were carried out during the second (28 June) and third flights (20 July). The last flight was also open to invited guests.

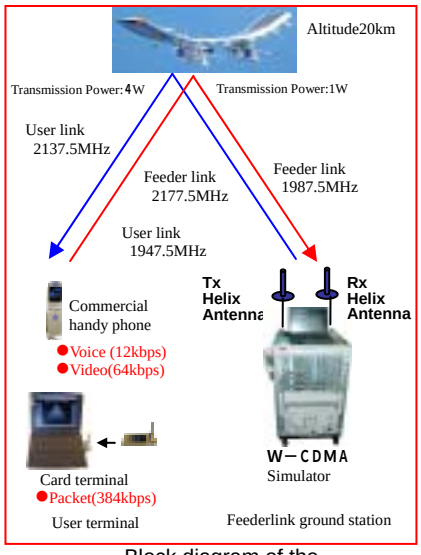
The first flight(digital television broadcasting)

On the morning on 24 June, the flight was determined taking conditions such as the weather into consideration. Pathfinder Plus took off at 9:37 AM, and reached a height of 20 km at 3:37 PM. It then

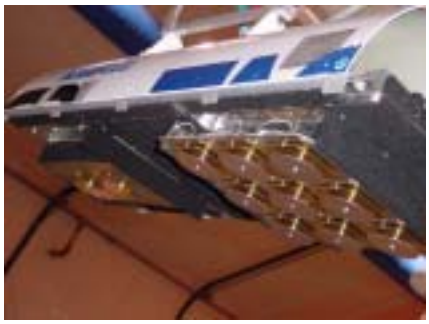
began to relay a digital television broadcasting signal. The relayed signal was received at the ground receiver, and the monitor displayed a clear HDTV image and sound. It was the world's first successful digital broadcasting test relayed using the stratospheric platform. This experiment involved the ISDB-T method that is used for Japan's terrestrial digital broadcasting. We verified that this system can produce good reception even with the severest parameters (Mode 3, 64QAM, inner FEC rate 7/8). We obtained data on such as transmission characteristics, temperature in pod, and verified that the stratospheric communication link is sufficiently stable.

The second flight (IMT-2000 communications access)

At 8:20 AM on 28 June, Pathfinder Plus took off and reached a height of 20 km at 1:28 PM. After reaching this height, we attempted IMT-2000 communication access using a commercial handy phone terminal, but we could not connect. According to our research on the cause, there was a large interference signal within the return link. This interference signal came from a next island that was more than 200 km horizontally away from Pathfinder Plus. The signal was not observed on the ground check. We finally obtained the data by combining a commercial handy phone with a high-gain external antenna to improve the signal to interference ratio. In this experiment, we could access IMT-2000 communications signal in stratospheric relay link involve large delay with only a little adjustment of protocol.



Block diagram of the
IMT-2000 communications access



Tx and Rx antenna for
IMT-2000 communications access

The third flight (IMT-2000 communications access:open experiment)

We suppressed the interference experienced during the second flight by a new antenna (9 elements array) which has a beam pattern which reduces the side level by 10 or 15 dB. Pathfinder Plus loaded with the new antenna took off at 8:29 AM on 20 July, and reached at altitude of 20km at 1:24 PM. After this, we retried communications access by handy phone, and succeeded. It was the world's first IMT-2000 voice/video communications access using a stratospheric relay. This means that terrestrial and stratospheric communication systems can be combined using the same terminal without attachments. This experiment was open to 40 of invited guests from several countries and voice/video access demonstrations were carried out in their presence.

Video access
relayed through stratosphere

Closing remarks

This experiment was long term and involved about 3 months of work in Hawai'i. The expected data obtained by the dedicated efforts of staff. The data and know-how gained from the experiments should be very useful in the development of future communications systems based on airship-type stratospheric platforms. We would like to extend our special thanks to all the participants.

http://www2.crl.go.jp/mt/b181/index.html