In-Flight INTERNET

via satellite communications

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Connexion by Boeing demonstration flight " CBB One" (B737)

Internet services on board are expanding on commercial airlines domestic and international.
For many businessmen, these services should be highly appreciated, since the long time flight would be no more the "blind time" during business trip.
Popularization of in-flight Internet service will be the bright news for satellite communication industries that experienced the serious depression in the last few years.

SPACE JAPAN REVIEW magazine introduced the summary of services by Connexion by Boeing(CBB), pioneer and promoter of in-flight internet service, in October/November 2004 issue.
This time, CBB total system architecture and the latest status of service deployment will be addressed.

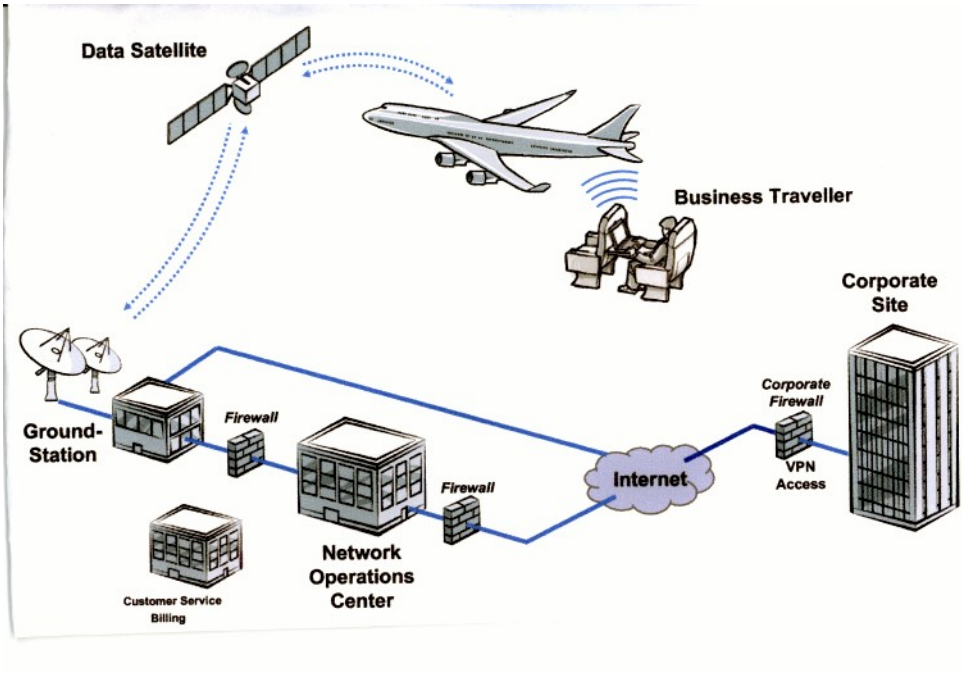
What is Connexion by Boeing ? ▪▪▪

The two-way broadband on board internet system provided by Boeing is called as " Connexion by Boeing (CBB)". Its system concept was first announced in April 2000. Although the decrease of airline passengers caused by the terrorism in Sep.11, 2000 once threatened the early realization of the

CBB system, first demonstration flight using the commercial aircraft was successfully achieved in 2003.

System architecture is as shown in the figure below. The communications satellites utilized are different depending on the flight area, using commonly Ku-band (14/12 GHz band). For South-East area, SUPERBIRD-C operated by Space Communications Corp.(SCC) at 144E was chose.

Forward link from ground station to aircraft uses one transponder, providing four simultaneous links to each aircraft with 5Mbps (20Mbps in total).
In the return link from aircraft to ground, each aircraft transmitting at 1Mbps max. shares the return link transponder with spread spectrum multiple access.
Each aircraft not only precisely track the satellite, but finely control its transmitting power, regardless of flight attitude and the position on the route.



CBB total system architecture

In order to most effectively utilize the network, and to avoid interference to the other systems, it is extremely important to precisely monitor and control the return link transmitting power and other communication parameters. This job is performed all the time by Network Operation Center,

In the aircraft, RF LAN equipment (Ethernet terminal at every passenger seat in some aircraft of some airline companies) is provided. Each passenger's PC is linked to the satellite via PC terminal of either type, on board rooter/ transceiver data box, and on board antenna.
On the ground, it is linked to Internet through ground station and network operation center.

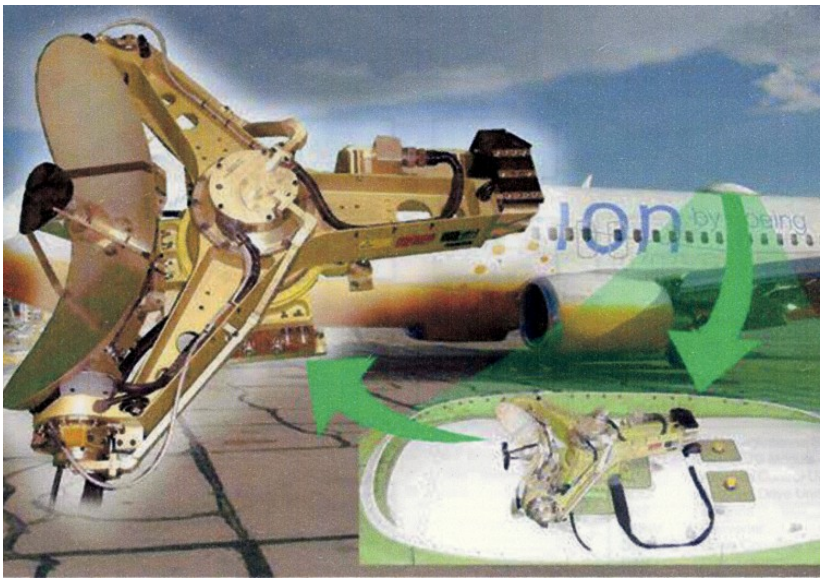
On board antenna subsystem built in Japan ▪▪▪

It is easily imagined by the satellite communications specialists that one of the most difficult development theme in CBB system could have been the on board antenna subsystem.
It is to be installed not only on 747 class, but also on much smaller 737. In addition to the severe limitation on weight and size, aerodynamic characteristics of aircraft must be maintained. Acquisition of satellite must be secured even at aircraft maneuver and vibration. Elevation angle to the satellite at high altitude flight route, and use of one satellite by multiple aircrafts should also have given much difficulties to the design of the antenna.

Probably, under terribly difficult design constraints, the development of antenna subsystem should have been made, in order to successfully provide the Internet environment on board aircraft in flight.

For this challenging development, Mitsubishi Electric (MELCO) in Japan was selected as the contractor, and successfully completed the development. All aircrafts in the world equipping CBB will install high performance tracking antenna subsystem built by MELCO.

CBB antenna production should be different from the production of fuselage or wing of B777 and B787 in Japan, since all design and development was done in Japan using Japanese technology. MELCO antennas are installed not only on Boeing-built aircrafts, but also on Airbus-built aircrafts.



CBB antenna subsystem

As shown in the figure above, antenna is elliptical parabolic type. In the initial phase of development, phased array type which controls antenna beam electronically was studied in parallel. However, mainly because of performance degradation at high altitude flight route and high cost, parabolic antenna with mechanical tracking was selected. MELCO provides control system and transmitter/receiver in addition to antenna.

SUPERBIRD in satellite fleet・・・

Communications satellites which support Connexion by Boeing are from different operators depending on the area of the world. In Japan, Space Communications Corp. (SCC) which is ranked at No.8 in "World Top 25 Satellite Operators" list in American paper was selected.
SCC is providing services for CBB to South-East Asian area including Singapore using two SE-beam transponders
In SUPERBIRD-C satellite located on 144E, and to Indian Ocean area by two steerable beam transponders on the same satellite.

SCC also provides gateway services for CBB consisting of connection with ground Internet network, live TV reception and re-transmission to aircrafts, data transmit/receive to and from aircrafts, and network operation/monitor job using the optical fiber line connected to CBB network operation center in U.S.. Satellites covered under this gateway service contract are SUPERBIRD-C and Asiasat-3S.

SCC Ibaraki Network Operation Center

CBB Transmit/Receive Antenna

（Photo: Courtesy of Space Communications Corp.）

CBB service route・・・

Lufthansa Airlines started CBB service in May 2004, earliest in the world. Presently Lufthansa
Is the most advanced airline in CBB service deployment. It provides CBB service in 35 international routes from Munich and Frankfurt. Strategic attitude for CBB by Lufthansa is clearly observed.

Two major Japanese airlines, JAL and ANA early decided to introduce CBB. Presently, JAL provides CBB service in five routes, New York, London, Singapore, Paris and Moscow. ANA provides service in Los Angeles, New York and Paris. San Francisco route is now under preparation. In both airlines, installation of CBB system to aircrafts and expansion of CBB service routes are now rapidly under way.

In addition to the airlines described above, 4 routes of Korean Asiana Airlines, 1 route of Taiwan China Airlines, 4 routes of Korean Air, 10 routes of Scandinavian Airlines, 1 route of Singapore Airlines are in service of CBB.

Furthermore, Austrian Airlines, ETHIAD Airways and ELAL Israel Airlines will start CBB service shortly. CBB service is being expanded to the world major airlines. No U.S. airlines are found in the list ! They might not afford to introduce new services because of the serious recent operation difficulties with U.S. airline companies.

The number of the CBB system installed aircrafts was 40 all over the world as of February 2005. The number could have become much more late this year.

CBB installed Lufthansa A340 (CBB antenna on the top left of fuselage)

(photo: courtesy of Mr. Sakato, MELCO)

How to use CBB on board ▪▪▪

According to my friends who have tried CBB service, people with the level of carrying PC for their business trip should not have difficulty in connecting and using the service on board. Once they experience, they don't like long airline trip without CBB, and try to look for the airlines or routes with CBB service.

User registration is only necessary before the trip. On board, you will not find problem in PC connection and handling, so long as your PC is RF-LAN compatible, in any airlines, any class. By sign-in on board, you can start access with outside networks.

Price for the "long flight" above 6 hours flight time is about $30 for continuous connection. Time dependent price of $30 for the first 30 min., with 25cents for each additional 1 min. can be selected. At economy class seat where PC power terminal is not equipped, selection of above price course should be subject to PC power capacity.

Nominal connection speed is estimated as 100～200kbps. According to some report in Internet, similar measured figures are reported. Although this figure is of course much lower than terrestrial environment where optical fiber is rapidly becoming popular, it should be useful enough for usual E-mail or intranet access by businessmen. Moreover, satisfaction by users should be large for the fact that broadband communication is available on board commercial aircrafts.

Near Future trend of in-flight internet・・・

After the businessmen carrying PC successfully become CBB customer, next target customer would probably be the group tourists.

First business application should be "chat" by E-mail from air, using same third generation cellular phone terminal. The similar scene in Japanese train that many young people enjoy chat may be seen on aircraft shortly. Necessary technology development effort might already been progressing.

Second application can be the entertainment like cinema broadcast via satellite in real time basis.
It is reported that Singapore Airlines already started such service. Other airlines will follow from early 2006.
CBB has been deploying the service for ships. It was announced that Teekay Shipping Co., one of the world leading shipping agent already started using CBB on their tankers in North Atlantic route.

It is sometimes said that the satcom application for which the user is not aware that it is via satellite, should become very popular application for the general public. For instance, only small percentage of subscribers of Broadcasting Satellite service in Japan should be aware that their
TV programs come from space after 72,000km trip. This application should be the typical "great success" in utilization of communications/broadcasting satellites by the general public.

I have read a comment by the famous Japanese sports player active in Europe saying that he felt very happy when he found recently RF-LAN available in aircraft. Certainly, he should not be aware that he communicated on board via communications satellite. From this fact, we can say that CBB service is qualified to become the very popular application of satellite for the general public.

Once the application is expanded from business use to public use, present CBB communication capacity supported by the existing technologies would soon be saturated sooner or later.
Development request in near future from CBB system to satellite/on-board antenna suppliers or satellite operators, for the much higher speed, higher performance next generation system, which requires large breakthrough of satellite communications technologies is eagerly awaited.

Topics in land/maritime mobile satellite communications・・・

In regard to the land and maritime mobile satellite communications, Connexion by Boeing is deploying service to ships as described above. Big topic in this field should be the global service of "BGAN"(Broadband Global Area Network) using Inmarsat-4 series satellites. For this topic, I look forward to the report by other adequate author appearing in SPACE JAPAN REVIEW shortly.

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The cooperation by Mr. Onitake of Boeing Japan in providing materials for this article is greatly appreciated by the author. All figures and photos unless otherwise noted are provided by Connexion by Boeing. Some information on system performance in the description of total system performance is derived from the published information from ARIB, Japan, not from published information by CBB.
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