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ETS-V/EMSS EXPERIMENTAL PROJECT ON MOBILE SATELLITE COMMUNICATIONS

ABSTRACT

Communication by radio wave is the only method possible for "mobiles", that is, aircraft, ships and land vehicles. At present, however, radio communication services for mobiles in terrestrial networks have inevitable limitations such as limited service coverage, insufficient channel capacity and unstable quality. In recent years, a world-wide satellite communication system has been operated by INMARSAT on a commercial basis for large vessels. However, the vast majority of aircraft and smaller ships navigating far from land still communicate with land by means of short-wave radio. Short-wave, however, is disrupted by ionospheric conditions, and therefore is judged to be unstable and insufficient quality.

The research and development of mobile satellite communication systems will contribute not only to a revolutionary improvement in safe navigation and efficient operation of aircraft and ships, but also to the provision of new services such as telemedicine and on board computer communications. Further, the introduction of moble satellite communications will greatly benefit drivers of land vehicles and people in remote areas with no communication methods, especially in times of emergency or disaster.

In 1978, Radio Research Laboratory (RRL), Ministry of Posts and Telecommunications, started the research and development of satellite communication systems for mobiles and is now coducting experiments on land, maritime and aeronautical communications via the Engineering Test Satellite Five (ETS-V), which was launched by a three-stage H-I rocket to a position of 150 degrees of East in the geostationary orbit in August 27th, 1987, from NASDA Tanegashima Space Center. This system is called the Experimental Mobile Satellite System (EMSS). The 6/5 GHz bands (C-band) are used between the satellite and Kashima ground earth station; the 1.6/1.5 GHz bands (L-band) are employed between the satellite and mobiles.

For the establishment of basic technology of mobile satellite communications, the following experiments are being carried out.

— Evaluation of transponders on board the satellite
— Evaluation of ship, aircraft, land vehicle and hand-held earth stations
— Evaluation of modulation and voice coding techniques, and channel assignments
— Experiments on mobile positioning and satellite ranging
— Analysis of wave propagation characteristics in mobiles

The RRL has already developed transponders on board the satellite, a ship earth station, an aircraft earth station, land mobile earth stations and a hand-held message communicator.

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Onboard equipment for mobile satellite communication experiments are called AMEX. The development of AMEX is shared by RRL, ENRI and NASDA. AMEX consists of a C-band antenna, an L-band antenna and transponders. The L-band antenna has two beams which cover the northern Pacific Ocean, including Japan proper, and the Western Pacific Ocean. The C-band section of the transponder has a redundant configuration. The L-band section has a two-channel configuration corresponding to two-beam antenna coverages. The frequency bandwidth of the transponder is 3 MHz for each aeronautical frequency band and maritime frequency band, both of which can be switched on on board the satellite.

Kashima ground earth station is located at Kashima Space Research Center of RRL in Ibaraki Prefecture, Japan and plays a variety of important roles in EMSS experiments. It assigns voice and data channels or several types of mobiles, it collects and processes many kinds of experimental data, and it monitors and controls transponders on board the ETS-V. Basic operations of the C-band and L-band transponders are controlled by Kashima ground earth station; other payloads of the ETS-V are operated by National Space Development Agency of Japan (NASDA). For experimental purposes, this earth station has several kinds of communication channels such as SCPC, TDM/TDMA, SSMA and packet. (The C-band receiver was developed by Electronic Navigation Research Institute (ENRI) of Ministry of Transport.)

Kashima ground earth station also has another function to perform, that is, high precision ranging of the satellite with using an L-band turn around station. This station is located at Yamakawa Radio Observatory of RRL in Kagoshima Prefecture.

Adoped in the aircraft earth station is a newly developed phased array antenna, one which can track the satellite by electronic scanning. The antenna is installed inside a fairing on the top of fuselage of a Boeing 747. A transceiver unit, a power supply unit and a data collection/process unit are installed on the upper deck of the aircraft. The phased array antenna was specially designed for the installation in a Boeing 747 in order to satisfy severe conditions such as space limitations, thermal and mechanical strength and safety requirements of the aircraft. This aircraft earth station is installed in a Japan Air Lines' cargo jet liner and the in flight experiments are performed mainly on a transoceanic flight route between Tokyo and Anchorage.

The ship earth station adopts a compact, lightweight above-deck structure that can be installed even on small vessels of about 30 tons. The above-deck unit has a newly developed circuit to reduce signal degradation caused by sea reflection fading in low elevation angles to the satellite. The below-deck structure consists of a transceiver unit that has several types of modulators and voice coders and a data collection unit. This unit is capable of collecting and processing experimental data in automatic procedures. The ship earth station is presently installed on the "OSHORO MARU", a training ship of Hokkaido University. On-board experiments are performed on training routes between Hakodate and the west coast of North America, and between Hakodate and Singapore.

The hand-held message communicator is the smallest, most lightweight earth station of all the types of earth stations developed in the EMSS project. Resembling an attache

case, a person can carry it anywhere. To contact the ground earth station he need only point the antenna on the lid toward the satellite. This earth station can transmit and receive messages at very low speed (100 bps) through satellite links. Research on even smaller, compact units is still being carried out.

The land mobile earth station, mounted on land vehicles, can establish voice and data communication channels through the satellite while moving. The problems to be studied in land mobile satellite communications are signal degradation caused by shadowing and blocking by trees and buildings. Three types of modulation techniques are currently under study to determine the future direction of land mobile satellite communications.