Utilization Plans for Ka band Satellite Communications System using COMS

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***Abstract* —** It is so difficult to communicate between satellite terminals by the distributed weak signal along with the beam size in case that the satellite beam covers wide area or higher signal is needed. For overcoming this problem, one should make the size of terminal large, so should pay more for system construction.

This paper looks around the configuration and functions of the multi-beam switching satellite communication system architecture, and introduces the utilization plans such as propagation test, verification test and practicality verification in Ka band OBS Satellite Communications System for COMS.

***Keywords* — Disaster Communication, COMS, Satellite**

Ⅰ. Introduction

A communication satellite system provides the communication services between the remote terminals within the beam for natural disaster communication such as prediction, prevention, recovery service and the satellite multimedia service such as Internet via satellite, distance learning, remote-medicine in a satellite network composed with a hub station and several remote terminals.

But it is indispensable that one should enlarge the satellite capacity for satisfying the increasing needs on the satellite services as satellite frequency resource and satellite orbit are restricted in comparison with the needs of the satellite services. In advanced countries in the satellite communications field an on-board switching satellite uses the multi-beam which means several independent beams divided a desired coverage by space.

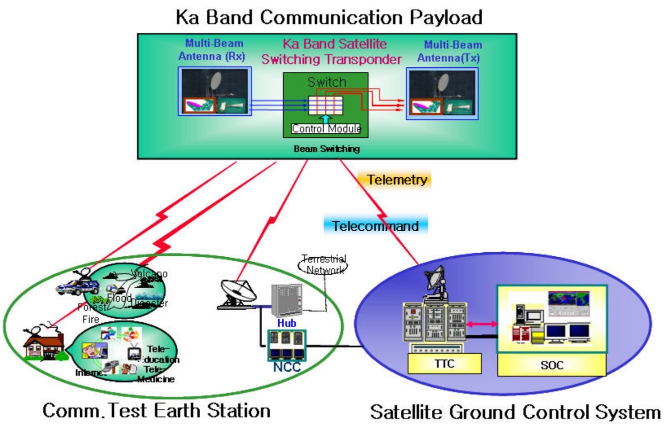
It is so difficult to communicate between satellite terminals by the distributed weak signal along with the beam size in case that the satellite beam covers wide area or higher signal is needed. For overcoming this problem, one should make the size of terminal large, so should pay more for system construction.

This paper looks around the configuration and functions of the multi-beam switching satellite communication system architecture, and introduces the Utilization Plans for Ka band OBS(On-Board Switching) Satellite Communications System using COMS(Communication Ocean and Meteorological Satellite) in Republic of Korea.

Ⅱ. OBS Satellite System Architecture

General Information:

An OBS satellite communication system consists of Ka-band communication payload, Ka-band test earth station (TES) and geostationary orbit satellite ground control system (SGCS) using SATCOM such as figure 1. Ka-band satellite communication payload consists of transponder subsystem which supports transponder channel in redundancy and antenna subsystem that supports three beams as service coverage. Ka-band TES system is composed of a central hub station and several remote terminals. Central hub station performs the functions of service network management and control as well as communications service using remote terminals. SGCS performs the functions of the communication link with the satellite spacecraft to monitor the spacecraft status and control the equipments of the spacecraft and the function of the interface with the network control center for control of communication payload.



(Figure 1) Conceptual Diagram of the Ka band Satellite communications Network

The purpose of the overall SATCOM system is to develop the satellite communication system including a communication payload, a satellite ground control system, and a couple of communication test earth stations that can support a variety of communication services.

The SATCOM will provide communication services for natural disaster such as its prediction, prevention, recovery service in the government communication network and high-speed multimedia services such as Internet via satellite, remote-medicine, and distance learning in the public communication network.

Service coverage for the SATCOM satellite system is three regions named by beam A, B and C. Beam A will be assigned to the South Korea for national disaster service network and satellite multimedia service network, while beam B and C will be assigned to the North Korea and North-east of China respectively for satellite multimedia service network same network as the one of the South Korea.

The link availability for SATCOM system will provide at least 99.7 % in every year during the service periods. For the link availability, quality of services provides 10^{-6} BER at least to the end of the service life. The SATCOM system uses 400 MHz Ka frequency bands for communication services. Uplink frequency range is 29.6 GHz to 30.0 GHz and downlink frequency range 19.8 GHz to 20.2 GHz. The FSS system provides four 100 MHz wide operational channels. The frequency plan is demonstrated the assignment of four active RF channels with a 100 MHz nominal bandwidth in Ka-band. The channel 2 & 4 uses different polarization. The access scheme to communicate between earth terminals in the SATCOM is TDMA access scheme at all service network operation.

The SATCOM operates in the geostationary orbit of 128.2°E longitudes for Ka-band Fixed Satellite Services (FSS). The spacecraft will have a service life of at least seven (7.7) years same as spacecraft life time; however, the design lifetime of the SATCOM system will be at least twelve (12) years to achieve the following main missions:

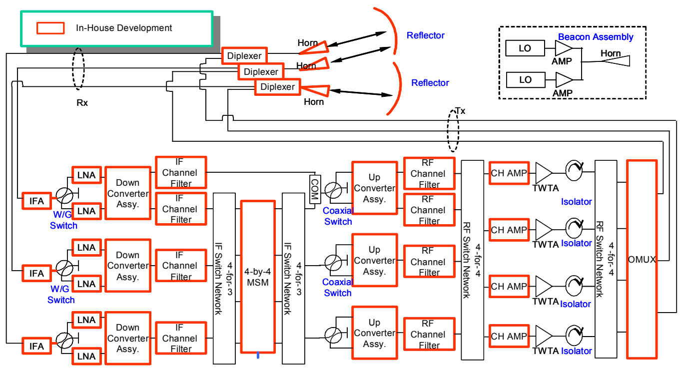
- In-orbit verification of the performance of advanced communication technologies.
- Experiment of wide-band multi-media communication service.

Ka-band Payload and OBS System

The Ka-band communication payload under development consists of multi beam antenna and on-board switching transponder subsystem which includes all the necessary microwave hardware in order to receive, switch, amplify and transmit microwave signals within the defined coverage area. The Ka-band communication payload system is designed to be capable of the communication service function among the individual beams.

The transponder subsystem has the beam switching function for high speed multimedia services including the Internet via satellite in the public communication network and for natural disaster communication services in government communication network. The antenna subsystem generates three Ka-band multi beams for the required coverage areas and simultaneously transmits/receives the microwave signal to and from the earth station via beams, respectively. In order to gain insight into the basic direction to taken in our design of a Ka-band communication payload system, we have performed a lot of case study by regulating a configuration.

The communication payload provides 3 main functions: 1) Ka-band conventional repeater, 2) Ka-band on board switching including microwave switch matrix (MSM) repeater and 3) Two multi-beam antennas as described in figure 2. The repeater as a “bent pipe” supports communication services for natural disaster service such as its prediction, prevention, recovery services in the government communication network. The Ka-band “on-board switching” repeater and “multi beam antennas” are designed for Ka-band high speed multimedia services such as Internet via satellite, remote-medicine, distance learning in the public communication network.



(Figure 2) Structural Diagram of the Ka band Satellite communications System

The payload system is designed to be capable of the communication service function among the individual beams. To achieve these capabilities, high gain multi spot beam antenna and the on-board switching technologies are used to complete the channelization of each block into 3 narrow channels. The main advantages offered by this approach relative to a conventional bent pipe type global beam approach are as followings:

- High data throughput

- Reuse of frequency
- Multi spot beams
- Adaptive modulation
- On-board switching

Ka band communication payload system has been developed successfully, and more than 80% equipment of transponder and antenna has been designed, manufactured and tested by ETRI and domestic companies as shown in figure 2. Also Ka band payload system was integrated and confirmed validation process.

To integrate Ka transponder into spacecraft, ETRI has performed all the required procedures such as performance validation of equipments, mechanical interface validation between equipment and transponder panel, an electrical performance test on the transponder level, space environment test including satellite launch vibration and space thermal vacuum environmental condition as shown in figure 3.

When space environment test on COMS spacecraft onboard Ka payload was performed according to the schedule, ETRI perfectly analyzed satellite launching vibration condition, thermal vacuum condition over Geo-stationary orbit and test condition inside thermal vacuum chamber.

At the time of transponder performance test on the spacecraft level, test facility, EGSE, developed by ETRI was used for the measurement of each test parameters. The test results are all compliant to the requirements.

After Ka band antenna system was developed, compact antenna test range named CATR was performed to verify performance and alignment at the spacecraft level. To do that, spacecraft mock-up was used to simulate interface between antenna and spacecraft. Antenna alignment and performance results are all complaint to the required specifications.

(Figure 3) Assembly images of the Ka band Satellite communications System

For the purpose of reliability, Ka band payload system has been developed in accordance with product assurance procedure during development period. In particular, Ka band payload system has been satisfied to the spacecraft product assurance process and requirement from Astrium who is COMS spacecraft manufacturer. During development period, the Ka band payload system is verified on the pint of reliability and product assurance from Telesat Canada, a technical consultant of Ka payload system project.

Architectures and Operation of the Test Earth Station

The Test Earth Station (TES) System provides Ka-band satellite communication services with beam switching function in the government communication network and the public communication network via SATCOM. It consists of a Ka-band hub station and a number of Ka-band remote terminals. Ka-band hub station consists of antenna, RF module, Modem, BB, etc. It also includes NMS, multimedia server interface and SCM function. Remote terminal consists of antenna, ODU and IDU with user terminal interfaces.

The TES shall be capable of transmitting and receiving satellite communication service signals in the public communication network and in the government communication network at the Ka-band. It shall perform the function of timing and frame synchronization with itself, and shall broadcast its information to all remote terminals to be synchronized for satellite beam switching and TDMA access.

(Table 1) Specifications of the TES System

Hub	Parameters	Terminal
7.2	Antenna(m)	1.2
82.5	Tx EiRP(dBW)	59
37.5	Rx G/T(dBK)	19.1
Linear	Polarization	Linear
140	IF(MHz)	140
BPSK/QPSK	Mod/Dem	BPSK/QPSK
RS/ Convolution	FWD Coding	RS/Convolution
Turbo, Variable	RVS Decoding	Turbo, Variable
10^{-6}	BER	10^{-6}

The TES provides an EIRP capability of 78 dBW for hub station and 57 dBW for remote terminal. The G/T of TES is no less than 32 dB/K for hub station, and 19 dB/K for remote terminal. The TES in the public communication network shall provide a capability of data transmission up to 70Mbps for feed-link and up to 10Mbps for return-link. The TES in the government communication network shall provide a capability of data transmission up to 8 Mbps.(Table 1)

Ⅲ. Utilization Schemes

Ka band Satellite Propagation Test Plan:

The purpose is activation of the Ka band utilization technology and creation of the new service through this test. The test items are space performance verification of the Ka payload, Ka frequency rainfall attenuation quantity measurement and the rainfall predictive modeling. The expected effect and application field as a Experimental result are establishment for the domestic rainfall attenuation modeling which is suitable in Ka satellite transmission environments and base preparation of international standardization, and we prepare practicality test-bed experiment of COMS satellite communication payload, make guaranty the efficient application technique in public service and broadcasting service.

And also practicality verification of COMS payload it leads, foreign competitive power acquisition of the domestic satellite terminal enterprise, objective proof to practical use level of technique of localization development satellite technique and world level acquisition of space technique, and maximization of the efficient use of the national outcome goods with continuous application of the satellite payload.

Verification Test of the Technology Development:

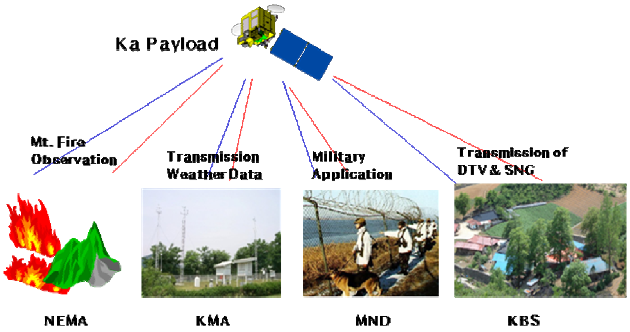
ETRI constructs test-bed for the verification system using ETRI's developed satellite communication system, and will make use for Ka band technology development project and technology support for industry/academy/research institute. Verification work will be performed by required institute of technology verification.

The operation of the test-bed and satellite payload will be started middle of the next year after launching and IOT(In-Orbit Test) test.

Practicality Verification of the Ka band Public Communication Services: (Figure 4)

Disaster prevention and recovery services include the voice and low and medium-speed data service necessary to a national prevention and a recovery, and the video information service it will be able to grasp a damage situation easily from the disaster center. The transponder type is bent-pipe type for a disaster prevention service and its coverage limits in the South Korea region.

Especially, Disaster prevention and recovery services will be able to provide the backup capability of the ground administrative network the urgent disaster network construction and of course to use to construction of the urgent communication network when the ground communications network which is caused by wind flood damage occurs problems.



(Figure 4) Images of the Public Services using Ka band Satellite communications

As the public communications service is provided high speed internet service and the various information such as remote education and remote medicine quickly to the island and rural area, the medical treatment agency and the professional educational institution, the creation of the various services can be possible in the center of the national institution after performance prove for the satellite communication system through the experiment. The transponder type to be used is multi-beam switching type for the public communication services and its coverage limits in the South Korea region and North Korea region by beam switching.

Ⅳ. Conclusions

This paper looks around the configuration and functions of the multi-beam switching satellite communication system architecture, and introduces the utilization plans such as propagation test, verification test and practicality verification in Ka band OBS Satellite Communications System for COMS.

We hope many of the satellite communication expert take part in this utilization plans and joint experiment program.

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