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Direct Broadcast Satellite–Radio Program

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NASA

DIRECT BROADCAST SATELLITE - RADIO PROGRAM

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SUMMARY

NASA is committed to providing technology development that leads to the introduction of new commercial applications for communications satellites. The Direct Broadcast Satellite - Radio (DBS-R) Program is a joint effort between The National Aeronautics and Space Administration (NASA) and The United States Information Agency/Voice of America (USIA/VOA) directed at this objective (ref. 1). The purpose of this program is to define the service and develop the technology for a direct-to-listener satellite sound broadcasting system. The DBS-R Program, as structured by NASA and VOA, is now a three-phase program designed to help the U.S. commercial communications satellite and receiver industry bring about this new communications service. Major efforts are being directed towards frequency planning, hardware and service development, service demonstration, and experimentation with new satellite and receiver technology.

INTRODUCTION

The Direct Broadcast Satellite - Radio Program was initiated with an interagency agreement in early 1988 to plan for ongoing NASA/VOA DBS-R activities. An expanded interagency agreement in May 1990 called for a very detailed technical effort with joint management and funding. This agreement was designed to provide service and technology definition leading to the development of a direct-to-listener satellite sound broadcasting system. NASA's Lewis Research Center, which has an established reputation for commercial communications development, was designated the lead center for this effort. Supporting Lewis in this work is NASA's Jet Propulsion Laboratory (JPL), where research in MSAT-X (mobile) and personal communications is being conducted as part of the SATCOM Program. Lewis and JPL efforts in this area are sponsored by NASA's Office of Commercial Programs (ref. 2).

A DBS-R type service has been under discussion in the international arena since 1971 and domestically since at least 1967 (refs. 3 to 13). With the evolution of digital capabilities and mobile satellite communications, the potential quality and availability of DBS-R type services have grown well beyond original expectations. By its nature, a DBS-R satellite system can be made very flexible in terms of coverage area-from a wide broadcast area to a very restricted broadcast area. The Direct Broadcast Satellite - Radio

System Tradeoff Study (ref. 14) indicates that DBS-R will be capable of providing various quality audio signals (AM, FM, FM stereo, and CD) for all radio settings (fixed, portable, and/or mobile) in a variety of environments (indoor, outdoor, rural, urban, and suburban). Other studies have shown that DBS-R systems provide an economical cost per broadcast-channel-hour for wide area coverage (ref. 15).

DBS-R offers listeners, as well as service originators, many benefits heretofore unavailable in a broadcast medium. The most important benefit is the wide-area coverage available to provide simultaneous country, regional, or continental coverage via satellite. This type of coverage opens up opportunities for audience access to new types of programming. Particular types of programming that might be made available are educational, cultural, national, or target-audience oriented, which may not be economically attractive to offer in any other way. Governments, as well as private, domestic, and international organizations, are beginning to realize the potential benefits of establishing a DBS-R type service. Domestic and international commercial communications companies have just begun to realize the potential influence they and their broadcast customers would have by utilizing this type of service. Commercial radio broadcasting has not seen such potential for change since the introduction of FM stereo broadcasting.

The DBS-R program, as structured by NASA and VOA, is a three-phase program to help the U.S. commercial communications satellite and receiver industry maintain its competitiveness in this and related areas of communications (ref. 16). Program management is provided jointly by the Communications Systems Branch in the Space Electronics Division of the Lewis Research Center and by the Voice of America's Office of Engineering. Efforts are now being focused on frequency planning (as called for in WARC '92), hardware and service development, service demonstration, and experimentation with new satellite and receiver technology.

PHASE ONE

Phase one of the DBS-R program (the 1988 Interagency Agreement) was essentially the assembling of all relevant information on what was happening in the DBS-R arena and determining what needed to be done to have a viable program. From this effort, a new interagency agreement was formulated, a specific seven-part program plan was developed, and a joint funding profile was agreed to by NASA and USIA/VOA management.

PHASE TWO

Phase two of the DBS-R program began in May 1990 with the signing of the new interagency agreement which stipulated the joint project management and a six-part program plan described in the following sections.

System Definition

NASA's Jet Propulsion Laboratory, in concert with Lewis Research Center, performed technical tradeoff studies to determine what a DBS-R system might look like and what the appropriate digital bit rates might be. Digital bit rates are identified that were applicable to a DBS-R service. These rates are:

16 to 32 KBPS - Monophonic AM quality;
48 to 64 KBPS - Monophonic FM quality;
96 to 128 KBPS - Stereophonic FM quality; and
192 to 256 KBPS - CD quality.

Service definition has identified user needs requiring less than "CD quality". These are:

News broadcasts;
Disaster warnings;
Educational programs; and
Cultural programming.

Within selected portions of the 500 to 3000 MHz range, a DBS-R satellite will become either weight or power limited, depending on what specific frequency is selected. Choice of frequency also affects space segment costs (ref. 14).

Satellite Demonstration/Experiment

In September 1991, NASA Lewis, in cooperation with NASA's Jet Propulsion Laboratory, conducted the first mobile live satellite experiments, uplinking from COMSAT's Coast Earth Station, in Southbury, Connecticut, to INMARSAT's MARECS-B satellite and downlinking to a mobile van traveling the highways of Connecticut. The purposes of this experiment were (1) to determine whether the concept of satellite sound broadcasting would really work with a small mobile antenna, (2) to obtain technical measurements in a mobile environment, and (3) to lay the groundwork for technical demonstrations in Washington, D.C. and Cleveland, Ohio, in late November and early December 1991.

During the period from mid-November to mid-December 1991, NASA's Office of Commercial Programs, the Lewis Research Center, the Jet Propulsion Laboratory, and the U.S. Information Agency's Voice of America (VOA) conducted the first live public demonstrations using a mobile DBS-R terminal in Washington, D.C., and Cleveland, Ohio.

These demonstrations were witnessed by the Washington and Cleveland news media, foreign ambassadors and embassy staff members, representatives of U.S. government agencies and representatives of the U.S. commercial communications satellite and receiver industry.

Propagation Measurement

Through an established propagation program at NASA's Jet Propulsion Laboratory, NASA is sponsoring DBS-R research by the University of Texas. Results indicate that small-scale antenna diversity in the DBS-R receiver may be a realistic approach to mitigating signal impairment in the indoor environment.

Receiver Development

The VOA is sponsoring efforts by NASA's Jet Propulsion Laboratory to develop a low cost DBS-R receiver. On the basis of advanced sub-band and transform audio coding methods being developed in the U.S.A. and overseas, audio coding between 16 and 256 KBPS has been identified for DBS-R receivers as realistic and achievable. Digital audio broadcasting is feasible for direct reception by low-cost portable, semiportable, and fixed receivers (ref. 16).

The receiver development activity has been divided into the following three phases, to gain a better understanding of the diversity and complexity of this area of the program:

> Phase 1 consisted of defining the requirements and the basic design for portable and mobile receivers. Phase 1 has been completed (ref. 16).
>
> Phase 2 is to analyze and design the signal processing portions of a DBS-R receiver to the point of formulation of a functional block diagram and to estimate what actual performance parameters can be established. Phase 2 is currently underway at JPL (ref. 16).
>
> Phase 3 will consist of building, testing, and demonstrating a prototype digital radio receiver that is compatible with reception of radio programs from satellites. Phase 3 will begin in FY93 (ref. 16).

Market, Legal, Regulatory, and Organizational Studies

The Lewis Research Center and Contel Federal Systems have explored the market, legal, regulatory, and organizational aspects of DBS-R system implementation. The results of this study indicate that (1) consumer demand tends toward improved quality audio products; (2) DBS-R systems are feasible at realistic costs; (3) the inherent limitations of current terrestrial broadcast systems preclude audio quality enhancements until changes occur in the existing systems; (4) DBS-R systems can deliver programming more cost-effectively than can shortwave systems; (5) DBS-R system implementation and operation face difficult but resolvable legal and regulatory impediments; and (6) staged implementation with capacity matched to demand offers a sound business approach to the introduction of DBS-R service.

This study also led to some recommendations which will help to better focus and direct the program. These recommendations are to (1) publicize the DBS-R technical and operational concept to private industry to stimulate interest, and to other countries to foster cooperation in establishing regional systems; (2) continue current concept development efforts to more clearly delineate system level trade-offs that have to be made between spacecraft and receiver technical capabilities to optimize the system and to standardize the interfaces; (3) keep abreast of developments affecting DBS-R worldwide; (4) undertake an experimentation program to measure propagation characteristics in the 1.0 to 2.5 GHz range, with emphasis on spectral bands between 2.31 and 2.36 GHz under realistic operating conditions; and (5) explore the possibility of stimulating the launch of a privately-funded DBS-R satellite. Possible participants might be spacecraft and receiver manufacturers for the development of standards, and broadcasters for the assessment of programming and market potential (ref. 15).

WARC Activities in 1992

The International Telecommunications Union, an organization within the United Nations, convenes periodic Administrative Radio Conferences to construct agreements among member nations on the use of the radio frequency spectrum. The World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum was held in Malaga/Torremolinos, Spain in February 1992 (ref. 17). The conference made a decision on a frequency allocation for DBS-R.

The allocation is at 1452 to 1492 MHz for most nations. However, in the 1452 to 1492 MHz allocation, some countries will not allow introduction of a DBS-R service until the year 2007. The allocation for the United States is 2310 to 2360 MHz. The allocation for Japan, South Korea, China, the Commonwealth of Independent States is 2535 to 2655 MHz. In India, the allocations are 1452 to 1492 MHz, 2310 to 2360 MHz, and 2535 to 2655 MHz (ref. 18). The WARC also called for a Conference to plan the use of all bands for DBS-R type services, prior to 1998 (ref. 18).

PHASE THREE

Phase three of the DBS-R program is just beginning now that there are established international allocations for DBS-R (ref. 18). These allocations are key to what and how the program will be developed and how it will be funded. The following are some thoughts as to what needs to be accomplished to bring about a viable DBS-R service offering in the commercial arena:

1. WARC Activities - The U.S. needs to continue its planning activities so as to be ready for the next planning conference prior to 1998 (ref. 19). Those planning activities need to be shared at least with Canada and Mexico, our two closest neighboring countries most affected by any decisions that are made.

2. Receiver Development - Effort needs to continue with Phase 2 and Phase 3, which will yield a basic receiver design to be used for testing and evaluation. From this basic design, more sophisticated receivers capable of receiving FM, FM stereo, and CD types of service must be developed.

3. Data Compression - The necessary data compression methods for transmission of various quality (AM, FM, FM stereo, and CD) audio data over space communication links must be developed. Utilizing efficient data compression techniques will increase orbit/spectrum capacity, enable cost effective commercial digital audio transmission, and reduce space segment costs by reducing bandwidth requirements.

4. Modulation and coding - It will be necessary to look at advanced modulation and coding techniques to improve DBS-R signal quality. This improvement will be necessary as one accesses and uses the available higher quality audio services.

5. Electronic Flat Plate Antenna Development - For DBS-R to be successful, it is necessary to have a compact electronic receiver package. Part of this package is the antenna. The antenna being contained in the case almost dictates that the antenna be of a small, flat-plate type. (In larger receivers, the antenna could, of course, be larger). One might envision this antenna being less than 1/4 inch thick by 2 to 3 inches in diameter, depending on the size of the case.

6. Multiple-band Antenna on Space Craft - Multiple DBS-R allocations may dictate that DBS-R spacecrafts have multiband antennas if the service is to be offered regionally, particularly in the Western hemisphere and Asia.

7. Experiments and Demonstrations - To accomplish technology transfer it will be necessary to set up experiments to demonstrate DBS-R technologies to the hardware industry (satellite and receiver manufacturers) and to users (carriers and programmers).

CONCLUDING REMARKS

The NASA/VOA DBS-R program has been designed to assist the domestic satellite industry, the domestic receiver industry, and the domestic broadcast industry in creating a new service to the domestic and worldwide listening public. The DBS-R program presents a highly focused effort to provide a new service, technology definition, and technology development (ref. 1). Since the inception of the DBS-R program, many significant advances have been made to enhance the development of a DBS-R service. Most notable are (1) the identification of a domestic and international market niche for a DBS-R service; (2) the definition of the requirements and basic design of a portable and mobile receiver; (3) the conduct of experiments and demonstrations on the viability of a mobile DBS-R service; and (4) the international allocation of frequencies for a DBS-R type service.

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