Digital Audio Radio Broadcast Systems Laboratory Testing Nearly Complete

Radio history continues to be made at the NASA Lewis Research Center with the completion of phase one of the digital audio radio (DAR) testing conducted by the Consumer Electronics Group of the Electronic Industries Association. This satellite, satellite/terrestrial, and terrestrial digital technology will open up new audio broadcasting opportunities both domestically and worldwide. It will significantly improve the current quality of amplitude-modulated/frequency-modulated (AM/FM) radio with a new digitally modulated radio signal and will introduce true compact-disc-quality (CD-quality) sound for the first time.

Lewis is hosting the laboratory testing of seven proposed digital audio radio systems and modes (see the table). Two of the proposed systems operate in two modes each, making a total of nine systems being tested. The nine systems are divided into the following types of transmission: in-band on-channel (IBOC), in-band adjacent-channel (IBAC), and new bands. The laboratory testing was conducted by the Consumer Electronics Group of the Electronic Industries Association. Subjective assessments of the audio recordings for each of the nine systems was conducted by the Communications Research Center in Ottawa, Canada, under contract to the Electronic Industries Association. The Communications Research Center has the only CCIR-qualified (Consultative Committee for International Radio) audio testing facility in North America.

DESCRIPTIONS OF LABORATORY-TESTED SYSTEMS

System	Source coding	Data rate tested, kbs	System type	Proposed band, MHz
USA Digital FM-1	MUSICAM	256	(1) IBOC	88 to 108
USA Digital FM-2	MUSICAM	256	(1) IBOC	88 to 108
AT&T/AMATILSB	(2) PAC	128	(1) IBOC	88 to 108
AT&T/AMATILSB	(2) PAC	160	(1) IBOC	88 to 108
USA Digital AM	MUSICAM	92	(1) IBOC	525 to 1705
AT&T	(2) PAC	160	(3) IBAC	88 to 108
Eureka 147	MUSICAM	224	New band	1452 to 1492
Eureka 147	MUSICAM	192	New band	1452 to 1492
VOA/JPL	(2) PAC	160	(4) DBS	2310 to 2360

(1) In-band on-channel.
(2) The AT&T-developed source-coding scheme called Perceptual Audio Coding (PAC) is derived from the notion of distortion-masking in the human auditory system, the phenomenon whereby one signal can completely mask a sufficiently weaker signal in its frequency or time vicinity.
(3) In-band adjacent channel.
(4) Direct Broadcast Satellite.Proponents delivered their proposed systems to Lewis in January and February of 1994. Laboratory testing began in March 1994 and concluded in June 1995. Following the laboratory testing, the systems will be installed in a van for field testing in San Francisco, California.

The main goals of the U.S. testing process are to (1) provide technical data to the Federal Communication Commission (FCC) so that it can establish a standard for digital audio receivers and transmitters and (2) provide the receiver and transmitter industries with the proper standards upon which to build their equipment. In addition, the data will be forwarded to the International Telecommunications Union to help in the establishment of international standards for digital audio receivers and transmitters, thus allowing U.S. manufacturers to compete in the world market.

The overall testing procedures were developed by the Electronics Industries Association in cooperation with the National Radio Standards Committee, all system proponents, equipment manufacturers, and other interested parties. The basic goals of the laboratory tests were to determine the digital audio quality produced by each system, the reception reliability, the ability to coexist with other receivers and broadcast stations (including, in the case of in-band on-channel, the host analog station), and the repeatability of all tests. System testing was conducted with digital audio radio encoders and receivers supplied by the proponents. Other test gear was either provided by interested third parties or purchased by the Electronics Industries Association.

The laboratory tests conducted at Lewis were done in two phases: digital and in-band compatibility. Some tests were conducted on all systems, and others were designed for specific system types. The digital tests (conducted on all systems) included evaluation of quality and characterization of signal failure and of multipath, co-channel, and adjacent channel impairments. The in-band tests (conducted on specific systems) included tests to measure possible interference to the existing analog transmission caused by the introduction of in-band digital audio radio. Tests also were conducted to assess the compatibility of the analog and digital ancillary service channels with the in-band on-channel and in-band adjacent channel signals.

Onsite testing specialists conducted threshold-of-audibility and point-of-failure tests at Lewis. Results of all transmission tests were digitally recorded on digital audio tapes and sent to the Communications Research Center for assessment by listening specialists.

Laboratory test results were announced by the Electronics Industry Association on September 24, 1995, in Monterey, California. Their Digital Audio Radio Subcommittee indicated that these results by themselves reflect only half of the picture. The second half of the picture will come from the field testing to be conducted in San Francisco,

California. These tests, which are equally critical, will determine how well each proponent's system will perform under real-world, uncontrollable conditions.

The field test data plus the laboratory test data will complete the testing process for establishing standards. The United States will be able to establish realistic domestic digital audio radio standards based on hard data. The United States will also be a key player in establishing future international digital audio radio service standards.