Digital Audio Applications to Short Wave Broadcasting

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Abstract - **Digital audio is becoming prevalent not only in consumer electronics, but also in different broadcasting media. Terrestrial analog audio broadcasting in the AM and FM bands will be eventually be replaced by digital systems. In the United States, developments include in band digital systems for the FM and AM bands, while in Europe and elsewhere, the Eureka 147 system is undergoing large scale trials. Digital audio broadcasting via satellite is a reality in conjunction with direct to home TV broadcasting. Satellite delivery of audio to mobile receivers is under development. Worldspace has proposed a system of moderate rate digital audio delivery via satellite internationally via a three satellite system, while two organizations have been granted licenses to provide CD quality satellite audio domestically in the U.S. The one broadcasting service which has indicated an interest in switching to digital, but is somewhat behind in system development is short wave broadcasting.**

Tbe minimization of data rate is very important in broadcasting because of bandwidth and power constraints. Audio compression is therefore used to reduce the data rate required to transmit and reproduce tbe audio at the receiver. The data rate that is needed depends on the audio bandwidth that is to be maintained, whether it is monaural or stereo, and the distortion level that can be tolerated by the audience. A great deal of effort bas been expended to bring down the data rate needed to reproduce CD quality audio, on the high end of the audio compression performance scale, and on speech compression for telephony, on the low end of the scale. Less work has been done in the medium bandwidth speech and music area, which is most appropriate for short wave broadcasting.

The bandwidth of a short wave channel is 10 kHz. The narrow bandwidth and the very difficult propagation characteristics of the HF bands will severely limit the data rate that can be transmitted. It will take a very efficient compression scheme to achieve the desired voice and music quality. In addition, attention must be paid to the interaction of the receiver and audio decoder in minimizing undesirable audio artifacts when the received signal approaches threshold. This paper describes the unique requirements of audio compression systems suitable for HF broadcasting from the perspective of the overall short wave broadcasting system design.

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AM **broadcasting is one of the oldest broadcasting services** in existence. It is most extensively used in the medium wave bands (around 1 MHz) for local broadcasting, and in the short wave or HF (3 MHz to 30 MHz) bands for international broadcasting. The HF bands are suitable for long distance broadcasting because radio signals at these frequencies are reflected from the ionosphere as well as from the surface of the Earth. This allows signals to travel thousands of kilometers by means of one, two, or more hops.

Unfortunately the ionosphere is not an ideal reflecting surface. Its reflective properties vary with time of day, solar cycle, and other seemingly random phenomena, which results in a variety of propagation impairments. Listening to a HF broadcast can range from the annoying to almost impossible because of the signal fades, noise, and other impairments, including interference from other stations on the same frequency. In spite of this, HF broadcasting has until recently been the best way to disseminate information over a wide area. Now other means of information delivery, such as the Internet and direct to home satellite broadcasting arc becoming more available. To compete with these, HF broadcasting reception reliability and audio quality will have to be significantly improved. The broadcasting infrastructure is there. A successful conversion to digital broadcasting would go a long way toward improving the quality of short wave audio and returning listeners to this service.

The short wave bands are also used by radio amateurs for communications, also using AM. They must also be kept in mind in the conversion to digital process. While there is very little distinction between broadcasting and communications when using AM, the processing delay factor in digital systems can be more of a hindrance in two way communications.

Several independent studies are currently under way to define systems for HF digital broadcasting. It is hoped to select the best approach and define a "world standard" that most broadcasters will use. A group of international broadcasters and representatives from broadcasting equipment manufacturers are working to set up a consortium called Digital Radio Mondiale. The goal of this consortium will be to define system requirements and work to facilitate the conversion of HF broadcasting to digital.

One system for digital HF is being studied at the Jet Propulsion Laboratory, under sponsorship by the Voice of America. This system is being adapted as far as possible from a design that was developed for satellite digital audio broadcasting. Since the audio bandwidths and propagation arc different, some of the system trades have to be redone. Some of the mitigation techniques that were developed for the satellite system, however, arc applicable and will be useful in a HF broadcasting system design.