

Direct Broadcast Home Terminals — Status Report

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The evolution of technical considerations for Direct Broadcast Satellite Service (DBS) has or certainly promises to place the home TVRO terminal directly in the arena of new television display technologies. There are few broadcast services which have incorporated the embodiment of more varied and sophisticated technologies ... from gallium arsenide monolithic integrated circuits to DES encryption algorithm standards and antennae efficient at frequencies not many years ago considered to be unfit for transmissions of any variety. This paper will briefly summarize the status, developments and technology which are to be embodied in this new broadcast service.

Those of us involved in the DBS concept are perhaps most limited by existing display technology. The current norms of consumer equipment capabilities are proving to be a relative high cost burden on the finalization of new display techniques as new techniques must be limited or modified to accommodate standards developed decades before satellite transmission was feasible. DBS has given rise to practical, yet difficult questions of how to introduce for instance, an additional 40dB of dynamic range in an audio signal to conventional receivers as digital audio transmission techniques hurdle headlong into the low-cost analogue environment of the home receiver. The issue of incorporating high or extended definition television capability into transmission standards that for now must exist in an NTSC world present problems of economy of spectrum in which transmission costs per Hertz exceed any previous economic norms; namely high power satellites. A quipster recently equated the reinvention of existing technology by saying that had Thomas Edison been of limited mind set we would, today, be enjoying the use of larger candles. The DBS industry is attempting on the whole to provide a service in which existing display technology is satisfied without sacrifice of future capability. This goal is replete with difficulties in setting hard standards, and costs in downgrading temporarily signal capabilities that represent tomorrow's services. The progress that is being made is perhaps best reviewed by a look at the basic elements of the DBS TVRO equipment that will appear in the home.

The most obvious element of the home reception equipment is the parabolic reflector. The reality of DBS has rested in no small measure on the ability for ease of installation of the antenna, the performance of that antenna and the long term stability and survivability of the antenna in a wide variety of environments. It is safe to say that the offset parabolic reflector has become the norm for DBS in that two major problems are overcome by its application: (1) a 60cm reflector cannot tolerate the shadow loss created by the presence of the LNC directly in the middle of the signal path and (2) the offset dish attains a more vertical attitude of the reflector in those climates where ice and snow accumulation would most seriously impair link performance. The efficiency of the DBS antenna becomes far more critical when manufacturing than does, for instance, the considerations for C-Band (4GHz) antennae. Precision stamping of metal must be held to within a ten-thousandth of an inch over the entire surface of the reflector that is designed for 12GHz application. Paint type and application cannot destroy the surface tolerance and must in fact act like Teflon in repelling surface build-up of foreign matter. A properly designed offset parabolic antenna for 12GHz application must attain better than 70% efficiency to allow for

link budget variations introduced by weather, settling of structures (particularly in Northern climates) and less than accurate installations as regards pointing errors. The present plans for deployment of high-power DBS services will see the 0.6 Meter antenna as the most common size used throughout the United States.

The Low Noise Converter (LNC) represents an integral part of the antenna system that through its associated feed horn and polarization control has forced existing LSI technology to a new frontier. The goal of providing DBS technology at reasonable consumer pricing prohibits the use of discrete circuit FET technology which has been so popular in C-Band LNA or LNC construction. The need for superior carrier to noise performance, environmental stability and broadband performance has dictated that MIC or MMIC technology be applied to DBS equipment. Such LSI technology is rare, difficult to attain in integration but holds promise for future applications well beyond DBS. When one considers local oscillators operating at switching speeds measured in GigaHertz, it is not difficult to imagine CPU switching speeds limited only by memory access time; this is one of the underlying driving forces for this new display technology that is not immediately apparent. The LNC in the final analysis is a super low noise element of the DBS System that provides a broadband 1GHz I.F. to the heart of DBS's new display technology ... the Indoor Electronics Unit.

The DBS Indoor Electronics Unit (IDU) is where the business of new display technology and, in fact, the business of DBS will occur. Originating with a broadband FM I.F. the IDU has the responsibility for coherent conversion of visual, aural and data signals to the consumer environment. One of the most commonly overlooked basic facts of satellite television transmission is that it is an FM transmission standard which is not quickly correlated to our existing AM visual conventions. Setting aside the capabilities of new technologies, the final order of business for the IDU is to convert the FM transmission standard to the AM/FM requirements of today's television receiver; dependent upon the philosophy employed by the DBS programmer, the outputting of baseband video and audio signals are also a requirement of the IDU. Channel selection via the use of Frequency Locked Loops or similar techniques appropriate for the 1GHz I.F. and channel spacing is yet another basic function of the indoor unit. Whether this selection of channels is five channels, thirty-two channels or one hundred channels is the basis of standardization efforts best addressed by a separate paper reviewing that work in progress as it is also related to collocation of spacecraft as of yet undecided by the Federal Communications Commission. The basics of the IDU having been defined, let's look toward those signal features and functions that have been revealed or proposed that would define DBS as a new display technology.

AUDIO TRANSMISSION

At least one and perhaps more of the existing DBS license holders have incorporated the transmission of digital audio in multiple channelization with their signal parameters. The application of this technique promises at least three system features: (1) the attaining of quality in reception only now emerging in the discrete Compact Digital Disc technology of the audiophile world, (2) the ability to dynamically assign and reassign multiplexed data as audio coherent signals (stereo, mono or bilingual) or as data formatted for auxiliary services such as program downloading to computers and (3) a form of encryption for the television signal which simultaneously provides superior services while protecting economic investments in the programming. Some digital audio services proposed for DBS would provide for signal to noise and dynamic range capabilities perhaps exceeding those of the Compact Disc format standard. Such capability would require that television audio be taken seriously by the consumer and the broadcaster and that the home reproduction

equipment from amplifier to speaker be evaluated in the same light as a state-of-the-art component audio system. As previously indicated, should the full range of such an audio system be utilized, some limiting or compression will be required when this capability is delivered to conventional reception equipment. Various concepts present the digital audio capacity as either a discrete transmitted signal or more than likely a basic function of the video waveform residing in sync.

VIDEO TRANSMISSION

The issue of video transmission, as reflected in the preceding comments on digital audio, is at best complex. One service already on the air is utilizing conventional NTSC video with separate aural subcarrier in a standard associated with today's C-Band reception characteristics. The more likely transmission method being considered is the use of multiplexed analogue components including the digital audio as a single carrier. This method has been proven to deliver better link performance through (1) the inherent technique and (2) the absence of the aural subcarrier which causes less concentration of energy in the visual carrier of a transponder. In retrospect, the use of an enhanced video transmission standard will provide better link performance, a greater ease (if not inherent ease) of encrypting the video signal and an apparent improvement of video quality when the signal is viewed on receivers capable of RGB video inputs. It is well to footnote that the majority of potential DBS customers will, if for no other reason, denote a distinct signal difference by virtue of being free of terrestrial signal aberrations caused by multiple path diversities and other ground transmitted signal abnormalities. There is no question that the video portion of the DBS signal will represent to the most severe critic an upgrade of display quality.

DATA TRANSMISSION

Perhaps one of the most exciting and promising aspects of the DBS business is the data capacity that is being envisioned as integral to the transmission standard. While this capability is optional to the DBS programmer and the subject of recommended standardization proceedings, the capabilities are functionally unlimited as pertains to teletext-like services, discrete downloading of data such as computer programs, video games and even data-based additional television signals such as freeze frames. The DBS receiver will contain the capability for interface to other microprocessor based devices. The practical ability to deliver auxillary services as part of the video entertainment business will be realized yet this year in far greater capacity than will be possible through today's alternative means.

TRANSACTIONAL FUNCTIONS

The DBS Indoor Electronics Unit will be a "smart" terminal for those programmers using enhanced transmission standards. The basis of pay programming will be functionally implemented to permit pay-per-view which is accounted and even directly billed to the consumer through the IDU allowing a keen competitive edge over preauthorized or continuously billed systems. The ability for parents to code-set the ratings of programming that younger family members may view is yet another function of the smart receiver associated with sophisticated DBS services. The logical (and planned) interface of the DBS Receiver to the telephone will permit interactive functions for the consumer and the ability for a programmer to poll and receive instantaneous ratings of viewership for programs in progress. The planned technology of systems (such as Comsat's STC, for instance) will permit discretely addressing millions of viewers in a matter of hours for any number of purposes which are just base-lined at transactional functions. In the early 1960's Bell Labs produced a

film which showed the "home of the future" being controlled via touchtone control from central computers. DBS represents an enhancement of this as of yet unrealized promise in concentrating switching and addressing functions where they might well best reside ... on a non-terrestrial basis. These last few statements may well sound as optimistic as Bell's early 1960's film and before new enhanced display capabilities give way to science fiction, let's conclude by reviewing the status of this DBS industry.

DBS, which by FCC action has become a generic term, is presently alive and in service at 12GHz. USCI, a venture of General Instruments, Prudential Insurance and others is presently delivering five channels of service to a broad area of the Northeastern United States via leased transponders on Canada's Anik satellite. The USCI service is a low power service and as such requires dish sizes which are in excess of those DBS services committed to higher power satellites. The minimum dish size, on average, for reception of USCI is 1.2 Meters. Satellite Television Corporation, a subsidiary of COMSAT, will inaugurate service to the Eastern Seaboard of the United States in the Fall of this year utilizing focused beams from SBS-4 and permitting the installation of .6 Meter (2 foot) antennae for reception of multiple channels incorporating digital audio, extended data capacity and enhanced transmission techniques. During 1985 and 1986 satellites will be launched from which a single bird will permit the steerable transmission of up to eight 230 watt transponders on a nationwide basis. Further action of the FCC, world regulatory bodies and the industry itself will finally determine the complexion and indeed success of this new delivery medium, but the long awaited promise of a new and enhanced compliment to today's entertainment services is present and being well accounted for in planning that which will see new display technologies entering our homes yet this year.



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