SHF - NEW QUALITY FOR CABLE TV

Israel Switzer, P.Eng.

Switzer Engineering Services Limited
5840 Indian Line, Mississauga, Ontario, Canada
L4V 1G2

ABSTRACT

The quality of the signal received by cable television systems would be improved if there was a more direct link between broadcast studios and cable systems. Such direct links have regulatory and legal obstacles. Television broadcasting using frequency modulation at SHF (12.2-12.5 GHz) would provide a very high quality signal feed to cable television systems and others while overcoming the legal and technical problems associated with direct signal delivery schemes previously considered.

INTRODUCTION

Cable television will not become a meaningfull factor in society until it successfully penetrates our major cities. While those in our industry who are concerned with the legal and economic problems affecting big city prospects for cable television try and overcome these problems, we who are concerned with engineering aspects of the industry must simultaneously overcome the engineering problems. Transmission quality is one of the major parameters to be considered in the overall engineering of cable television systems for major cities. At our present stage of development of cable television technology we have achieved a high degree of capability in our distribution systems. Amplifiers, cables, signal processing and system design have all advanced significantly in the last few years. The present state of the "distribution art" in cable television is now advanced to the point where we can profitably direct our attention to improvements in other aspects of the whole television system. This paper proposes some improvements in the link between the broadcaster and the cable system.

THE STUDIO-CABLE LINK

Television program production has achieved a very high degree of picture quality. Cameras, film chains, video tape recorders and all the transmission equipment used to interconnect studios, network centres and transmitters have all achieved excellent performance standards. We may now concern ourselves with some improvements in the link between studio and cable system, particularly the television broadcast transmitter and the signal path from transmitter to cable system.

The high power broadcast transmitter has a very difficult job to do. It must take a complex baseband signal and impress it on a very high power carrier for transmission. The visual carrier transmitter is required to operate linearly at power levels of up to 55 KW peak power. By contrast, the peak power per channel typically used in cable television equipment does not exceed 0.0001 watt (-40dBw). Broadcast transmitter powers are almost 90 dB greater than cable system levels. Our experience in a number of situations has been that we can provide a noticeably better picture to our subscribers if we have a direct feed from a broadcast studio instead of an "off-air" pickup from a high power transmitter. The "off-air" pickup is further degraded by the probability of some multi-path distortion in even good quality "off-air" reception.

We have, over the years, had several cable system head-ends co-located with local broadcaster's transmitters. In such situations we have preferred to obtain a "direct feed" from the local broadcaster, bypassing his transmitter. We have also tried "direct feeds" from the output of the transmitter, obtaining our signal from a small probe in the output transmission line, thus avoiding any possible problems in propagation from transmitting antenna to a receiving antenna. Even in such cases we preferred the quality obtained from a good quality, low level modulator fed directly from the broadcaster's video line.

The broadcaster has good quality transmission in his STL (Studio Transmitter Link). This STL is usually a high quality FM microwave system. Alternately, it may be a high quality video cable link. We are convinced that our picture quality in big city cable systems would benefit considerably if we could extend the broadcaster's STL right through to our cable system, creating a direct link from broadcaster to cable systems.

LEGAL CONSIDERATIONS

Our existing direct links with broadcaster's are strictly informal. Broadcasters' program

rights cover broadcast only. They do not have the right to provide programs on a closed circuit basis. Our efforts to extend our use of direct broadcaster-cable links have been blocked by these legal considerations. Negotiations to obtain such direct connection rights for all of the programs in a broadcaster's schedules have been very slow and frustrating.

A SOLUTION - SHF BROADCASTING

We believe that the problem could be overcome by the use of SHF (Super High Frequency) television broadcasting. ITU Region II encompasses the Western Hemisphere. The band 12.2 - 12.5 GHz is allocated in Region II to "Fixed", "Mobile Except Aeronautical Mobile" and "Broadcasting". The band 11.7 - 12.2 GHz is also allocated to "Broadcasting" and other services but these other services include "Broadcasting-Satellite" and this band would have to be shared with satellite broadcasting services. The use of frequency modulation technique coupled with omni-directional broadcasting of this signal would, in effect, extend current STL techniques right out to the cable system head-end. We propose that broadcasters would apply to operate high power SHF transmitters in parallel with their present VHF or UHF transmitters. An SHF transmitter would be a conventional FM microwave transmitter, as presently used for high quality STL service, driving a power amplifier to provide several thousand watts of power into an omni-directional transmitting antenna. The amount of RF power required can be estimated by comparison with conventional STL type microwave systems. A 1 watt transmitter feeding a 6 foot diameter antenna has an ERP of approximately +45 dBw. Achieving the same ERP with an omni-directional antenna of about 15 dB gain requires a transmitter power of about +30 dBw (1,000 watts). RF power for frequency modulated carriers is easily achieved at SHF frequencies at relatively low cost with klystron amplifiers. Klystron amplifiers in the 1,000 to 10,000 watt range are available and many are being used as satellite up-links and in special purpose military systems.

Antennas with circular polarization would be desirable to help reduce the effects of multi-path propagation. This is probably not essential because receive antennas of modest diameters achieve considerable directivity. A 6' diameter receiving antenna has a half-power beam width of about one degree at 12 GHz.

SHF broadcasts would be available to anyone within line of sight range. Because of the relatively high cost of the FM receivers required it is likely that only cable systems and larger MATV systems would avail themselves of the service. Any future developments in satellite broadcasting would use frequency bands and transmission techniques similar to this proposed terrestrial service and any improvements in the performance and costs of receiving systems for satellite television broadcasting would immediately benefit this terrestrial service as well. Cable systems have nothing to fear from such developments. I believe that cable service, where available, will always be more attractive a proposition than direct reception of either terrestrial or satellite broadcast services. Transmission at these frequencies is strictly line of sight. Anyone not having a clear and direct line of sight to the terrestrial or satellite transmitter will be dependant on some kind of cable service as an intermediary.

DEVELOPMENTS ABROAD

There is considerable experimentation with terrestrial SHF broadcasting in Europe and Japan. Propagation characteristics have been thoroughly investigated and considerable work has been done in developing the equipment and antennas required. Even the UHF band is becoming saturated in some of these areas and SHF is looked upon as a natural means of expanding television broadcast services. Both FM and VSB-AM techniques are being explored. Figure 1 shows two types of antennas being used in experiments in the Netherlands. The bibliography appended to this paper lists some of the papers and reports describing these experiments.

PROSPECTS IN NORTH AMERICA

In centres where cable television is firmly established, broadcasters are increasingly dependant on cable television systems as part of the link between studio and viewer. In the Toronto region where there are now almost one million cable homes we estimate that 90% of all viewing of UHF stations and about 50% of all viewing of VHF stations is by cable. Broadcasters in such situations must be just as concerned about the quality of their links to cable systems as they are concerned about the quality of their more direct links to viewers. We believe that broadcasters in such a situation can be persuaded to provide more direct and higher quality links to cable systems. Early discussions of the subject proposed point-to-point microwave services but ran into the legal problems previously discussed and the technical and logistics problems of providing direct point-to-point microwave service to a very large number of cable systems in a metropolitan area. We hope that an omni-directional microwave service - SHF broadcasting - can overcome both the legal and technical problems of providing these direct studio to cable links.

Initial experiments await the confirmation of spectrum allocation at the forthcoming World Administrative Radio Conference (WARC). We have made representations to the Canadian government asking them to confirm the present ITU allocations with a view to early implementation of the terrestrial SHF broadcast services we have proposed, as well as satellite broadcast services.

BIBLIOGRAPHY

G. F. Koch and H. Thielen

BIBLIOGRAPHY

G. F. Koch and H. Thielen -
Transmitting Antenna with Cosecant-Shaped Vertical Pattern for 12 GHz Television System, IEEE Transactions on Communications, Vol. COM-22, No. 9, September 1974 pp 1391 - 1393

K. Sakowski -
Planning Parameters for Terrestrial Broadcasting in Band VI, NTZ Journal, Vol. 26, No. 5, 1973, pp 228 - 233

J. W. A. van der Scheer -
Distribution and Broadcast of TV Signals in the 12 GHz Band, International TV Symposium, Montreux, 1974

T. Saito et al -
Omni-Directional Biconical Horn Antenna Using Metcal-Plate Lens for SHF TV Broadcasting, 1973 G-AP International Conference, Boulder, Colorado, pp 379 - 382

T. Saito et al -
NHK Kinuta SHF Experimental Station, NHK Laboratories Note #150, January, 1972

T. Saito et al -
NHK Kinuta SHF Experimental Station, NHK Laboratories Note #182, October 1974

Forschungsinstitut Der Deutschen Bundespost Beim Fernmeldetechnischen Zentralamt (Darmstad) various internal and published reports