is multiresolution or scalable source coding,[12] which is beyond the scope of this article. It should be mentioned that with today's source coding technique, MR source coding might result in a higher aggregate data rate than that of SR coding, unless some form of quality compromise is introduced. For example, additional bandwidth or higher order modulation might have to be used. It might be more difficult to implement layered services for 6-MHz bandwidth occupancy than for 7 or 8-MHz systems.

An MCM system is very flexible for layered and scalable transmission, as different groups of MCM carriers can be assigned to a different order of modulations, power levels, and channel coding mechanics, leading to stepwise graceful degradation or shaping of coverage for various services.

For an SCM system, layered transmission can be achieved by using nonequally spaced constellation modulation and different channel coding.[13]

Conclusion

To transmit digital ATV signals at 18 to 25-Mbit/sec data rate within a 6-MHz bandwidth, a spectrum efficiency of about 4 bits/sec/Hz must be achieved. To meet the very low BER ($\leq 10^{-9}$) requirement, concatenated channel coding, with an inner trellis code and an outer Reed-Solomon code, can be used. SCM and MCM have comparable performance on a Gaussian noise channel. SCM is robust to frequency domain impulse or tone interference while sensitive to time domain impulse interference. On the other hand, MCM is robust to time domain impulses but vulnerable to tone interference.

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ENGINEERING REPORT

Production and Distribution of Entertainment in the NII

By Kenneth P. Davies

The production and distribution of entertainment is a very important economic activity in the U.S. The motion-picture industry has annual revenues of $12 billion in the U.S., employs 400,000 people directly, and is a major ($8 billion) contributor to exports. The television industries have gross revenues of $25 billion annually and deliver services to almost 100 million homes over 1,500 stations. Other elements of the cultural industries, including music, recording, the theater, and the arts, are similarly important. Radio and TV broadcasting have, for many decades, formed the "information network" for most Americans, in good times, in emergencies, and in times of disasters. The cultural industries will doubtless form an essential part of the National Information Infrastructure (NII) in the future.

Summary of a presentation to Workshop on Advanced Digital Video in the NII by SMPTE Engineering Vice-President Kenneth P. Davies, Canadian Broadcasting Corp. (CBC), Montreal, Quebec, Canada H4W 1R5.

Digital Video and Imaging

Motion pictures and television have made use of digital techniques in production for many years, initially in applications that were otherwise impossible in analog technology, such as standards conversion, storage, and special effects. Increasingly, this technology has moved into applications where the unique properties of digital technologies offered cost, quality, or performance advantages, and today virtually all professional level production is based on digital techniques,

frequently making use of advanced computing techniques. Motion pictures, such as *Jurassic Park*, would be impossible without the processing provided by a large number of processing work-stations, while the TV news would disappear from the screen without digital effects, transmission, and storage.

Increasingly, the standards employed for these activities are convergent with those of computers and telecommunications, as these industries move to common technology for their diverse applications. Current standards for motion pictures and television are used widely in the computer field for graphics and displays. In production and distribution these industries are already in the "digital age," in fact leading the way in practical applications.

The entertainment industries make heavy use of new technologies to enhance the value of the products and to make them more available, of higher quality, or more acceptable to the users. They are, however, very conscious of the need to protect the value of the consumers' investments in equipment and access to services. Thus compatibility and interconnectivity are of high priority in the setting of standards, avoiding premature obsolescence, and allowing software and hardware from the earliest days to work satisfactorily today in all American homes. In the development of the NII, this concept may be a significant contribution to its acceptability by consumers.

Digital Distribution

Over the next few years, the distribution of motion pictures and television will increasingly become digital, irrespective of the delivery medium: terrestrial broadcast, cable, satellite, or the telecommunications network; and also in package media such as videocassette, video CD, or CD-ROM. Development of digital compression techniques has made digital delivery the technique of choice due to the inherent flexibility, economy, quality, and compatibility with the burgeoning communications networks. These developments will enable better distribution of current services to consumers and will allow the development of new innovative services, with levels of significant interactivity, for entertainment, education, information, and transactional services. Such broadcast services are highly complementary to many of the interactive services likely to form the content of much of the NII, and their inclusion within the NII structures, and enabling regulation, is strongly recommended. This would have the effect of making this very large pool of services and the nationwide, broadband (20 to 40 Mbits/sec) delivery capability available to bootstrap and advance the implementation of the full range of NII services by many years at the consumer level.

Intellectual Property Rights

Introduction of the NII and of digital delivery to the home will open up many questions concerning the protection of property rights associated with cultural items, including motion-picture and television programs, works of art, books, music, and performance. Such items are likely to be available in the NII and in related "appliances," in high-quality, digital forms and will be widely accessible. It is thus essential that means be provided, in both the NII and in legislation, to ensure that these rights are respected, by the inclusion of access control; mechanisms for payment; and audit and security of storage, transmission, and display at all levels. Additionally, traceable codings will be needed to enforce such laws in the event of piracy or other unauthorized uses of content. Similar security concerns may exist in respect of privacy for other potential NII services, such as health care. The value of many cultural properties is very high, and failure to respond, from the beginning, to these concerns may have significant negative consequences on the development of the services essential to the implementation of the NII.

A further concern of the cultural industries is that the NII should be open to all suppliers of content and services equally and on an equitable basis. In this way consumers will be better served and the potential for the creation of "gate-keepers" exacting an undue influence on content would be eliminated.

Conclusion

Although technology may make the NII possible and telecommunications and computing may form the backbone of its implementation, it is content and useful applications that will attract the usage necessary for its success. The cultural industries, particularly motion pictures and television, can thus be seen as an essential part of the NII, providing the content and services that will provide many of the high-quality services, both point-to-multipoint (broadcast), on demand (interactive), and informational. The inclusion of the cultural industries in all phases of the development and implementation of the NII, including policy, legislation, and regulation, is thus essential.

In addition, the digital delivery infrastructure currently being planned and deployed by the TV broadcasting industry (over-the-air, cable, satellite) can readily accommodate the greater needs of the NII for the delivery of a wide range of services and is already, in large measure, interoperable with the other telecommunications network elements of the NII. Its inclusion within the NII has the potential to advance by many years the availability of NII services to consumers throughout America, to render the NII universally and equitably available, and to reduce significantly the cost of implementation and operation, making it more affordable for all applications and services, especially at the consumer level.