INNOVATIONS

A NEW SERIES OF ARTICLES WHICH WILL EXPLORE SOME OF THE COMPLEXITIES OF EMERGING TECHNOLOGIES

TELEVISION TECHNOLOGY FOR THE 21ST CENTURY

BY COLIN KNOWLES, DIRECTOR PLANNING, AUSTRALIAN BROADCASTING AUTHORITY

THIS IS THE FIRST OF SEVERAL ARTICLES TO BE PUBLISHED IN ABA UPDATE IN THE NEXT FEW MONTHS DISCUSSING DEVELOPMENTS IN TELEVISION TECHNOLOGY. IN THIS ISSUE WE DISCUSS DEVELOPMENTS IN DIGITAL TERRESTRIAL TELEVISION. SUBSEQUENT ARTICLES WILL DISCUSS SOME OF THE FACTORS INFLUENCING THE SYSTEM REQUIREMENTS OF FUTURE TELEVISION SYSTEMS.

Since 1985 much publicity has been given to high definition television (HDTV) as the television of the future. Developments in Japan, based on analog transmission technology and spectacular demonstrations of wide screen high quality television pictures made the television viewing experience similar to that of cinema. Demonstrations at that time were taken direct from studio videotape recorders to studio quality projection television systems. Their transmission required about four or five times the channel width of conventional television picture and were therefore suitable only for transmission over cable or satellite channels. [For a discussion of analog and digital technologies, see later.]

Subsequent developments have reduced the transmission channel width by complex processing of the signal. Satellite-delivered HDTV pictures in Japan today use about twice the width of a conventional television channel to deliver HDTV pictures to the home. The receivers remain expensive and the take-up rate has been slow.

Europe started its own HDTV development in a concerted attempt to catch up with Japan in the development of advanced television. It sought to develop a system for satellite-delivered HDTV which would be substantially compatible with other normal definition satellite services. Planning and systems design for these services was well advanced. The European developments resulted in HD-MAC, another analog based system, which was used during the Barcelona Olympic Games to convey HDTV pictures to many parts of Europe.

DIGITAL TECHNOLOGY

In 1985, Australia suggested to the international community of the International Telecommunication Union (ITU) that any future television standard should be based on digital technology.

This would introduce a system which could be built on during the next century, rather than one which would be constrained by a technology of the 1930s. The proposal generated little interest until around 1989 when the USA decided that it was being left behind in advanced television technology.

An ambitious program was launched, designed to deliver substantially improved television over-the-air to American viewers. The program used a technology competition to develop a new advanced television system for North America.

Early candidates for the US system were a mix of digital and analog systems. Digital systems rapidly emerged as the leaders and in 1990 the Radiocommunications Bureau of the ITU (formerly the International Radio Consultative Committee (CCIR)) formed a special task group to study digital terrestrial television broadcasting (DTTB).

DIGITAL TERRESTRIAL TELEVISION BROADCASTING

DTTB does not seek to immediately achieve the full quality of HDTV but rather offers a range of service qualities depending on the choice of the broadcaster and the type of program material. Eventually DTTB will cover a range of quality requirements extending well beyond the present day HDTV objective of at least one thousand lines per picture and a 16:9 aspect ratio, down to quality levels which permit multiple services to be transmitted over a single channel with a picture quality roughly equivalent to that obtainable from a good quality domestic video cassette recorder. In other words, there is considerable scope for future development as transmission technology, television cameras and display devices improve.

WHY DIGITAL?

Digital technology seeks to address a number of related requirements. HDTV targeted a single objective (large screen high definition television) while DTTB addresses a range of requirements from basic services to HDTV and beyond. At the upper end of the range, the availability of channel capacity in the spectrum may limit what is ultimately achieved. The lower end requirements might be confined to basic information services, some of which could be delivered by telephone line.

HDTV was designed for screen sizes greater than one metre diagonal. These are very large and expensive, hardly the type of receiver for use as a second set in the kitchen or bedroom. In the future, flat screen displays will almost certainly be developed to the point that cabinet size is reduced and perhaps hung on the wall like a painting. For the moment, this technology (for large screen sizes) has still to be perfected.

DTTB offers the prospect of a cheap small screen television receiver being available for applications when high definition or large screen is unnecessary. Because of DTTB technology, these receivers are expected to contain less complex and lower cost electronics, yet be able to take programs from exactly the same signals that on a large screen receiver would be displayed at higher levels of resolution.

Digital television techniques therefore open the way for a family of television standards which might allow a single receiver to be used for satellite, cable, or free-to-air reception, permit the viewer to make a choice about the receiver type best suited to his or her needs, and provide a path for future development of television technology beyond that which seems feasible today.

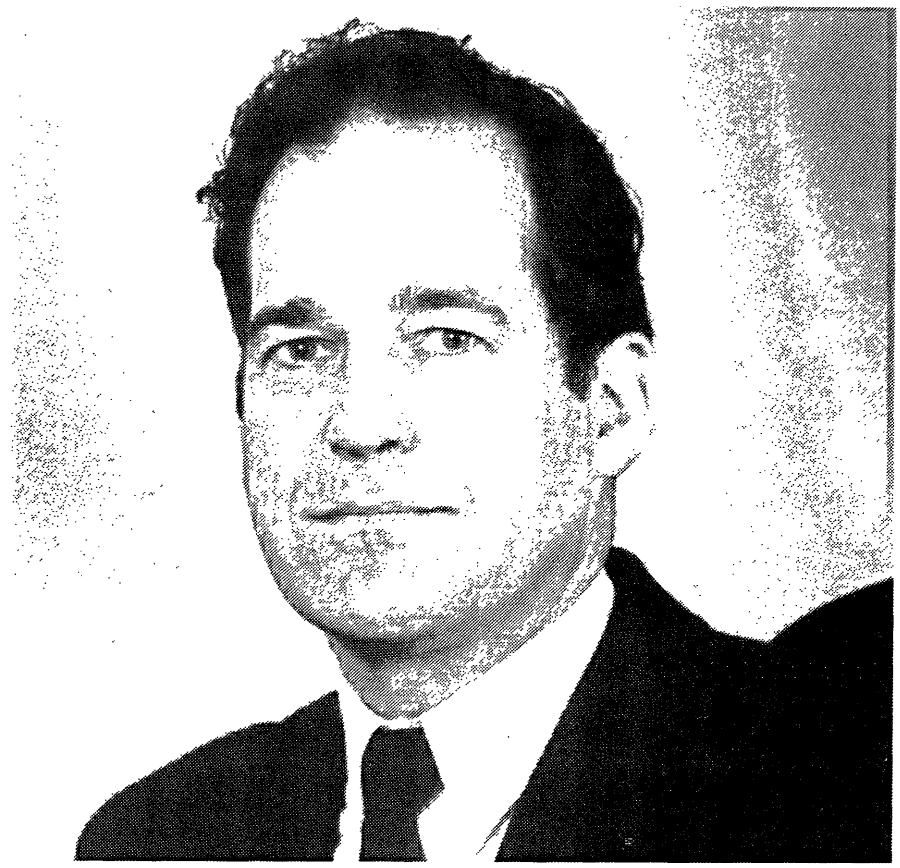
A higher degree of commonality between entertainment television requirements and other visual communications technology (such as computer imaging) could assist to reduce costs for all types of visual displays and accelerate the availability of things like wide screen flat panel display devices.

Error correction

Digital transmission systems use simple on/off signals. This type of transmission is used by computers and many computer-based systems. It has the advantage that as long as the receiver is able to distinguish the difference between the 'on' and 'off' state (or signal, no-signal state) then the received signal can be perfectly reproduced. With more complex processing of the signal, the receiver can reconstruct a perfect signal even though some parts of the received signal may be missing. This is known as error correction.

Analog transmission depends on variations of level of a signal in much the same way as the pitch and volume of a musical instrument or the human voice varies. If the instrument is played in a noisy location, quiet passages are difficult or impossible to hear. The electrical signals of analog transmissions become weaker as they pass through the transmission channel, and noise is added to the signal as it passes through the system or it may be swamped by other signals arriving simultaneously at the receiver. The receiver, just like the human ear, is unable to distinguish signals that are quieter than the noise and the information is lost. This loss of information impairs the received sound or picture.

Error correction for analogue signals is very difficult if not impossible to achieve.



Colin Knowles, Director Planning, ABA

Data compression

Digital transmission has drawbacks, because the original picture or sound information is essentially analog and its conversion to digital signals for transmission generates a very high volume of data. In its raw form this data would take up much more channel space than the analog signal. The raw data must therefore be extensively processed to reduce the signal to essential information.

To take an extreme example, if only one small portion of a picture changes in a given time, then only that information need be sent to the receiver for the receiver to display a faithful reproduction of the original.

These techniques known as data compression, or digital compression, reduce the volume of data to be sent over the transmission channel to its essential components. Compression requires very fast and complex signal processing computers. Advances in solid-state technology have allowed these processors to be built into a few integrated circuits which when produced in large volumes can be sold at reasonable prices. Digital television has thus become possible as a direct consequence of the developments in computing and digital signal processing.

Once the signal is in digital form it is relatively easy to store on compact disk, pass to computers or transmit (along with other digital data) over cables, satellites, or over the air. Nevertheless, each transmission medium has its own special characteristics and the signal must be optimised for that medium. Fibre optic cables are relatively immune from electrical noise and reflections. Satellite channels are influenced by electrical noise and the signal fades in rain showers.

Terrestrial over-the-air broadcasts suffer from reflections as a result of buildings, hills and water, are attenuated by trees and other obstacles and suffer from electrical noise. Terrestrial broadcast is by far the most complex medium over which to transmit complex digital signals. Considerable emphasis must be given to overcome the problems of reflections and additional error correction must be incorporated into the system to cope with the various potential signal impairments. That is why we will see compressed digital transmission technology used on satellite delivered services earlier than its introduction for terrestrial broadcast.

Developments towards new systems

Development work in the US has shown digital technology to be feasible and the candidates have now formed a 'grand alliance' to work together to achieve a single system for the future needs of North America. Europe too, has been working on digital television technology while continuing to try to convince broadcasters to adopt HD-MAC. Japan is active in the digital world. Its HDTV MUSE system is used to broadcast from satellite for about eight hours per day, but growth in viewer numbers is slow.

The computer industry, telecommunications carriers, equipment manufacturers and broadcasters have all begun to strongly back DTTB. Europe is lagging behind the US but has ambitious plans and some tentative systems have been demonstrated. In addition, both Europe and Japan have developed considerable expertise in the production of advanced television equipment and programs through their work on HDTV. This technology is essential in the production of television cameras and display devices for future television systems.

The US hopes to have a new generation DTTB system standard determined within twelve months. Transmission could commence as early as 1995. However, because reception of DTTB requires viewers to purchase a new television receiver, it will be some considerable time before conventional television transmissions will cease. In practical terms, conventional television will remain available until at least the year 2010 in the USA and probably much later in Europe.

European plans call for the establishment of multi-channel satellite delivered digital services by 1995 and DTTB by 1999.

Over the last few years, several groups of experts in Australia have worked on future television technology and actively participated in the international debate about future television standards. Much of this work has taken place within the television specialist groups of the ITU Radiocommunications Bureau. These experts have worked in conjunction with the Department of Transport and Communications in representing Australia's views to the international community.

Consultative group

The ABA has specific responsibilities under the Broadcasting Services Act to advise the Minister on broadcasting technology. In response to this, the ABA has formed an expert group to advise it specifically on the subject of digital terrestrial television broadcasting matters. This group comprises experts from the ABA, industry and government. It will not attempt to duplicate the work of the other national groups but rather to analyse their combined outputs in a coordinated way. It will put information on these developments and the issues they generate into the public forum by way of 'plain English' discussion papers and assist in formulating national positions which Australia's delegates can take to international meetings. These positions are designed to enhance the value Australia can gain from developments and influence the direction of developments to ensure the eventual systems adopted are suitable for integration into the Australian environment and not simply suited to the high density population areas of North America and Europe. (For further details of this group, see p.5.)

Some Definitions:

Digital transmission
Transmits information by way of 'on'/'off' electrified impulses.

Analog transmission
Transmits information by way of a signal of varying level (intensity) or frequency.

Aspect Ratio
The picture ratio: horizontal (or long side) to the vertical (or short). Existing television has a 4:3 aspect ratio. Future systems propose a wider picture with an aspect ratio of 16:9 (i.e. a picture 90cm high would be 160cm wide).