

Interactivity: An Essential Element for Broadcasting on the Information Superhighway

By Louis Libin and Kenneth P. Davies

The broadcasting industry is in the midst of a period of rapid change, brought about by the introduction of digital transmission technology for terrestrial and satellite broadcasting and for cable delivery. Initially, this new capability might be used to deliver current programming in a more efficient fashion or to enhance the capability of the delivery chain to include more programs. There exist, however, opportunities for the broadcaster to become a deliverer of new programming, such as interactive programs, and to deliver data services, becoming a part of the Information Superhighway in effect and bringing the benefits of it to users throughout their service areas much ahead of other mechanisms, such as the telecommunications network. The paper discusses some of these opportunities and the interactivity mechanisms that will be required to effect such services, in the context of broadcasting.

For three-quarters of a century, broadcasting, first as sound and later as television, has supplied the needs of the world population for up-to-the-minute information, news, weather, sports, and a host of other sound and vision services. Broadcasting has served as the prime source of real-time content and has provided the mechanism to deliver broadcast services into the majority of homes globally. Millions of people the world over tune in one or more times each day to broadcasting services. How many other media can claim such widespread use?

The world is now, however, entering a new era, the Information Age, characterized by the convergence of digital delivery mechanisms, terrestrial sound and television broadcasting, satellite broadcasting, cable and fiber to the home, and a host of telecommunications options. This evolution is claimed to be the on-ramp of the Information Superhighway, which will result in an era when each user will have access to every service in a completely open "network of networks." It

is projected that new and exciting services will abound, eclipsing all that currently exists...at some undefined price, of course. Some may disagree with this nirvana perspective and recognize that such simplistic solutions may be based on an inadequate understanding of the possible alternatives, or perhaps of the economics of the situation.

Broadcasters have always shown great initiative in adopting new technologies and have led the way in developing digitally based methods for the production, distribution, and transmission of radio and TV services. The powerful processors that are in use every day for picture manipulation and video servers cause many computer systems to appear lethargic in comparison. The introduction of digital broadcasting to the home will create an immense information network that will dwarf the best efforts of telecommunications in terms of locations served and capacity. Broadcasters already have the capability and depth of resources to produce content for the Information Superhighway and have an essential role to play in its implementation. The next step is to ensure that the protocols and standards for broadcast delivery are compatible with the open, interoperable concepts of the Superhighway concept. The major element currently

missing is an appropriate mechanism to achieve the level of interactivity needed for broadcasting services.

Requirement for Interactivity in Broadcasting

Interactivity may mean different things. Each individual has his or her own perception of what "interactivity" means. Indeed, when discussing "interactive television," few can clearly express the difference between computers and television. These are different media; they are merging, but they are different in one important aspect. Computers are non-real-time machines, and television sets (broadcasting and cable) are real-time devices. A user can interact with any computer. In fact, a computer requires that interaction, but in the user's own time frame. On the other hand, a television receiver does not require much interaction, and this is confined mainly to the channel selector and the volume control on the remote control. The consumer is somewhat at the mercy of the broadcaster or cable operator for the correct path to follow. Essentially, computers serve best in a point-to-point environment, while broadcasting is definitely a point-to-multipoint service.

Interactivity may exist at a number of levels, from full interactivity with symmetrical channels in the two directions (games, for example), through limited interactivity in which the return channel is very much smaller in capacity compared to the forward channel, to local interactivity, in which the interaction is only with the data downloaded into the receiver. There exist large differences in the requirements for response time; games need response times of a few tens of milliseconds for proper interaction, while transactional interaction, such as shopping or banking, can interact far more slowly. It is thus

Presented at the Montreux International Symposium in Montreux, Switzerland, in June 1995 (paper no. M95-9). Louis Libin is with NBC, Inc., New York, NY 10112. Kenneth P. Davies is with the Canadian Broadcasting Corp. (CBC), Montreal, Que., Canada H4W 1R5. Published by permission of the IBC and the Montreux Symposium.

essential that the needs for interactivity be matched with the capability of the return channel in performance and cost.

Some examples of interactivity are shown in Table 1. Typical response data requirements and response times for some of these applications are shown in Table 2.

Some Possible Alternatives for Interactivity

It is necessary to continue developing a better understanding of the technologies that can deliver broadcast interactive services to and from the home, and how they can best be applied to a growing range of viewer needs. This learning should not focus strictly on technical issues; but should address the broad range of human factors that can help foresee how people will use this new technology in their day-to-day lives.

The Return Path

The return path necessary for real broadcast television interactivity can be effected in a number of ways, including radio links (either terrestri-

al, satellite, or hybrid); telecommunications links (using either wired or radio connections); or over cable distribution systems through the direct implementation of return channels. The return channel is an integral part of the broadcast interactive television system. This is the portion that will allow the home viewer to respond and interact with the transmitted information.

In most cases, the return path will be operated on a "multipoint-to-point" basis, linking many users of the broadcast service back to a central point. In addition, some local interactivity will also be present at each user site. The orderly use of the return path in a multiplex will be controlled by command information sent along a forward data path associated with the program.

Multiplexing techniques, such as time-division multiple access (TDMA) are well developed in the field of cellular radio, as are the techniques of spread-spectrum transmission, such as code-division multiple access (CDMA) used in the emerging personal communication services

(PCS) environment. Using these techniques, a number of users can share a common return path without interference.

In the consideration of the return path for interactive uses, a number of factors need to be considered, such as the amount of data to be transmitted, the duty cycle of the data "burstiness," the allowable latency (the apparent delay time for transmission) and the set-up time (the time needed to establish the connection from the user to the multiplexer, a significant period of time in switched telecommunications networks). It should be noted that the latency may be a variable, dependent on the number of interactivity requests currently being processed.

The integration of the interactive return path into developing systems for other telecommunications applications has merit in terms of a sharing of the costs of development, implementation, operations, and usage, but it may impose operational and access constraints that are undesirable for this purpose, such as excessive overhead or delay.

Table 1 — Examples of Interactivities

Program Related

Program guide	Description of the programs available from a certain program provider. The scheduled programs may be customized to a viewer's need
Subtitling	Subtitles to be inlaid in the image at the receiving system
Program summary	A summary of the main program. The summary is updated during the program
Audience polling	Viewers vote for the program outcome or answer questions to obtain a polling result

Transaction Related

Home shopping	Interaction from the viewer with a mainstream program. The viewer could send a message to the central office to buy the merchandise
Gambling or gaming	Placing bets on races and games
Auctions	Placing bids on goods and services
PPV ordering	Ordering programs and intellectual programmer rights (IPR) agreements

Educational Uses

Student question and answers	Interaction with instructor and feedback on progress
Comprehension test	Measure progress of student
Local interactive	Teletext and near video-on-demand selection

Table 2 — Typical Responses

Interactive Services	Data Rate	Response Time
Video on demand	L	M
Home shopping	M	L
Home banking	M	L
Games	M	H
Gambling	M	M
Distance learning	M	M
Data downloading	H	H
Program guide	L	L
Subtitling	L	H
Program summary	L	H
Auctioning	M	M
Audience polling	L	L
Multichoice program	L	H
Share dealing/stock	M	M

Low Data Rate (L) implies a data rate of approximately 150 bits/sec or even less for simple return commands, including simple error correction.

Medium Data Rate (M) implies a data rate value of approximately 6 to 7 kbits/sec for more complex applications and instructions, including the requirement for more sophisticated protection for security and error protection coding.

High Data Rate (H) implies a data rate of approximately 64 kbits/sec for more demanding applications.

Current Implementations of Broadcast Interactivity

Fully Interactive

At present, interactivity is achieved either by the addition of very low-power radio transmitters to the TV set, or in a set-top unit, or by means of a connection to the switched telephone network. For satellite services the latter is preferred. In the U.S. the FCC has allocated a small band of the VHF television spectrum from 218 to 219 MHz for the radio links and has licensed its use in most of the major markets.

For radio-based systems, a number of areas of the spectrum can be considered, including the existing TV bands, compatible use of the current UHF allotments for cellular radio, or spectrum allotted for personal communications in the 1.5 to 2.0 GHz region. In the U.S. a band at 218 to 219 MHz has been allotted specifically for broadcast TV interactive links. The return links will be very low power and likely would use spread spectrum techniques to further reduce any problems of interference.

Interactivity is then effected using cellular techniques in this band, with up to about 75,000 subscribers per cell, with a collection network linking the cells using very small aperture satellite terminals (VSAT) or Public Switched Telecommunications Network (PSTN) technology. An anticipated usage per viewer of 5 sec/hr is the current estimate. Four companies have been licensed, and it is anticipated that 10% of the locations will be served by the end of the first year of operation.

EON Corp. (formerly TV Answer) has developed and is now in the early implementation of a system for upstream signaling called Interactive Video and Data Services (IVDS), carried on a tiny slice of radio spectrum above VHF channel 13 (218 to 219 MHz). The EON delivery system is an interesting example of how a hybrid two-way network can be assembled.

The system is arranged as micro-cells of a few hundred users, with the cell sites interconnected by the use of V-Sat satellite technology. The sys-

tem is fully bidirectional and does not make use of the digital transmission capability of the TV service itself. By the use of satellite technology in this fashion, the system will have nationwide coverage capability from the outset. Systems are also fielded by the companies RTT, Tee-Net, SCA, and WTW. The RTT system is entirely based on PSTN communications.

Locally Interactive

Locally interactive systems operate without a return path to the program source by selecting among a number of redundant transmissions, either in a single channel or on two or more channels, to effect some degree of interactivity. For some learning applications, this technique can be highly effective and can be augmented with PSTN techniques. One example of such a system is discussed next.

The company ACTV offers a multichannel feed into the viewer's home; the viewer selects the desired channel. With a football game, for example, the viewer may have a choice of watching a close-up of the

wide receiver or the running back, etc. It is not really interactive, in that the viewer cannot send any signal back through the TV, but it does offer the viewer greater choice.

The ACTV technology involves broadcasting multiple synchronized audio and video signals into the home at one time, although the viewer sees only one. With the aid of a "smart" set-top converter box, these signals are then edited into a personalized program utilizing viewer input and computer commands embedded in the TV signal. The technology is one way; i.e., no return signal is sent back to the cable TV head-end, either by cable, telephone, or any other means. Because of this one-way feature, however, an unlimited number of viewers can have the opportunity to interact and participate.

The viewer, using the handheld remote control, interacts by making selections or decisions called for by the programming. The "smart" converter box uses the input from the viewer and automatically switches between various program segments in a manner invisible to the viewer. To the eye the results appear seamless and uninterrupted, yet interactive and personal, since the viewer sees only the one version of the programming determined by his or her inputs.

The ACTV technology can be used with a single broadcast channel in several ways. For example, the graphic overlays may be generated within the unit and audio encoded in the video, and therefore do not require more than a single channel for transmission. Compression allows multiple signals to be combined into a single channel to provide some more sophisticated applications over conventional transmission facilities.

Further Developments in Broadcast Interactivity

There is considerable interest worldwide in the addition of interactivity to TV broadcasting services, both those delivered over the air by terrestrial transmissions and those delivered by broadcasting by satellites. Similar interest may be noted in the use of interactivity in wired systems, such as cable TV and television services delivered as part of the

PSTN. Interactivity may be used, for example, to enable additional service options, to provide viewer feedback, to provide pay per view (PPV) capability, or to control downloading of additional video or data within the broadcast channel.

On recommendation from the chairman, Prof. M. Krivocheev (Russian Federation), ITU-R Study Group 11, in Working Party 11C, has prepared a draft new question on Interactive TV Broadcasting, Question 232/11, leading to Recommendations in 1998. Broadcasting systems will probably be used for other purposes as well, so it seems to be of great advantage to incorporate the broadcasting receiver into interactive systems. For such purposes, the return channel is an important part of the system; good isolation would be required between the received and transmitted signal, and therefore good frequency separation would be needed.

In the context of distance education (DE), the addition of interactivity to broadcast services may prove of considerable benefit, particularly to developing countries, where conventional education methods are increasingly unable to respond to the rising demand for learning. Distance education is widely recognized as a key component of the response to this challenge. However, quality learning requires much more than just the delivery of information from a source (teacher) to a receiver (learner). Far more important than simple delivery is the sharing and enhancement of the educational process, which is provided by interactivity.

In May 1995, two bodies of the United Nations, UNESCO and the International Telecommunication Union (ITU), announced their agreement to cooperate in the definition, development, and implementation of a pilot project to explore the use of the emerging technology of interactive broadcasting in distance education.

The pilot project will result in the installation of a broadcasting-based interactive distance learning system in one or more developing countries, aimed at the critical area of in-service teacher education. In view of the

wide range of broadcasting and telecommunications services likely to be found, both terrestrial and satellite delivery alternatives are included, while interactive return and control paths using PSTN and satellite facilities are planned. Special consideration has been given in the project design to the presentation of information, the use of interactivity, and the Learning Centre design to foster the development of an optimal pedagogical approach for this application. Furthermore, the use of the interactive portion of the system during out-of-service times for access by the remote learning centers to a central instructional library/data base and to the wider range of resources available through the Internet has been included, thus enhancing the educational value of the pilot project facilities.

It is planned that the project will become operational early in 1998. Further refinement of the interactive distance education system is anticipated during the three-year developmental phase of the pilot project, during which time the technical and pedagogical performance will be carefully monitored by the project team of experts from UNESCO and the ITU.

A number of developments in telecommunications are also of interest to the development of interactive television. The wide implementation of digital services, such as PCS and, later, FLMPs, will offer wide access from digital terminals to the digital network, offering new possibilities for return channels. Similarly, the introduction of mobile satellite services (both LEOS and geostationary) will allow interactivity at the global level. In the less developed parts of the world, radio-based extensions to the network, such as local loop bypass (LLB) and radio trunking will allow interactivity to be developed economically in many regions. Clearly, the development of interactive broadcasting is yet another example of the synergism contained in the "convergence" equation.

Conclusion

Broadcast interactive television holds out to our society the promise of tremendous personal freedom and control over our communications. If

we want to realize that potential, there are several goals on which we will need to focus our effort and attention.

- First, we need to continue developing our understanding of the technologies that can deliver interactive television and how they can best be applied to a growing range of consumer needs. This learning should not focus strictly on technical issues, but should address the broad range of human factors that can help us foresee how people will actually use this powerful new capability in their daily lives. At this stage of the game, we should not unwittingly shortchange the value of experimentation and research in a rush to simply "do something." Short-term profits for individual companies are no substitute for informed farsighted planning.

- Second, policy makers should carefully examine the range of alter-

natives to make the best use of available spectrum.

- Third, we should keep aware of international developments in this fast-moving technology and stay active in efforts to arrive at international standards.

- Fourth, we should focus on ways to utilize the existing television broadcast infrastructure as we seek to move to new levels of communications capability.

- Finally, we should strive to understand what customers really want and need. Market demand is one of the very best guides for determining how best to use scarce spectrum.

Interactivity is an essential part of the future of broadcasting and its development is an urgent matter, bringing benefits to broadcaster and viewer, to education and entertainment, to new services and enhanced versions of the current ones, and to

maintain the broadcasting service in its preeminent position on the Information Superhighway. Interactivity will loom large in the future plans of the broadcaster, enabling new services, new sources of revenue, and a better understanding of the viewers' needs and preferences. The farsighted work of Study Group 11 of the ITU-R, UNESCO, and the several companies involved commercially in implementing services is clearly the direction for the future.

No broadcaster or service provider can afford to ignore these developments or stand on the sidelines as standards are developed for the future. If we can realize its full potential, broadcast interactive television would make human communication freer than it has ever been in the past. That potential holds out tremendous promise.

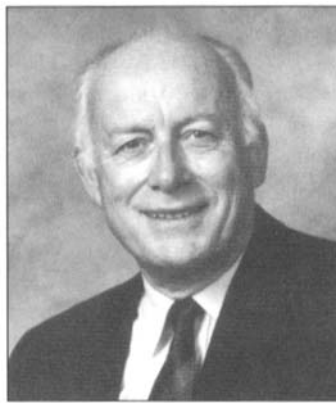
THE AUTHORS

Louis Libin is director of technology for NBC, where he is primarily responsible for spectrum and RF transmission technology issues as well as providing expert guidance to NBC-owned and operated stations on all broadcast engineering and project issues. In addition he represents NBC before the FCC and U.S. technology interests internationally. Libin concentrated on physics and electrical engineering as an undergraduate and optical electronics as a graduate student. He began his career as a design engineer, working on circuit and broadcast systems design. He is the author of numerous papers on various engineering subjects.

Kenneth P. Davies is currently a senior consultant for the Office of the Senior



Louis Libin



Kenneth P. Davies

Director of Engineering at the Canadian Broadcasting Corporation (CBC) and has just completed a four-year term as SMPTE Engineering Vice-President. A graduate of McGill University in Montreal with an honors degree in communications, Davies has been involved in many aspects of radio and television broadcasting during his career at CFCF-TV, Canadian

Marconi, Central Dynamics, and since 1977, at the Engineering Headquarters of the CBC. Much of his work has focused on advanced production systems, graphics and digital processing, and more recently, HDTV and the evolution of digital broadcasting.

In his current position Davies is responsible for the development and introduction of new technologies into CBC production, distribution, and broadcasting activities, in

addition to the CBC's representation in the development of technical standards, regulations, and recommendations. He chairs the Canadian Committee for ITU-R Study Group 11 and the ITU-R Task Group 11/1 (HDTV production) and also participates in a number of international committees dealing with advanced TV technology.