Use of the Television Vertical Interval to Broadcast Time for Everyone and Program Captions for the Deaf

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TELEVISION IS MORE THAN WHAT YOU SEE

Television today is a valuable source of information. Vast amounts of knowledge, labor, and money have gone into the production of documentaries designed to teach and inform us about everything from drug abuse to ancient African religious rites to the latest advances in science and medicine. In addition, the daily news is broadcast as it happens. Although halfway around the world, we watched via television President Nixon's landing in Red China. We saw the first man walk on the moon, and the tragedy of the 1972 Winter Olympics in Munich.

Because of television, our children are learning to spell before they enter kindergarten. We can learn to speak a foreign language, play a guitar, or even prepare a gourmet feast for Saturday night's dinner party, all through the amazing medium of television.

But television has an even greater potential for communications. A television picture is sent much like movies are projected, as a series of still pictures. There is a small period of time between pictures called the vertical interval. This corresponds to the horizontal black bar seen by the viewer when the picture rolls. It is black because no picture information is being sent, but it is still part of the television signal. The National Bureau of Standards at Boulder, Colo., has developed a new system which utilizes a small part of the vertical interval to distribute accurate time and frequency signals. This new system is called the NBS TvTime System, and its development has led to other exciting possibilities for television communications.

IT'S TIME FOR TvTIME, BUT WHY?

Almost any attempt to trace the source of time and frequency available to the public eventually leads via telephone companies, power companies, radio and television stations, and commercial time services to the National Bureau of Standards. The most common link is radio station WWV. However, a study undertaken in 1969 showed that WWV was no longer meeting many U. S. needs for readily available time. The age of the computer and high-speed communications systems has brought about the need for more accurate time information, preferably in digital form. WWV's shortwave radio signals are characterized by noise, fading, and other atmospheric limitations. The signal that finally reaches us is no longer precise enough to meet these needs.

A better system was needed. NBS recognized the communications capacity of the vertical interval, and realized it could be used to send digital time information. After much research, the TvTime System evolved [1]. Using the vertical interval, digital information rides piggyback on existing television networks, providing time in hours, minutes, and seconds. And for the scientific community, precise time is available to millionths of a second.

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HOW TvTIME WORKS

We have come a long way since Samuel Morse first devised a code for long-distance communication via electricity. Today's high-speed codes can change at a rate of five million times each second, and circuits capable of deciphering these codes are small in size, offering convenience of use.

By inserting a high-speed time code into the vertical interval at the television network, one electronic circuit can communicate the time of day to another electronic circuit using a television signal—and nothing is seen on the TV picture. If a time decoder is attached to a television set, the time *can be* displayed on the screen.

It should be stressed that the time is not visible on an ordinary TV set. Even with a specially adapted set, the time can be turned off if desired. Neither the viewer nor the broadcaster is bothered by the signal.

WHAT ARE THE ADVANTAGES OF TvTIME?

The NBS TvTime System is characterized by low user cost, exceptional accuracy, and very wide coverage of the population centers of the United States. This is possible because the national television distribution systems are of a quality and enjoy a maintenance standard not matched by other systems. The TvTime System is easy to use, does not fade, is subject to little or no interference, and is adaptable to an electronic interface with computers, data recorders, and other digital systems.

All of this is great for the consumer, but what about the broadcaster? Is there any motivation for him to put the NBS signals on the air? Yes, there is. A complete TvTime installation will help the broadcaster too. In addition to providing a convenient time display on the studio monitors, the system will provide a one-way communication channel from the network to affiliates. It will also generate program titles and captions as desired, e.g., news and emergency messages. Finally, it will provide a 1-MHz frequency reference and a once per second pulse for synchronizing station operations. the TvTime System would be a valuable addition to the network facilities.

FROM TIME TO CAPTIONS

In October 1971, the TvTime System was being tested at the ABC network in New York City [2]. In addition to the time being displayed on the screen, written messages were being sent to other ABC affiliates and to the NBS in Boulder. The message capability pointed the way to another use for the system—program captions for the deaf.

If captions could be encoded into the vertical interval using the TvTime System, the television networks would have one less problem to worry about. For years, U.S. organizations for the deaf—representing some 20-million deaf and hearing-impaired persons—had been trying to get the networks to

caption all programs. Understandably, however, the networks were reluctant to do so. Why should they force all viewers to see captions just to benefit a few? The NBS TvTime System could be the answer. The networks could broadcast captioned programs, but only those viewers with specially adapted television sets could see them. Other viewers would not be aware of them.

As it turned out, captioning was indeed a possibility. By December 1971, not quite two months after the ABC tests began, NBS efforts were being directed toward that goal. The TvTime System was modified to provide captions and was demonstrated at the National Conference on TV Captioning for the Hearing Impaired at Knoxville, Tenn. Caption decoders were connected to the TV sets at the conference; ABC had all necessary equipment, including keyboards for generating captions. In addition to the regularly scheduled program, captions were sent from New York.

A flurry of excitement followed the Conference. As one attendee wrote: "The National Bureau of Standards demonstration . . . was the highlight of the conference. This technical breakthrough might be considered the 'moon shot' for the millions who never heard the words 'one small step for man; one giant step for mankind. . . .' The 'moon launch' for captioned television was successful, but the outer reaches of space are yet to be charted."*

No wonder there was so much excitement. The TvTime System appeared to be the first real solution to the problem of captioning. Over the years, several methods had been tried, but none of them proved feasible. One method involved the use of two separate transmitters and two television sets, one each for sending and receiving captions, and another pair for sending and receiving the regular picture. Needless to say, this was very expensive and, therefore, never became operational.

Another technique used a telephone connected to an electronic device inside a television set. Originally intended for emergency warnings, it was never used to caption regular TV programs. It required much complicated equipment and was extremely expensive.

More recently, other methods have been pursued. Some children's programs employ videographs. This has proven to be quite successful in teaching not only the deaf, but all young children.

In August 1972, the HEW funded WGBH-TV (PBS affiliate in Boston) to caption a series of reruns of "The French Chef." The captions were videotaped along with the picture and were very well done. WGBH-TV had hoped to make a study to determine the success or failure of their efforts, but they ran out of money before this could be accomplished. However, viewer comments were put together in a report which showed that both deaf and hearing-impaired audiences were in favor of captioning.

Although technically feasible, most of these methods are not practical. One big problem still exists: the captions distract the hearing viewers. The NBS TvTime System solves this problem. Captions, in code form, are transmitted along with the normal television picture, but a special decoder connected to the TV receiver is needed to make the captions appear on the screen. Without the decoder the signal remains undetected. Even with a decoder, the viewer has the option of turning it on or off as desired. The code in no way interferes with normal television reception.

In February 1972, the system was demonstrated at Gallaudet College for the Deaf in Washington, D.C. By this time, many improvements had been made. The PBS (educational) network is now testing the captioning aspects of the system. They plan to continue these tests throughout 1973 and part of 1974.

As indicated by the large number of inquiries received by NBS, the interest in captioning appears to be great. This interest has now spread overseas. In England, the British Broadcasting Corporation has developed a system called CEEFAX [3], [4] which was designed to provide news, information, entertainment, and captions for the deaf. Experiments using CEEFAX are scheduled for late summer 1973. The Independent Broadcasting Authority, also in England, is working on a captioning scheme called ORACLE [5].

In Japan, two television information and captioning systems were demonstrated in May 1973: the "TELESCAN" system developed by Osaka Asaki Broadcasting Company and Matsushita Electric Company, and another system (unnamed) developed by station NHK.

All of the above systems use the vertical interval and are similar in some ways to the NBS TvTime System.

The ABC and PBS tests have proven that the NBS TvTime System is technically feasible. It is economically feasible as well. A complete network installation to generate, transmit, and decode captions will cost approximately $3000.** The home decoders can also be made inexpensively. The deaf have indicated that the value of captions to them is far greater than the small additional amount for a decoder attached to a television.

FIRST THE CAPTION DECODER, THEN A CHIP

It goes without saying that a television set has some gadgets and extras that help to produce the picture that is seen, especially if the set is color. Many times, TV manufacturers add devices that make the picture clearer and more vivid and that provide automatic fine tuning. A TV message decoder would be just such an attachment. Adding the captioning capability to any existing television set would not require a complete overhaul of all the electronic circuits. In fact, it is possible to do all of the caption processing by attaching a processor to the antenna terminals. This is costly, though, because the processor would have to have extra tuners and converters that are already in all TV sets. It is easier for a service man to attach the caption processor to one point in the set.

The caption processor consists of four parts: decoder, character storage, character generator, and a converter for display on the TV screen. First the digital code is extracted from the television signal. It then accumulates in code reservoirs, or memories, that store a complete caption. Next, the codes are translated into alphabet characters using a character generator. Finally, the characters are converted into a form that enables a complete caption to be displayed on a television screen. When another caption is sent, the entire caption processor is cleared and ready for the new message.

At the present time, several prototype versions of caption

*From "Perspectives from an ivory tower: A look at the National Conference on Television for the Hearing Impaired," by Bill Jackson, in *Video Memos*, a publication of the Southern Regional Media Center for the Deaf, University of Tennessee, Knoxville, Tenn., February 1, 1972.

**Not including cost of tape reader and punch or other high-speed input/output devices such as disk or magnetic tape store.

processors have been developed. The most promising aspect of the design is that it lends itself to being almost entirely digital. This means that the caption processor could be made into one integrated circuit, or "chip," such as those now used in the new desk-top calculators and minicomputers.

The advent of the chip within the last decade has made possible the development of large computer-type digital circuits at very low cost and small size. With a chip, it is conceivable that the complete caption processor would someday cost as little as $20 and be about the size of a 50¢ piece.

As the TvTime System becomes more and more popular, it is reasonable to assume that an integrated circuit chip will be a forthcoming development. The same chip may have a number of other features such as channel identification, emergency warning messages, as well as, of course, accurate time and captions.

LOOKING AHEAD

It is a welcome thought to consider that the television is expanding its capabilities. The TV industry is a multimillion dollar operation, with news and entertainment being two of its most noteworthy products. Soon your TV set may have available the time of day so accurately and so reliably, it may be used as the reference for everything in your house that depends on time. Your clocks could be set electronically. While you're away from home, your pet's automatic feeder could be operated from TvTime.

The computer terminal in your house will need to know the time very accurately. What is a computer terminal doing in your house? The little box on the TV set that gives the time also gives you captions and warning messages. Cable television offers even more possibilities. With a box and an electronic keyboard, you may be able to get help from a local computer to do your arithmetic problems for taxes, budgeting, and checking accounts. It won't make much difference how complicated the problems are. You may be able to send a message to a grocery store for a delivery. Imagine having an illness diagnosed in your own home through a device attached to your TV set. The infomation could be sent to a hospital and analyzed.

Television has come a long way, but it has a big future ahead. TvTime and captioning are two capabilities that have been a long time coming. It's a huge task to get such a bonafide industry like television to wake up to new opportunities, new areas of research. But isn't that first step always the biggest?

BUT WHAT ABOUT THE PRESENT?

All of this is in the future, though, and before it becomes a reality, we must take care of the present. What is the status of the TvTime System and what are the steps toward implementation?

Since the TvTime System will use part of the TV broadcast spectrum, authorization must be obtained from the Federal Communications Commission. A petition requesting authorization to broadcast both time and captions was filed with the FCC on December 22, 1972. They have not yet ruled on our request; however, we expect the issue to be opened for public debate in fall 1973. We feel it is only a matter of time before approval is granted.

Then it will be up to the networks to put the TvTime signals on the air. ABC and PBS, both having tested the system, are likely to support its implementation, and we expect the other networks to eventually follow suit.

As for the home decoder, the present prototype equipment, made of readily available parts, is feasible for home use. The cost of this equipment is economically viable. However, while the prototype decoders are feasible, NBS will provide circuit diagrams and advisory assistance to integrated circuit manufacturers who are interested in developing a low-cost decoding chip. Several manufacturers have indicated an interest in this possibility, and it is reasonable to expect decoding chips will be on the market soon after the system becomes operational.

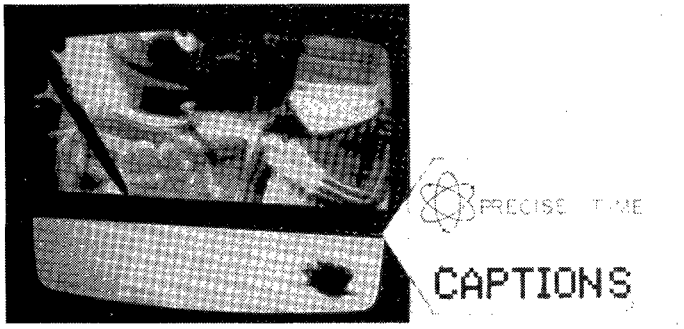

Fig. 1. A code, sent in the vertical interval along with the regular broadcast, can be decoded to provide time and/or captions.

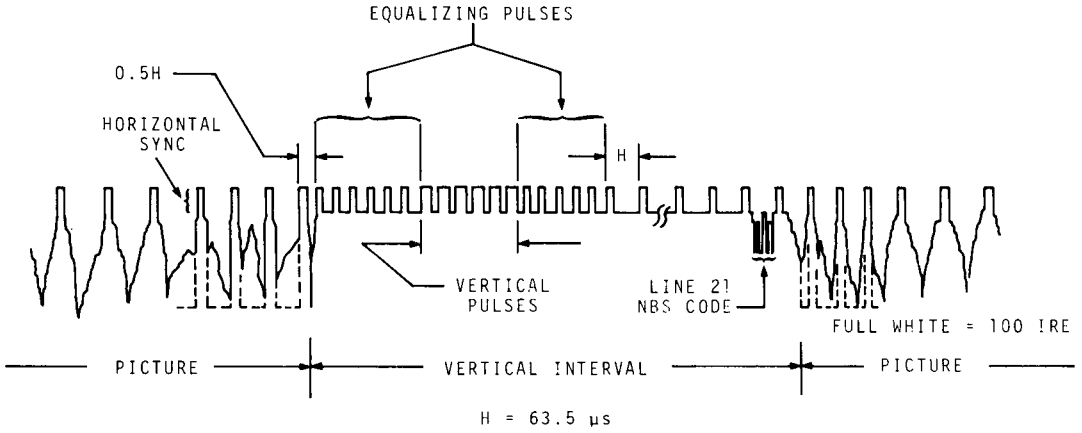

Fig. 2. Waveform diagram of the television format at the vertical interval. The NBS digital code is on line 21.

Fig. 3. Beginning in August 1972, "The French Chef," featuring Julia Childs, was captioned by WGBH-TV, Boston (a PBS affiliate). For eight weeks, the deaf were able to watch and enjoy Julia Childs at her best. (Photo courtesy of WGBH-TV.)

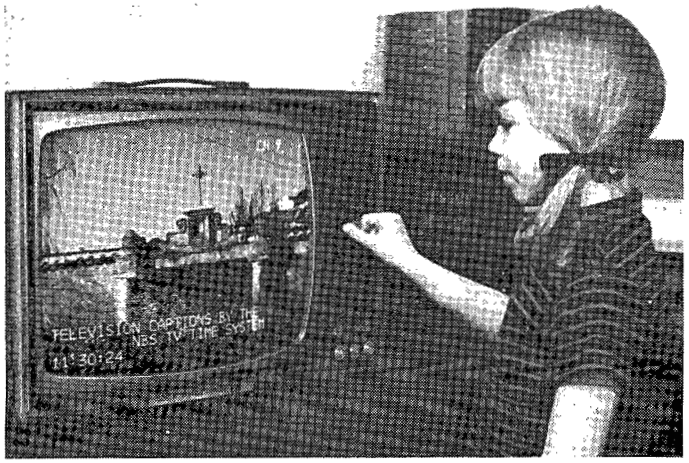

Fig. 4. By turning a switch, a television viewer has the option of seeing time, captions, and in the future, perhaps, channel identification.

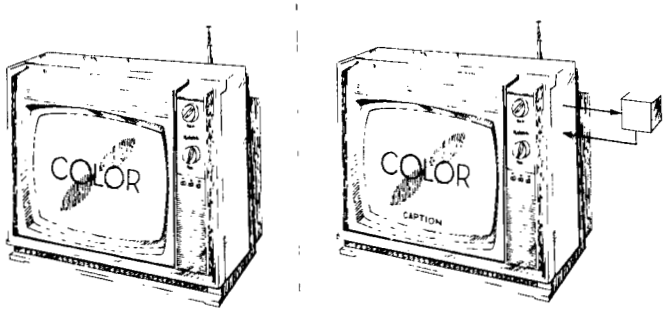

Fig. 5. The television on the left receives regular television programming. The addition of a small decoder, as seen on the right, makes captions available at the touch of a button.

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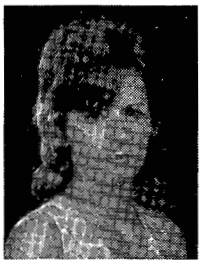

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Since the summer of 1969 he has been with the National Bureau of Standards' Time and Frequency Division. His initial work was concerned with determining effective modes and formats for WWV and WWVH. For the past three years he has been actively involved with time distribution via television. He has extensive knowledge of many areas of the broadcast industry and serves as a Consultant for the Boulder radio stations.