AN OVERVIEW OF CABLE TELEVISION FOR MICAB

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June 1972

P-4855

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North American cable television systems are a good approximation of what is currently feasible. Emphasis has been on 12-channel, single coaxial cable systems. Distribution costs alone for the 12-channel systems last year ranged from a low of about $2100 per kilometer of plant to as much as $2700 per kilometer of plant simply for the strand, electronics, and labor for the installation of typical aerial plant (where amplifiers are spaced to offset the cable loss at 216 MHz). More recent systems have spaced the amplifiers to offset the cable loss at 270 MHz to allow for more channels per cable although the cable is tested through 300 MHz. In going from 12 to 20 channels, the average increase in distribution cost has been only $400 per kilometer of plant.

Distributing more than 12 channels on a single cable, however, requires the subscriber to use a special frequency converter with the television set. Per unit converter costs tend to vary from $35 to $50 in small quantities and can be as low as $20 in large quantities. While the typical inexpensive converter overcomes many deficiencies in the conventional television set (e.g., poor shielding and high local oscillator injection into the cable distribution system via the drop cable), it merely replaces them by other deficiencies (e.g., poor

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*This paper was presented at the final plenary session of the 1er *Marche International* de la television par *Cable* (MICAB), the First International Cable Television Market held at Cannes, France, March 6 through 10, 1972.

frequency stability and poor adjacent channel rejection). One speaker at the MICAB conference mentioned that the old-style converters used in one cable system in New York City required eight full-time technicians to maintain some 33,000 converters. Some of the new varactor-tuned converters offer remote tuneability; they may prove to be more reliable but currently there are insufficient data on them.

Converter development still has a long way to go. Despite recent improvements in converters, they still are characterized by limited dynamic range due to poor large signal characteristics and unexceptional noise figures, and by poor frequency stability. In aerial systems (i.e., cable systems installed on utility poles) where varying temperatures cause large signal-level changes, some experts rate the degradation of the set top converter as equivalent to the degradation caused by the distribution system. To provide high quality and high capacity on a single cable, a much more expensive converter at every subscriber's location is required to provide isolation, whether or not the full capacity of the cable is available to every subscriber.

The average cost of installing a second cable in the United States, including both labor and electronics, is about 50 percent more than a single cable for just the distribution plant between the headend and the subscriber drop. Since no alternative to the cheap converter is currently available, dual-cable installations are the only means for providing high quality and high capacity simultaneously. Experiments to test the range of programming that might be provided with a high-capacity cable system and to search for new sources of revenue to support such programming are therefore best carried out over dual-cable systems. High-capacity systems would allow the possibilities of instructional television to be fully tested for use in preschool, elementary and secondary school, university education, vocational and adult education.

At medium penetration, the investment per subscriber for a dual-cable plant is comparable to that for a single cable plus converter. At high penetration, the dual-cable system is certainly preferable since it results in lower investment per subscriber and better quality.

There are substantial savings in labor costs if an extra trunk is installed at the same time as the other cables. A shadow trunk, which is

an extra trunk cable that includes no electronics, can be installed for only about 10 percent more than the cost of the single cable plant. With shadow trunking, the much larger investment in electronics will be postponed until such time as it may be needed. Larger housings allow room for future installation of the electronics. Many operators prefer to follow this approach in the United States because they have seen no evidence of revenues to cover the extra costs of providing the much larger number of channels or a return capability. These operators assume they will be able to provide a two-way capability on this system some day if it proves attractive to do so. The questionable part of the design is that the single feeders must carry signals in both directions. There is, however, no evidence as yet to prove one can provide high quality, high capacity and high continuity of service operations plus the two-way capability on the single feeder plant.

In general, cable television distribution in Europe poses greater problems than in the United States. In Europe, the adjacent channel interference problem in the home television set tends to be worse than in the United States due to the use of wider channel bandwidths. Thus some systems spread the signals out over both the VHF and UHF bands. There is no counter part to this in the United States since a high percentage of sets can be adjusted for satisfactory adjacent channel operation. There is even more need for better headend equipment and set top converters in European systems to act as buffers between the highly variable signal standards within individual countries, i.e., ORTF 1 and 2, and between countries, e.g., SECAM and PAL and the highly variable home TV-set characteristics. Unlike the United States, most European systems are underground (except in rocky areas) which also raises the costs.

There are some important developments in technology of which little has been said at this Conference. The development of a special receiver for cable use is, of course, a preferable solution to the converter but more difficult to implement because of the high cost and long life of the TV receiver (about 10 to 12 years in the United States). The phaselocked audio-video processor, when locked to a

frequency comb generator, may significantly reduce intermodulation products if there are common synchronizing signals on all channels. By reducing the number of distinct frequency beats, phaselocking of the carriers reduces the distortion of the cable distribution system. Investigation of suppressed carrier operation where a phaselocked carrier would be reinserted at the TV set has been proposed. One channel in such a distribution system could be devoted to the transmission of an unmodulated carrier for reinsertion on all channels. This approximates the optimum system on an information-theory basis for the transmission of the maximum number of channels through a coaxial cable for a given level of intermodulation.

It is apparent that many European companies already have equipment for distributing 12 to 20 channels and are developing new amplifiers and special terminal equipment for two-way services. The problem is how to attract subscribers to such systems given the large number of existing poor-quality master antenna television installations (MATV systems) in multiple-dwellings. The answer depends on finding a way to fill all those channels or to develop the market for the two-way services.

It is not clear whether or not communication satellites will have a particularly important role in interconnecting cable systems by 1980. Regional terrestrial microwave links are currently able to provide a cheaper cable-system interconnection than a first-generation satellite system, unless the channels are priced on an incremental cost basis for the satellite and on a fully allocated cost basis for the terrestrial microwave links.

In the United States, satellites can apparently compete with terrestrial microwave links on AT&T's longest routes for the TV networking service. In Europe, satellites will compete on long hauls (e.g., from the Scandinavian countries to Spain), since the reliability and continuity of service of long microwave links is not satisfactory. In the U.S., such companies as Western Telecommunications already supply television signals to about 120 cable systems in the Western States. Some of these signals (Los Angeles independent stations) are carried as far as 2000 kilometers by terrestrial microwave link, which virtually

makes them part of a regional network. In northern Canada, the situation is quite different because of the long, uninhabited distances between small communities. To cope with this special situation for which terrestrial microwave is ill suited, Canada is carrying out an imaginative satellite development program consisting of a first-generation Anik satellite and an advanced program called the Canadian Technology Satellite. This latter satellite will use high-power tubes with an output of 200 watts, more than 20 times the power of the output traveling wave tubes currently in use in Intelsat communications satellites. Such higher power-per-channel satellites permit smaller and thus cheaper ground stations suitable for community receivers.

One of the most recent developments in the United States has been in multichannel, single-sideband AM and FM microwave equipment. Five companies are currently developing versions of this equipment, especially the single-sideband AM version. This multichannel microwave equipment is intended to provide "Local Distribution Service" (LDS), i.e., local cable-television system interconnection. Operating in the region between 12.7 and 12.95 GHz, LDS equipment can provide 6 to 20 television channels over distances up to 30 kilometers to a receiver that costs no more than a single-channel FM receiver. Such microwave systems may offer an alternative to supertrunk installations for interconnecting multiple headends within a single large city. In addition, Local Distribution Service equipment offers the possibility of transmitting the best 20 urban programs to cable television systems serving rural towns as far as 30 kilometers outside the urban-area boundary. Laser or optical interconnection will be useful for studio-to-headend links of 1 to 7 kilometers; greater distances may be covered in areas of infrequent rain and fog or where greater periods of being out of commission* prove acceptable to the users.

A lot of nonsense has been written in the United States about two-way service on cable systems. No one really knows how to build good, reliable two-way systems today. It may be necessary to limit the number of subscribers per trunk to 1000 in order to limit the

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* The cumulative time out of commission is referred to as the total link outage time.

number of spurious signals leaking into the system. Low-error rate responses for a variety of services may require high-quality, flexible transponders. These two demands may necessitate processors, or even minicomputers, for the subscriber-return signals at each subtrunk or at each trunk amplifier. If two-way systems of this type prove necessary, they could enhance the attractiveness of switched systems analogous in some ways to those suggested by Rediffusion and Ameco. Clearly, wider experimentation in two-way-systems technology is needed.

At the present time there is tremendous uncertainty concerning the demand for any of the proposed two-way services; little data exists on which to base a decision as to which are best suited for cable television systems and which may be more cheaply provided by the existing telephone system. Given the uncertainty about revenue from two-way systems, only operators with adequate capital reserves for several years should take part in such experiments. Others are well advised to stand on the sideline and observe. This is clearly a capital-intensive, high-risk area.

Many people have been carried away by the social idealism behind community television on cable systems run by volunteer non-professionals, despite the availability of factual data on the problems of attracting a sizable audience for such programming on a consistent basis. It is not important for the audience to be large; but the smaller it is, the more precisely its size and its characteristics must be known. Community origination on cable television is a recent development. The problem of covering the small production costs of community television remains unresolved even though free distribution via the cable system may be assured. The facilities available for community origination are typically those used by the cable operator for his own local originations.

To place the facilities available for community origination on U.S. cable systems in perspective, note the following figures. Large network stations--television broadcast stations belonging to the major networks in the United States--have a typical capital investment in studio equipment of $5 to $6 million. Contrast this with the several

hundred independent television broadcast stations in the United States. Most of these are UHF stations, which have a typical investment in studio equipment of $1 to $1-½ million. In general, the independent UHF television stations operate at a loss.

Local origination on cable television operates with investments in studio equipment ranging from less than $30,000 to as much as $300,000 (although only a few have an equipment investment in excess of $100,000). Since most U.S. cable systems producing non-automated local origination programming have about 3000 to 30,000 subscribers, their investment in equipment averages about $10 per subscriber. Systems with investments in origination equipment of less than $50,000 to $90,000 tend to cablecast in black and white.

To place the hourly cost of community and cable operator locally originated programming in perspective, note the following figures. Network programming costs range from $100,000 per hour to as much as $800,000 per hour for specials. The average cost last year for one hour of network programming was about $225,000. Educational broadcasters with $1 million of studio equipment typically originate 5 to 10 hours per week of local programming at a cost of $3000 per hour to as much as $30,000 per hour. Some cable television systems attempt to originate 20 to 30 hours per week of programming using volunteers; typical costs per hour of origination vary from $50 to $300 per hour. To produce neighborhood programming, ½-inch portable videotape recorders are being used successfully. Tape recording in natural settings avoids formality and artificiality. Such low-budget local origination by the cable operator or by community groups must rely more on the appeal of a hobby or of an important community issue than on slick professional techniques to attract an audience.

In both the United States and Canada, UHF broadcast stations benefit when there are numerous large cable systems to distribute their signals. Since these cable systems carry the UHF stations in the VHF band, this places them on a par with the VHF stations. The cable system provides the UHF station the convenience of detent tuning on the home

television set, better receiver quality and larger coverage area. For many UHF broadcasting stations, carriage on cable systems is essential in order to be financially successful.

In order to support the investment required for good quality headend equipment and a good studio for local origination, it is often necessary for several smaller cities to join together and franchise a common cable system. A potential market of 20,000 to 60,000 households is required to support a high-quality, urban cable system which includes a color studio, headend electronic equipment for 20 or more channels of programming, and a computer and peripherals for real-time, two-way interactive television. This assumes a penetration of 30 to 40 percent of the households.

When a single system serves such a large area that it covers 20,000 to 60,000 households, however, how can one avoid compromising the ideal of providing separate programming to each neighborhood? Neighborhood programming in this situation requires as many as four to six trunk cables emanating out of the headend so that each can carry separate community programming. Such an arrangement spreads the fixed-investment cost of the antenna tower and headend over a large number of households, yet also provides the possibility for distinctly different programming aimed at small local groups within the franchise area.

Pay television is likely to be a major source of income for cable operators. Per-program, pay-TV operation has already begun in hotels in the United States and is likely to spread rapidly over the next few years. There are various types of black boxes for implementing the pay-TV service on a per program basis; some use optical decoders, magnetic decoders, or electronic descramblers. Cable operators can better afford the high cost of film and videotape cassette playback equipment than can the average consumer. Also, as long as the cost per hour of prerecorded material remains high, cable operators will be able to invest in libraries of this material more readily than the individual consumer. It may prove simpler to implement such a system rather than leasing players and cassettes to consumers.

Using cable television to distribute video cassettes on a pay-TV basis will maximize the fraction of revenue collected from consumers going directly to the producers and distributors of the software because it minimizes the incremental investment in the delivery system and in

copies of the software. The high costs of playback equipment and programming on a per-hour basis and the lack of standardization in cassette equipment indicate that the cable operator will play a key role in distributing pay-TV programs whether on film, magnetic or holographic tape, or videodisc.

It is popular to give names to communication barriers such as the Iron Curtain or the Bamboo Curtain that inhibit the free flow of information. There is a copper curtain (an electromagnetic shield or barrier) that currently prevents filling channels on cable television systems. There is enough television programming from the European countries to fill 20 television channels. The technology to build such systems is readily available within European companies. Why they are the channels of the few existing systems largely empty? All major countries of the world, including Western Europe, tend to exclude the continuous domestic distribution by microwave link of the national networks of their neighbors. No country permits unrestricted distribution of foreign television programs by microwave link, even when cable television operators are prepared to pay for the interconnection costs. The copper barrier may be less visible, but it is there all the same. Only a few countries in the world, such as Belgium, the Netherlands and Canada, are coming to terms with this problem by debating the issues openly.

The Common Market members might strengthen their unity by arranging to have the individual national networks carried to each of the member countries. One might some day look forward to the extension of this arrangement to all the members of the European Broadcasting Union (EBU). With permission to transmit continuously any country's national network television programs over cable systems in any member country without payment of copyright, cable television would be able to provide an attractive service, which would promote its own growth. If these programs are carried in the original language, the result may be to increase the market for the translated programs -- increasing the value of the copyrights.

In the near future*, there is another role for cable television. In most of the world, where there is no counterpart to the several hundred

*Before the arrangements for such international networking via satellite or microwave link are consummated for cable systems, before we learn how to build two-way interactive cable television systems to the home and learn how they may generate revenues to cover their costs, and while community groups are slowly learning to utilize cable television to generate community concern and action.

U.S. independent television stations, overcentralized paternalistic control of one or two national networks is the rule. Cable television permits the development of local television stations and of regional networks broadcasting perhaps on UHF or operating purely closed circuit so that programs are only available over the cable.

Independent UHF broadcast stations have difficulty operating profitably in the U.S. since they must compete with the three networks and with the independent VHF stations for audience and advertiser revenue. In many countries, however, a tax on television sets is used to support television programming. With local and regional tax revenues, and possibly local and regional advertising revenues, and with fewer channels to compete against*, there is little doubt that professional local television will be successful in Western Europe.

When we refer to local origination in North America, we generally have in mind origination by the cable operator as a public service using amateurs and semi-professionals. Community origination controlled and produced by community groups is a potentially important variant of local origination. (In the 100 largest U.S. television markets, the Federal Communications Commission requires each cable system to make one channel available free of charge for public access under the February 1972 rules.) For most of the world, local origination may also mean municipal and regional television--an alternative to broadcasting under the paternalistic, overcentralized control of a Federal government ministry.

In developing countries, decentralization and public access may appear synonomous with loss of authority and even anarchy. For such countries, improved centralized communications appears to be a necessary tool in gaining acceptance of a common language and for forging a sense of national identity. But, for highly developed countries, where decentralized communications and increased flexibility to cope with local issues is desirable, cable television may prove a useful tool.

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* U.S. cable television systems with 10,000 or more subscribers carry an average of about nine to ten stations in addition to automated services such as time and weather, news tickertape service and the stock market reports.

Each of these potential developments -- community origination, the worldwide growth of local and regional television stations, interactive television in every home and the continuous international distribution of national networks -- depends on the high capacity and flexibility of cable television distribution systems; each may constitute a major revolution in communications.