The Universal Communications System of the Future, Telephone or TV Cable?

by Paul Baran
Com21, Inc.
83 James Ave.
Atherton, CA 94027.

Abstract

This paper addresses the question, "Can cable TV become the universal communications platform of the future, and even supplant the twisted pair telephone loop system?"

BACKGROUND

Pre-Cable

To begin, let's briefly review some of the history of cable television. Cable started life as an extension to a TV antenna forty years ago, delivering a couple of local TV broadcast stations to those unable to obtain a workable antenna site. TV was characterized then by Newton Minnow, chairman of the FCC, as being a vast wasteland -- three mass audience networks, each seeking the lowest common denominator of intelligence.

Impact of the Satellite

As recently as twenty years ago, cable's future didn't look bright. This outlook changed dramatically with the technological innovation of using satellites to deliver premium programming to each cable head end. For the first time, urban areas could justify cable to obtain access from satellites to new programming not available off the air from broadcast stations. This led to a period where the cable system operators fought for urban franchises, each promising to deliver more non-existing services relative to the competition in order to win the big city franchises. In parallel, the industry developed the political muscle to pull off the Cable Act of 1984 which absolved the industry from having to fulfill the more outrageous promises made during the franchising frenzy. Over time, in an era of minimum regulation of cable TV, the value of cable systems increased from about $600 to $2500 per subscriber.

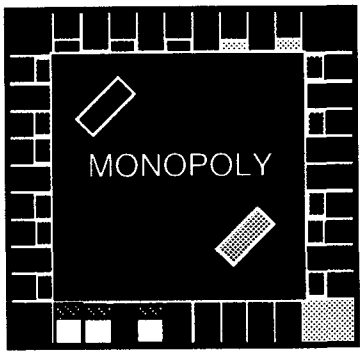
Today

The cable TV industry can be rightfully proud of the tremendously increased diversity of programming it has brought to the nation. I rarely watch the three over the air networks. Rather it is CSPAN, A&E, the Discovery Channel, the Learning Channel and a few PBS stations that get my attention. As the number of program channels has increased, so has the diversity of the audience and the wider the range of programming that became feasible. And, this trend is just beginning. The dramatic increase in the number of channels that can be delivered using the latest technology is but one dimension of the coming changes.

THE MONOPOLY GAME

The passage of the 1992 Cable Act represents a coming of age as Congress recognizes the importance of this new and growing industry and as an important monopoly subject to rate regulation. Of course, the cable industry tends to view it

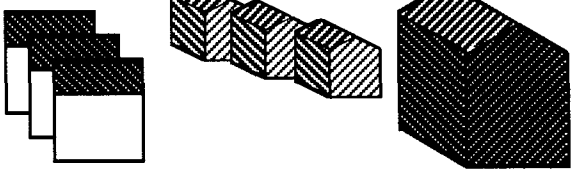
as our government's proclivity to punish success and reward failure. But, then there are many ways to look at the same situation. Since the industry is being considered as being a monopoly it is fun to think of it terms of the old board game "Monopoly"



1. ACQUIRE THE RIGHT PROPERTIES

2. BUILD HOUSES

3. BUILD HOTELS



As you'll remember, when you played Monopoly, you acquired properties on the roll of the dice. Then after all the properties are divided, you'd swap properties with the other players. For example, when you hold all the yellow titles you create a monopoly position which allows you to double the rents the other players had to pay you if they were unlucky enough to land on your property As the game continued, you saved up enough money to build little green houses on the properties, increasing your rental income. After you accumulated even more money, you built big red hotels. And, when any of your rival players landed on them, you really cleaned up.

Since 92 % of the TV homes in the US are now passed by cable, the properties in the real game have already been divided up among the players. We are beyond that stage. Investment in new technology to increase revenue is underway -- more channels, pay per view, and even movies on demand. These investments are the little green houses. So far, so good.

Now, with the new digital technology now available, the cable TV industry is in position to build the Big Red Hotels -- with their huge potential revenue opportunities. Before we get into the specifics of the revenue implications for cable, let's review where the technology is going.

TECHNOLOGY ADVANCES

About five years ago the architecture of using fiber as TV trunks to carry analog TV signals was developed by Jim Chiddix and his ATC colleagues. Given the increased use of fiber means that quality of the TV image, system reliability and the number of channels delivered by cable may all be expected to improve dramatically over time.

Digital

Also rapidly developing are new technologies in the areas of digital processing, transmission and switching. While analog TV sets will continue to be with us for many years, we are already seeing the benefits that digital brings. Images can be transmitted without additive distortion or picture quality loss. And, with digital processing, the removal of redundant information permits compression, allowing the signal to occupy far less channel bandwidth than before. Recording and resurrection no longer means irrevocably degraded picture quality. Once recorded, there need never be any reduction of image quality over time or over distance.

CableLabs Architecture

The cable system architecture of the future as envisioned by Steve Dukes and

his colleagues at CableLabs is a universal two way general communications system, with the upper ends of the network interconnected by fiber loops. Separate fiber loops carry analog and digital signals, with some of the digital signals being ATM-based. ATM is a new transmission and switching scheme that uses small self-addressed packets of digital bits for very high speed transmission over fiber optic facilities. Longer distance fiber loops provide a redundantly connected transmission capability using fewer head ends in a regional area and offering significantly increased system reliability.

Time-Warner Orlando

While the CableLabs architecture is pointing the direction, others in the industry are also moving forward to develop their own systems of the future. One leading edge system is being developed by Jim Chiddix, Dave Pangrac and Jim Luddington and their Time-Warner colleagues for trial in Orlando, Florida. It is an ATM-based, digital transmission network that will support voice, data and TV.

On the Importance of ATM

With digital, all signals whether they be voice, or data or pictures are identical in transmission formats. This allows the transmission of a mixture of different signals together in a highly efficient form. Networks of the future will be based upon ATM, or asynchronous transfer mode, a fancy name for fast packet switching.

With ATM, all information is transmitted as short standardized 424 bit long cells or packets. ATM is a universal building block technology for future telephone and data networks and is particularly useful when video must be stored in digital memory and retrieved on demand. Some industry pundits even believe that all digital transmission and switching in the future will use ATM cells, because of its compatibility with very high speed digital switching networks.

If one were to design an entirely new telephone system to best meet today's and tomorrow's requirements, it would not be built the same way as our existing telephone system. It would be built using many of these new technologies instead. Of course, it would have to interconnect with the existing telco system. Functions that once required a large and complex installation like the telephone central office are today relatively simple to implement using new technology. New fiber optic, digital and radio technologies open new options to the designer. The designer of these future system sees three significant new factors to be considered:

- The availability of new technology such as ATM
- The availability of a cable TV network with up to one GHz transmission path to homes, either in place or anticipated
- The incremental deregulation of the telephone industry which is enabling efficient system interconnection

COM21, A NEW SYSTEM

A small group of colleagues and I have joined together to create a new company, Com21 Inc., which is working together with strategic partner companies to further define and study such a new telecommunications system. Com21 believes this new system can significantly enhance the Nation's telecommunications infrastructure by using several of these new technologies to deliver a wide range

of new services over the cable television plant. Ultimately, Com21 intends to be a communications operating company which implements and supports this new system.

This new system is based upon the use of the existing cable TV plant as a transmission path. It uses short distance, unlicensed radio to eliminate any requirement for additional in-house wiring. It particularly matches the evolving future generation cable TV architecture as defined by CableLabs. By taking advantage of the dramatic progress in the technologies of fiber optics, advanced networking, and wireless communications, the new system will be able to deliver a new range of telecommunications services and do so at lower cost than current telephone systems. Voice telephone calls and computer to computer data calls will interconnect with the local telephone system and interexchange carrier long distance facilities. Importantly, while offering many more features and benefits to the subscriber, the new system also can utilize subscriber's existing telephone devices and in-building wiring.

Com21 System's costs are projected to be substantially less than the capital and operating costs of today's existing telephone system built on earlier technology. Based upon initial cost estimates, the capital required to install a Com21 System is about one-third of the cost for an equivalent local telephone system. And, most importantly, most of the cost occurs at the time that each subscriber is connected. Reduction in cost is achieved through the efficiency of shared use of existing facilities both within the local cable TV system as well as within the subscriber's home or business.

Com21 System Features

The Com21 System use small, personal cordless telephones sharing a 2+ Mb/s channel in a no-license-required radio band. Each cordless telephone has its own separate channel. Up to eight or ten different conversations can be simultaneously supported together with high speed data terminals and multimedia-based computers. An optional modular jack allows connection to the existing telephone system in the house for origination or reception of calls from either the present local telephone carrier or via the Com21 system. The modular jack arrangement allows full compatibility with existing consumer telephone equipment, fax machines, modems and existing in-building telephone system wiring. Flexibility to dynamically add devices to the network without installation delays is designed into the system, as each handset or data terminal interface has its own unique number. The entire system utilizes ATM cells for maximum efficiency and simplicity of system interconnection. Very high data rates of up to 155 Mb/s can be provided to meet the high bandwidth requirements of some business customers.

Detailed Technical Description

A detailed technical description of the Com21 System can be found in "The Role for Cable and PCN" , *Conference Proceedings of the Society of Cable Television Engineers Annual Conference on Emerging Technologies*, New Orleans, LA, January 7, 1993). And, there is a second article describing the system, "Radical Telephone Grabs Huge Bandwidth Promise, "in the May 1993 issue of *Signal Magazine*, .

NEW REVENUES OPPORTUNITIES FOR CABLE

With that brief technology interlude complete, now let's go back to the Big Red Hotel opportunities that are just ahead for the cable industry. Probably the two largest markets representing the greatest opportunity are multimedia and telephony. While I personally believe that a large multimedia market will develop, there is the usual skepticism for any service that does not presently exist. I heard multimedia characterized by one skeptical industry observer who asked the question, "What happens when you cross a lemming and a sheep?" His answer: "A multimedia investor."

To avoid such cheap shots, let's set the multimedia opportunity aside for the moment and limit the discussion to a single service that presently exists today and can be quantified, telephony.

Entering Each Other's Business

My friend Dr. Michael Bowles of Hughes Aircraft Company asks the amusing question, "What will the costs and revenues likely to be if a) The cable TV companies entered the telephone business, and b) if the telephone industry enter the entertainment TV business?" Let's take a look at one analysis:

This chart suggests that this is a no brainer. The cost of cable entering into the telephone business is moderate, while the economic upside payoff can be very large. And, the opposite appears to be true for the telco industry's entry into cable TV. Thus, the cable TV industry has much more to gain from this coming competition, while the telephone industry, as we know it today, has more to lose -- unless it joins with the cable TV industry, or overbuilds using the same technology.

Similarities and Differences

Both the telco and the cable TV industries are moving towards a universal communications systems carrying voice, data and TV over fiber optic links, with voice and data in the form of ATM cells. At the top of the networks, both the telco and the cable industry's approaches appear to be converging. Each system in the future resembles the other. The only major critical difference is the last few miles -- the local loop as the telephone companies call it. Here, the advantage of cable TV's availability of a 1 GHz-capable coaxial cable to the home has a major cost/ performance advantage over the telephone company's twisted pair.

Of course, the local telephone carriers could change their tail circuits and overbuild with coax. They could acquire cable TV systems (something which is

	Telco does CableTV	Cable TV does Telephone
Cost	$150 to $400 Billion	$20 to $40 Billion
Added Market Potential	$15 to $30 Billion /year	$100 to $200 Billion / year.

presently prohibited within their telephone service areas), or work together with cable TV companies. The technical options are open. Another constraint on the local telephone carriers is that their allowable rates of return are based on huge quantities of unamortized facilities on their balance sheets including the long depreciation lifetimes assigned to their twisted pair local loops.

To overcome the data rate choke point of the twisted pair local loop, the telephone industry has been pushing the development of improved digital twisted pair transmission technologies. These include ADSL and HDSL, and N- ISDN. ADSL, asymmetrical digital subscriber line, provides a 1.5 Mb/s data path in one direction and a lower data rate in the other direction for the delivery of data. HDSL, high speed digital subscriber line, uses two twisted pairs, one in each direction. For local loops in relatively close proximity to the central office with short transmission distances, the data rates can be increased using these technologies into the four megabit/second or higher range.

ISDN

Of the technologies that are being discussed, the one that has received most attention is ISDN, or Integrated Services Digital Network. ISDN was a wonderful idea many years ago when it was first created. However, it has become an increasingly obsolete technology as other options have been developed while its implementation was delayed. ISDN was intended to be the technology to deliver both data and voice telephony over a single twisted pair. There are several parts to the ISDN approach. One relates to switching in the network while the part of most interest is the digital channel to the home or business.

The major pressure for providing lower cost ISDN comes not from the telephone companies, but from information activists lobbying Congress and other governmental agencies. Data networks are being built to interconnect major universities and research centers. The government subsidized Internet is now operating in 30 countries and has been growing over 15% per month. Millions of computers are now intermittently connected. The Internet, an informal network of networks, was primarily intended to be used by the science and education communities. Instead it has grown into an international user-to-user network for non-commercial uses. The next generation of the backbones of this network are being planned to operate at gigabit per second rates, i.e. the National Research and Education Network. This network is viewed as the information superhighway with few off ramps. What is needed is a farm to market equivalent road system to connect users at home and schools at data rates beyond today's 9600 bits per second (or about 24,000 bits per second with next generation analog modems.)

ISDN offers a 2B+D connection on a twisted pair. This is two channels of 64,000 bits per second plus one of 16,000 bits per second. Unfortunately, ISDN's terminal devices are complex and expensive. In part, this is because the ISDN concept is based primarily on a circuit switched philosophy. Increasingly. data applications require a high burst rate, with long allowable dwell times. Instead, ISDN is optimized to support a low steady data rate.

In the US, ISDN has not gone well. The terminal devices for ISDN remain expensive. At each local telephone

carrier, each separate switch to handle ISDN had to be retrofitted with new hardware and software at considerable expense. Then came the compatibility problems. Terminal devices made by Northern Telecom didn't work with the switches made by AT&T, and vice versa. After several years of this kind of impossible compatibility war going on in the marketplace, a new, lowest common denominator standard was defined, N-ISDN. Or, National ISDN. Terminal devices made to the N-ISDN standard were to be able to work with all switches with suitable software.

Last year, five RBOCs announced support N-ISDN. This new national standard was to overcome ISDN's past limitation of being able to serve only islands of users near ISDN equipment switches. No sooner than this announcement was made when US West and Southwest Bell spoke up and said in effect, 'Thank you, but we haven't been able to recover our early investment in ISDN, so we don't plan to change to N-ISDN.'

The momentum for National ISDN remains elusive. Indeed, it remains everyone's favorite example of how not to deploy new technology! Even if ISDN does eventually become widely available, it represents a high cost, low function service which will have to compete with the capabilities and inherent architectural advantages of cable-based alternatives. It shouldn't be much of a battle.

SUMMARY

While the regulatory issues are being resolved over time, cable is contemplating entry into the telephone business along at least two paths.

The first is joining with Competitive Access Providers to provide fiber optic dedicated trunks to businesses.

The second path is as a PCS provider, with the plum being a new monopoly to be given away by the FCC, a la cellular.

While these may be interesting businesses, they pale alongside the opportunities that cable faces as a potential new universal two-way network providing telephone, data, and multimedia telecommunications services taking advantage of its basic superior end-channel.

The key will be in understanding the opportunity , how to best utilize the new emerging advanced technologies and architecture, and the will to do so.