Advanced Data Communications Applications for the CATV Industry

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ABSTRACT

Two way cable plants have traditionally been used to provide interactive television services to home subscribers. The deployment of fiber technology and the impact of digital data services within the cable industry has accelerated the move toward telecommunications and local area networks.

Today's delivery costs for video (broadcast) entertainment services and data delivery remain less expensive via analog facilities vs. digital facilities. Furthermore, metropolitan community cable TV networks already provide ample bandwidth for the delivery of bi-directional services including video, voice, local area networks (LAN), alternative telecommunications access and real time control systems.

Unlike baseband LANs such as Ethernet and Token Ring, broadband LANs based on cable TV technology offer the ability to span large metropolitan areas and can be expanded to support multiple networks on a single cable. Cable systems can be structured as a LAN backbone data architecture to support baseband sub-networks, bridges and routers, and can replace T1 circuits, dedicated and dial-up phone lines.

This paper will provide a technology brief, present case study applications and address the impact and benefits of cable TV data networks.

INTRODUCTION

Can today's cable TV plants support computer networking? Although industry visionaries have begun to look forward to the days when the tree and branch analog cable plant will be replaced by switched digital networks, we should not overlook the existing analog cable TV infrastructure. Although originally designed to deliver broadcast TV signals to home subscribers, it presents an excellent conduit for high speed data transmissions without compromising existing entertainment programming. Broadband-cable TV "networks" already provide ample bandwidth for the delivery of bi-directional services, including video, voice, metropolitan area networks (MANs), and local area networks (LANs). Data and electronic service access may include alternative telecommunication links for businesses using native LAN connections, in-house cable TV operations connectivity, environmental monitoring, real time control, work-at-home "cablecommuting", image transfer, INTERNET and electronic bulletin board access and others. Electronic "data kiosks" could provide personal digital assistant (PDA) users with information downloads. Imagine linking your Apple Newton PDA to a kiosk at a subway station using an infra-red interface and downloading the train map, schedules and fares - over the cable TV plant! Furthermore, computer networks can utilize excess cable TV channel capacity to supplement and expand revenue which benefits the cable operator.

CATV TECHNOLOGY BRIEF

Community cable TV plants are a ubiquitous medium comparable only in geographical coverage to phone companies. Industry estimates indicate that between 50% and 60% of all homes in the U.S. are connected to cable and approximately 80% of all homes in the U.S. can be easily connected. Because cable TV plants are metropolitan in nature, they can support local businesses, municipal governments and community schools.

Broadband-cable TV based data communication systems, when compared to baseband systems such as Ethernet and Token Ring or even telephone data equipment, provide a sophisticated and flexible backbone solution. Broadband-cable TV based LAN systems inter-operate with video or other data transmissions by having an allocated frequency slot on a cable plant as if they were a television channel. The inherent advantage of cable TV systems, is the ability to simultaneously carry multiple services including broadcast video, multiple LANs, point-to-point data, security, image transmissions, video teleconferencing, voice and other value added services on a single wire. This sharing technique is referred to as frequency division multiplexing (FDM). In contrast to broadband-cable TV systems, baseband communication systems use the entire bandwidth of the wire for transmission and reception of a single signal on either copper or fiber based cable.

A review of the existing cable plant architecture shows a frequency domain multiplexing (FDM) system which utilizes multiple 6 MHz channels on a single coaxial wire. Plant capacity has increased over the years through the introduction of line amplifier technology which permits an increase in frequency bandwidth. Cable plant capacities range from 5 MHz to 350 MHz in older systems to plants which support up to 450 MHz. Hybrid fiber/coaxial super trunking systems are gradually replacing the older coax only systems, and are now capable of supporting 1 GHz of bandwidth. The transmission requirement for data is a two-way duplex data path. LAN devices on broadband-cable TV systems utilize one channel for reception (downstream) and one channel for transmitting (upstream).

LAN PROTOCOL FOR CATV

The support of hundreds of computer devices on municipal cable plant requires a contention access protocol that is bandwidth efficient, cost effective, and supports commercial type data services. The plant's tree-and-branch architecture invariably dictates the type of LAN access scheme that can be used. Because the data transmissions on the plant are bi-directional and the span of the system can be extremely long (30+ miles), creating significant transmission delay times conventional baseband LAN access methods cannot be used. Designed as a video distribution system, the plant cannot be modified into a point-to-point configuration, nor can it be fashioned into a ring. Using the given tree-and-branch topology, a Carrier Sense Multiple Access with Collision Detection (CSMA/CD) based broadcast contention system meets the criteria given above. To meet the distance, spectral efficiency and data bandwidth requirements for a commercially viable cable TV LAN, a modified CSMA/CD scheme must be used.

CSMA/CD based LAN interface devices designed for metropolitan cable TV plants utilize upstream channels for transmitting and downstream channels for receiving. Each LAN device sends messages using an upstream channel; the message is received at the headend, translated to a downstream channel, retransmitted and received by the destination device - assuming no two devices transmitted at the exact time. If message "collisions" do occur, it is the job of the CSMA/CD protocol to detect collisions and retransmit until the message is properly sent. To establish this duplex transmission path on the cable plant, a device called a frequency translator is required at the headend.

needs described in this presentation. These products permit the transportation of standard LAN protocols using a broadband cable plant as a data backbone. The plant allows multiple LANs to be added onto a single cable to increase data bandwidth on demand.

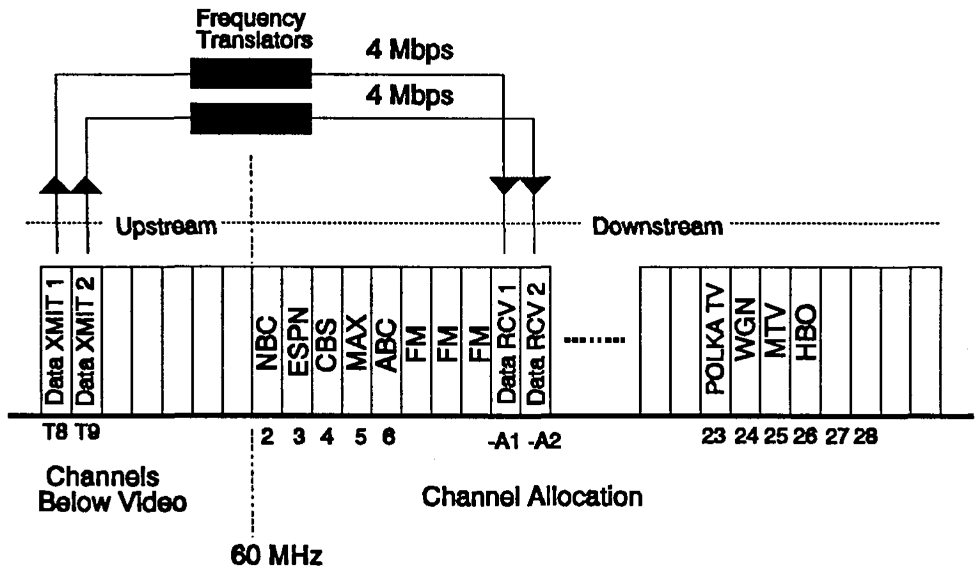

FIGURE 1: Example of LAN Channel Allocation for Cable TV Plants

Because broadband based cable TV LANs operate in the frequency domain, several networks can be operated on a single coaxial cable. Individual LAN backbones are easily configured by assigning different frequency pairs (channels) using one frequency translator device per LAN. This individualized backbone approach permits flexible bandwidth on demand expansion, or segmentation by business, academia or service application.

CATV DATA INTERFACE EQUIPMENT

LAN connectivity equipment for cable TV applications is currently marketed which addresses the diverse data communication Gateway and bridging interfaces between broadband cable and a variety of standardized LAN protocols, including Ethernet and Token Ring are available. General computing equipment which uses asynchronous RS-232 interfaces (ie. printers, terminals, optical code readers, PCs) can also be interfaced to the metropolitan community network.

CASE STUDY APPLICATIONS

Business-to-Business:

Business-to-business data networks which require high speed bandwidth can easily be created on municipal cable TV plants. Using a LAN multi-point architecture, businesses can connect PC based file servers, mainframes and graphic workstations. High speed graphic file transmissions would occur electronically in a matter of seconds. Shared T1 (1.544 Mbps), low speed phone modems (1200-9600 bps) and other multiplexed telecommunications equipment could be eliminated. Figure 2 compares telecommunications data equipment with market ready LAN products available for the cable TV industry.

This problem solving example for business-to-business applications was recently implemented by the Village of Schaumburg, IL in cooperation with Tele-communications Inc. Three data line alternatives were available to the Information Systems (IS) organization: 1) install a private fiber network, 2) use existing low speed point-to-point telephone equipment with multiplexing modems or 3) obtain bandwidth on the municipal cable system's two way institutional network for high speed LAN data transfers.

A new fiber network would be cost prohibitive; a telephone modem/mux system using a digital data service line (typically 9600 bps) performance would not allow high speed connectivity between public service facilities (police and fire); the LAN would provide multipoint connectivity at a 4 Mbps data rate/RF cable TV channel.

Schaumburg Police and Fire Departments use a computer aided dispatch system linked across the institutional network LAN to each Public Service Facility in the Village. The dispatch system operates on a Novell NetWare file server system, which is connected to the backbone using a LAN bridge. The bridge provides an interface from a baseband Ethernet LAN to cable TV plant backbone.

Community Schools (K-12)

The City of Glenview, IL, in cooperation with Tele-communications Inc., is utilizing the institutional cable TV plant to network 7 schools within the district. The district's computer system utilizes Unix based server equipment at each school site, which are then connected to the broadband-cable TV LAN backbone using TCP/IP as the network transport protocol. This computer network supports both instructional and academic applications. Apple Macintosh computers are bridged onto the LAN backbone via an Ethernet-on-broadband media access unit (MAU) connected to an AppleTalk-to-Ethernet bridge. Teachers can share files across the network and communicate using electronic mail facilities.

REVENUE EXPANSION

The cable operator is always looking for new sources of revenue. This is especially attractive if the service can be offered over the existing plant. Many cable operators deployed two-way ready cable plants during the franchise frenzy of the early 1980s. Not many operators found a need for this two-way capability, so it either went unused or was drastically under utilized. The prime reason for this capability was the deployment of residential interactive services. Although the network was apparently ready to handle this traffic, the users did not have a reason to use this capacity. Cable operators were relegated to the opinion that they would either not use the two-way plant capacity or give it a minor role, like plant status monitoring. Early on, operators tried impulse buying technology that could make use of the interactive nature of the plant as an order collection mechanism. Both applications have very small bandwidth requirements. Even in a modest subsplit cable plant only a very small portion of the 25 MHz is utilized. With deployment of fiber optics into the cable plant, this small return path can provide enormous revenue potential. What is an operator supposed to do with this new found upstream path?

	NATIVE SPEED	TOPOLOGY	CONNECTIVITY	COSTS (Equip.= Pairs)	LINE CHARGES	ADVANTAGES	DIS-ADVANTAGES
ETHERNET INTERFACE Broadband-CATV	Local - 10 Mb Backbone - 4 Mb	LAN/MAN broadcast multi-point CATV	School-Inter/Intra Business-Inter/Intra Mfg.-Inter/Intra Tele-commuting Campus-Inter/Intra Residential	Equip. $3990 Instal. $TBD	Per Franchise	Std. Ethernet Interface Performance MAN Coverage (30 Miles) Multi-media Expansion	CATV Channel Allocation
PC LAN CARD Broadband-CATV	4 Mb	LAN/MAN broadcast multi-point CATV	School-Inter Business-Inter Mfg.-Inter Tele-commuting Campus-Inter	Equip. $895 Instal. $TBD	Per Franchise	Performance MAN Coverage Multi-media Expansion	CATV Channel Allocation
LAN BRIDGE Broadband-CATV	MAN - 4 Mb LAN - 10 Mb 16 Mb WAN- 0 - 2.048 Mb	Bridge-LAN/MAN/WAN broadcast multi-point CATV/T1/LAN	School-Inter/Intra Business-Inter/Intra Mfg.-Inter/Intra Campus-Inter/Intra	Equip. $17000 Instal. $TBD	Per Franchise	Expansion LAN Gateway LAN/WAN/MAN Coverage Multi-media	CATV Channel Allocation
RS-232 MODEM Broadband-CATV	38.4 Kb (0.0384 Mb)	Business-Inter Node broadcast point-to-point CATV	Tele-commuting Electronic BBS Residential	Equip. $1390 Instal. $TBD	Monthly $TBD Usage $TBD	Performance Uses CATV Connection Multi-media MAN Coverage	CATV Channel Allocation
T1	1.544 Mb	LAN/WAN leased line point-to-point TELCO	School-Inter Business-Inter Mfg.-Inter	Equip. $9600 Instal. $2400	Monthly $1200 Usage $5/mile	WAN Coverage Voice, Video	Req's Native LAN Bridge Cost-to-Performance Expansion req's 2nd line
RS-232 PHONE MODEM Dial Up Line (Voice)	9600 Kb (0.096 Mb)	Node dial up line point-to-point TELCO	Tele-commuting Electronic BBS Residential	Equip. $600 Instal. $0	Monthly $15 Usage $TBD	Better for WANs	Impacts Voice Line Performance
RS-232 PHONE MODEM Dedicated Line (DDS)	9600 Kb (0.096 Mb)	Node dedicated line point-to-point TELCO	Business-Inter Tele-commuting Electronic BBS Residential	Equip. $1100 Instal. $750	Monthly $200 Usage $0	Better for WANs	Requires 2nd line Performance

FIGURE 2: A Comparison of CATV LAN vs. Telco Data Interfaces

Cable Regulation

The cable act of 1992 has provisions for the controlling of certain tier rates a cable operator may charge his subscribers. If operators end up with a fixed rate structure it may be prudent to investigate other uses of his broadband cable TV plant. The current regulations are aimed at the rates charged to subscribers for video entertainment services. The regulations allow for the incorporation of alternative data services over the cable network.

Return on Investment

Selling excess network capacity on cable for data services is a natural expansion for the cable operator. The single largest investment necessary for a data network is the network itself. The transport mechanism of the network, the cable plant, is already in place. The hardware needed to add data capability is not only available at this time, but at a small investment.

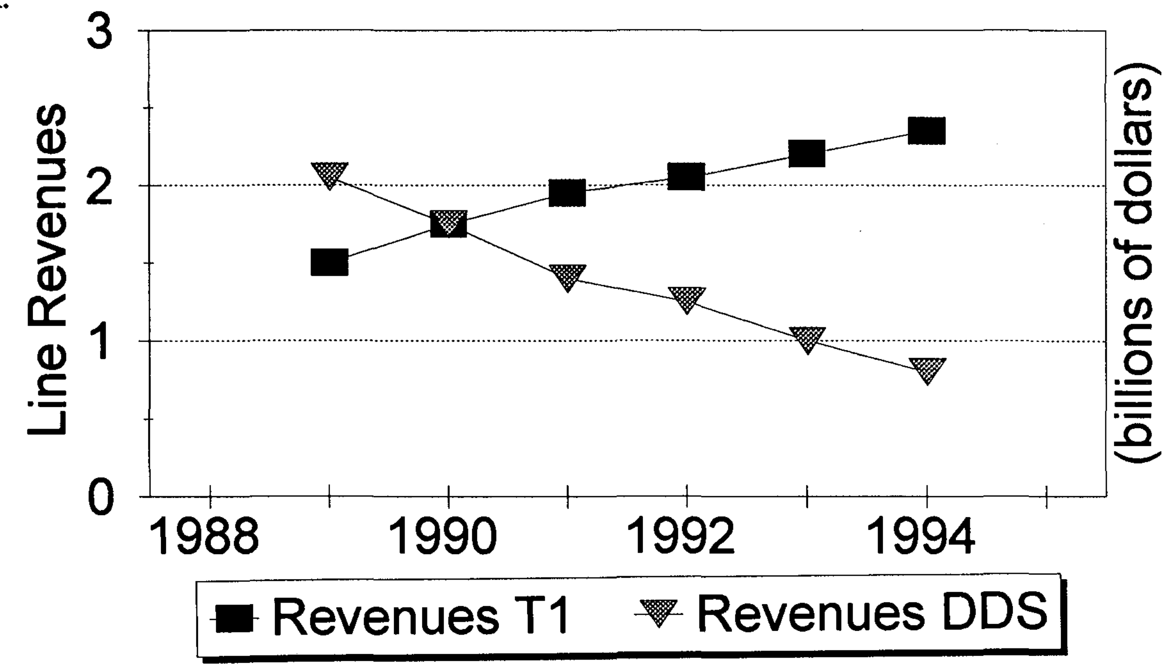

FIGURE 3: Estimated Telco Data Revenues

Estimates of Revenue for Telco Data Services

The graph in Figure 3 demonstrates the revenue opportunity that LAN type data services could present to cable TV operators. In 1993, it is estimated that the revenue from combined digital data services and T1 services will exceed $1B, not including data over voice grade telephone lines, which accounts for an additional revenue stream of about $800M.

CONCLUSION

Many operators are faced with the reality that they are perhaps reaching subscriber saturation levels. As subscriber counts are starting to stabilize, there are fewer areas to extend the reach of the cable TV system economically. The current subscriber is reluctant to add more premium channels to his monthly bill and there is only so much video entertainment a subscriber is willing watch. Therefore, other revenue streams need to be investigated.