DATA ON CABLE FOR PROFIT

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The paper reviews the technical standards for international packet switching networks as well as the bus access methods applicable to Local Area Networks (LAN) and Cable Television Wide Band Area Networks (WAN).

The LANTEC™ 8400 token passing, packet switching data communication system for residential and institutional cable sytems permits the interconnection to the outside world at any point along the cable system and enables the operator to transform his coaxial cable network into a telephone bypass and Teleport delivery network for the transmission of high speed data.

Automated network control, automated coaxial cable maintenance and automated billing systems are presented as necessary ingredients to assure profitable operation.

1. Evolutionary Developments

Some of you may recall the blue sky dreams of our industry in the early 70's.

The broadband capabilities of the CATV coaxial cable were to provide all these wonderful services like home banking, home shopping, energy management, security and data communication.

Here it is 1984 and we are finally on the right track. It is my prediction that data communication on CATV will become, in the very near future, a revenue producer for every cable operator.

If we look at the evolutionary development of data communication in general, we find that in the early 70's the ideas were present, but there were also too many questions seeking solutions.

In retrospect, it was clearly too early then to transmit data on cable in a cost-effective manner.

As early as 1976 we saw the first CCITT standards developed for packet switching. At about the same time, Xerox developed a baseband high speed data transfer system called Ethernet.

EVOLUTIONARY QUESTIONS IN THE 1970's

- WHAT KIND OF TRANSMISSION PROTOCOLS?
- WHAT TRANSMISSION STANDARDS?
- WHAT TYPES OF MICROCHIPS?
- WHAT STANDARDS FOR SPECTRUM UTILIZATION?
- HOW DO WE INTERCONNECT?

These baseband systems are working; they fulfill a need, but are restricted to short intra-plant installations.

So what about broadband? Since about 1978 we see the evolution taking a faster pace. Without standards for transmission and protocol, we would not be able to interconnect to the world around us.

TRANSMISSION STANDARDS OF THE 1980's

- POINT-TO-POINT DATA TRANSMISSION PROTOCOLS
  - INTERNATIONAL CCITT V.35
- PACKET SWITCHING DATA TRANSMISSION PROTOCOLS
  - INTERNATIONAL CCITT X.25
- IEEE STANDARD 802
  - POLLING SYSTEMS
  - COLLISION DETECTION SYSTEMS 802.3
  - TOKEN PASSING SYSTEM 802.4

Now, that standards have been set, we can build the equipment.

2. Comparison of Standard Bus Access Methods

A brief look at the three standard Bus Access Methods should be taken to identify which method appears most suitable in a CATV network.

2.1 Polling System

A polling system requires a centralized controller. This controller would select the sequence of transmission of any associated terminal along the system. The controller would address each terminal modem, verify its readiness to transmit, go through a formal handshake and then listen to the transmission from the terminal modem. After completion of transmission, the controller would select the next terminal.

Polling systems are identical to this panel of people that all want to speak. But as long as I have the floor, as directed by our panel moderator, the others are not permited to say anything.

POLLING SYSTEMS

- CENTRAL CONTROLLER
- DIRECTED SEQUENCE
- HANDSHAKE DELAY
- PRIORITY TO LONG "TALKERS"
- THROUGHPUT A FUNCTION OF TRAFFIC LOAD
- LIMITED USE FOR HIGH DATA RATES

The deficiencies of a polling system are quite apparent. The terminal modems with a lot of data will "talk" for a long time. In other words, the priority is given to whoever has a lot to "say" and short urgent messages from others might be delayed.

Another deficiency is the centralized controller itself. In case of a failure, a redundant unit must be available which increases the front end cost of the system.

Tele-Engineering Corporation's Tele-Dat II was a polling system and we have learned from our mistakes.

It may be interesting to note that all proposed two-way converter systems are polling systems. This is fine for low speed data and opinion polling, but does not permit the data transfer at high rates with a high throughput.

2.2 Collision Detection Systems

The term Carrier Sense Multiple Access/Collision Detection (CSMA/CD) is well known in the world of LAN (Local Area Networks). Collision Detection is used by most baseband and broadband high speed data transfer systems.

Collision Detection is used by Ungermann-Bass and Sytek to name just two.

Tele-Engineering is designing and installing broadband LAN systems in-plant, inter-plant and in campus environments all over the U.S. and in every case Collision Detection Equipment has been applied.

CSMA/CD uses the principle "listen before you talk" or "listen before transmitting, listen while transmitting" to gain access to the network. All stations listen to the medium and stay silent if it is in use. When silence occurs, then any and all stations may jump in and transmit.

This method is very similar to the rule that we use when we are in a meeting. We let one person finish. Then, when there is silence, anyone may speak. When multiple speakers attempt to talk simultaneously, they usually detect the "collision" and stop talking. So if you now picture a meeting where everyone has something important to say and barely waits for silence to occur, there will be many collisions and interruptions.

COLLISION DETECTION SYSTEMS (IEEE 802.3)

- CARRIER SENSE MULTIPLE ACCESS/COLLISION DETECTION (CSMA/CD)
- LISTEN BEFORE YOU TALK
- MANY INTERRUPTIONS
- THROUGHPUT A FUNCTION OF CABLE DELAY
- THROUGHPUT DECREASES WHEN TRAFFIC LOAD INCREASES
- PRIORITY TO LOUD "TALKERS"
- IDEAL FOR SMALL SIZE BROADBAND SYSTEMS

Conversely, in a CSMA/CD system, a high traffic load will cause many collisions and interruptions. This tends to restrict the throughput of the network. The network throughput is decreased rapidly as the traffic load increases.

The length of the cable system also plays an important role in the network throughput. Picture our group of people a mile apart. It would take time for the sound to travel the distance. During this time, another speaker may talk and the transmissions will collide.

CATV systems are by nature longer and more extensive than broadband LAN systems and cable transmission delays will reduce the throughput even further.

There is also a level consideration in Collision Detection systems. Unintended priorities are produced any time the levels of the RF signal are different at the various receivers. The stronger signal may "capture" the receiver and no collision is detected. Although one message has gotten through, a new problem has established itself. A transmitter with a higher signal level has a better probability of gaining access to the medium than lower level transmitters.

With tap steppings of 3 dB, which is our industry standard, it is imperative that the LAN designer has exact distance measurements of every cable length between taps and that the drop wire lengths are identical.

Collisions also have the potential to cause frequency "splatter" on broadband systems, introducing additional interference components that may show up in other TV channels on the system.

2.3 Token Passing Systems

This bus access method has been standardized by IEEE 802.4 and offers a real alternative to Collision Detection Systems, Token Passing is the distributed version of polling.

If we picture our group of people again. Instead of the meeting chairman passing the go ahead to the next person, a token is passed from one person to the next.

Possession of the token allows a terminal modem to transmit. After sending data, or in the case that there is no data to be sent, the terminal modem will send the token to the next station. The token is then passed around a logical ring. Every terminal is given the same priority and collisions do not occur.

Since the station that has the token does not have to listen to the system to determine whether the medium is silent, there are no interruptions. An increase in traffic load therefore does not decrease the throughput. Only the cycle time of the network may slightly increase.

Since the Token Passing System does not wait for collisions, cable delay on long systems will not decrease the throughput either. Systems up to 25 miles of cable length become practical.

There are also no priority problems. RF level variations between transmitters can be substantial before errors would occur.

TOKEN PASSING SYSTEMS (IEEE 802.4)

- DISTRIBUTED VERSION OF POLLING
- TOKEN PASSED AROUND A LOGICAL RING
- INDEPENDENT OF CABLE DELAY
- INDEPENDENT OF LEVEL VARIATIONS
- SYSTEMS UP TO 25 MILES
- THROUGHPUT NOT A FUNCTION OF TRAFFIC LOAD
- 4 LEVELS OF PRIORITY
- IDEAL FOR CATV SYSTEMS

A Token Passing System operates without a mandate for minimum message length. The IEEE token access standard foresees four (4) levels of priority. Transmissions of lower priority are deferred when the network is heavily loaded. Each station computes network loading by measuring the time between token passes. When there is no traffic load the token is passed around very quickly and the cycle time of the network is very short.

As loading on the system increases, the time to return to the station increases. If the time exceeds a pre-determined threshold value, then low priority traffic is deferred until the traffic load decreases.
Each of the three lower priority levels have separate threshold levels, which helps to maintain minimum cycle times even in high traffic periods.

As we will see later, this concept of priority selection can be used for service categories and revenue structuring.

In summary, it appears that the Token Passing Bus Access Method has clear advantages for CATV systems and is considered the best vehicle to establish high and low speed data communication on our cable systems in the very near future.

3. Packet Switching

Affiliates with the United Nations, the Consultive Committee of International Telephony and Telegraphy (CCITT) is a branch of the International Telecommunications Union (ITU).

CCITT deals mostly with telecommunications to establish world wide system interconnections. The V-series standards for point to point traffic and the X-series for switched and distributed systems are important and considered mandatory in any networking involving the telephone systems.

CCITT recommendation X.25 covers the standards for packet switching system that will apply throughout the world.

Needless to say, any distributed packet switching data system working on twisted pair, baseband or broadband will be designed to the X.25 standard if it is to be interconnected to the world.

Interconnection with AT&T, SBS, MCI, DTS services, uplinks etc. is exactly what must happen to establish CATV as a data communication medium. Interconnection is the key to home banking, shopping, energy management, security, electronic mail and all the other blue sky services that we are talking about.

PACKET SWITCHING (CCITT X.25)

- INTERNATIONAL STANDARD FOR INTERCONNECTION OF DATA SYSTEMS
- INTEGRATED SERVICES DIGITAL NETWORK (ISDN) ARCHITECTURE
- PACKETIZING OF DATA
- FORMATTING OF DATA PACKETS
- ORDERLY TRANSFER OF DATA PACKETS FOR PUBLIC NETWORK INTERCONNECTION

And we know already that any one of these services cannot be profitable by itself. So the most logical solution appears to be to establish a data transfer network on the cable that first provides for business data communications, then integrates P.C. traffic and then adds all the other categories to it.

So, now, without further delay I can now introduce to you the advanced packet switching, token passing data communication system for the cable industry - the LANTEC^{TM} 8400 System.

The LANTEC^{TM} 8400 product line has just been introduced for the first time, here in Las Vegas, at this NCTA convention.

4. LANTEC 8400^{TM} Data Communication System

4.1 LANTEC 8400^{TM} Token Passing Packet Switching Equipment

LANTEC^{TM} 8400 System utilizes self starting, token passing, random access addressing, which permits communication between any number of modem terminals.

LANTEC^{TM} 8400 equipment design conforms to the international standard of CCITT X.25 and to the latest IEEE standards 802.4 for token passing bus access method.

LANTEC^{TM} 8400 DATA COMMUNICATION SYSTEM

- PACKET SWITCHING TOKEN PASSING (CCITT X.25/IEEE 802.4)
- RESIDENTIAL SYSTEM (SUB-LOW)
- INSTITUTIONAL SYSTEM (MID-SPLIT AND HIGH-SPLIT)
- DISTRIBUTED TOPOLOGY
- 1 BIT/Hz SPECTRAL EFFICIENCY
- 4 SYSTEMS PER 6 MHz CHANNEL AT 1.5 MHz EACH
- USER SELECTABLE SPEED SETTINGS FROM 300 TO 19,200 bps.
- NETWORK MANAGEMENT
- STATUS MONITORING AND REDUNDANCY SWITCHING
- AUTOMATIC UNIT RATE BILLING SYSTEM

LANTEC^{TM} 8400 is a local area network, wideband area network and CATV network communications system designed to meet the needs of multiple data users in a local or extended area coaxial cable network.

4.2 Application

LANTEC^{TM} 8400 is designed to accommodate transmission on standard sub-low residential CATV systems as well as on institutional mid-split or high-split systems, Local Area Networks (LAN) and Wideband Area Networks (WAN).

4.3 Frequencies

On sub-low residential networks, the LANTEC^{TM} 8400 system works on channels A-2 or A-1 in the forward direction on T7, T8, T9 or T10 in the return direction.

On mid-split systems the return frequencies are maintained as T7-T10 and the forward frequencies varied to Ch. 7, I or H.

On high-split systems, the return frequencies are maintained as T7-T10 and the forward frequencies changed to Ch. M (234 MHz) through Ch. P (252 MHz).

4.4 Spectrum Utilization

IEEE Standard 802.4 addresses the various physical signalling techniques and media defined for Local Area Networks (LAN) and CATV systems.

Using a multi-level duo-binary AM/FSK modulation, channel bandwidths of 1.5, 6 and 12 MHz are recommended by the IEEE standard.

LANTEC^{TM} 8400 operates in any 1.5 MHz band within the above mentioned TV channel assignments. This means that 4 independent systems can operate in a TV channel assignment.

Data rates of over 1 Mbps are used in a 1.5 MHz band, permitting an approximate bit to Hertz rate of 1.0 as prescribed by the IEEE 802.4 standard.

Equipment operating at data rates of 5 Mbps and occupying a 6 MHz channel are in design to satisfy multiple high speed users.

4.5 Distributed Topology

In the Token Passing system, all modem terminals transmit on the same frequency on the return (low) channel and receive on the same frequency in the forward (high) channel.

At the headend, a simple frequency translator is used to re-transmit all low return transmissions into the high forward band. In this manner each modem "listens" to every other modem on the system, inclusive of its own transmission.

The token or the permission to transmit is passed from one modem terminal to the next in accordance with a sequential address number system. Each modem terminal knows the address of the previous and following modem. The token is therefore passed around a logical ring.

Addresses and sub-addresses can be developed to identify groups of modem terminals that always talk together. In the same manner, using sub-addresses, a group of modems can be interconnected with the modem that represents the gateway port for a particular service category.

Flexible topology permits gateways to occur at any point along the CATV or LAN system. Examples of gateways are Up-links, MCI, SBS, DTS services, AT&T, security boards, branch bank offices, computer data bases, electronic mail points and any other data service carriers that you may find located in your service area or that may be interconnected by telephone, microwaves, satellite up-links or coaxial regional interconnect networks.

The LANTEC™ 8400 system, for the first time, enables the cable operator to approach business and home computer data traffic within and outside of his franchise area in complete disregard of the cable system layout. The only remaining consideration that the cable operator must make is to assure that the CATV cable, whether residential or institutional is in front of the potential user.

5. LANTEC™ 8400 Components

The components of the LANTEC™ 8400 system have been conceived to permit automated maintenance, computerized network management and automatic unit rate billing.

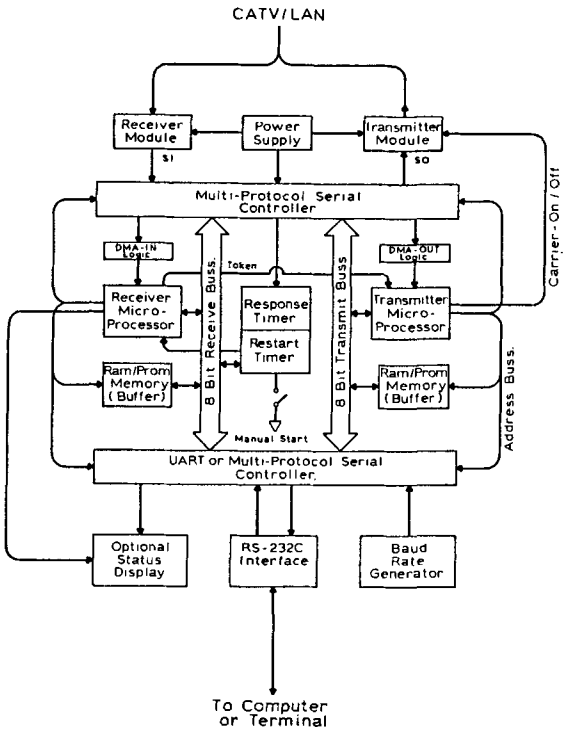
The product line consists of the following:

LANTEC™ 8400 BUILDING BLOCKS

LANTEC 8401	Single Port Modem
LANTEC 8404	Four Port Modem
LANTEC 8408	Eight Port Modem
LANTEC 8412	Twelve Port Modem
LANTEC 8441	Headend Translator
LANTEC 8442	Network Control Unit (NCU)
LANTEC 8451	Status Monitoring Module (indoor)
LANTEC 8452	Status Monitoring Module (outdoor)
LANTEC 8453	RF Redundancy Switch
LANTEC 8460	Automatic Maintenance System Computer
LANTEC 8470	Automatic Unit Rate Billing System Computer
LANTEC 8481	5-30 MHz Drop Trap
LANTEC 8482	5-30 MHz Feeder Trap

5.1 LANTEC™ 8401 Single Port Modem Terminal

The LANTEC™ 8401 modem terminal consists of four basic modules, i.e., the transmitter module, the receiver module, the power supply board and the communications board.



3 23 84

LANTEC 8401
RF Modem
Simplified Block Diagram

TELE-ENGINEERING CORP

FIG. 9

The transmitter and receiver modules are shielded. Output levels are adjustable from + 35 to 50 dBmV to permit operation in the standard CATV distribution system environment.

The transmitter module contains harmonic suppression filters to provide interference free transmission characteristics.

The operating frequency of the unit is changed by replacing the transmitter and receiver modules or by utilizing the optional frequency agile modules.

The RF modules assume 1 bit/cycle modulation. To increase the spectral efficiency to 2 bits/cycle of bandwidth, the transmitter/receiver modules can be replaced with quadrature amplitude modulation and detection which would permit 8 LANTEC™ 8400 systems to operate on one 6 MHz video channel assignment.

Optionally, the modem can be provided with a status display that would indicate the set-up status of various handshake conditions. For instance, the busy condition of an addressed modem is immediately displayed.

The communications board combines separate microprocessors for the transmitter and receiver sections. It includes the multi-protocol serial controller chip, the DMA control logic, the interrupt logic, two RAM/PROM memories, a digital clock, a response timer, a re-start timer as well as RS-232C drivers, baud rate generator and optional status indicators.

Speed selections can be made by the user for 300, 600, 1200, 2400, 4800, 9600 and 19,200 bps.

5.2 LANTEC™ 8404, 8408, 8412 Multi-port Modem Terminals

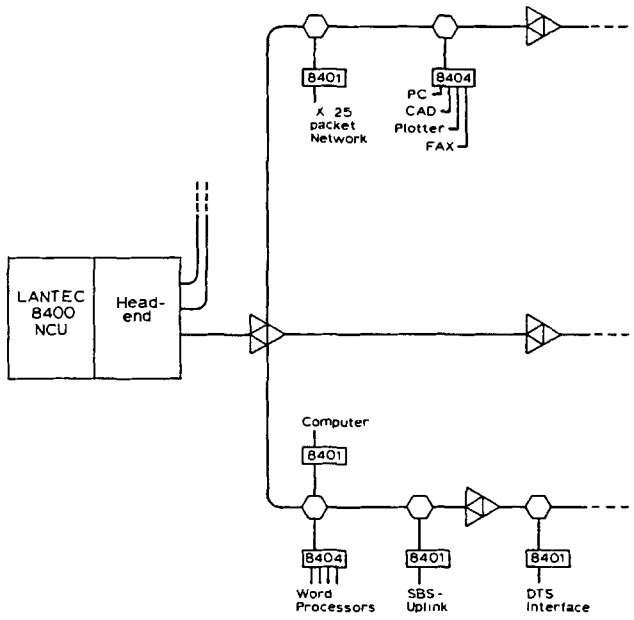
To accommodate multi terminal users we have developed multi-port modems for 4, 8 and 12 ports. All ports are serial RS-232C and can be selected by the user as to the desired speed.

Multi-port units require the inclusion of additional communication boards, and a larger power supply module. The communication boards are stacked which increases the height of the unit and the price.

5.3 LANTEC™ 8400 Distributed Topology and Loading

As mentioned previously, distributed topology is one of the benefits of the token passing bus access method.

Figure 10 indicates a number of terminals interfacing with a computer on a different trunk of the residential CATV system. In addition, the computer delivers data to an SBS up-link location and to a local Digital Termination Service (DTS) both at different locations on the system.



3-23-84
LANTEC 8401
Distributed Topology
CATV System Application
TELE-ENGINEERING CORP

FIG.10

Most of you have spent the money to satisfy the license requirement for an institutional network. And now this capital sits idle except for some limited point-to-point connections.

Figure 11 indicates that direct interconnections with in-plant LAN networks are possible. The in-plant LAN is a mid-split network used for factory automation, computer aided design, accounting, word processors, etc. By interconnection with your idle mid-split institutional network you can provide data transmission to other branch locations, to satellite up-links, to DTS and provide communications to the outside world.

There is a lot of talk about Teleports. You may just be able to convert your idle institutional system to become the Teleport transportation or collection system.

The LANTEC™ 8400 packet switching, token passing data communication system permits flexible extension of your institutional system for business data communication. Closer investigation of businesses within your franchise area may well show you that with slight routing modifications and additions, your institutional system can become the best telephone bypass network in the area and a great revenue producer.

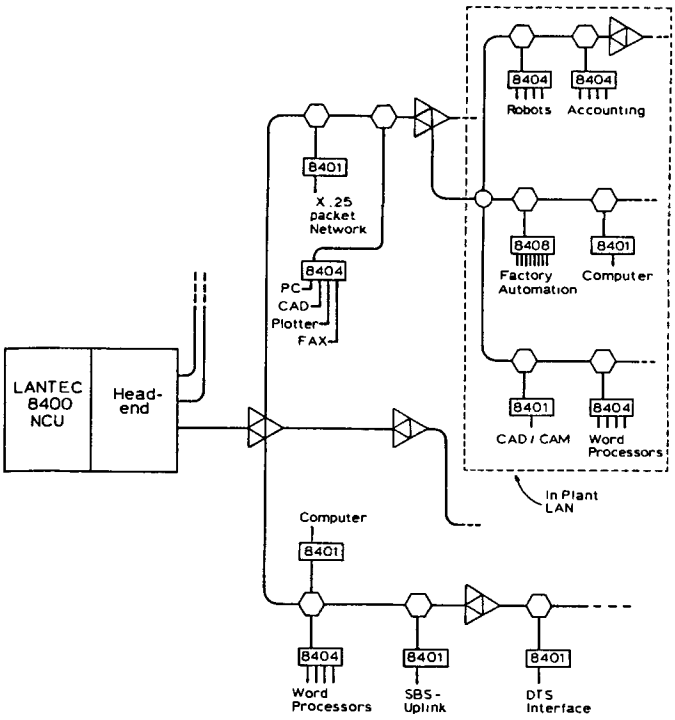


FIG. 11

LANTEC 8401
Business LAN Interface
CATV Institutional System
TELE-ENGINEERING CORP

Assuming standard traffic engineering principles, a LANTEC™ 8400 system can support 250 terminal modems operating at 19,200 bps or about 16,000 terminal modems operating at 300 bps.

There can be a mixture of baud rates throughout the system and, as I said before, the baud rates are selectable by the user.

Let us suppose then that you have connected 5,000 modem terminals to the system and they are all working at high data speeds, the system will not experience a breakdown. All that is going to happen is that the token does not get around to all terminals within the design cycle time of one second.

In other words the communications rate of the high speed users will slow down a little. In addition low priority users will be passed over and may have to wait a second or two until the peak load traffic period is over.

You may want to use this occurrence to up-grade a particular complaining low priority user for higher revenues and you may start thinking about deployment of a second LANTEC™ 8400 system to accommodate the increasing usage on your system.

Again, it should be recognized that four LANTEC™ 8400 systems can operate on only one 6 MHz channel spectrum. Considering the number of unused channels on your institutional system, the expansion possibilities are indeed unlimited.

5.4 LANTEC™ 8452 Status Monitoring Module

CATV systems lack status monitoring. Our industry has always relied on the subscribers to call in to report system or amplifier problems. This method cannot be used when you transport business data communication on your system.

As a matter of fact your serving telephone company can always point to the fact that there is discrete hard wire going to every telephone which does not contain any active elements.

So, it is my firm belief that your institutional system cannot become the telephone bypass instrument and compete with the telephone company without having status monitoring, automated maintenance and possibly automatic redundancy switching.

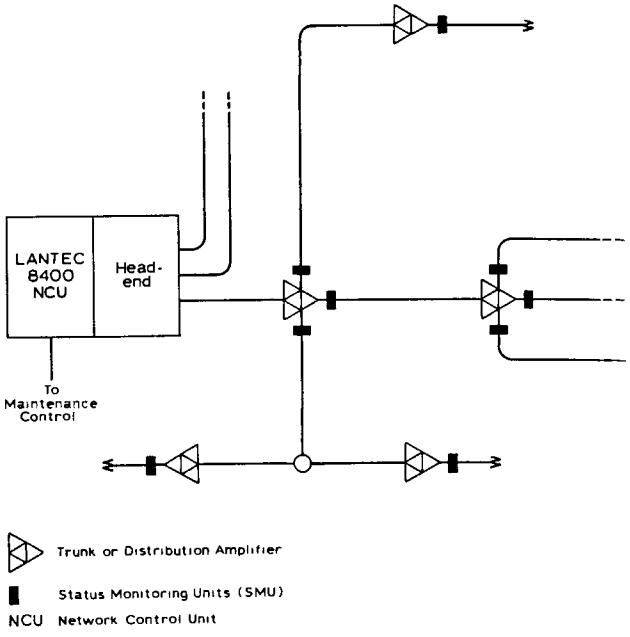


FIG. 12

LANTEC 8400
Advanced LAN / CATV
Topology
Status Monitoring
TELE-ENGINEERING CORP

Figure 12 indicates a trunk and feeder protected institutional system with status monitoring modules.

The LANTEC™ 8452 outdoor status monitoring modules can be installed external to the line amplifier. They do not communicate on a fixed data rate, but rather respond to a polling modem. This polling modem is one of the token passing modems and is installed at the headend or the system maintenance location.

When asked to respond, the status monitoring module (SMM) communicates up to 128 bits of data per poll.

The polling modem does not hold its token longer than any other modem terminal on the system. Therefore only a few SMMs will be polled at a time during the one second cycle time of the sytem. Yet there can be many hundreds of SMMs connected without decreasing the data communication capability of the LANTEC™ 8400 system.

Status monitoring is then handled as a separate subsystem of the LANTEC™ 8400 that collects the information from the SMMs during a period of say 10 seconds.

The same principal of subsystem architecture can be used for other low speed services, like energy management, security, polling etc., without affecting the data throughput of the system.

5.5 LANTEC™ 8453 RF Redundancy Switch

Suppose you are ready to transport high speed data on your institutional system and you are asked by your potential customer about the outage time or the availability of your system.

What are you going to tell him?

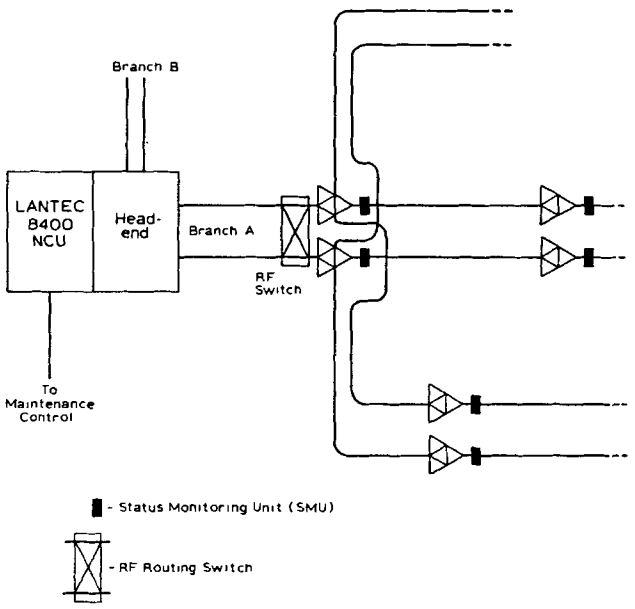
You cannot really tell this sensitive prospective customer that you have a status monitoring system that lets you see which amplifier is not performing right and that you are sending a technician out to fix the problem.

Your customer will say "thanks, but no thanks" if you cannot give him 100% availability, 24 hours a day.

Figure 13 shows an example of Branch Switching Redundancy using the LANTEC™ 8453 RF Redundancy Switch.

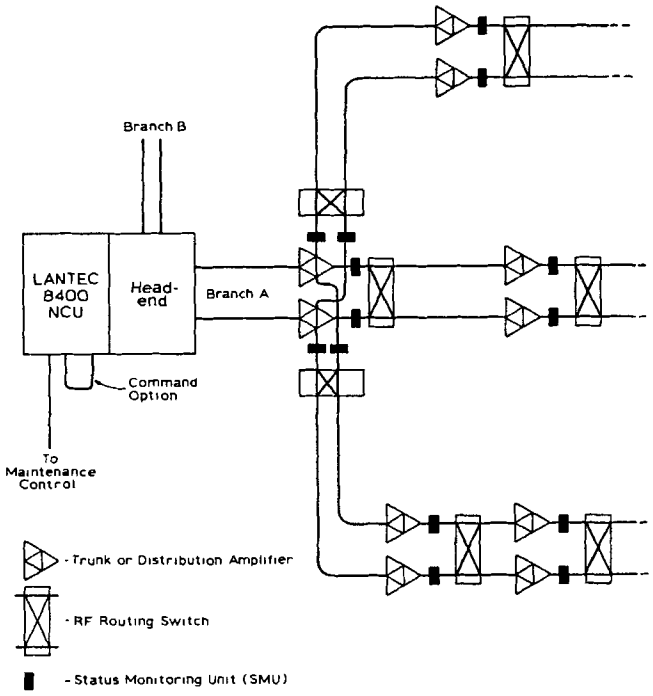
Your institutional system is simply duplicated to protect the traffic of this sensitive customer along the branch of the system that he uses, i.e., between his data locations and the gateway point.

Another form of redundancy is provided by the Segment Switching Redundancy shown in the example of Figure 14.



LANTEC 8400
Advanced LAN
Topology
Branch Switching Redundancy
TELE-ENGINEERING CORP

FIG. 13



LANTEC 8400
Advanced LAN
Topology
Segment Switching Redundancy
TELE-ENGINEERING CORP

FIG.14

Here, LANTEC™ 8453 RF Switching modules have been placed at every amplifier. In case of any amplifier failure, indicated by the status monitoring system, you simply command the particular module to switch to the redundant segment and then send your technician out the next day to fix the amplifier.

With segment switching redundancy you have achieved 100% availability provided there is somebody there 24 hours to push the right button.

5.6 LANTEC™ 8460 Automatic Maintenance System Computer

Revenues of data communications are measured at a unit rate per kilobits transmitted. If you have many customers sending data at rates of 19,200 bits per second, the pennies are starting to add up.

You may want to have 24 hour personnel to protect your revenue stream.

In case you don't, the alternative is the LANTEC™ 8460 Automatic Maintenance System Computer. A standard IBM PC with Tele-Engineering software can be used to fully automate your system maintenance.

The LANTEC™ 8460 system software is designed to function independently of multi-vendor terminal equipment. It utilizes forward and return pilot frequencies to access the spectrum performance of the system.

The controller at the headend is initialized by programming the system topology of your system by sequential inputting of trunk branches, amplifiers and feeder amplifiers.

The SMMs provide information on level variations of ± 3 dBmV. Alarm indications are provided for level variations of over ± 6 dBmV.

Figure 15 shows a typical screen layout for two amplifiers on different branches.

It is obvious that trouble shooting can be reduced to reading the printout and implementing the steps as outlined. The maintenance software allows immediate restoration of the system by switching to the redundant segment, pinpointing the problem to the faulty network device and instructing the technician in the proper fault clearing sequence.

The LANTEC™ 8460 maintenance system has a thirty day continuous memory to store performance data. The performance data can be printed locally or transmitted remotely, on a demand basis.

LANTEC™ 8460 AUTOMATIC MAINTENANCE SYSTEM

ITEM	BRANCH	TRUNK	AMP. NO.	CRITERIA ± 3	CRITERIA ± 6	REDUNDANT
1	2	4	4015A	over	under	NO

Forward module OK
Check return module
Set output level to + 32 dBmV
Check flatness
Restore station to complete

2	1	3	3008A	over	over	YES

Outage of forward module
Return module OK before switching
Redundant segment ok
Replace forward module
Set output level to + 33 dBmV
Set pad value to 6 dB
Set equalizer to 9.5 dB
Check flatness
Restore station to complete

Figure 15

5.7 LANTEC™ 8442 Network Control Unit (NCU)

Where the LANTEC™ 8460 computer system concerns itself only with the availability of the transmission media, the LANTEC™ 8442 Network Control Unit concerns itself with the proper functioning of all connected LANTEC modem terminals.

At the headend or maintenance center of the system, a LANTEC™ 8442 NCU is installed and constantly monitors the addressing, the token passing sequence, the handshake protocols, the packets transmitted and received at every modem terminal.

During initialization of the NCU, it is important to program all addresses of all participating terminals into the memory. The token passing traffic is compared against this memory and any anomalies will be reported. Priority levels of the various customer categories are set in accordance with the type of service desired.

The NCU software permits the pinpointing of modem terminal problems to the board or module level so that expedient maintenance procedures can be effected before the customer registers the outage.

Figure 16 indicates a typical screen layout on the CRT connected to the Network Control Unit.

LANTEC™ 8442 NETWORK CONTROL SYSTEM

TERM #	ADDRESS #	Tx STATUS	Rx STATUS	COMM. BOARD
25	203568	no	ok	ok
unit does not pass token Tx level low				
38	203589	ok	ok	no
unit responds irregular check response timer/re-start timer				
45	203678	no	no	no
check power and RF connections				

FIGURE 16

The screen information can be printed and given to the technician who will be on his way to change the unit.

The third failure listed may be a disconnected unit. Terminal 45 may be disconnected from power or RF. A telephone call seems appropriate to find out the status before sending a technician.

5.8 LANTEC™ 8470 Automatic Unit Rate Billing System

It was mentioned earlier that every modem terminal on the system listens to the traffic on the system and can be placed anywhere on the system.

By installing a LANTEC™ 8401 modem terminal at the headend or office location, a traffic count can be made in megabits per second. The LANTEC™ 8470 combines the traffic count with the senders' addresses, priority level, sub-addresses, date and time of transmission as well as address of the number called.

The LANTEC™ 8470 computer then sorts the data in transaction files that permit the collection of data by customer and by priority rate level to record the number and length of calls made in megabits per second.

The LANTEC™ 8470 software includes a billing program for automatic billing of all data traffic as well as balances, past dues and standard account maintenance routines.

A billing summary program provides an instantaneous overview over all completed and invoiced transactions.

LANTEC™ 8470 DATA TRAFFIC BILLING SYSTEM

NAME: TELE-ENGINEERING CORPORATION

ADDRESS: 2 CENTRAL STREET, FRAMINGHAM, MA 01701

TERM #: 203568

DATE	TIME	DESTINATION	RATE	Mbps	AMOUNT
3-05-84	6:27 pm	30546	0.005	6.450	$ 32.25
3-28-84	11:07 am	30555	0.009	8.502	76.52
3-30-84	10:16 am	20654	0.009	3.600	32.40
			Total Amount:		$141.17

FIGURE 17

6. SUMMARY

Token passing, packet switching systems are in existence now and can form the basis for additional revenues for every cable operator.

The LANTEC™ 8400 token passing, packet switching data transfer system has been developed to provide a total range of services to the operator. The system provides for status monitoring, automatic transmission system maintenance, network control, account maintenance and automatic billing.

The development of data transmission on cable systems is considered the most important factor in the search for additional revenues.

Institutional systems have been left idle and are especially suited to provide multiport distributed data communication services.

The equipment, the LANTEC™ 8400 can help to develop a new revenue stream of data transfer speeds that cannot easily be supported by the twisted pairs of the telephone company.

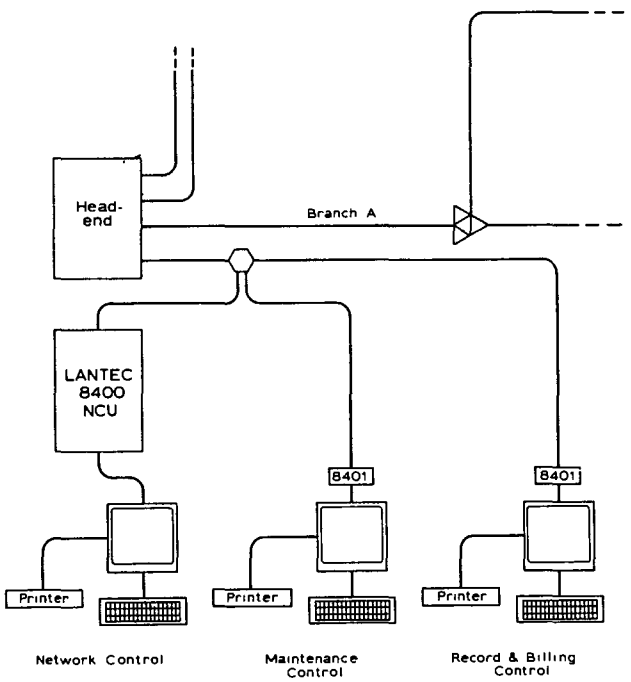


FIG. 18

The coaxial cable is a powerful tool. Even though your experience has been such that the distribution of entertainment television is all you can handle in your daily operations, have an open mind. Research the data transfer requirements in your franchise area. Start with a few LANTEC™ 8401 modem terminals and experiment. Then build a new business communication network and a Teleport transportation system with minimum capital expenditures and gradually build up a new revenue base from business data communications that may soon exceed your revenues from entertainment.

Tele-Engineering Corporation has an experienced staff of system engineering that is available for consultation on matters such as:

- ingress on residential sub-low
- return activation
- extension of institutional system
- redundancy considerations of institutional system

Tele-Engineering Corporation can also provide your business data communication system on a turnkey basis to give you the necessary assurances that everything works flawlessly.

Whatever your approach may be is not important. What is important is that you recognize the fact that the window of time for data communication on cable is open wide and that you must act soon or be bypassed by other more enterprising organizations.