ROUTE-24™
SYSTEM DESCRIPTION

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Table of Contents

List of Illustrations

I. INTRODUCTION

1. Introduction to T1

The fundamental concepts of T1 will be discussed before the system features of the Route-24 Intelligent Access Multiplexer are presented.

A T1 digital facility interconnects digital communication systems in North America. As a result, a T1 network usually has multiple T1 line terminations at each node (Figure 1). These nodes can be at a customer's site or at a carrier's central office, which creates a hybrid of private and public networks. A T1 facility can carry from one to several hundred multiplexed signals, allowing end users to integrate separate voice, data, compressed video, and wideband analog signals into a network. The DS-1 signal is the first level in the North American T1 digital hierarchy:

Signal	Number of T1 Signals	Bitstream (Mb/s)
DS-1/T1	1	1.544
DS-1C/T1C	2	3.152
DS-2/T2	4	6.312
DS-3/T3	28	44.736
DS-4/T4	168	274.760

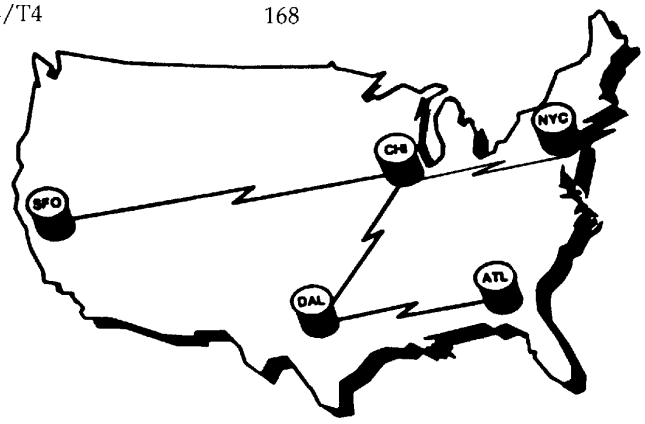


Figure 1: T1 Network is a Hybrid of Public and Private Networks

A DS-1 (T1) signal is a bipolar pulse train with a 50 percent duty cycle (Figure 2). The DS-1 signal is divided into time slots of 648 nanoseconds or 1,544,000 time slots per second. Each time slot represents one binary digit or bit of information. By using pulse code modulation (PCM) and time-division multiplexing (TDM), a T1 multiplexer encodes the voice, data, compressed video, and wideband analog signals by filling a time slot with a pulse or leaving it empty. A time slot with a pulse has a value of one, while a time slot without a pulse has a value of zero. Thus, the presence or absence of a pulse, not its polarity, signifies the information in a time slot.

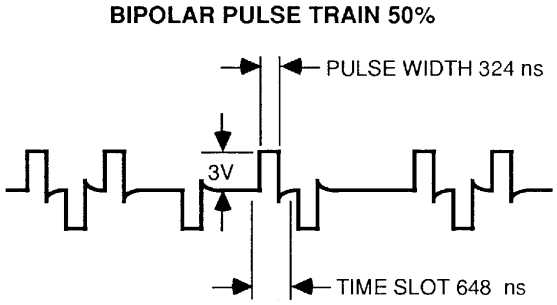


Figure 2: DS-1 Signal Characteristics

Normal DS-1 signals consist of consecutive pulses that are bipolar or have an alternating polarity, which is called AMI or Alternate Mark Inversion line coding (Figure 3). T1 systems use AMI because the DS-1 signal has no dc components, error detection is simplified, timing recovery is easier, and band width requirements are reduced. On the other hand, DS-1 signals with consecutive pulses of the same polarity exhibit a transmission error known as a bipolar violation (BPV).

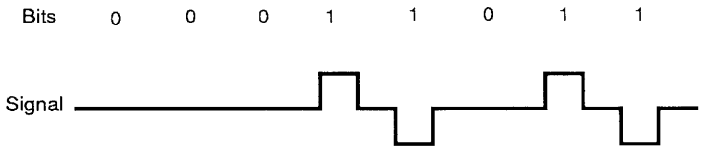


Figure 3: AMI Signal Line Coding

DS-1 signals can be transmitted about 6000 feet over 24-gauge twisted pair wire, which is the most widely-used transmission media. To send signals more than 6000 feet, T1 systems require a repeater, which amplifies the signal to compensate for the signal losses and ensures an adequate signal level at the customer site.

The receiving T1 equipment must detect the pulses in a received DS-1 signal to identify each time slot. Because pulses occur only when ones are transmitted, DS-1 signals with too many consecutive zeros cause timing problems. The minimum number of ones pulses required for reliable timing varies with the type of T1 equipment; however, AT&T has defined a standard pulse density requirement:

N pulses in every 8(N+1) bits, where N = 1,2,3, ...23

This formula shows that no more than 15 consecutive zeros should be transmitted. In other words, the minimum pulse density must equal one, that is, one pulse in every 16 bits. In the past, this requirement was important; however, modern T1 repeaters can handle up to 80 consecutive zeros. In spite of this, the pulse density requirements depends on the type of T1 equipment. To maintain pulse density, T1 equipment may stuff a pulse, that is,overwrite the zero

in the time slot with a one, to maintain pulse density. Even though pulse stuffing maintains the minimum pulse density, it has drawbacks.

The primary drawback of pulse stuffing is that it corrupts the original data. It is not a problem for voice transmission because the effect on the quality of the received signal is negligible. For data transmission, however, pulse stuffing is disastrous because it introduces errors in the data signal. To maintain pulse density during data transmission without corrupting data, another method must be used. One such method is clear channel capability or 64CCC.

Clear channel capability uses the Bipolar Eight Zero Substitution (B8ZS) encoding scheme. B8ZS replaces any eight consecutive zeros with a fixed code containing two BPVs (Figure 4). This type of line coding requires that the T1 equipment at each end must encode and decode B8ZS and that the network equipment is transparent to the B8ZS signal. Not all networks can implement B8ZS because some T1 network equipment corrects intentional BPVs.

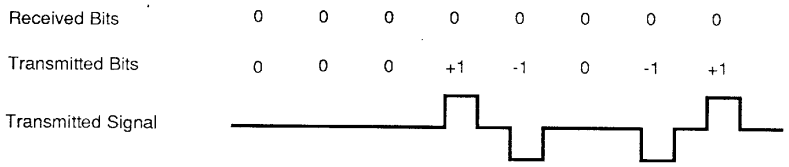


Figure 4: B8ZS Encoding

The sending T1 equipment must transfer the timing information to the receiving T1 equipment, so that the receiving equipment can identify each time slot. To do this, modern T1 equipment uses one of two line coding schemes: superframe (SF) format or extended superframe (ESF) format.

The DS-1 signal is divided into frames of 192 information bits and 1 framing bit. Framing bits occur in a fixed pattern of ones and zeros.

In the SF format (Figure 5), each superframe consist of 12 frames. Each frame consists of 24 channel words and one framing bit. Each channel is sampled 8000 times per second or 8000 frames of 193 bits. The framing (Ft) bits alternate every frame; they are in odd-numbered frames. Likewise, the signaling bits (Fs) are in even-numbered frames. The T1 equipment uses this unique sequence to identify the sixth and twelfth frames as carrying channel signaling information (dialing, idle, busy, on-hook, and off-hook). The sixth frame carries the A signaling bit, while the twelfth frame is called the B signaling bit.

Each channel word consists of 8 bits. If the bits represent voice, the sending T1 equipment must also transmit signaling information. One way of doing this is to use robbed-bit signaling

Robbed bit signaling uses or robs the least significant or eighth bit in the sixth and twelfth frames. In the first five frames, the eighth bit of each voice channel carries the least significant bit of voice information. In the sixth frame, the eighth bit of each channel carries signaling information (A bit). Then, in the seventh through eleventh frames, the eighth bit of each channel carries the least significant bit of voice information. Finally, in the twelfth frame, the eighth bit of each channel carries signaling information (B bit). In the SF format, this sequence repeats every 12 frames. Because robbed bit signaling uses only the least significant bit of every sixth frame, it has little effect on the quality of voice transmission.

The SF format does have one limitation: it cannot measure the error rate on a live T1 circuit. To monitor circuit performance, the live traffic must be stopped before a test pattern can be sent. The second format, ESF, on the other hand, does not have this disadvantage.

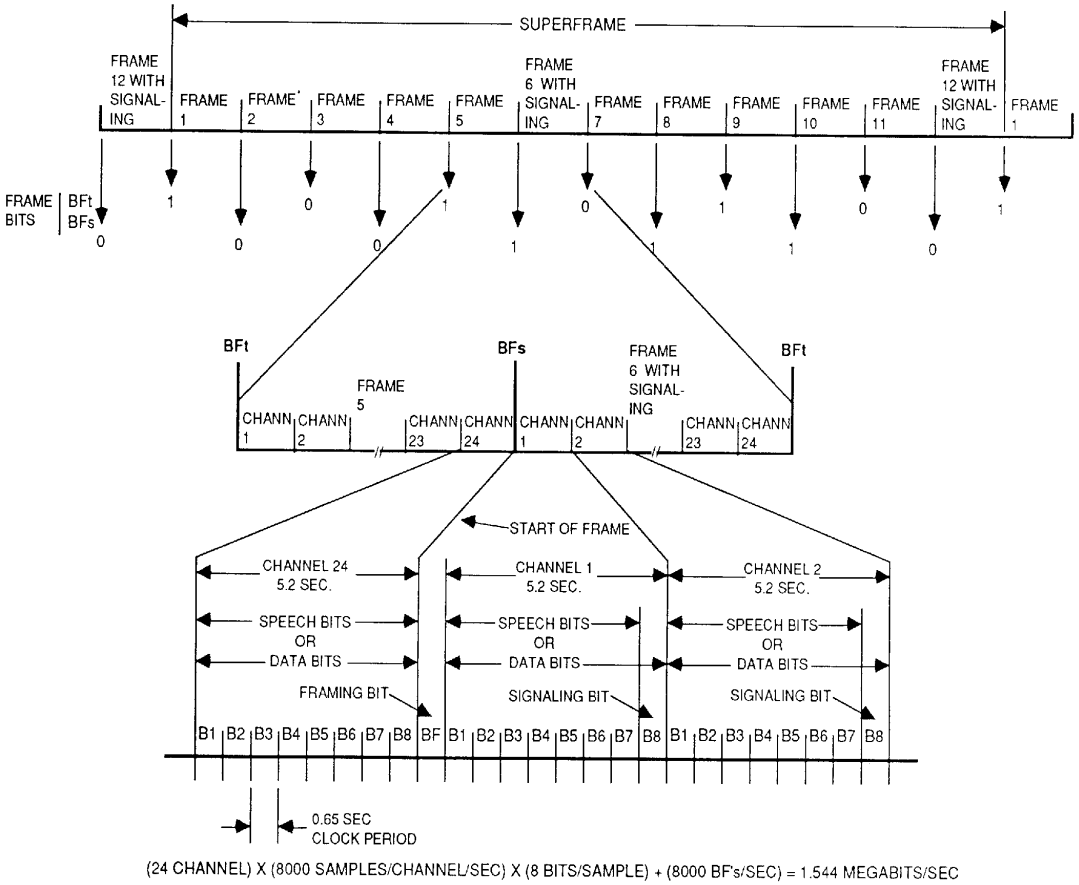


Figure 5: SF Format

The ESF format has a different framing sequence than SF: 24 versus 12 (Figure 6). Also, for robbed bit signaling, ESF uses frames 6, 12, 18 and 24. On top of this, ESF allows T1 equipment to monitor live traffic, because modern T1 equipment needs only 4 kb/s to maintain frame synchronization, which is half of that required by T1 equipment using the SF format. The 8 kb/s of overhead information is divided into 3 separate channels:

- 2-kb/s channel for framing;
- 2-kb/s channel for error checking. The T1 sending and receiving equipment detect bit errors by using a six-bit Cyclic Redundancy Check code (CRC-6) on every superframe to calculate and then compare their results.
- 4-kb/s channel, called the Facility Data Link (FDL), allows a customer to control diagnostics and transmit performance statistics.

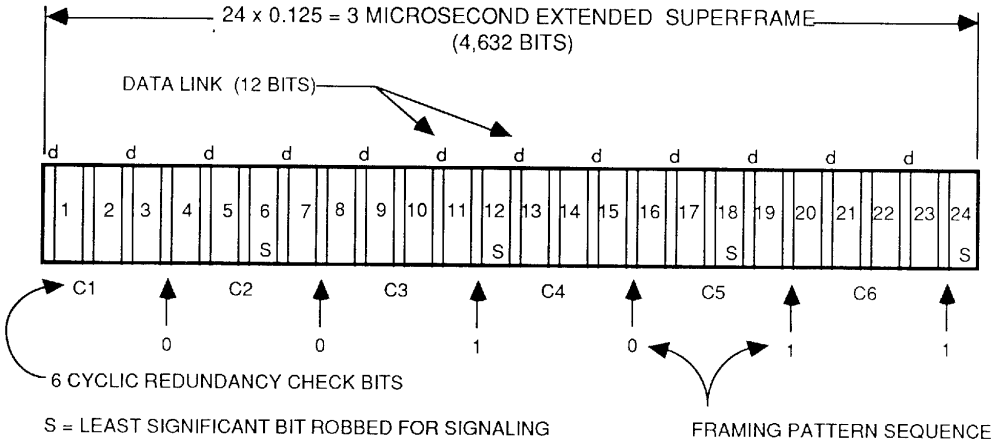


Figure 6: ESF Format

T1 equipment provides service via the following media:

- Twisted Pair. Using standard telephone wire is the most popular way of transmitting T1. One pair is for transmitting T1 and the other pair is for receiving T1. A T1 signal can be transmitted about 6000 feet before a repeater is needed to regenerate the T1 signal.
- 18 GHz and 23 GHz Radios. These radios can transmit T1 between buildings on opposite sides of a street or across a campus or industrial facility.
- Digital Microwave Radio. It is similar to the 18 and 23 GHz radios, but they operate in the common carrier and industrial microwave bands of the spectrum. They can carry many T1 lines.

- Fiber Optic Systems. These systems directly transmit 1.544 Mb/s over a fiber optic line. By using multiplexers, many T1 signals can be transmitted over fiber.
- Coaxial Cable. They interface T1 systems via coaxial cable modems.
- Common Carriers. T1 systems can be leased from common carriers with terrestrial and satellite service. They offer:
  - T1 Service Between Customer Sites;
  - T1 Service From the Customer Premises to a Central Office of a Local Exchange Carrier;
  - Central Office T1 Multiplexing Service;
  - High-Speed Switched Digital T1 Service.

2. The Customer Premises Specialist

Telco Systems NAC is a specialist in customer premise T1 multiplexing. We are a major supplier of customer premise T1 multiplex equipment, serving the business communication end user market with cost-effective, intelligent network solutions. The Route-24 Intelligent Access Multiplexer and MuxView™, our network management system, serve the changing demands of customers by having feature sets that can be expanded to meet their future requirements.

3. System Features

The Route-24 Intelligent Access Multiplexer uses time-division multiplexing and pulse code modulation to combine voice and data onto a single T1 line. Whether used alone or along with our DS-1 compatible ESF channel service unit, digital crossconnect, low bit rate voice (ADPCM) system, digital drop and insert system, or digital echo canceller, Route-24 was designed for customer premises applications.

Because Route-24 is fully network compatible, it can interface a customer's voice and data devices with any private or public T1 facility or service. To transmit and receive any combination of voice, data, or compressed video, Route-24 offers:

- Flexible system architecture allows each Route-24 multiplexer to be configured for the immediate needs of a customer and to be easily reconfigured or upgraded in the future;
- Direct interfaces for up to 24 voice, high-speed data, low-speed asynchronous and synchronous data, and compressed video channels;
- Subrate multiplexing of up to 32 asynchronous or 20 synchronous subrate channels in one DS-0 channel;
- Programmable bandwidth allocation;
- Time-of-day reconfiguration;

- Software-controlled I/Os means no switch or jumper settings;
- Local or remote nondisruptive system configuration and control;
- Automatic or manual system reconfiguration;
- Call monitoring, incoming and outgoing;
- Remote diagnostics;
- Standard loopbacks;
- Digital test-tone or quiet code.

II. SYSTEM ARCHITECTURE

The flexible architecture of Route-24 allows customers to configure their Route-24 Intelligent Access Multiplexers for their immediate needs, while allowing them to upgrade or change their systems.

1. Compatibility with Public and Private Networks

The Route-24 Intelligent Access Multiplexer is fully compatible with all current network channel and framing specifications. It has the following programmable T1 options:

- Line Codes
  - B8ZS (Bipolar Eight Zero Substitution);
  - Clear Channel Capability (transparent).
- Framing Formats
  - Superframe (SF or D4);
  - Extended Superframe (ESF).
- Synchronization Sources
  - Received T1 signal (looped timing);
  - Internal 1.544-MHz clock (master timing);
  - DDS clock (DDS timing).
- Consequently, Route-24 can interface with any T1 equipment and/or service having a D3/D4 interface; such as:
  - Multiplexer in a public or private network;
  - Channel banks;
  - Digital crossconnect systems;
  - AT&T Accunet T1.5 M-24 Digital Data Termination (DDT) service;
  - AT&T Subrate Data Multiplexing service (PUB 54075).

2. Compatibility with Customer-Premise Equipment

Route-24 supports the following AT&T and EIA voice and data interfaces:

- Low- and High-Speed Data. Route-24 supports the RS-232-C, RS-422/449, and V.35 data interfaces with channel data speeds from 1.2 kb/s to 1.536 Mb/s.
- Voice. Route-24 provides 4-wire E&M/TO and 2-wire FXS/FXSDN/PLAR interfaces.

Consequently, Route-24 can interface with the following customer equipment:

- Host computers or front-end processors;
- Facsimile devices;
- CAD/CAM workstations;
- Compressed video devices;
- Personal computers;
- Remote printers and plotters;
- Statistical and TDM multiplexers;
- Analog and digital PBXs;
- Key telephone systems;
- D3/D4 channel banks.

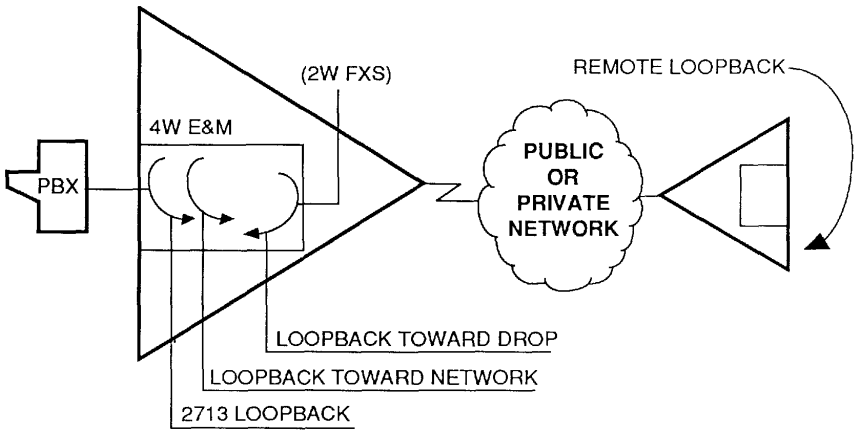
3. Alarms and Diagnostics

Route-24 continuously monitors its operation and reports any system errors or errors in the signals received from the customer equipment or the T1 network. Alarms are reported in four ways: (1) video display terminal (VDT), (2) visual alarms on the link interface unit, (3) external audible alarms, and (4) outward dialing via a built-in modem to report alarms to a MuxView site. By using a VDT, a user can query Route-24 to isolate the alarm condition to individual system modules or incoming T1 signals.

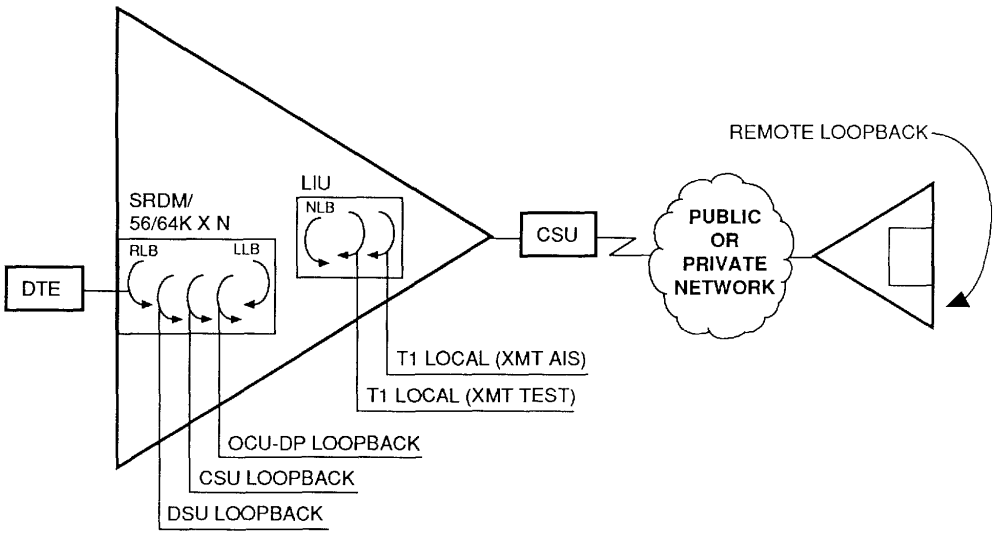
In addition to alarm and diagnostic statistics, Route-24 provides the following troubleshooting aids:

- Inserting a digital 1-kHz, 1-mW test tone or quiet code on any receive channel;
- Looping the outgoing T1 line back toward the customer premise (Figure 7);
- Looping the incoming T1 line back toward the network;
- Looping a voice channel back toward the network or the customer premise;
- Looping a data channel back toward the network, including any or all subrate multiplexed channels;
- Looping a data channel back toward the customer premise, including all subrate multiplexed channels.

As a further aid in isolating faults, MuxView generates trouble tickets; generates reports for the network, site, and equipment; and maintains a history log.



Loopbacks for Voice Channel Units

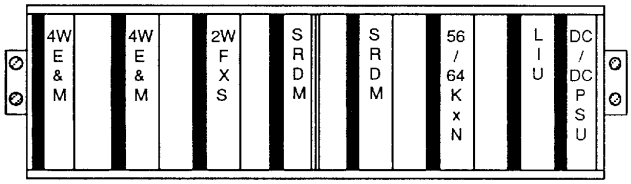


Loopbacks for Data Channel Units

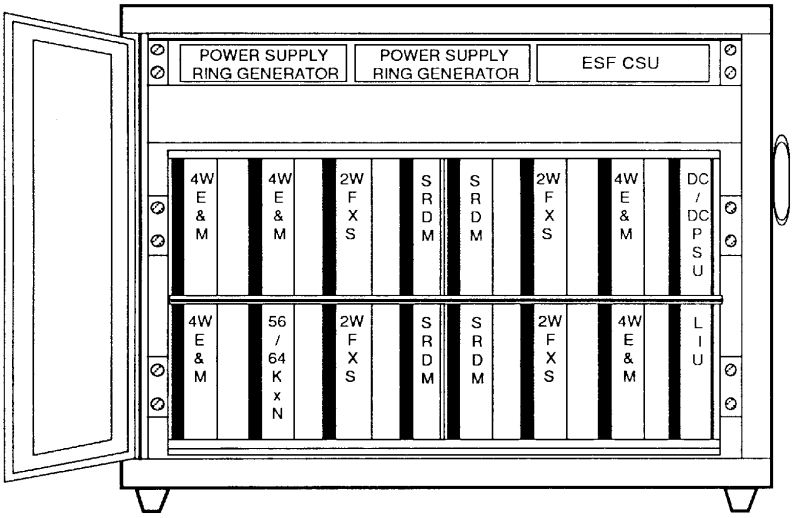
Figure 7: Simplified Loopback Diagrams

4. Route-24 Component Description

Route-24 uses the modular concept for system configuration. The basic system comprises an equipment shelf, an intelligent link interface unit (LIU), and a power supply unit (PSU). These three components are also known as the common equipment of a system. Each system requires common equipment. Then, the customer adds interfaces, options, and features to the system by plugging in additional modules and programming the system. Figure 8 shows a typical configuration. A Fractional T1 Route-24 (see below) can accomodate up to 11 time slots.



Fractional T1 Route-24 equipped with 6 channel units and common equipment (LIU and PSU)



Wall-Mounted Cabinet with power supply, ringing generator, ESF CSU, and Route-24 equipped with 14 channel units and common equipment (LIU and PSU)

PLUG-IN INTELLIGENT UNITS:
- 4W E&M/TO
- 2W FXS/PLAR/FXSDN
- 56/64K X N DATA UNIT (RSS-232, RS-422, V .35)
- SUBRATE DATA UNIT (RS-232)

Figure 8: Typical Route-24 Configurations

Link Interface Unit (LIU)

The Link Interface Unit (LIU) provides the T1 interface for the Route-24. It accepts one DS-1 signal from a T1 line, digital PBX, analog PBX with a D3/D4 channel bank, one DS-1 output from a fiber optic multiplexer or microwave radio, or data or channel service unit that has already converted the data bit stream to a bipolar one. The LIU supports the D3/D4 and Extended Superframe (ESF) framing formats and the bipolar eight zero substitution (B8ZS), zero suppression, and clear channel capability (64CCC) line codes. The LIU provides transmit equalization for up to 655 feet of cable to the DSX-1 crossconnect. Not only does the LIU provide the T1 interface, but it also provides the common logic and control between all the system components.

The LIU contains the system central processing unit (CPU) and nonvolatile memory. Its nonvolatile memory keeps a database of the programmed settings for the LIU and each intelligent channel unit. This allows the system to be restarted without having to reprogram the LIU and the intelligent channel units. The LIU also has a built-in modem for dial-up access by a remote terminal and for dialing out to a MuxView Elite site to automatically report alarms.

DC-DC Power Supply Unit (PSU)

Route-24 is powered from voltages supplied by the Power Supply Unit. The PSU requires -48 Vdc from either an office battery or local power supply. One PSU can power an entire Route-24 shelf.

Voice Frequency Units

The Route-24 voice-frequency modules encode and decode analog voice signals by using the standard μ-255 algorithm. The channel levels, signaling, and loopbacks are software-controlled:

- 4-Wire E&M/TO Unit. The 4-wire E&M unit interfaces with an analog voice circuit provided by E&M tie lines. It supports E&M Types I and II signaling, has a 600-ohm interface, and can be configured for normal or tandem tie line and transmission-only applications. It can be looped back toward either the customer premise or the network.

- 2-Wire FXS/PLAR/FXSDN. This unit acts as three cards in one, each software controlled. The 2-wire FXS/PLAR/FXSDN unit interfaces with the analog station or switching equipment, such as a PBX. It can be configured for loop start or ground start signaling and a 600- or 900-ohm interface. It can be looped back toward either the customer premise or the network. Also, it can be used in private line automatic ringdown applications when configured for PLAR or in tandem access applications, such as MEGACOM, when configured for FXSDN.

Data Units

Route-24 has two types of data modules that support the RS-232-C, RS-422/449, and V.35 interfaces with channel data speeds from 1.2 kb/s to 1.536 Mb/s:

- High-Speed Data Unit.
  - Synchronous, Protocol Transparent;
  - Clear Channel 64K x N (N = 1, 2, ... 24) Support by B8ZS and Inverted Data Option for HDLC;
  - Dynamic Bandwidth Control;
  - Time-of-Day Reconfiguration;
  - Software-Controlled Options (Timing, RTS, CTS, etc.);
  - Automatic Channel Identification on Hardware and Software (Model Number, Serial Number, and Software Revision);
  - Various Loopbacks for Diagnostics;
  - At 56K x 1, Fully Compatible with DDS Standards (OCU-DP, CSU, and DSU)
- Low-Speed Subrate Data Unit.
  - Accommodates Quad Synchronous/Asynchronous Rates from 1.2 kb/s to 19.2 kb/s;
  - SRDM Compatible with PUB 54075;
  - DS0-A and DS0-B Subrate Capability;
  - Cost Effective Alternative to Stand Alone Subrate Data Multiplexers;
  - Mix and Match Subrate Data Speeds for Various Services - ATM, CAD/CAM, and Videotext;
  - Automatic Channel Identification on Hardware and Software (Model Number, Serial Number, and Software Revision);
  - Recognizes and Responds to DDS Network Control Codes: Channel, DSU, and OCU Loopback.

Shelves and Cabinets

Route-24 is available in two shelf configurations. All shelves are 19-inches wide, 11-3/4 inches deep, and are flush- or center-mounted in a rack or cabinet. They are available with or without EMI-protection. One type of shelf has 2 mounting positions for the common equipment and up to 11 voice or data channel units, or a mix of both. It occupies 3 vertical mounting spaces (5.2-inches high) and is 11-3/4 inches deep. The other type of shelf has 2 mounting positions for the common equipment and up to 24 voice or data channel units, or a mix of both. It occupies 6 vertical mounting spaces (10.4-inches high) and is 11-3/4 inches deep.

A system may require an AC-DC power supply, ringing generator, or ESF CSU. These modules are mounted in a power supply/ringing generator/CSU shelf that holds up to two power supply/ringing generator modules and one ESF CSU module. It is 1-3/4-inches high (1 rack space), 19-inches wide, and 11-inches deep.

Other Equipment

Certain applications may require the additional equipment:

- Channel Service Unit;
- Ringing generator for 2-wire FXS units;
- Fuse panel for power distribution;
- Cables for DTE ports of data channel units;

III. NETWORK MANAGEMENT

The software programming capabilities enhance the flexibility of Route-24. Whether the system consists of a basic point-to-point or point-to-private backbone configuration, Route-24 operates under instructions stored in nonvolatile memory on the Link Interface Unit (LIU). A user accesses the nonvolatile memory and controls Route-24 by entering commands from a MuxView Elite or MuxView VT system. MuxView Elite is a Windows-386 based, mouse- and keyboard-driven program using a series of icons and user-friendly screens. The alternative is to use a local or remote VDT connected to the MuxView VT interface to enter commands from menus, which guide a new user through system configuration and diagnostics. An experienced user can bypass the menus by entering abbreviated commands.

Route-24 has two control ports for an operator to access using a MuxView Elite system or a local or remote VDT using MuxView VT:

- A local terminal port;
- A Bell-212A compatible modem port.

MuxView Elite Functional Command Summary

Administration

- Generate reports: users, illegal log-ins, network, site, links, equipment, cards, locate equipment, locate card, opened trouble tickets, closed trouble tickets, and historical trouble tickets;
- Enter administrator name;
- Create and delete users; grant or revoke user access to network, delete networks, and assign security level;
- Access database;
- Request database backup to the hard disk or floppy disk;
- Create history backup;
- Set date and time of day.

Configuration

- Configure video display terminal and modem ports;
- Create and access network;
- Create and delete site;
- Define site parameters;
- Define and delete equipment;
- Install nonintelligent cards;
- Create and delete links;
- Select network and site;
- Reconcile intelligent cards with information in database.

Diagnostics

- Authorize call to site, initiate call to site, get parameters from intelligent cards;
- Set polling interval, get status information, open trouble ticket, close trouble ticket, log time of call, duration, and results of call.

MuxView VT Functional Command Summary

Utilities/Administrative

- Retrieve serial number, model number, and software revision of intelligent channel units;
- Set date and time of day;
- Save or reload options from memory.

LIU/T1

- Access LIU;
- Configure modem interface;
- Configure video display terminal interface;
- Access ESF CSU;
- Configure ESF CSU interface;
- Configure framing formats, zero suppression, idle code, T1 alarm and error formats, line build-out network, signaling, synchronization timing, and resynchronization;
- Status of T1 alarms, error counts, loopbacks, synchronization, and framing format;
- Reset error counters.

Voice Channel Units

- Access intelligent voice channel unit;
- Configure loopbacks, trunk processing, access system code bus, transmit and receive gain, impedance, build-out networks, and mode;
- Retrieve the number of incoming calls, outgoing calls, unsuccessful calls, calls answered, calls unanswered, and circuit busy time.

Data Channel Units

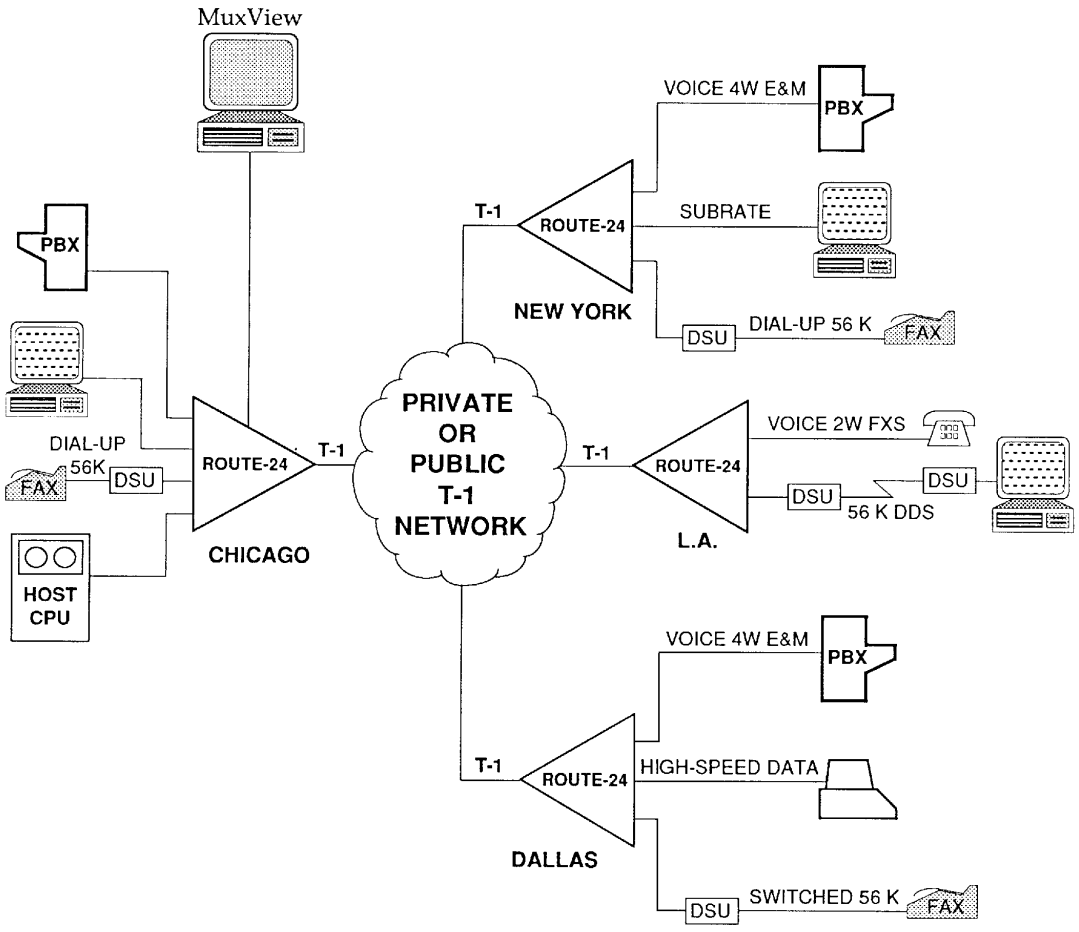
- Access intelligent data channel unit;
- Configure base data rate, bandwidth, clock source, mode, and control and idle codes.

Channel Unit Diagnostics

- Control loopbacks;
- Select code generator pattern;
- Display alarms in progress.

IV. SYSTEM APPLICATIONS

Route-24 can be used in many configurations because it is fully-network compatible, provides standard voice and data interfaces, uses plug-in modules, provides programmable options, and is controlled from a local or remote terminal (Figure 9).

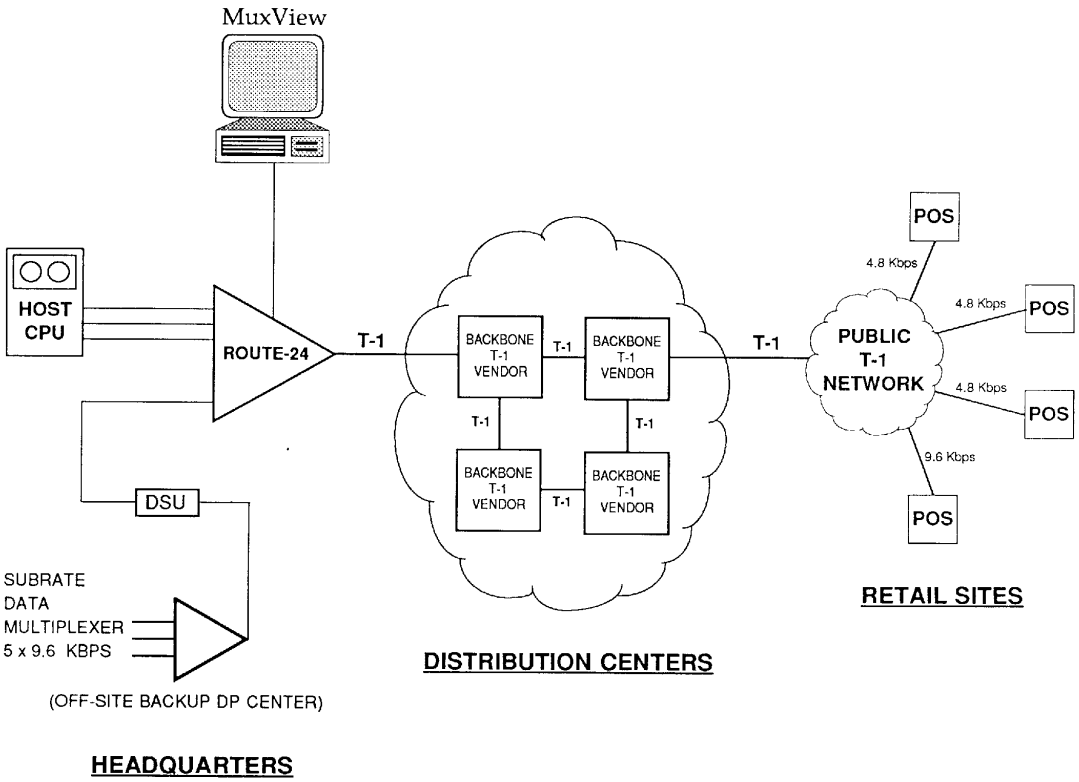


Headquarters to Branch Offices

Corporate headquarters wants a cost-effective way to utilize all its telecommunications resources, including faxes, PBXs, local and remote terminals, and video. They would also like to take advantage of the special services offered by T1 network suppliers, such as WATS lines, 800 numbers, and Switched 56.

Using a T1 multiplexer at each location, all of these services can be controlled from the customer premise, and used when required, maximizing the utilization (and cost effectiveness) of the T1 bandwidth.

Figure 9: Typical Applications

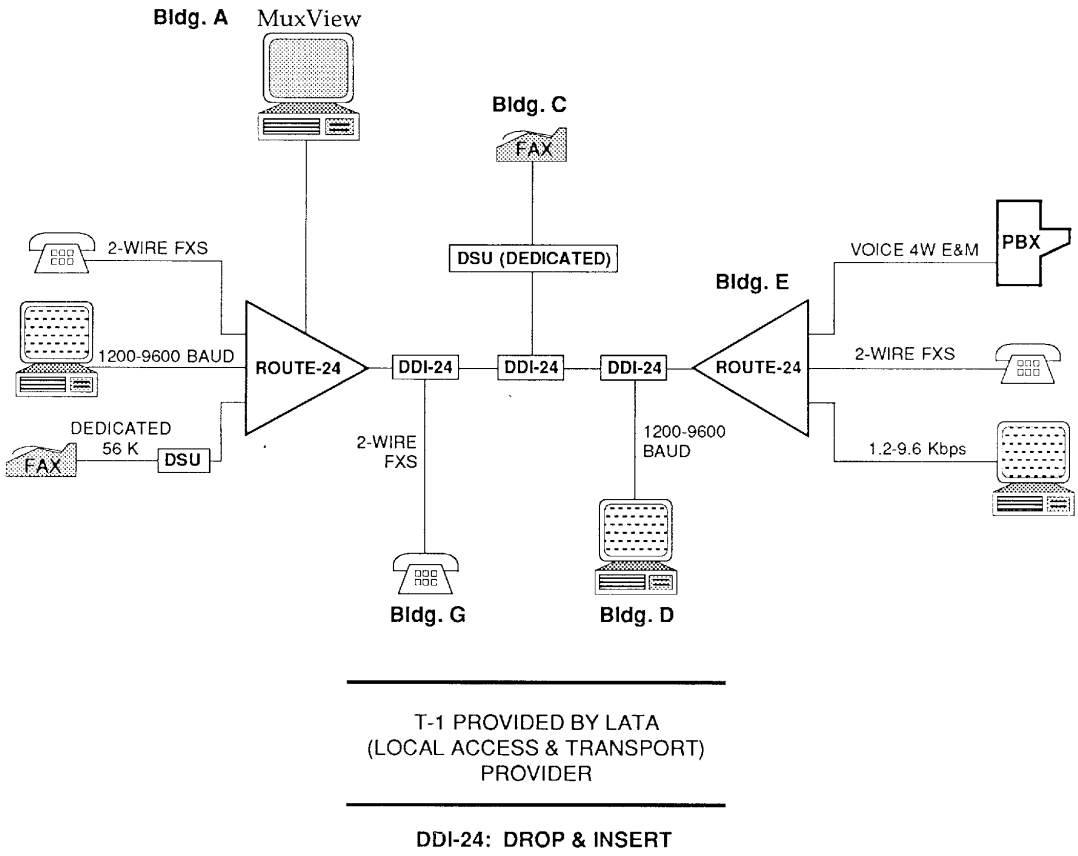


Point of Sale on Public and Private T1 Network

Let's assume that you have a number of retail locations, which need to communicate with your headquarters. You'd like to have information coming into your headquarters from these retail locations, all day long. You want to monitor inventory levels, sales levels, store traffic and more, all on a "real-time" basis. In addition, you would like a batch file transfer of total receipts at the end of each business day. All of this is easily accomplished using the right equipment.

In this application, we are showing the use of both a private backbone and the public network; the private backbone could be used for your distribution centers and the public network could be used for your individual stores. This is a very good example of a "hybrid" (mixture of public and private) network.

Figure 9: Typical Applications (continued)

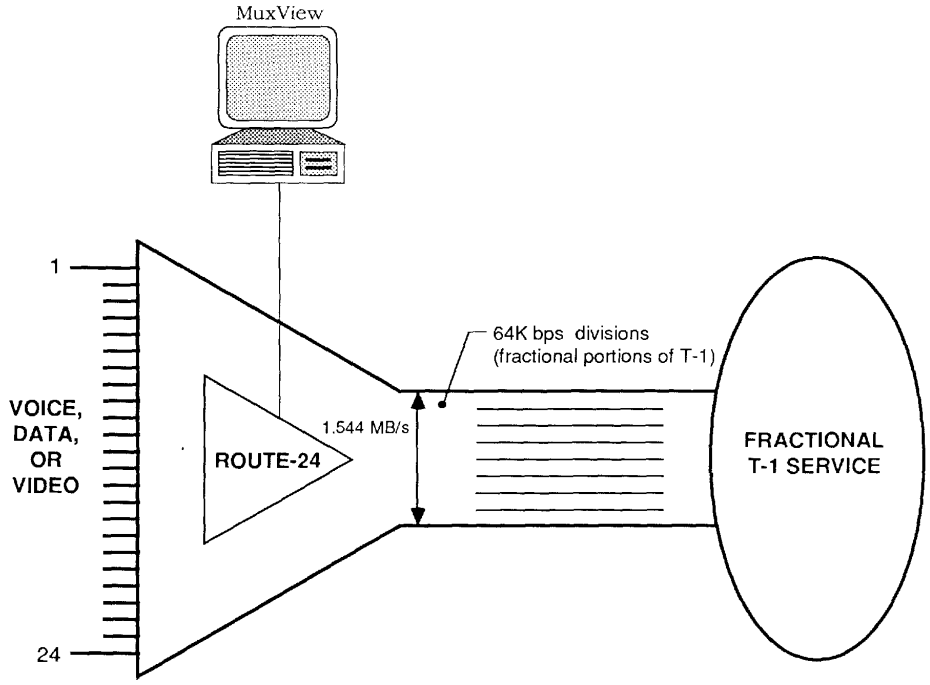


The "Campus" T1 Network

You can use T1 to set up a very cost-effective way to communicate across a university or business park campus.

The most economical way to accomplish this is with drop-and-insert (DDI) equipment. As your transmission travels from one building to another, you can actually "drop off" voice, data, or video signals to other locations on the way. All you have to do is install a DDI-24 unit at each of these locations. The rest of the T1 signal will continue to its appropriate location. This way, you get the advantages of T1 without having to install a complete multiplexer or channel bank at each location.

Figure 9: Typical Applications (continued)

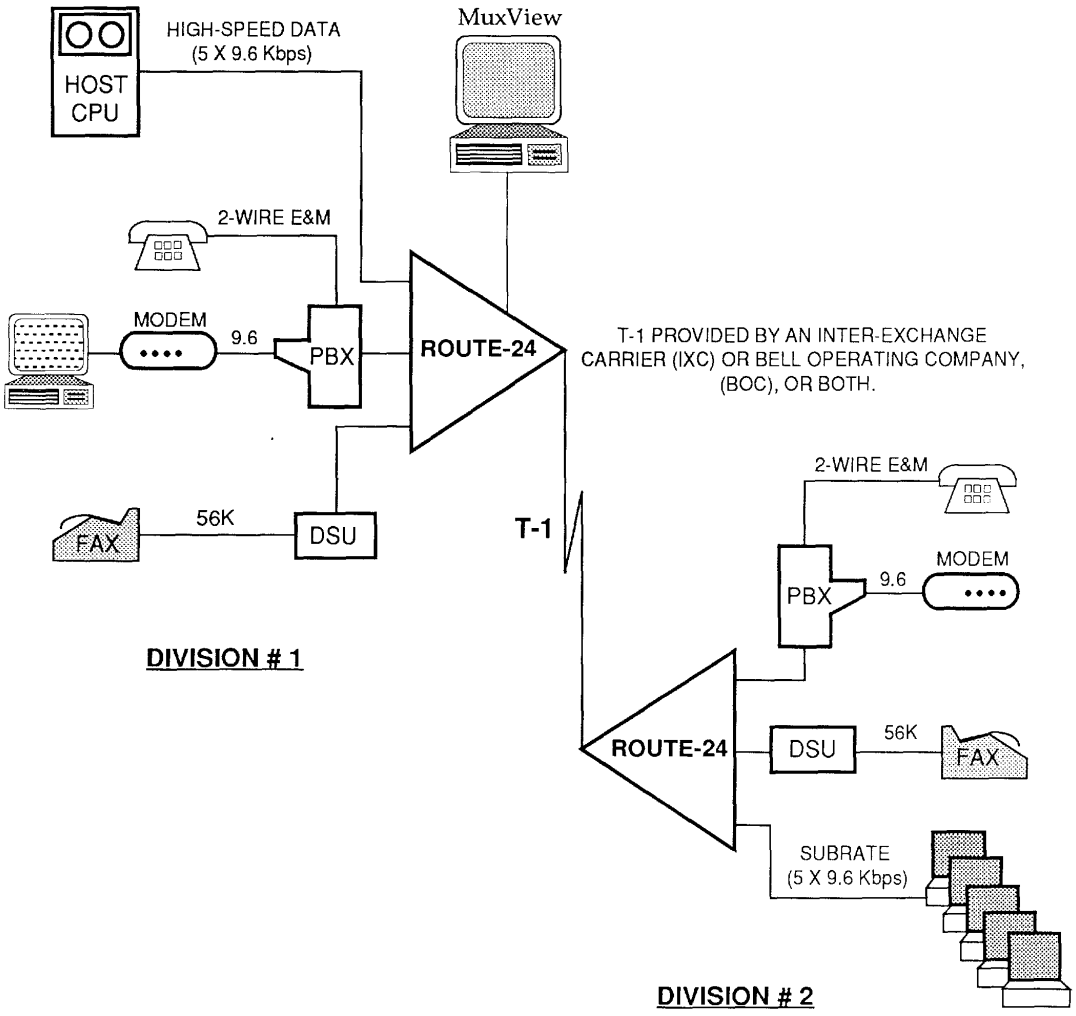


T-1, PROVIDED BY AN INTER-EXCHANGE CARRIER (IXC)
OR BELL OPERATING COMPANY, (BOC) OR BOTH.

Easy Access to Fractional T1

If you don't need the entire T1 "pipeline," you can lease a fractional portion of it. Fractional T1 divides the T1 bandwidth (1.544 Mb/s) into 64 kb/s sections (DS-0), which can then be leased. Fractional T1 will be offered by inter-exchange carriers, and Bell Operating Companies (BOCs).

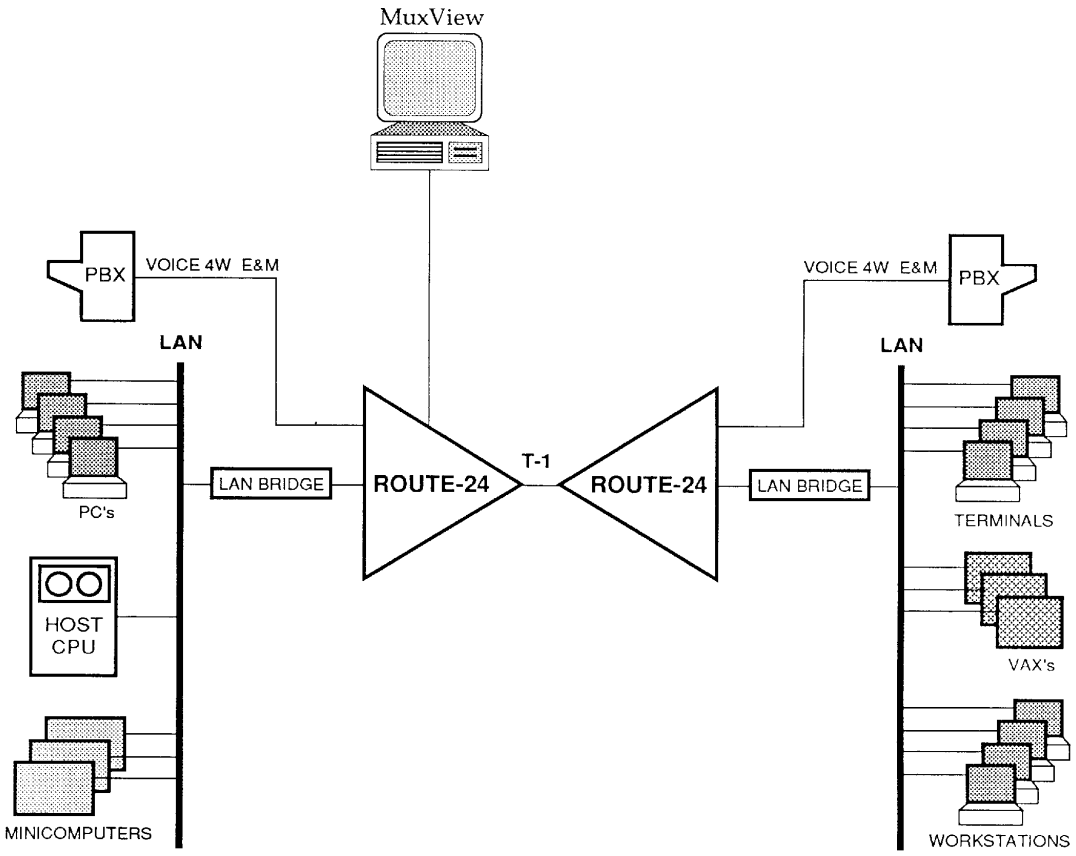
Figure 9: Typical Applications (continued)



Connecting Company Divisions Via a Leased T1 Line

This is a private point-to-point network, where all equipment is owned by you except the leased T1 line. Using T1 multiplexers, you have complete control of the configuration of your network. You can send voice, compressed voice, data, and video. You can change your bandwidth requirements at any time. Company divisions can be next door or across the country.

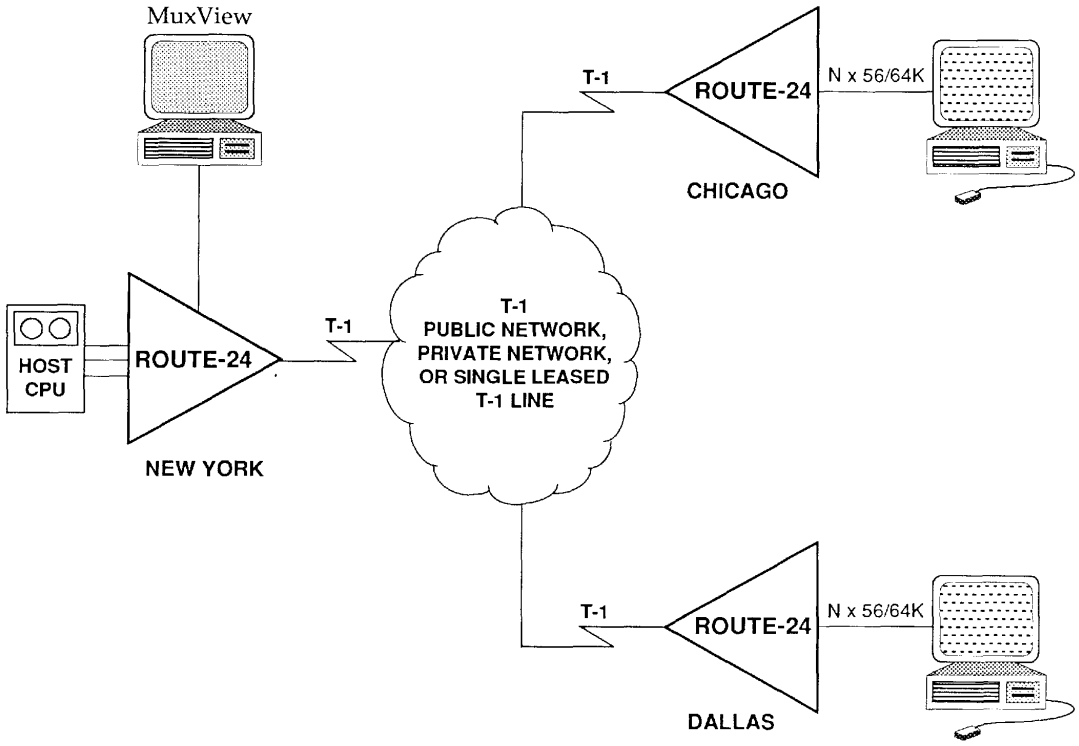
Figure 9: Typical Applications (continued)



The LAN/WAN Connections

You can combine your local area network with a wide-area T1 network for a very efficient LAN/WAN system. Wide area bridged or remote LAN bridges plug directly into a port on Route-24, which then sends voice and data signals out over T1 lines. Compatibility with the LAN is determined by the network bridge used.

Figure 9: Typical Applications (continued)

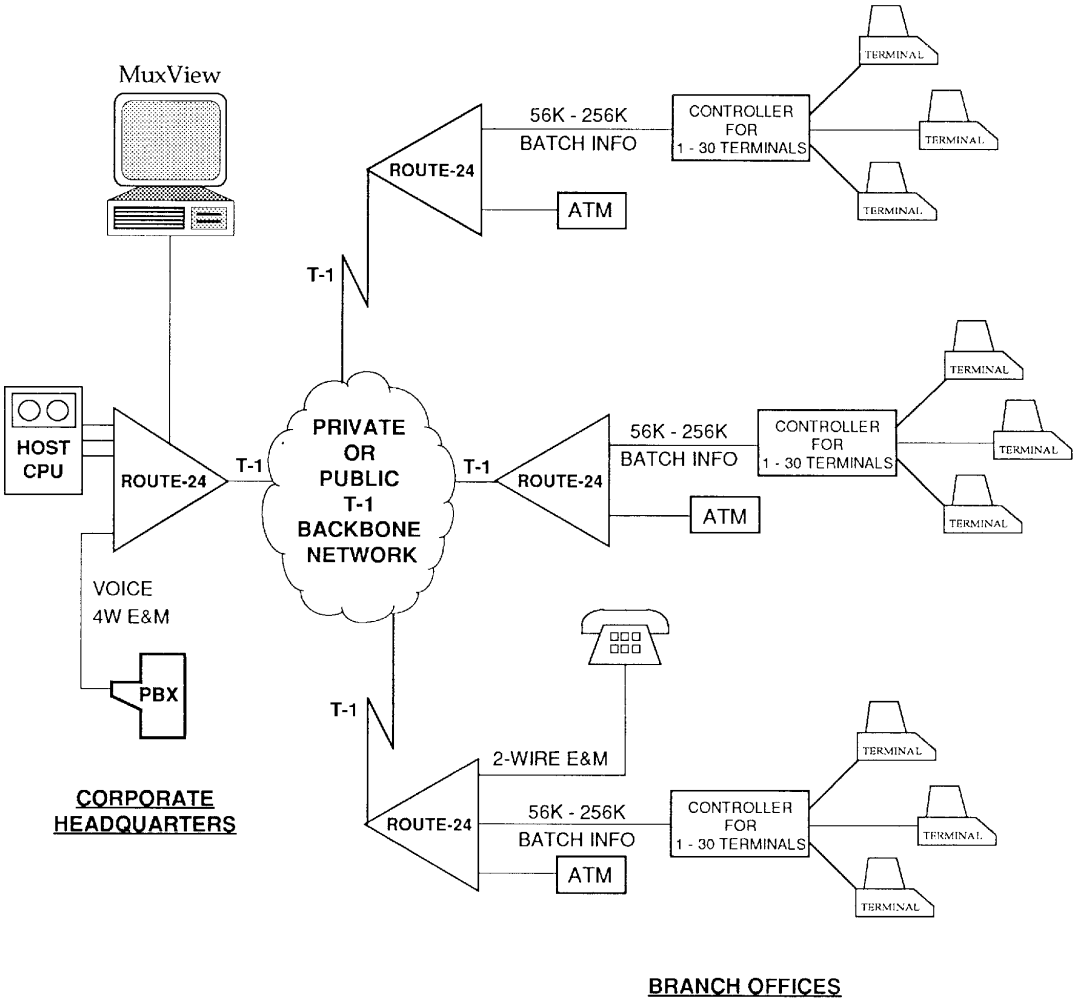


CAD/CAM Applications

A famous architectural firm has branch offices in Dallas and Chicago. Each office interacts with New York headquarters on projects. Their CAD/CAM workstations transmit data at low-traffic times at a speed of 56 kb/s to a T1 multiplexer.

The multiplexer sends the data over T1 lines through a public network, private network, or single-leased T1 line. At corporate headquarters, another T1 multiplexer receives the data and sends it to the host CPU.

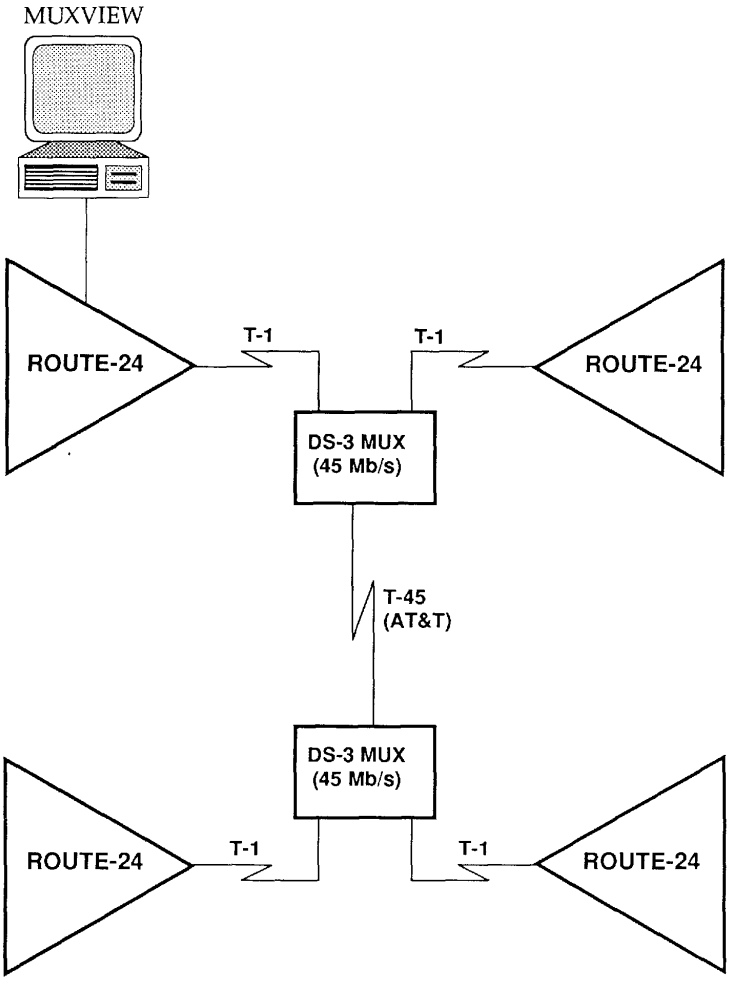
Figure 9: Typical Applications (continued)



Distributed Batch Data Transmission

If you want to connect a number of terminals (or ATMs) to your host computer, this is the most efficient way to do it using T1 lines. You can connect your terminals to a controller, which can be configured to run at a certain speed. The controller will help transmit data in batches through Route-24, out over a public or private T1 network. You'll only need one T1 line coming out from the network to a receiving T1 multiplexer installed where your host computer is located.

Figure 9: Typical Applications (continued)

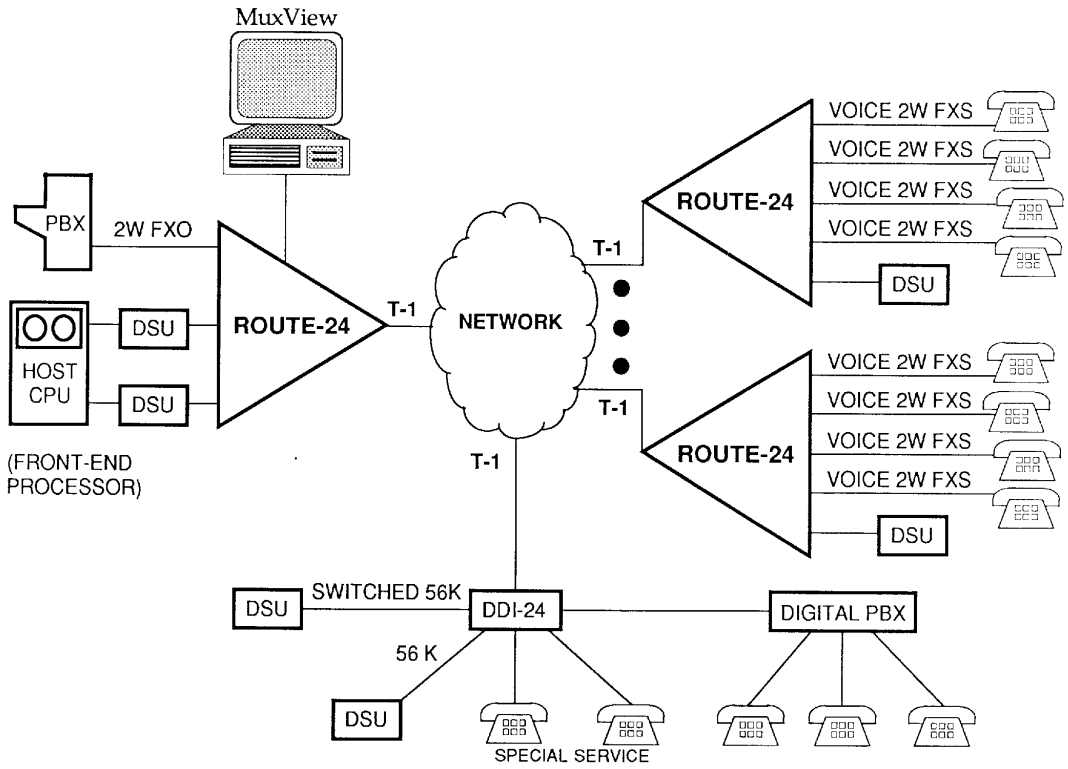


Superrate Hubbing (DS-3)

As demand for T1 increases, the need for higher capacity transmission will also rise. As this happens, DS-3 (45 Mb/s) will become more common. DS-3 carries 28 T1 signals, or the equivalent of 672 channels.

In a point-to-point network such as the one shown here, you can plug Route-24 into a DS-3 multiplexer, using the DS-3 multiplexer to access 45 Mb/s T1 service.

Figure 9: Typical Applications (continued)



Accessing an 800 WATS Service with FXS Lines

Let's say you want to take advantage of an 800 WATS service so that your remote locations can access your PBX or your host computer at your central processing center. These services, charged strictly on a per-usage basis, are offered by carriers such as AT&T (MEGACOM), U.S. Sprint (Fonline 800), and MCI (ULTRAWATS).

For example, a 4ESS switch may be used in the central office to process these calls. This switch is one of the new SDN (software-defined network) switches. The 4ESS switch only accepts a 4-wire E&M signal. For this reason, you would normally have to go through a local operating company, which would convert your 2-wire signals to 4-wire.

However, you access the 4ESS switch directly - and avoid going through the local carrier - by using the 2W FXS cards in Route-24. This can represent significant savings for you in this type of application. All of the functions you need to interface directly with the 4ESS switch are built into the 2W FXS cards.

At a regional office, your voice and data circuits could access the WATS service through a drop-and-insert multiplexer. A T1 line could be connected to a digital switch; on their way to the switch, individual data (switched 56) and voice circuits could be "dropped off," establishing a connection to the 4ESS switch.

1. Compatible with T1 Network

Because Route-24 is compatible with the public network at the DS-0 and DS-1 level, it:

- Can directly interface with the T1 outputs of digital channel banks, PBXs, D3/D4 channel banks, and central office digital switches.
- Can be used with all current T1 services, which makes cost-effective use of existing equipment network services;
- Will not become obsolete as ISDN and new T1 services are introduced;
- Allows the T1 network to switch individual voice and data channels instead of using obsolete bit interleaved technique that limits switching to full T1's.

2. Compatible with T1 Services

Route-24 operates over terrestrial and satellite T1 links that are owned by the user or leased from a common carrier. Generally, the services offered by each carrier are technically similar. In addition to the basic T1 service, the common carrier offers enhanced services. For example, AT&T offers:

- Transfer Arrangement - permits a customer to switch a long haul T1 facility between two local sites.
- M-24 Multiplexing - converts T1 circuits back to baseband voice and data signals. It can access the switched network and DDS circuits.
- M-44 Multiplexing - uses ADPCM to compress two T1 lines into one T1 line that transports up to 44 voice circuits and can be switched by the network.
- Automatic Protection Capability - provides redundant T1's between the customer's site and the central office.
- Customer Controlled Reconfiguration (CCR)/DS-1 Switch Port - permits a customer to electronically rearrange DS-0 channels between T1 lines.

3. Compatible with Customer Equipment and Interfaces

The Route-24 voice units can interface the following voice circuits at a customer's site:

- PBX Trunks - connect analog PBXs together by using a 4-wire E&M unit.
- Central Office Trunks - connect an analog PBX to a central office by a 2-wire FXO and 2-wire FXS units.
- Extension Lines - connect two telephones together, like an intercom, by using two, 2-wire FXS units optioned for private line automatic ringdown (PLAR) operation.

The Route-24 data units can interface data circuits with the following parameters:

- Channel Rates from 1.2 kb/s to 1.536 Mb/s.
- RS-232-C, RS-422/449, and V.35 Electrical Interfaces - are EIA and CCITT standards. These three are the most popular. For distance below 50 feet, RS-232-C is the most common low-speed interface. For distances up to 4000 feet, RS-422/449 is used. V.35 is the most common high-speed interface because it is compatible with the DDS network.
- Synchronous or Asynchronous circuit - has one or more clock source. In a synchronous circuit, the data communications equipment (DCE) supplies the clock to the data terminal equipment (DTE). DTEs may be remote terminals, PCs, or mainframe computers. Most mainframes and all high-speed circuits, such as those used for teleconferencing and CAD/CAM are synchronous. In an asynchronous circuit, each device has its own clock, and they are not synchronized. In this mode, the data format solves slip problems.
- Protocols - defined by the data format. Because Route-24 is a time-division multiplexer and transports any data format, it is protocol transparent.

4. Compatible with Network Standards

- PUB 43801 (Transmission specifications);
- PUB 54075 (Subrate Data Multiplexing);
- PUB 62411 (ACCUNET T-1.5 Service);
- FCC Parts 15 and 68 for T1 and DS-0;
- UL Approval.

IV. SYSTEM SPECIFICATIONS

Network

Interface	DS-1; DSX-1
Line Rate	1.544 Mb/s
Line Coding	Bipolar with Eight Zero Substitution (B8ZS); Transparent (64CCC).
Framing Format	D3/D4 (SF); Extended Superframe (ESF).
Channel Format	DS-0, 24
Voice Coding	μ-255 PCM
Signaling	Robbed bit

Features

Multiplexing Technique	Time division (byte-interleaved)
Network Types	Point-to-point; Point-to-private backbone; Point-to-public networks.
Configuration Control	Video display terminal port, RS-232-C; Dial-up and dial-out modem port, Bell 212A-compatible.
Configuration Storage	Nonvolatile memory
Configuration Selection	Manual; Automatic by time of day.
System Statistics	CRC errors; T1 slips; Errored seconds; Failed seconds.
Password Protection	2 levels
Alarms	Visual alarms on LIU; Reported to video display terminal; Relay contacts for external audible alarms, silenced by alarm cut-off switch; Dial out via Route-24 built-in modem to MuxView.

Voice Channels

Rate	64-kb/s PCM
Interfaces	4-wire E&M/TO, Types I and II; 2-wire FXS/PLAR/FXSDN

Data Channels

Formats		
	Low-speed	Subrate DDS M-24 compatible; Subrate DS-0A/DS-0B.
	High-speed	56-kb/s DDS
Rates		
	Low-speed	1.2 to 19.2 kb/s, asynchronous and synchronous
	High-speed	56 or 64 kb/s x N, up to 1.536 Mb/s, where N equals 1 to 24
DTE Interfaces		RS-232-C; V.35; RS-449/422.

Diagnostics

Loopbacks		
	T1	Outgoing back toward the customer premises; Incoming back toward the DS-1 network.
	Voice	Back toward the DS-1 Network; Back toward the Customer Premises.
	Data	Back toward the DS-1 network, including any or all subrate multiplexed channels; Back toward the customer premises, including any or all subrate multiplexed channels.
Test Code		1-kHz, 1 mW; Quiet code.

Synchronization

Clock Source	Received T1 (looped timing); Internal clock (master); DDS clock (external).

Power

Source	-48 Vdc; 110 to 120 Vac, optional
Consumption	115 watts, maximum (LIU, PSU, and 24 channel units)
Heat Dissipation	Convection cooling

Mechanical (shelf)

Fractional T1 Shelf:		
	Dimensions	19" W x 5.2" H x 11.75" D
	Weight	7 lb, empty; 25 lb, fully loaded, maximum
24-Channel Shelf:		
	Dimensions	19" W x 10.2" H x 11.75" D
	Weight	15 lb, empty; 50 lb, fully-loaded, maximum