# Networking Voice Logging Recorders

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**Abstract:**

Voice logging recorders are used in a wide variety of applications for Public Safety, security, financial transactions, Telemarketing, health care, transportation and many other areas. Often, the recorders may be located in a secure telephone area, while the Communications Supervisor is located floors, buildings or even cities away. Under these conditions, it is often desireable or necessary to access the recorders for the purpose of monitoring calls, retrieving archived calls, changing password security or system settings, or making cassette copies of important calls in the convenience of a quiet office. Each of these requirements and more can be satisfied if the recorders are interconnected over a Local Area Network, using the recorders themselves as workstations or tieing in remote control units on the same LAN as the recorders.

This presentations describes some of the considerations in selecting a suitable network topology and also gives examples of some of the advantages and limitations associated with these choices.

**Introduction:**

The primary function of a Voice logging recorder is to capture and store every radio or telephone conversation connected to it. Since these are, typically, one time events, it is critical that no such conversation be missed. Thus, no matter what other events are taking place, including call playback, system configuration changes, networking activities, report generation etc. the primary emphasis must be on capturing and storing all call activity. Thus most logging recorders lend themselves very nicely to multi-tasking system approaches and still are "jealous mistresses" when it comes to allocating system resources to anything other than the primary recording function. Even in the presence of a solid multi-tasking operating system, a general priority hierarchy may look like:

1. All channel, 24 hour per day recording
2. Playback of any or multiple channels from:
   - Instant recall
   - Current recording tape or MO disk
   - Archive tape or MO
3. System security
   - User access
   - Media security
   - Bookkeeping
4. System setup and changes
5. Remote operations/ Networking

Some of the actions which may be taken by a password-eligible user either locally at the recorder, or remotely over a LAN include:

Establish Security levels for new users
Set up or change channel recording parameters
Monitor live calls
Recall stored calls using various search parameters
Re-record selected calls to cassette
Play back multiple stored calls simultaneously
View or print reports of recorder activity
Enable or inhibit Alarm and Warning messages
Copy channel settings or other data to diskette
Change Serial Mode Primary record tape
Eject a selected tape

**Making Network Connections:**

Network connections are made to the Network Interface Cards (NIC) in each PC and Server over the installed cabling. The architecture of the network is defined by the cabling system, as well as the rules and methods used to access that cable.

Network Interface Cards (NIC) Network Interface Cards are available from a wide variety of manufacturers, with several different types, depending on how you want to configure and wire your network. The three most popular network types are ARCNET, Ethernet and Token Ring. Dynamic Instruments has chosen to use Ethernet.

Network Media Network media is the cable used to connect a network. Coaxial cable, twisted pair and fiber optic cable are all in use today. Cables are rated for Network use in several ways:

The Transmission Speed or the rate at which it will transfer information
Maximum cable length before a booster is required
Shielding requirements
Price

Network Architecture The architecture of a Network defines the layout of the cabling system and workstations attached to it, as well as the rules used to transfer signals from one Network station to another. Before any station can use this cable system, it must first establish a communications session with another node on the network. This session involves the use of communication protocols to establish the session and cable access methods to send signals over the cable.

Topology The topology of a network is a description of how the cable is layed out from one node to another.It is best seen as the "map" of the cabling system. Cable may be linear, running from one end of a building to another, with two distinct ends, or it may be strung in a ring so it loops back on itself. Another topology is a star, in which the cable branches from a central box, or concentrator. In reality, a linear cable may zig-zag through a building in all but a linear fashion.

## Cable Access Method

Using a Network Interface Card (NIC) there are two specific Cable access methods in general use today. These are:

A. Carrier Sensing, and
B. Token Passing

The Cable Access Method describes how a node gains access to the cable system. Linear cable systems often use a carrier sensing method, while ring and star systems may use a token passing method. When the card gains access to the cable, it begins sending packets of information to other nodes. When a NIC is purchased, it is purchased for use with a specific topology using a specific cable access method. Dynamic Instruments has selected the CSMA/CD - Carrier Sense Multiple Access/Collision Detection - method per standard IEEE 802.3, and we use this in both linear and star-like configurations.

In the Carrier Sensing method, a node checks to see if the cable is in use before it begins transmitting. Its transmission is like a radio broadcast across the entire cable; every other node hears it and then determines whether the transmission is for it. If not, it rejects the broadcast. If two nodes broadcast at the same time, a collision occurs and both back off, wait for a random time interval, and try again.

## IEEE 802 Access Control Standards

The Institute of Electrical and Electronics Engineers (IEEE) has developed a set of standards for defining the way network interface cards transfer data from a system to the network. The protocols are accepted by the ISO - International Standards Organization - and work at the physical and data-link layers of the OSI - Open Systems Interconnection - reference model. The IEEE 802 body consists of a group of committees with the goal of producing technical standards open to all vendors so that a wide range of network interface products will work together. These products include network interface cards, bridges, routers, and other components used to create local twisted pair and coaxial cable-based networks or wide area networks using common carriers such as the phone system.

The IEEE 802 committees are shown below. The physical and data link layers are directly related to available network interface cards.

| | |
|---|---|
| IEEE 802.1 | Internetworking |
| IEEE 802.2 | Logical Link Control (LLC) |
| IEEE 802.3 | CSMA/CD LAN |
| IEEE 802.4 | Token-Bus LAN |
| IEEE 802.5 | Token-Ring LAN |
| IEEE 802.6 | Metropolitan area network |
| IEEE 802.7 | Slotted-ring LAN |

IEEE X.25 Wide area network protocol

The 802 standards allow computers and devices such as Voice Logging Recorders from many different vendors to be connected locally using twisted pairs and coaxial cables, or over wide areas using high-speed cable systems; for example, fiber opic or common carrier services such as the phone system.

An important part of the 802 standard is referred to as Global Addressing. In this scheme every Network Interface Card from every manufacturer is assigned a unique address, so that no two cards on the same network have conflicting addresses. The addressing scheme provides a forwarding function, important on internetworks, to ensure packets reach their final destination on the local or remote LAN. If a question arises as to the address of a particular, installed card, it can be determined by locally running the card diagnostics.

Addressing Scheme

- Each network has a specific address; in most Voice Logging Recorder applications, a single network is involved so that a network address is, typically, not an issue
- Each node on a network has a special address; part of this address is hardwired on the NIC by the manufacturer of the Network Interface Card, and part is programmed by the application software
- A node's complete address consists of it's network address plus it's node address
- Think of a network address as a street name and a node address as the house number

(Example):

| | | |
|---|---|---|
| NIC address: | 00AA00A5A4D1 | |
| Interrupt: | IRQ5 | |
| CPU address: | 340-34FH | |
| Node: | 1.1.1.01 | (Recorder Interface Parameter - IP - address) |

Packets

- Information sent between nodes is "packaged" according to the protocol rules
- At each level, information is added to the packets in the form of headers and trailers
- Information included may be source and address data, communications parameters and synchronization information

**The OSI Model:**

Perhaps the most prominent standards body today is the International Standards Organization, ISO. It has a broad membership which helps to prevent a single vendor from overly exerting its influence in defining standards in the computer industry.

ISO has developed the Open Systems Interconnection (OSI) seven-layer model for data communications as shown below. The model can be viewed as a ladder of processes that take place when messages or data pass from an application running in a workstation to the physical network. In turn, the model describes the reverse process when a packet is received from the network and is processed for use by an application. Each layer defines specific rules that programmers and recorder designers use to design interoperable products.

| | |
|---|---|
| **Application** | Node address added; Application.exe, Socket opened |
| **Presentation** | Code-set information added; Formatting |
| **Session** | Communications parameters added |
| **Transport** | Checksum header added; TCP |
| **Network** | Packet quantity/sequence info added; IP, Routing |
| **Data Link** | Packets, checksum, addrs header, trailer; NIC |
| **Physical** | Cable system; Packets sent as bitstream |

The OSI protocol stack; packets and the DI-939

**Thin Coaxial Ethernet - 10BASE2:**

- Thin 50 Ohm cable type RG-58 A/U
- Network requires 50 Ohm termination at one end and a terminator with ground at the other end
- The maximum trunk segment length is 185 meters (607 feet)
- T-connectors are used to connect the cable to the Network Interface Card (NIC)
- Must obey **5-4-3** rule

- Up to **5** trunk segments may be joined using **4** repeaters
- Workstations (recorders or remotes) are allowed on only **3** of the segments. The others are used for distance
- The maximum trunk (overall) length is 910 meters (2985 feet)
- You can have a maximum of 30 workstations per segment. Repeaters count as workstations

| | Twisted Pair | Coaxial |
|---|---|---|
| Cost | Low | Moderate |
| Bandwidth | Moderate | High |
| Length | Hundreds of feet | Thousands of feet (Topology dependant) |
| Interference | Some | Low |
| Reliability | High | High |

<u>Cautions/Characteristics:</u>

Twisted Pair: Susceptible to some outside interference
Has distance limitations but may be corrected using coaxial backbones (hubs)
May already be installed in the form of existing telephone twisted pair lines
The most economical wiring system
Is available in both shielded (STP) and unshielded (UTP) version
May be Category 3, Category 4 (10 Mhz BW), or Category 5 (100 Mhz BW)

Coaxial: May be affected by outside interference
May act like an antenna as distance is increased picking up noise from motors, radios etc.
Has problems with grounding; requires special attention
Emits signals that may be monitored by intruders

**Sockets:**

A Socket is an endpoint for communication, that can be named and addressed in a network. In the present application, a socket is a physical location and address in the DI-939 Digital Voice Logging Recorder.

Socket Types:

A. Stream: To the Transport layer protocol
B. Datagram: To the Transport layer protocol
C. Raw: To the Network layer protocol

In the OS/2 implementation of sockets:

A. Stream sockets - Interface to TCP
B. Datagram sockets - Interface to UDP
C. Raw sockets - Interface to ICMP and IP

**The 5 - 4 - 3 Rule for TCP/IP Thin Ethernet Topology:**

When using Thin Ethernet cabling, and interconnecting Dynamic Instruments recorders and remote control units, several important factors come into play. If the recorders and remotes are in relatively close proximity, the units should still be attached with a minimum of 6 to 10 feet of coaxial cable. As the distance between units grows, potential maximum continuous cable length becomes an issue. In order to avoid transmission problems and possible data loss, the length of network cabling in a trunk segment between repeaters is limited to about 610 feet. 5 trunk segments may be joined using 4 repeaters. Workstations (recorders or remotes) are allowed on only 3 of the segments as shown in the Figure with the 5-4-3 rule. The other segments are to remain unpopulated and are used for creating distance between the desired workstations. Each segment can have a maximum of 30 workstations, and repeaters count as workstations. A 50 Ohm termination is required at each end of a segment and one end should also be grounded.

By adding repeaters and populating 3 of the segments, a maximum of 90 attachments are allowed. At that point, the maximum Network length allowed is 910 meters, about 3,000 feet.

**The 5 - 4 Rule for Ethernet Star Topology and 10BaseT Twisted Pair cabling:**

If twisted Pair cabling, which is already installed in many buildings, is used, a different configuration such as a star topology may be employed. In this configuration, there may be no more than 5 total link segments and 4 concentrators between any 2 recorders. An example of such a topology with 4 segments, 3 concentrators (hubs), and 4 DI-939 Voice Logging Recorders is shown. In this configuration, distance is limited to about 100 meters (330 feet) between elements. In some cases, a combination of cabling such as twisted pair and coax or fiber optic and coax may be used with active hubs which support multiple connection types.

**Dual Networking:**

In some applications, a requirement may exist to combine recorded voice files with other data, such as a Transaction Number, an Account Number, or perhaps a Social Security Number. In this way, telephone conversations can be linked to specific customers or purchasing activities, and the flexibility of search fields is greatly enhanced. If specific data funcionality can be addressed, even though other, existing networking operations may be taking place, a "dual" network can be configured. An example of just such an application is shown in the accompanying figure.

Here, a series of Voice logging recorders and remote terminals are connected via TCP/IP to record telephone transactions in a financial institution. Supervisors are sometimes recalling selected voice files over the LAN to verify Buy/Sell orders. Off to one side is a mainframe computer which contains account information about the Company's customers, including their Account Number, which in this case is the Customer's Social Security Number. As customers call in on the 800 number, they are asked to enter their account number before being able to access account information. This is all done via automated attendant, with no human intervention yet.

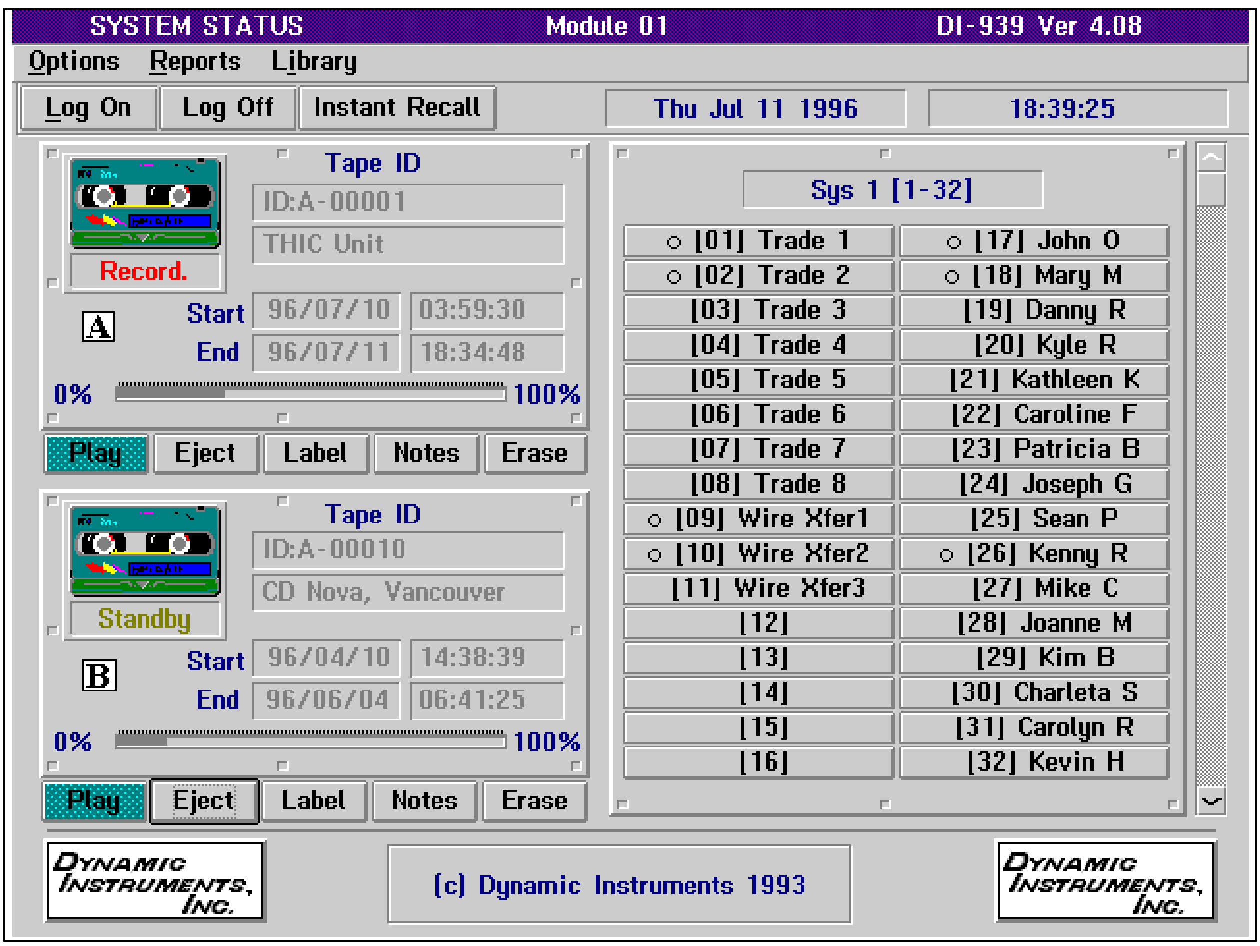
Should a customer decide to place a buy or sell order, their account information is tranferred via "Screen Pop" to the next available agent. At the moment the agent goes "off-hook" and begins speaking with the customer, the SSN is transferred via TCP/IP to the Voice Logging Recorder and becomes a special Search Parameter field which is appended to the ensuing conversation. While this is taking place,

other recorder functions which may include voice playback or monitoring over the network are going on and both must take place in "Real-Time" . Thus dual LAN addresses, incorporating 2 network cards in each recorder are established.

**Summary:**

A methodology for connecting Voice logging recorders over a Local Area Network, using TCP/IP protocol in essentially a peer-to-peer mode has been described. This approach has the advantage of providing voice over the network in almost real-time, with an average latency of perhaps half a second. If the size of the networked recording system is relatively small, on the order of 200 channels of telephone line and radio traffic total, or less, network activity will typically be at a very acceptable level. Should an incredible amount of call playback activity be requested, an element of collisions or delay could occur. If this is anticipated, or if the number of lines networked together grows substantially, alternate approaches to transmitting voice files may be considered, to reduce maximum network traffic.

**Main System Screen for Networked Operations**
**DI-939-D2**



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## Glossary of terms commonly used

| | |
|---|---|
| API | Application Program Interface |
| ATM | Asynchronous Transfer Mode |
| CDFS | CD-ROM File System |
| CID | Configuration, Installation & Distribution (Architecture) |
| CSMA/CD | Carrier Sense Multiple Access/Collision Detection |
| DDS | Direct Digital Service (lines) |
| DPI | Distributed Program Interface |
| FAT | (DOS) File Allocation Table |
| FTP API | File Transfer Protocol - Application Programming Interface |
| HPFS | (OS/2) High Performance File System |
| ICMP | Internet Control Message Protocol |
| IPX | Internetwork Packet Exchange |
| ISDN | Integrated Services Digital Network |
| LAN | Local Area Network |
| MAN | Metropolitan Area Network |
| MAU | Multistation Access Unit |
| MHS | Message Handling Service/Mail Handling Service |
| MLID | Multiple Link Interface Driver |
| NetBEUI | (IBM's Network) Basic Extended User Interface [Implementation and extension of Net BIOS] |
| NIC | Network Interface Card |
| NICE | Network Information and Control Exchange |
| NSP | Network Services Protocol |
| ODI | Open Data-link Interface |
| OPT | (Novell's) Open Protocol Technology |
| OSI | Open Systems Interconnection |
| OSPF | (Protocol) Open Shortest Path First |
| PAP | Printer Access Protocol |
| RPC's | Remote Procedure Calls |
| SFT | System Fault Tolerance |
| SMDR | Serial Management Data Report |
| SNA | Systems Network Architecture |
| SNMP | Simple Network Management Protocol |
| TCP/IP | Transmission Control Protocol/Internet Protocol |
| TLI | (IBM's) Transport Library Interface |
| TTS | Transaction Tracking System |
| UDP | User Data Protocol |
| VMTP | Versatile Message Transfer Protoco |
| WAN | Wide Area Network |