N1 Ethernet/IP Network

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Introduction

Introduction to the Metasys N1 LAN

The Metasys® N1 Local Area Network (LAN) can use Ethernet or ARCNET® technology in the circuit boards and software of Operator Workstations (OWSs) and the Network Control Module (NCM 350s). These devices communicate over the N1 Ethernet/IP cable via an Ethernet Adapter Card, which is also known as a Network Interface Card (NIC).

Note: For ARCNET installations, refer to the N1 ARCNET Local Area Network Technical Bulletin (LIT-636017).

The Metasys N1 LAN (hereafter referred to as N1) carries all types of communication, including shared point and control information, database uploads and downloads, commands to field equipment, summaries, and change-of-state messages. The N1 supports the distributed nature of the Metasys Network, in which each node has a specific function to perform and relies on others only for shared data. For example, one node might be located in the basement and serve a chiller, while another node may be located in the penthouse and serve the cooling towers. In addition, the nodes could share data, such as the same outside air temperature.

The N1 Ethernet/IP (as opposed to ARCNET) uses the industry standard User Datagram Protocol (UDP) service provided by Transmission Control Protocol/Internet Protocol (TCP/IP) and works with single and multiple segment LANs.

Introduction to Ethernet

Today, Ethernet is the most widely used LAN technology; approximately 80 percent of all LAN connections installed use Ethernet. It strikes a good balance between speed, price, ease of installation, and supportability.

The Ethernet standard is defined by the Institute of Electrical and Electronic Engineers (IEEE) in a specification known as IEEE 802.3. The 802.3 specification covers rules for Ethernet LAN configurations, media, and how the elements of the network should interact. The Ethernet protocol provides the services called for in the Physical and Data Link Layers of the Open Systems Interconnection (OSI) reference model. According to the 802.3 specification, Ethernet networks transmit data at a rate of 10 million bits per second (Mbps). This means that when a station transmits a packet onto the Ethernet medium, it transfers data to the destination node at a rate of 10 Mbps. This equals approximately 250 pages of text per second.
The major benefits of an Ethernet network are:

- **performance**
- **flexible cabling and device connections**
- **low cost per connection, interoperability**
- **equipment and topology compatibility**
- **easy installation and expandability**
- **reduced maintenance costs**

Ethernet transmits data efficiently and flexibly. Ethernet segments may be connected to a variety of other communications types such as high speed backbones running up to 155 megabits per second. Backbone options include the 100 Mbps Fast Ethernet, Fiber Distributed Data Interface (FDDI), Token Ring, and the Asynchronous Transfer Mode (ATM).

Note: Metasys nodes can only connect directly to 10 Mbps Ethernet. To use higher speed backbones, other network equipment must be installed.

The Ethernet network standard is used reliably in commercial and industrial settings around the world every day. Peer-to-peer communications and automatic network configuration enhance the reliability of Ethernet. Peer-to-peer communication ensures that the network is not dependent on any single device to control the transmission of data between devices.

Due to Ethernet popularity, you can link systems built by many different vendors to the same Ethernet LAN. Its extensive installation base, widespread vendor support, and use of standard Personal Computer (PC) hardware and software make Ethernet easy and economical to expand. Ethernet’s wide implementation contributes to its interoperability and provides a common basis for supporting heterogeneous networks.

The access method used by devices connected to an Ethernet LAN is another key element defined in the IEEE 802.3 specification. The Ethernet access method is called Carrier Sense Multiple Access with Collision Detect (CSMA/CD). Carrier Sense Multiple Access (CSMA) provides a means for all hosts on a baseband network to be able to access the network medium. Collision Detect (CD) is a method each host uses to determine when another host is attempting to use the network. When a node is ready to transmit, its “carrier sense” listens to see if other devices are already transmitting because with CSMA/CD, each station contends for access to the shared medium. In other words, any node can attempt to communicate at any time.
A collision on the Ethernet LAN results when two nodes try sending packets at exactly the same time. Collisions are considered normal events, and Ethernet networks are designed to quickly resume normal activity after a collision occurs. If the network hardware detects a collision, both devices delay at random intervals and attempt to resend. The process repeats until the packet transmits successfully or is automatically aborted after sixteen consecutive collisions. A message transmits at optimum speed if there are no collisions with other nodes.

Table 1 is a comparison of ARCNET and Ethernet methods of operation.

<table>
<thead>
<tr>
<th>N1 LAN Feature</th>
<th>ARCNET</th>
<th>Ethernet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Media</td>
<td>Coax, Twisted Pair, Fiber</td>
<td>Coax, Twisted Pair, Fiber</td>
</tr>
<tr>
<td>Speed</td>
<td>2.5 Mbps</td>
<td>10 Mbps</td>
</tr>
<tr>
<td>Network Access</td>
<td>Token Passing</td>
<td>CSMA/CD</td>
</tr>
<tr>
<td>Topology</td>
<td>Bus, Star, Mixed</td>
<td>Bus, Star, Mixed</td>
</tr>
<tr>
<td>Network Type</td>
<td>Single Segment LAN</td>
<td>Multiple Segment LAN</td>
</tr>
</tbody>
</table>

This section includes a few key terms that appear throughout this document. Appendix A: Glossary of this document contains a complete glossary of Ethernet and important networking and connectivity terms.

**Node**--A node is any addressable device connected to the LAN using an Ethernet Adapter Card.

**Metasys Node**--A Metasys node is a specific type of node (NCM or OWS), which is connected to the N1.

**Internet Protocol (IP)**--The IP is the network-level protocol from the TCP/IP family of protocols, which clearly identifies a node on the network. The Metasys system uses IP for routing messages on an Ethernet LAN. TCP/IP protocols were developed with public funding and are in the public domain. It is used when referring to network-layer items such as addresses and routing. In many contexts, IP, Internet, and TCP/IP are used interchangeably. Each node must have a unique IP address.

**Segment**--A segment is an electrically continuous section of cable that is terminated at both ends (i.e., does not pass through a hub or repeater). See Figure 1.

**Private Network**--A private network runs only Metasys software with no third-party nodes or applications. A private network is the most desirable network option, because performance can be more readily maintained. A private network is not susceptible to problems caused by non-Metasys Network traffic.
**Segmented Network**--A segmented network runs Metasys software on its own Ethernet segment. Third-party equipment or applications may coexist on separate Ethernet segments.

**Shared Network**--A shared network is one in which both Metasys software and other nodes and applications coexist on the Ethernet media. It is the least desirable configuration from the standpoint of ensuring optimum performance and data integrity in the face of high traffic levels.

**Multinetwork Feature**--A feature available on the M5 Workstation that allows multiple Metasys N1 Ethernet Networks to coexist on the same transmission medium in isolation from one another. Nodes within a single Metasys N1 Ethernet Network can communicate only with other nodes within their network, or M5 Workstations with Multinetwork feature.

![Diagram of Bus Segment](image)

**Figure 1: Defining a Bus Segment**
Depending on the LAN, the N1 may use non-Johnson Controls (third-party) products. Therefore, this document may not contain all the installation, commissioning, and troubleshooting information you need. Furthermore, collaborate with the network administrator or whoever has responsibility for providing network support, because there may be established vendors and equipment standards for your site.

The Setting Up the Metasys Network on Ethernet section later in this document details the process of connecting Metasys NCMs and OWSs to an Ethernet/IP configured network. Specifically, it outlines installing the hardware and software and configuring both the NCM and OWS. Consult the following documentation for additional details on installing and commissioning that is performed at the OWS:

### Table 2: Additional Sources for Information

<table>
<thead>
<tr>
<th>Topic</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering and commissioning the NCM</td>
<td>Network Control Module 300 Series Technical Bulletin (LIT-6360251)</td>
</tr>
<tr>
<td>Troubleshooting bridges, hubs, and repeaters</td>
<td>Manufacturer’s literature</td>
</tr>
<tr>
<td>Coax, twisted pair, and optical fiber cable preparation</td>
<td>Manufacturer’s literature</td>
</tr>
</tbody>
</table>

For a thorough introduction to Ethernet networks, consult *Ethernet Tips and Techniques: For Designing, Installing and Troubleshooting Your Ethernet Network*, 2nd Edition by Byron Spinney. This book, which is included with Global Learning Services Module LM49, is a good starting point for anyone who needs to install an Ethernet network or who wants to learn the basics about Ethernet. The References section of this document includes a list of sources of information on networks and connectivity.

In addition, *N1 Ethernet/IP Network Product Bulletin Supplement (LIT-635033a)*, which is located in the *Metasys Network Sales Resource Manual (FAN 635)*, can help determine whether it is possible and/or advisable to run Metasys software on a particular Ethernet Local Area Network (LAN). It also provides insight as to the complexities of the existing network. The last section of this supplement compares the features and benefits of the two communications networks used with the Metasys Building Automation System (BAS): ARCNET and Ethernet. The purpose of this information is to help you select the most appropriate BAS backbone network.
Designing the Network

This section contains considerations that are important for designing and laying out the N1 LAN. How to choose the network configuration, media, and components is also covered.

**General**

Your decision to use one network over another may be based on several factors including cost of installing wiring and customer requirements. You may also want to decide, based on your specific application, what offers the best balance of cost, performance, and reliability for current and future needs. For installations that already use Ethernet cable, the expense associated with installing additional coax cable for an N1 ARCNET LAN may be prohibitive. That is why a Metasys system now supports the transmission of N1 messages across the existing Ethernet cables with minimal impact on performance.

Note: ARCNET and Ethernet can coexist on the same network. (See Figure 18.) For example, the Metasys Ethernet Router integrates Metasys N1 LAN ARCNET segments with an Ethernet network. The router provides the physical connection between a Metasys ARCNET segment and the Ethernet network. No special commands are necessary to switch between networks; data automatically transmits between networks without operator knowledge or intervention. However, when you add a directly connected IP network node to the Ethernet/IP network, you need to manually modify the configuration on each Ethernet Router. Refer to the Metasys Ethernet Router Technical Bulletin (LIT-6295035).

Metasys software is a distributed, peer-to-peer application. The overall traffic generated by any Metasys application with up to 50 nodes is generally very limited (less than two percent of total bandwidth). However, every Metasys node sends messages to all other existing Metasys nodes on a continual basis.

There are a few, general rules you should be aware of when designing the N1 LAN. They are:

- Follow all National Electric Code (NEC) and local code restrictions.
- Do not wire more than 100 Metasys nodes to any one network.

  Note: Do not exceed 100 total nodes when using the M5 Workstation Multinetwork feature.
• For all wiring, follow Telecommunications Industries Association/Electronic Industries Association (TIA/EIA)-568A requirements for pinout configurations, cabling topology, and distance limitations.

• Make sure to follow the cabling lengths and required cabling distance between two nodes, repeaters, or hubs as described in Table 6.

• Make sure all components in the LAN comply with IEEE 802.3 or Ethernet Version 2 (V2.0) specifications.

• Be aware that rules restricting the number of repeaters and routers between nodes vary by manufacturer. Some allow two hops, but most allow four. Limiting routers to no more than four hops between any two NCMs ensures that communication performance is maintained.

• Make sure you have a transceiver for fiber optic and 10Base5 connections.

This section focuses on the following factors for deciding how to design the N1 LAN:

• system performance requirements

• media

• components

• configuration

• manageability and maintainability

• limitations

• specifications

---

**System Performance Requirements**

Evaluating various network design options requires collecting and understanding historical data and networking resource needs. In cases where there is no existing network, you should survey vendors or others who have experience with similar network requirements. There are many different methods of segmenting, routing, and filtering traffic on a given LAN. You may want to seek the advice of a network consultant when in doubt. The preferred order of configurations, starting with the most desirable, is as follows:

1. Private--Metasys software only.

2. Segmented--Metasys software on its own Ethernet segment.

3. Shared--Metasys software and other applications all on the same network.
It is recommended that Metasys software run on its own segment or network to ensure optimum performance and data integrity. Gateway and network port NCM types generate much higher traffic levels than other NCM types. It is strongly recommended that message traffic from these NCM types be limited to dedicated Ethernet segments. For a shared network application, it is important to gather the following information and to understand how these factors affect network usage:

- number of users
- type of functions
- frequency and duration of use
- network traffic patterns
- uptime and bandwidth requirements

**Network Users**
The performance of the N1 depends mostly on how many nodes are installed and how the system’s functions and features are applied at these nodes. For example, a system with many nodes and light data sharing operates more efficiently than a system with few nodes and heavy data sharing. Therefore, you need to consider how the data is shared when designing the system applications.

**Network Functions**
For shared network applications, the size of the files that are being transferred, printed, and saved, in addition to geographical and environmental concerns, are also issues to consider when making decisions about segmentation, hardware, and media types.

**Network Usage Characteristics**
Identifying potential traffic problems early helps to determine the need for and location of bridges and routers. It is equally important to understand that to remedy unreliable communication problems, such as frequent Metasys software online/offline occurrences, a second network or segmentation of the existing network may be needed. Isolating devices that frequently communicate with one another can reduce collisions.

**Network Traffic Patterns**
It is important to know the network traffic pattern. When using an existing Ethernet LAN as the Metasys N1 Network, it is very important to understand the potential impact of the traffic from non-Metasys equipment on the LAN.

If Metasys software is installed on a shared network, the network needs to have sufficient capacity to handle the Metasys communications. Sufficient bandwidth is particularly important during periods of peak traffic.
For a Metasys system to run properly, the network must have available bandwidth of 30N^2 bps, where N equals the number of Metasys nodes. On a typical 10 Mbps Ethernet LAN, a 50 node Metasys Network consumes only 0.75% (less than 1%) of the bandwidth. However, if these 50 nodes were spread among different buildings and connected by a 56 Kilobits per second (Kbps) WAN (Wide Area Network), the Metasys Network saturates the 56 Kbps WAN and does not run. Depending on the network topology, WAN traffic may be reduced by using routers to filter messages within the building.

Although a Metasys Network requires a minimum connection rate of 56 Kbps, it only uses a small portion of this bandwidth for its required communication. The following equation gives a guideline as to how much of the available bandwidth is required for a Metasys Network:

\[
\frac{30N^2}{\text{WAN Speed in bps}} \times 100 = \text{Percent Utilization}
\]

Where N equals the number of Metasys nodes and 30 is the number of bps needed per Metasys node.

For example, the equation for a system with six NCMs and one OWS running across a 56 Kbps link would read:

\[
\frac{30 \times (7)^2}{56,000} \times 100 = 2.62\%
\]

This says that at a minimum, a Metasys Network requires 2.62% of the capacity of the 56 Kb WAN link. Additional bandwidth is required to run global features such as Data Sharing or Demand Limiting/Load Rolling (DL/LR).

Use the above equation to roughly estimate bandwidth needs. If the application requires NCM to NCM communication on a regular basis (e.g., accessing Outdoor Air Temperature points, Demand Limiting/Load Rolling [DL/LR], Metalink™), add an estimate of this traffic density to this amount to obtain the overall bandwidth required. In general, you should reserve 2% of the 10 Mbps total bandwidth for a Metasys Network. Additional customer or branch application traffic must be accounted for separately.

Table 3 identifies your network requirements.

<table>
<thead>
<tr>
<th>Type</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private</td>
<td>High</td>
</tr>
<tr>
<td>Segmented</td>
<td>Moderate</td>
</tr>
<tr>
<td>Shared</td>
<td>Moderate-Low</td>
</tr>
</tbody>
</table>

Note: Reliability varies depending on the site configuration.
With the proper equipment, many different types of media can be connected to the N1 LAN. These include:

- Attachment User Interface (AUI) Cable
- 10Base5, Thick Coaxial
- 10Base2, Thin Coaxial
- 10BaseT, Unshielded Twisted Pair, Shielded Twisted Pair
- 10BaseFL, Fiber Optic Cable

The cabling lengths, distances between nodes, and the advantages and disadvantages associated with each media are summarized in Table 6 of this document. Detailed descriptions of transmission media and configuration options are covered in the Designing the Network section of this document.

The following information briefly describes the different types of media that are referred to throughout this document:

**AUI Cable**—Attachment User Interface (AUI) or drop cable is often used to connect an Ethernet hub to a backbone cable via a transceiver. AUI can also be used to connect a workstation or piece of networking hardware to a networking medium the equipment does not directly support. AUI is comprised of eight twisted pairs of wires, which makes working with it a challenge. The major benefit when using an AUI connection is that it supplies power to any external transceiver.

**10Base5, Thick Coax Cable**—Thick coax, the cable type specified by the IEEE 10Base5 standard, is rarely used in new installations. It is terminated at either end by an N-type connector. A 50-ohm terminator cap is also required at each end.

**10Base2, Thin Coax Cable**—Thin coax is the cable type specified by the IEEE 10Base2 standard. These cables are terminated with BNC connectors. Thin coaxial cable supports only 30 transceiver connections per segment and limits segment length to 185 meters (607 feet). It is flexible and easy to handle. A 50-ohm terminator cap is also required at each end.

**10BaseT, Twisted Pair Cable**—Specified by the IEEE 10BaseT standard, Unshielded Twisted Pair (UTP) and Shielded Twisted Pair (STP) are the most common and economical media to install. The connectors are also more affordable. The maximum recommended length of this cable is 100 meters (330 feet). Many buildings have CAT3 UTP 24 gauge telephone lines already in place that could be used for the LAN.

Note: IEEE 802.3 standard requires category (CAT) 3, 4, 5 with 2- or 4-pair wire.
10BaseFL, Fiber Optic Cable—Specified by the IEEE 10BaseFL standard, fiber optic cable is used in broadband applications and those involving long distances. Maximum distance for fiber optic cable varies by manufacturer. Both plastic and glass fiber optic cabling contain fiber strands sheathed by an insulating material. Plastic fiber provides better resiliency and fewer handling restrictions than glass fiber. Glass fiber is very costly to terminate and degrades over time; however, it offers longer distance specifications and higher data rates than plastic fiber.

You have several media choices for the N1 LAN. The most common medium is the twisted pair using a star configuration, because it is inexpensive, and easy to install, troubleshoot, and repair. UTP cable used for LANs is similar to telephone cable, but has somewhat more stringent specifications regarding its susceptibility to outside Electromagnetic Interference (EMI) than common telephone wire. Shielded Twisted Pair (STP) comes with a shielding around the cable to provide more protection against EMI and is recommended for use in manufacturing environments or where high interference is present.

Of the two types of twisted pair cable, UTP is the more commonly used. 10BaseT, the specification for running Ethernet on UTP, stands for 10 Mbps, baseband signaling (the signaling method used by Ethernet networks), over twisted pair cable. Other Ethernet specifications include 10Base5, which uses a thick coax cable, and 10Base2, which uses a thin coaxial cable media. Today, 10Base5 is seldom installed in new Ethernet networks, and 10Base2 is used only in very small office networks. An additional standard allows 10BaseFL Ethernet to run on fiber optic cable.

To reduce long term maintenance and vendor costs, stay within the guidelines of the existing LAN topology. Thin coax cable is used in most isolated or standalone installations because it provides excellent protection against noise and interference. Twisted pair, a less expensive choice, is best suited for short distances. It is used in most desktop and LAN environments. Optical fiber, which provides optimum noise immunity and lighting protection, can be used for runs between buildings.

The N1 LAN components are designed for thin coax cable or twisted pair. Fiber optic connections are also available by using an AUI connector and fiber optic transceiver.

Note: Fiber optic connector styles must be selected to match the converter. This varies according to application requirements. The SMA, SC, and ST are the types of connectors.
It is important to confer with the network administrator about internal standards. Many buildings have a cabling system and media standard in place, and all installed networks must follow this standard. Complying with an existing standard may result in higher short term installation costs but results in long term maintenance cost savings.

The components of Ethernet include both hardware and software. Many of the N1 LAN components are vendor products. Refer to Appendix B: Ordering Information of this document for a list of all vendor products that have been tested with the N1 LAN. For details about special configuration steps, refer to vendor documentation.

The following information briefly describes each hardware component that may be required by the network configuration and media. Some Ethernet networks use each component while others use only some of the components. Refer to Appendix B: Ordering Information of this document for recommended vendor and part numbers. Table 4 contains the NCM code equivalencies for Europe and North America.

Table 4: NCM Code Equivalencies

<table>
<thead>
<tr>
<th>North America</th>
<th>Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCM300</td>
<td>NCM311</td>
</tr>
<tr>
<td>NCM350</td>
<td>NCM361</td>
</tr>
<tr>
<td>NCM Series (NCM300 and NCM350)</td>
<td>NCM Series (NCM311 and NCM361)</td>
</tr>
</tbody>
</table>

- **NU-NCM350-1 (NCM350)**--An NCM350 or upgraded NCM300-1 with a ROM150 Memory Module upgrade is required. The NCM350 is an improved hardware platform that supports the same features as the NCM300 plus Ethernet communication, Dial-up, S2 Migration applications, internal modems, and internal RS-232 connections. The NU-ROM150 Memory Module is already installed in the NCM350. An Industry Standard Architecture (ISA) compatible Ethernet Adapter Card needs to be purchased separately and installed in an ISA slot.

Note: The NCM350 supports either ARCNET or Ethernet applications. Because the NCM350 is required for Ethernet applications, use NCM350s whenever there is a possibility that Ethernet might be deployed at a later date.
• **NU-NCM300-1 (NCM300-1)**—An NCM300-1 (Version B or later) with a ROM150 Memory Module upgrade may be used instead of an NCM350. For ROM150 installation instructions, refer to the *Setting Up the Metasys Network on Ethernet* section, *Installing the Hardware at the NCM* subsection, *Installing the ROM150* heading located in this document.

Note: The NU-NCM-300-0 (NCM300) may be returned to the Johnson Controls Repair Center to be upgraded to an NCM-300-1 or NCM-350. The NU-NCM300-0 is not field upgradable.

• **NU-ROM150 Memory Module**—The NU-ROM150 Memory Module is required to upgrade an NCM300-1 to an NCM350 for Ethernet support. Refer to *Appendix B: Ordering Information* of this document for information on ordering the upgrade kit, which includes the NU-ROM150-1 (Flash SIMM), installation instructions, and a new NCM350 label.

• **Ethernet Adapter Card**—Metasys nodes (OWS or NCM350) require an Ethernet Adapter Card, which is commonly referred to as a NIC, to communicate over the Ethernet network. The Ethernet Adapter Card installs into either the ISA card slot on both the NCM350 (NU-NCM350-1) and OWS.

The Ethernet Adapter Card supports coax, AUI, and twisted pair connectors directly and fiber optic connections when used with an AUI to fiber optic transceiver. Many PCs (OWSs) are now manufactured with an integrated Ethernet Adapter Card.

• **Fiber Optic SC Connector**—The SC connector, similar to the ST and SMA connectors, is a fiber optic micro transceiver. Technical enhancements include an auto-reset jabber feature and five diagnostic Light-Emitting Diodes (LEDs).

• **Fiber Optic ST Connector**—The fiber optic ST connector is a micro transceiver that enables the use of fiber optic media. This transceiver can be combined with existing copper based AUI Ethernet configurations to allow AUI-to-fiber connections. It is plug compatible with most IEEE 802.3 hardware and implements all Ethernet transmit, receive, and collision detection functions.
• **Fiber Optic SMA Connector**--The Fiber Optic SMA connector is a common hardware component used in Ethernet networks. It allows an AUI cable to connect to various media, including thick or thin coaxial, fiber, or twisted pair as well as repeaters, bridges, and intelligent hubs. With a Metasys Network, a transceiver is needed only for fiber optic connections. The Ethernet Adapter Card intrinsically supports AUI, twisted pair, and thin coax connections.

• **AUI Transceiver Cable**--AUI transceiver cable is a 15-pin cable. It may be required if there is not enough space in the NCM standard enclosure when the fiber optic transceiver is connected directly to the Ethernet Adapter Card.

• **T-Connectors**--A T-connector is required at each OWS, repeater, and NCM when the transmission medium is a thin wire coax.

• **Terminator Caps**--Terminator caps are 50 ohm resistors that are required to properly terminate the N1 LAN. They prevent signal reflections. A terminator cap is required at the end of each segment in a bus network when the transmission medium is a thin wire coax.

• **Hub**--The hub is the core of a network or cabling system. Twisted pair, AUI, and fiber optic Ethernet, and many proprietary network topologies use hubs to connect multiple cable segments together. These cable segments could be a star or bus topology. Hubs have multiple ports to attach the different cable runs and combine different media types. The intelligent hub acts as a multi-port bridge in that it monitors the physical port address segments to prevent collisions and improve efficiency and network speed.

  Note: The isolation capability of an intelligent hub requires adequate processing power, memory, and interconnect technology.

• **Unmanaged Hub or Concentrator**--Similar to an inexpensive multiplexer, the unmanaged hub allows nodes to connect to the network in a star configuration. Many unmanaged hubs are being replaced with intelligent hubs. Unmanaged hubs do not provide additional functionality such as Simple Network Management Protocol (SNMP).

• **Gateway**--A gateway is used to pass network traffic from one protocol to another and to handle differences in data format, speed, and signal levels. An IP gateway would be used to transmit IP packets using different protocols such as ARCNET, IPX™, or SNA.
• **Repeater**--The function of a repeater is to regenerate incoming signals, so you can extend transmission distances while maintaining signal quality. In addition to collision detection, the repeater reshapes, re-times, and retransmits signals to both Ethernet segments. An Ethernet hub is also a repeater. The maximum number of times a signal can be regenerated for Ethernet is four times.

• **Multi-port Repeater or Hub**--A multi-port repeater connects more than two segments. The multi-port repeater usually has an AUI connection and multiple ports for thin coaxial, twisted pair, or other common media. The primary application for a multi-port repeater is to provide a connection to the thick coaxial backbone while serving an area that uses thin coaxial, AUI, or twisted pair.

• **Bridge**--Similar to the repeater, a bridge joins two network segments from separate LANs. However, a bridge passes only those packets intended for a node on the other side. The segments on either side of the bridge are separate in terms of length rules. The bridge can be used to lengthen a segment and to segregate traffic on busy networks. Isolating a Metasys system from other network traffic can increase reliability and still provide all network users access to Metasys data. A bridge is the best way to combine a Metasys segment with a shared segment.

• **Routers**--A router is a network device typically used in WANs. It forwards IP network traffic from one connected network to another. The router functions much like the bridge but also has filtering capabilities. The filters allow the router to make decisions on how to route the IP packets it sends and receives.

**Software Components**

The software components include:

• **Windows® 98 SE, Windows NT®**--Windows 98 SE and Windows NT are Ethernet compatible. The Microsoft® TCP/IP Protocol must be installed and configured.

• **Metasys Release 8.0 or later**--Metasys Release 8.0 or later software supports the Ethernet N1 LAN. All nodes running Ethernet must use Metasys Release 8.0 or later software.

• **Metasys Release 10.01 or later**--Metasys Release 10.01 or later supports the M5 Workstation Multinetwork feature.

• **NCM Drivers**--The NCM350 is designed to run with standard packet drivers.
**Ethernet Cards**

For use in the NCM350, order the NU-NET301-0. The OWS can use any Ethernet Adapter Card supported by Microsoft Windows software.

**Note:** A small number of NU-NET301-0 Ethernet adapter assemblies supplied by Kingston Technologies do not fit into the NU-NCM350. The cause is two reinforcement ribs on the mounting bracket that are too long. Only a limited number of the incorrectly bracketed adapters were produced. All new adapters are produced with the correct bracket. Inspect the NU-NET301-0 before taking it to a job. For a replacement NU-NET301-0, contact:

Tyler Ernt or Mike Kuppingter
17600 Newhope St.
Fountain Valley, CA 92708
1-800-435-2620

**Choosing the Metasys Components**

The following information is a list of components that you need for Metasys nodes.

- **Ethernet Adapter Card**—One Ethernet Adapter Card is required for each OWS and each NCM350 that is on the N1 Local Area Network (LAN).

- **Fiber Optic Transceiver**—One is required for each NCM350 and OWS connected to the network via fiber optic cable. Each fiber optic transceiver connects to the Johnson Controls equipment via an AUI port and then to the LAN hub via fiber optic cable.

- **Operator Workstation (OWS)**—Many PCs can be purchased with an integrated Ethernet port. Metasys software is compatible with this type of hardware as long as the integrated Ethernet Adapter Card is supported by Windows software. Refer to the *Operator Workstation Configurations Bulletin (LIT-636013d)*, located in the *Operator Devices* section of this manual, for Metasys OWS platforms that are currently recommended/supported as well as hardware and software options. Plug and play cards such as the Intel® EtherExpress PRO/10 LAN Adapter can be used in the OWS.

**Note:** For the OWS, you may also select an Ethernet Adapter Card that has an integrated fiber optic transceiver. This type of card allows the PC to operate in a smaller area.
Another important part of designing and installing a LAN is selecting the appropriate topology for the application. Ethernet networks can be configured in either a star, bus, or mixed topology.

**Star Topology**

The robust star network features two or more nodes connected to a central hub using unshielded twisted pair or fiber optic media. The hubs can be placed in wiring closets conveniently located in a building. The advantage of the star topology is ease of fault isolation by passing and repairing faulty nodes. A disadvantage is that the star topology requires more cable than a bus topology.

**Bus Topology**

Coaxial cable was the original LAN medium, and it is used in a bus topology. A bus network features nodes wired in a daisy chain with network terminators at each end of the chain. With the bus, all nodes are attached to a single length of cable. The advantages of a bus topology include low cable lengths and low sensitivity to node failures; the disadvantages include high sensitivity to distance and difficult prewiring for future expandability. This topology is rarely used in new LAN installations, because it is relatively difficult to accommodate adding new users or moving existing users from one location to another. It is also difficult to troubleshoot problems on a bus LAN unless it is very small.

Components of both the star and bus networks can be used together to provide a mixed network. Figure 2 and Figure 3 show the two most prevalent network configurations.
Figure 2: N1 Ethernet/IP LAN Star Configuration

Figure 3: N1 Ethernet/IP LAN Mixed Configuration

Note: Do not use RG-62A/U cable with Ethernet.
Of the three different N1 LAN network configurations, the star network is recommended for NCMs and OWSs that are widely separated from each other (500 to 1500 feet). The bus network, on the other hand, is best for NCMs and OWSs that are situated close to each other (under 607 feet). A mixed network is best for systems with some nodes that are close to each other, and others that are widely separated.

Use Table 5 to help decide which configuration is best.

### Table 5: N1 LAN Network Configurations

<table>
<thead>
<tr>
<th></th>
<th>Easiest:</th>
<th>Hardest:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ease of Installation</strong></td>
<td>Star</td>
<td>Bus</td>
</tr>
<tr>
<td><strong>Ease of Maintenance and Troubleshooting</strong></td>
<td>Star</td>
<td>Bus</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>Mixed</td>
<td>Bus</td>
</tr>
<tr>
<td><strong>Reliability</strong></td>
<td>Star</td>
<td>Bus</td>
</tr>
<tr>
<td>(can vary according to application)</td>
<td>Mixed</td>
<td></td>
</tr>
</tbody>
</table>

As a rule, it is easier to manage and maintain a network with a simple design than it is one with a more complex design. Techniques for simplifying a network design include:

- using consistent media
- providing cable and hardware accessibility
- limiting the number of nodes per segment
- clearly documenting the IP addresses used on all Metasys equipment
- establishing customer roles and responsibilities
- placing nodes in best physical location

The specific environment and application must be evaluated when selecting a media type. Where possible, use one type of media to avoid having to meet the different installation, maintenance, and test equipment requirements that are unique to each medium. Hardware connections and special equipment associated with each medium can further complicate network management and maintenance.
### Cable and Hardware Accessibility

Accessing the network cable and hardware is necessary for maintaining and expanding the network. To simplify future cable alterations, install a generously sized conduit for network cables in the walls.

Each type of media has length restrictions. For any one segment, avoid running cable beyond 80 percent of the allotted cable length. Use additional hardware rather than have segments that exceed cable limits. Maximum cable length is media specific and is covered later in this document. Cable run lengths must also be considered, because LAN communication equipment is typically stored in closets and may not be closest to the NCM.

### Number of Nodes

Other key LAN installation and design factors are the maximum number of Metasys and Ethernet nodes, as well as the maximum length of cable for each N1 segment. Up to 100 Metasys nodes (NCMs and OWSs) can reside on an Ethernet network.

### IP Addresses Documentation

Documenting IP addresses guarantees access to them at all times and reduces the chances of defining the addresses on more than one node.

### Roles and Responsibilities

The *N1 Ethernet/IP Network Product Bulletin Supplement (LIT-635033a)* in the *Metasys Network Sales Resource Manual (FAN 635)* contains questions that helps identify and manage network complexities as well as plan for future network growth. Also covered is the question whether the customer can meet bandwidth, security, software, and other requirements necessary to guarantee the performance of a Metasys system.
Table 6 contains the minimum/maximum cabling lengths and distances required between two nodes for various media. The minimum cable lengths also apply to repeaters and hubs.

### Table 6: Cabling Lengths and Distances between Nodes by Media

<table>
<thead>
<tr>
<th>Feature</th>
<th>Plastic Fiber Optic (Multimode)</th>
<th>Glass Fiber Optic</th>
<th>Thin Coax</th>
<th>Twisted Pair</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minimum Distance between Nodes</strong></td>
<td>*</td>
<td>*</td>
<td>0.5 m (1.6 ft)</td>
<td>2.5 m (8.2 ft)</td>
</tr>
<tr>
<td><strong>Maximum Length</strong></td>
<td>2000 m (6560 ft*)</td>
<td>2000 m (6560 ft*)</td>
<td>185 m (607 ft)</td>
<td>100 m (330 ft)</td>
</tr>
<tr>
<td><strong>Advantages</strong></td>
<td>EMI/RFI immunity</td>
<td>Impervious to EMI and RFI. Offers extended length.</td>
<td>Economical. Easy termination and handling.</td>
<td>Economical. Simple termination</td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>Shorter runs than glass fiber</td>
<td>Termination, equipment, and labor costs</td>
<td>Noise resistance lower than thick coaxial or fiber</td>
<td>Least noise resistance</td>
</tr>
<tr>
<td><strong>Number of Connects per Segment</strong></td>
<td>2</td>
<td>2</td>
<td>30</td>
<td>2</td>
</tr>
</tbody>
</table>

* Fiber optic distances vary by manufacturer.

** This is the number of physical connections allowed on one cable segment.

### Equipment Closets and Cable Runs

Identify the location of each node, all electrical equipment, and potential hazards using a copy of the facility’s layout. Also check for an adequate number of easily accessible, ventilated equipment closets with power. Centrally located closets minimize cable runs.

Consider placing cable for future growth during the initial installation phase. This reduces costs associated with installation and the interruption of normal office workflow.

A hop is a transmission of a data packet through a router in a network of interconnected segments of subnetworks. A measure of a path through an internetwork is the hop count (the number of routers the packet passes through enroute to its destination). Due to the inherent time delays in traversing Ethernet nodes, a general rule is to allow no more than four hops between any two nodes. However, this is dependent upon the equipment manufacturer’s specifications. Check with the manufacturer to determine the allowable number of hops.
Limitations

Certain characteristics associated with Ethernet communications can affect system performance. They include:

- speed
- access times
- distance

Speed

The speed of the Ethernet network is affected by the fact that Ethernet is forced to transmit extra data for each message sent. Not only do all messages sent on the network require message headers, but Ethernet’s minimum message size necessitates padding small messages. In addition, the CSMA/CD access method tends to slow down the Ethernet network when it operates at more than 60% of its bandwidth.

Thus, heavy Ethernet traffic may slow down performance of a Metasys system.

Notes: The Metasys system can be configured as a private network or connected to an existing network. When configured as a private network (i.e., when there are no other applications co-existing on the LAN), the Metasys system provides all the benefits associated with Ethernet, and experience high reliability. However, when configured with other applications on the LAN, caution must be taken to ensure that enough bandwidth is available to support the Metasys application.

Never attempt to connect an ARCNET node to an Ethernet network. This saturates the Ethernet network with ARCNET broadcasts and make the entire network unusable.

Access Times

Unlike the ARCNET network, which uses the token passing access method, access to the LAN cannot be guaranteed for time critical messages. Similarly, worst case response times for transmissions between nodes cannot be predicted, since Ethernet access times depend on the amount of other data being transmitted on the network. By tying into an existing shared Ethernet network, the network communication is subject to disruption caused by other nodes attached to the network.
Distance

As with all networks, distance limitations vary depending on the cable used. For example, an Ethernet thin coax network is limited to a total distance of around 2428 feet, with a maximum length for any one segment being 607 feet. For most BAS applications, the Ethernet distance limitations are not a problem. Care must be taken to abide by all distance limitations noted above as well as those given by the network component manufacturer. Limiting distances to no more than 80% of the design capacity allows room for future additions to the network. Ethernet is a LAN topology and is not a solution for a Wide Area Network (WAN) because of media distance limitations.

Using the same connection conventions established with the Metasys N1 ARCNET (e.g., connecting a remote OWS over phone, leased, or ISDN lines), connect remote devices. However, Metasys nodes can communicate over a WAN if a continuously connected, 56 Kilobits per second (Kbps) or higher speed connection can be provided for the remote Metasys nodes. This is a LAN to WAN internetworking issue. The design and components for this type of connection vary based on the type of LAN/WAN network. The services of a network consultant may be needed, if the customer does not have the expertise to provide this type of connection.
### Network Communications—N1 Ethernet/IP Network

#### Specifications

<table>
<thead>
<tr>
<th>Product Name</th>
<th>N1 Ethernet/IP Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>TCP/IP (UDP Datagrams), CSMA/CD</td>
</tr>
<tr>
<td>Error Checking</td>
<td>Cyclic Redundancy Check (CRC)</td>
</tr>
<tr>
<td>Communication Rate</td>
<td>10 Megabits per second (Mbps)</td>
</tr>
<tr>
<td>Addressable Nodes</td>
<td>Metasys: Up to 100, Ethernet: Up to 1024 per network segment (includes Metasys nodes)</td>
</tr>
<tr>
<td>Termination Method</td>
<td>End-of-Line Resistor (50 ohm) at End of Each Bus Segment (10Base2 and 10Base5 only)</td>
</tr>
<tr>
<td>Surge Protection</td>
<td>Varies by Vendor</td>
</tr>
<tr>
<td>Media Types</td>
<td>Coaxial Cable RG58A/U (Belden B89907, B9907), Unshielded Twisted Pair (UTP), Shielded Twisted Pair (STP) (CMP-00424 SAS-3 and CMP-00424 FAS-5 Belden), CAT 3, 4, or 5 with 2- or 4-pair Recommended, Optical Fiber (370-948-FDDI-02)</td>
</tr>
<tr>
<td>Configuration Choices</td>
<td>Star, Bus, Mixed (Star + Bus)</td>
</tr>
<tr>
<td>Standard Components for the NCM and the OWS</td>
<td>Ethernet Adapter Card (NCM must use.) OWS can use any Ethernet Adapter Card supported by Microsoft Windows software. Ethernet Adapter Cards that support plug and play installation are recommended. Fiber optic transceivers are required for fiber optic connections.</td>
</tr>
</tbody>
</table>

Note: Other cables will work. Call your cable supplier for information on the correct cable for your application.
Planning and Estimating an Installation

This section describes briefly what you need to know when planning to install the N1 LAN. Specifically it includes information about:

- protocol standards compatibility
- environment and power
- cabling guidelines

### Protocol Standards and Compatibility

10 Mbps N1 Ethernet LAN protocol standards and compatibility include:

- IEEE 802.3 CSMA/CD
- IEEE 802.3 10Base2, 10Base5, 10BaseT, 10BaseFL (FL/FOIRL)

Refer to the *Network Control Module 300 Series Technical Bulletin* (LIT-6360251) located in the *Control Modules* section of this manual for details about installing the NCM including space, environment, and power information.

### Environment and Power

Over time, the control needs of a building may require additional nodes. You will need a hub or repeater to expand the network if the maximum number of nodes per segment or the maximum length of a bus segment has been reached.

Adding nodes to the N1 LAN is not complicated. Refer to the *Setting Up the Metasys Network on Ethernet* section of this document for details on adding nodes to the N1 LAN. The star network affords the easiest expandability if one of its hubs has an unused port. However, the bus network is less costly to expand than the star network if the former requires an additional hub. Nodes can be added to either configuration until up to 100 Metasys devices are connected.
The acceptable cable layout for the N1 LAN depends on whether you have chosen a star, bus, or mixed network. Figure 5, Figure 6, and Figure 7 show examples of such network designs. However, there are many other layout design options.

**Star Network**

Follow the maximum cable lengths as shown in Figure 4 for a star network. Use hubs or repeaters to extend the N1 LAN.

![Cabling Guidelines](image)

**Figure 4: Maximum Distances for Star Network**

*Distances for optical fiber vary by manufacturer.*
Figure 5 shows an example of a layout for a star network.

*Fiber optic distances vary by manufacturer.

**Figure 5: Cable Layout for a Star Network**

Note: Terminators are required only for 10Base2.
Figure 6 shows an example of a coax (10Base2) layout for a bus network.

Notes:
- A-B and C-D must not exceed 185 m (607 ft).
- *Fiber optic distances vary by manufacturer.
- ① = 50 ohm Terminator Cap

Figure 6: Cable Layout for a Shared Bus Network
**Mixed Network**

Figure 7 shows an example of a cable layout for a mixed network, which uses coax cable.

![Cable Layout for a Mixed Network](image)

*Figure 7: Cable Layout for a Mixed Network*

- 185 m (607 ft) to Another Building*
- Fiber optic distances vary by manufacturer.
- ⑦ = 50 ohm Terminator Cap
For private Metasys Networks, use 10BaseT hubs. If the local network should expand, 10BaseT hubs can be connected to accommodate additional users. They can be connected using straight-through UTP patch cables or linked over a variety of media using the AUI port and appropriate transceiver. Figure 8 shows an example of a private Metasys Network configuration. This is not the only way to configure a private Metasys Network. When selecting a hub for this type of configuration, ensure compatibility with the IEEE 802.3 10BaseT specification for supporting 10 Mbps Ethernet UTP wire. See the *Installing Hubs and Repeaters* section in this document for more information on hubs.

**Figure 8: 10BaseT Private Metasys Configuration**
Setting Up the N1 Ethernet/IP Network

General

The following section describes the guidelines to follow when installing the N1 LAN. When routing the N1 LAN wiring, please be aware of the following rules:

- Do not allow loose T-connectors or adapters to touch the metal surface of the NCM base frame. To ensure that this does not happen, wrap electrical tape or install a plastic shroud around metal components.
- Follow vendor recommendations for connectors, accessories, and methods of termination.

Before You Start

Before installing the equipment on the network, it is important that the following information and components are available:

- A unique IP address must be defined for each node. To obtain these addresses, contact the network administrator or whomever provides network support. Duplicate IP addresses within a network can cause subtle errors that are difficult to correct.
- For a private Metasys Network, IP addresses can be assigned as desired. The network administrator must define a subnet mask for each NCM and OWS.
- If the network is more than one routed segment, each NCM and OWS node requires a defined router address. The router address is used with the destination IP address and the subnet mask to properly route and deliver packets to other subnets.
- When using the M5 Workstation Multinetwork feature to configure multiple N1 networks, you must assign a UDP port address to each N1. See the Configuring Multiple N1 Networks section of this document.
- When using an existing Ethernet LAN as the Metasys N1 Network, it is very important that the customer understands the potential impact of the traffic from non-Metasys equipment on the LAN. It is equally important that the customer understands how to remedy unreliable communication problems, such as frequent Metasys online/offline occurrences. Segmentation or a separate network may be required.
• There are many different methods of segmenting, routing, and filtering traffic on a given LAN. You may want to seek the advice of a network consultant if the customer does not have this expertise. Keep in mind the preferred order of configurations (private, segmented, shared) respectively.

• The media must support both the hub connection and the Metasys nodes. Port availability is also required. If no port is available, you must add a second hub, upgrade the existing hub, or replace the hub to make more ports available.

• Use NCM300-1 or NCM350-1 NCMs or later for Ethernet networks. If you are upgrading existing NCM300-1s to an Ethernet network, replace the existing NU-ROM101 Memory Module with an NU-ROM150 Module. (An NCM300-0 cannot be upgraded to an NCM350-1 in the field.)

• Use an Ethernet Adapter Card and NU-ROM150 Memory Module.

• Use ST, SC, or SMA transceivers for fiber connections. If connecting fiber to an NCM, be sure that the NCM enclosure can house the transceiver connected to the Ethernet Adapter Card. If not, short transceiver cables are required to connect the Ethernet Adapter Card to the transceiver.

• Obtain valid copies of Microsoft Windows software for all OWSs.

• Understand the characteristics of network utilization and identify areas of potential concern and problems. Most network administrators should have access to a network utilization profile. During peak activity, capacity may be exhausted. Extended peak times may cause Metasys performance problems such as online/offline occurrences.

• Reserve 2% of the 10 Mbps total bandwidth for the Metasys system. Additional customer or branch application traffic must be accounted for separately.

• Confer with the network administrator regarding the segmenting of Metasys system traffic from other LAN traffic. Installation of a third-party manufacturer’s bridge is one of the easiest methods available for providing Metasys segmentation.

When configuring your NCMs and commencing initial setup in a temporary location (before installation at a permanent location), you must make an Ethernet connection between the NCMs and OWS.
Connecting the OWS and NCM Using Crossover Patch Cable

If you do not have a hub available, connect the OWS to one NCM at a time. If the OWS Ethernet adapter is configured for an RJ45 (twisted pair) connection, use a crossover patch cable to directly connect the OWS and NCM. This cable enables two Ethernet adapters to be connected without going through a hub. Crossover patch cable may be available at a local electronics store, or you can make one.

Making Crossover Patch Cable

When looking at the end of an RJ45 connector, with the cable running away from you and the plastic tab toward the bottom, Pin 1 is on the right. Figure 9 shows how to connect the wires on the crossover patch panel.

Figure 9: Crossover Patch Cable Pinout

Connecting Crossover Patch Cable

After the cable is made, connect it directly between the Ethernet adapter in the OWS and the adapter in the NCM. Mark the cable, so you are able to identify it later.

Note: You must not use this cable when connecting to a hub. Hub connections require straight-through patch cables.

Connecting the OWS and NCM Using Coax Cable

If the OWS Ethernet adapter is configured for a BNC (coax) connection, use coax cable to directly connect the OWS and NCM adapters. Be sure to use a T-connector and a 50 ohm terminator at each end.

As long as the Ethernet Adapter Card in the NCM is configured for Auto mode, the adapter switches automatically between twisted pair and coax, whichever is connected. Auto is the card’s default mode.
Connecting the OWS and NCM Using AUI Cable

If you are using the AT-2000U Plus adapter card and want to configure it for AUI mode (instead of Auto), before you configure the NCM, you can connect to the adapter as follows:

2. At the other end of the AUI cable, connect a transceiver to convert from AUI to either twisted pair or coax (based on whether you are using the crossover patch cable or coax).

Refer to the Setting Up the Metasys Network on Ethernet section of this document for directions on configuring Ethernet Adapter Cards for the NCM and OWS and connecting Metasys NCMs and OWSs to Ethernet. For information about solutions to problems that may occur on the N1 LAN, see the Troubleshooting Procedures section of this document.

The Ethernet Adapter Card is a required component for the NCM350. It fits into one of the available expansion board slots. Refer to the Installing the Hardware at the NCM heading under the Setting Up the Metasys Network on Ethernet section located in this document for detailed instructions on installing the Ethernet Adapter Card.

For the NCM350, set the Ethernet Adapter Card according to Table 8:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Required Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation Mode</td>
<td>I/O Mode (NE2000)</td>
</tr>
<tr>
<td>I/O Base Address</td>
<td>320H</td>
</tr>
<tr>
<td>Interrupt Level (IRQ)</td>
<td>10</td>
</tr>
<tr>
<td>Boot ROM</td>
<td>Disable</td>
</tr>
<tr>
<td>Connector Type</td>
<td>Auto for Coax or Twisted Pair</td>
</tr>
<tr>
<td></td>
<td>AUI Cable for Connection to a Transceiver</td>
</tr>
<tr>
<td>AT Bus Compatible</td>
<td>Compatible</td>
</tr>
</tbody>
</table>

The OWS Ethernet Adapter Card is installed with and controlled by Microsoft Windows software. Follow the instructions for loading Microsoft Windows software on the OWS as described in the Microsoft literature.
Installing Hubs and Repeaters

Hubs, repeaters, and bridges may be installed in any convenient place where power is available. This may be inside or near an NCM or between NCMs.

Note: In the case of a shared or segmented network, the location of hubs and repeaters is best determined by whomever provides general network support at a location. It is important to identify and work with this group.

The layout of the network determines the exact location of the hubs and repeaters. They do not need to be installed in separate enclosures, since their enclosures provide adequate protection. Refer to the vendor’s literature for installation instructions.

Testing Cable

Testing the cable in the box or on the spool prior to installation identifies faulty cable. The two methods of testing cable are:

- Volt Ohmmeter (VOM)
- Handheld cable scanner or LAN cable meter

Volt Ohmmeter (VOM)

The VOM is not as thorough as other equipment but is useful for testing the basic functionality of wire media. To test for shorts, follow these steps as shown in Figure 10:

1. Check to make sure the braid and connector are not touching at any place along the cable. The presence of a short may be an indication that the braid and connector are touching.

2. Check for infinity at one end of the cable to confirm that it registers on the meter’s lowest ohm scale. An infinity reading indicates that there are no shorts.

Note: The infinity reading varies by VOM; however, on many VOMs, infinity is displayed as an overload (OL).
Perform a second VOM procedure to test for an open by following these steps:

1. Terminate one end of the **coaxial cable** with a connector.
2. Attach a 50 ohm terminator and check for an approximate 50 ohm reading.

Note: Ohm readings vary according to value, terminator tolerance, and cable length.

To test for continuity using **twisted pair** cable:

1. Short the individual wires of the **twisted pair cable** together at one end and check for continuity at the other end.
2. Check the ohm reading between Conductors 1 and 2, 1 and 3, and 1 and 4 to make sure all readings are 0 ohm or slightly higher, allowing for the resistance of the cable.
The handheld cable tester tool is easy to use. It provides information about cable length, shorts, noise, termination, impedance, and resistance. The more sophisticated meters also measure Ethernet traffic activity, collisions, and jabber. Most units are both menu- and dial-based. You can use most handheld testers to verify that your cable meets the applicable standards. Use the following steps to test cable with the handheld tester:

1. Terminate both ends of the cable with the appropriate connectors.
2. Attach one end of the cable to the tester.

Note: Most units have an autotest for shorts, opens, lengths of cable, and abnormalities.

3. For twisted pair cabling, use a loopback module to check for noise and to provide a cable pinout.

Installing all the cable support hardware, including conduits and cable troughs, is the first step of the installation process. To simplify this process, follow these rules:

1. Use the distributor’s kit or develop a system for numbering the cable ends as well as the box or roll from which you are pulling the cable.
2. Avoid pulling cable bundles over a stationary cable.
3. Pull cable without using excessive force and investigate heavy resistance to a pull.
4. Properly trim or secure excess cable.
5. Leave an extra foot or two at both ends of a run in case you need to replace cable ends.

This is a critical step, which can cause installation and troubleshooting problems if not properly executed. Each connector on the network impacts the entire network, so it is worthwhile to practice installing the connectors before attempting to do so.

The wiring instructions depend on whether the N1 LAN is a star, bus, or mixed network.

⚠️ WARNING: To avoid damage to equipment or possible electrical shock, be sure that the power supply to each node has been disconnected before wiring commences.
Wiring for a Star Network

Figure 11 shows an example of how the components of a star network are wired. Follow these steps:

1. At the hub, install the modules that are needed, referring to the manufacturer’s literature. Insert a cable into an open port on the hub.
2. Route the cable from the hub to the NCM.

For more details, refer to the Network Control Module 300 Series Technical Bulletin (LIT-6360251) located in the Control Modules section of the Metasys Network Technical Manual (FAN 636).

10Base2 System

For a 10Base2 system, install a T-connector on the NCM’s coax port (located on the NCM’s Ethernet Adapter Card). Wire the N1 cable from the hub to one side of the T-connector. If the NCM is at the end of the line, install a 50 ohm terminator cap on the other side.

10BaseT System

For a 10BaseT system, install a RJ45 plug on the cable and plug it into the Ethernet Adapter Card.

10BaseFL System

For 10BaseFL, attach the fiber cable to a transceiver, which is connected to an AUI extension cable. Attach the cable to the AUI port on the adapter card.
**Figure 11: Wiring Star Network Components**

- **Hub**: (Coax to Fiber)
- **Operator Workstation w/Ethernet Board**: 
- **NCM350**: 
- **T-connector**: 
- **50 ohm Terminator Cap**: 
- **Coax Connector**: 

*Note: Do not use RG-62A/U cable with Ethernet.*

*T-connectors and terminators are required for coax cable only.

Note: Refer to Table 6 for distance limitations.
Figure 12 shows an example of how the components of a bus network are wired.

If the NCM350/OWS is not at the end-of-line:
1. Install a T-connector into the coax port on the Ethernet card.
2. Wire the N1 cable from the previous node to one side of the T-connector.
3. Wire another length of N1 cable to the other side of the T-connector, which you wire to the next node.

If the NCM350/OWS is at the end-of-line:
1. Install a T-connector into the coax port on the Ethernet Adapter Card.
2. Wire the N1 cable from the previous node to one side of the T-connector.
3. Install a 50 ohm terminator into the other side.
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**Figure 12: Wiring Bus Network Components**

Note: Total cable length between Points A and B must not exceed distance limitations given in Table 6.

Note: Do not use RG-62A/U cable with Ethernet.
**Hybrid Networks**

A major advantage of Ethernet-based systems is the ability to use hybrid networks to meet special configuration requirements. Different types of media may be used in conjunction with hubs to connect readily accessible nodes, such as those located in a common office area, with inaccessible nodes located in a basement, equipment room, or plant.

10BaseT connectors can be used in areas with ready access to the network, less than or equal to 330 feet (100 meters). In remote areas, a fiber transceiver is used to increase distances. Maximum distances vary by manufacturer. The hub converts the fiber to whatever common backbone is deployed throughout the building. See Figure 13.
Figure 13: Method of Wiring to an Isolated NCM

Note: In this application, the existing hub must support or be augmented to support fiber connections.
To verify that the N1 LAN is installed properly, make sure that:

- the installation follows the recommended maximum and minimum cable lengths.
- only those nodes that are located at the ends of N1 LAN bus segments have 50 ohm terminators. The nodes between the two end nodes must not have 50 ohm terminators installed.
- the proper cables are being used. The recommendations are:
  - RG58A/U for coax (Belden B89907, B9907)
  - MCP-00424 SAS-3 and CMP-00424 FAS-5 Belden for twisted pair
  - 370-948-FDDI-02 for optical fiber
Other cable will work. Call your cable supplier for information on the correct cable for your application.
- the network is communicating properly. Ensure Metasys nodes come alive.
Setting Up the Metasys Network on Ethernet

Once your N1 LAN is connected and you have verified proper network communication, you are ready to connect the Metasys NCMs and OWSs. The process involves both hardware and software installation and configuration of both the NCMs and the OWS. Table 9 shows the sequence of steps.

Table 9: Sequence of Steps

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<th>Step</th>
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<th>Software Installation</th>
<th>Configuration</th>
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<td>1</td>
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<td></td>
<td>Obtain IP addresses, subnet mask address, and UDP port addresses.</td>
</tr>
<tr>
<td>2</td>
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<td>Configure Ethernet Adapter Card for the NCMs.</td>
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<td>Install the Memory Modules in the NCMs.</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td>Configure all NCMs to proper configuration.</td>
</tr>
</tbody>
</table>

Once you have completed the configuration, you are able to communicate between the NCMs and the OWS over the N1 LAN.
In cases where registered IP addresses are not available, the addresses and subnet mask can be defined. Figure 14 is an example of how the address might be selected for a private Metasys Network, without hubs or routers. IP addresses are of the form 10.X.X.X, 172.16.X.X, and 192.168.X.X where the last byte is the same as the Metasys node address.

**Choosing IP Addresses**

IP addresses may be chosen arbitrarily only for a private network (one which contains only Metasys devices).

If the network is ever connected to another Ethernet network, the IP addresses must be made compatible with the new network.

Note: If two nodes anywhere on the extended network have duplicate IP addresses, serious communication problems result.

**Choosing the Subnet Mask**

The subnet mask is a value, which is used to determine whether IP nodes are on the same Ethernet segment (or subnet).

Note: The subnet/node terminology used for addressing Metasys devices is not the same as the subnet referred to here.

Each of the four parts of the IP address is represented in the computer as a byte and therefore has a maximum value of 255. A value of 255 in the subnet mask means that that byte of the IP address is the same for all nodes on a particular Ethernet segment. In Figure 14, a subnet mask of 255.255.255.0 means that the first three bytes of each address on the segment are the same, and only the fourth byte is variable.
Suppose the segment in this example were connected (through a router) to another Ethernet segment whose addresses were 10.1.2.x, rather than 10.1.1.x. In order for a node on the example segment to communicate with another node, it would have to know whether the receiving node is on the same segment or on the other segment. The subnet mask allows the node to make this determination based on whether the first three bytes of the IP address are the same.

Note: When connecting Metasys nodes to an existing Ethernet network, consult the network administrator. For a simple private Metasys Network (no network routers), use a subnet mask of 255.255.255.0.

For more information on IP addresses and subnet mask addresses, refer to Before You Start in the Setting Up the N1 Ethernet/IP Network section.

**Choosing UDP Port Addresses**

UDP port addresses must be chosen if you are configuring multiple N1 networks with the M5 Workstation Multinet network feature. See the section titled Configuring Multiple N1 Networks in this technical bulletin.

**Hardware Requirements**

For the OWS, select an Ethernet Adapter Card that is compatible with Microsoft Windows software. For the NCM, the only card that is qualified for use is the NU-NET301-0. The current manufacturer of this card is Kingston Technology.

Note: A small number of NU-NET301-0 Ethernet adapter assemblies supplied by Kingston Technologies do not fit into the NU-NCM350. The cause is two reinforcement ribs on the mounting bracket that are too long. Only a limited number of the incorrectly bracketed adapters were produced. All new adapters are produced with the correct bracket. Inspect the NU-NET301-0 before taking it to a job. For a replacement NU-NET301-0, contact:

Tyler Ernt or Mike Kuppinger
17600 Newhope St.
Fountain Valley, CA 92708
1-800-435-2620

**Configuring Ethernet Adapter Cards for the NCMs**

Configure the Ethernet Adapter Cards for the NCM. Do this first since it may require the use of the OWS hardware. By doing this first, you do not disturb the OWS after it has been configured. The NCM network card must be configured to use IRQ10 and IO Base Address 320.
Configuring the OWS

Installing the Ethernet Adapter Card

Before loading any software, install the Ethernet Adapter Card into your OWS. Once the card is installed, verify that the OWS is physically connected to the network cable.

During the configuration process, you need to set various addresses.

Before configuring the OWS, make sure to contact your network administrator for the following:

- IP address
- subnet mask address
- gateway address/network router (if applicable)

Note: For private Metasys Networks, see Figure 14 for an example of how to assign the IP and subnet mask addresses.

The gateway/network router address applies only if the network consists of multiple Ethernet segments separated by routers (excluding Metasys Ethernet Router). Therefore, some applications may not require a gateway address. The field appears be blank or have 0.0.0.0., depending on the application.

If you need to move an N1 OWS frequently (as with an N1 laptop), you may need more IP addresses. If the OWS has an IP address on an Ethernet segment, it may be connected at any point on that segment. To connect it on a different segment, however, requires a different IP address compatible with the new segment. Thus, the OWS needs an IP address for each segment to which it may be connected. Make an OWS entry in the GLOBAL.DDL file for every desired connection point (as though an OWS actually existed on each segment). When moving an OWS from segment to segment, compile a NET.DDL file that configures the OWS to match the appropriate OWS definition on the new segment.

If you are running Windows NT software with Metasys Release 9.01 or later, refer to the Windows NT 4.0 Workstation Resource Kit and the Windows NT Server Resource Kit or see your system/network administrator for information about loading. Ethernet Adapter Cards should be installed in a workstation only by a qualified person. Consult your system/network administrator for assistance.

Loading Windows Software

If you already have Microsoft Windows software loaded, you can now verify that the NIC card is in the system. Follow the instructions for loading Windows software on the OWS as described in the Microsoft literature. You must load this software before loading Metasys Person-Machine Interface (PMI) software.
IMPORTANT: Upgrading from Windows 95 software to Windows 98 software is not supported. You must install Windows 98 software as a new install.

After the Windows software installation, you need to verify that your network card is listed in the system and add the Microsoft Protocol TCP/IP.

**Verifying Card is in the System**

With Microsoft Windows software running on the OWS, verify that your card is listed on the system:

1. Right click on the Network Neighborhood icon located on your desktop. A floating drop-down menu appears.
2. Select Properties. The Network dialog box appears (Figure 16).
3. Under the Configuration tab, verify that your network card is listed. If it is not listed, select the Add button and add it at this time.

Note: The current manufacturer of the NU-NET301-0 is Kingston Technology.

**Verifying Card is Programmed Properly**

To verify that the Ethernet Adapter Card is programmed properly:

Note: Steps 1 and 2 apply to the NU-NET301-0 or other NE2000 Compatible Ethernet Adapter Cards only. Non-NE2000 cards may not show the Resources tab.

1. Under the Configuration tab, select the line for the network card (NE2000 compatible).
2. Select the Properties button.
3. Under the Resources tab (Figure 15), verify that the Interrupt Request Queue (IRQ) and I/O address match the Ethernet Adapter Card configuration. You may need to run the software that comes with the Ethernet Adapter Card to determine the settings for which it is configured. To do this, select Start > shut down and restart the PC in MS-DOS mode.

Note: It may be necessary to reconfigure windows and the Ethernet Adapter Card to avoid conflicts with other devices in the OWS.
To add the TCP/IP protocol:

1. While still under the Configurations tab, look under the list of installed network components to verify that you have the TCP/IP protocol installed for your adapter card (Figure 16). Look for a line that contains TCP/IP and name of your adapter card. For example, it could say, TCP/IP and NE2000 Compatible. If it is not there, you must add it.

2. To add the TCP/IP protocol, click the Add... button. The Select Network Component Type dialog box appears.


4. Select Microsoft as the manufacturer and TCP/IP as the Network Protocol type, then OK.
Modifying the TCP/IP Protocol

To modify the TCP/IP protocol:

1. To configure the TCP/IP properties (establish the address of the OWS), select the TCP/IP that is assigned to the Ethernet Adapter Card.

2. Click the Properties button. The TCP/IP Properties dialog box appears.
Figure 17: TCP/IP Properties Dialog Box

Note: You must obtain the IP address, subnet mask address, and gateway/network router address (if applicable) from the network administrator.

3. Under the IP address tab, select Specify an IP address, and enter the IP address of the OWS. The IP address must be defined when the node is added to the Ethernet network.

4. Under the IP address tab, specify the subnet mask.

5. If applicable, enter the gateway address (network router) under the Gateway tab. The network administrator indicates whether the gateway address is applicable.

6. Click the OK button on the TCP/IP Properties dialog box. The changes are automatically saved.

7. Click the OK button on the Network Properties dialog box. The changes are automatically saved.

Note: Windows software may prompt you to reload files. Follow the prompts and load the necessary files. At the end of the installation, your OWS should be configured properly.
8. Reboot the OWS by clicking the Start button and selecting Shut Down from the menu. Choose Restart the Computer? from the Shut Down Windows dialog box and click the Yes button.

9. If you have an existing IP network, use the PING.EXE command to verify that Windows software is working properly. Packet Internet Groper (PING) is a network utility used primarily in TCP/IP networks. PING tests the accessibility of a remote network station by sending it an echo request and waiting for a reply. For more information on PING, see the Windows 98 Resource Kit manual, or the Windows NT Resource Kit manual. Send the PING command (PING xxx.xxx.xxx.xxx; fill in the IP address of the node to which you want to PING) to an existing node on the network to verify the network connection.

**Loading Metasys PMI Software**

Skip this section if the Metasys software is already loaded. Install the Metasys PMI (Release 8.0 or later) software following the instructions in the Operator Workstation Technical Bulletin (LIT-636013). At the end of the installation, exit the Metasys system.

**Modify METASYS.INI File**

You need to add two lines to the METASYS.INI file. For Windows 98 software, the file is located under the Windows directory C:\windows. For Windows NT software, the file is located in the WINNT directory. Under the Metasys bracket [Metasys], type the following:

```plaintext
Network_type=IP
subnet_mask=*  
```

* equals subnet mask number defined by the network administrator and follows the format of the following example:

Subnet_mask=255.255.255.0. For a simple private Metasys Network (no network routers), set subnet_mask=255.255.255.0.

Note: The METASYS.INI entries ARCNETIO, ARCNETMODEL, and ARCNETINT, if they exist, do not have to be deleted. They are ignored.
Every connection to the Ethernet must have a unique subnet address (also referred to as the gate address). To meet that criterion, changes need to be made to the NET.DDL and GLOBAL.DDL files.

**NET.DDL**

Note: In this section on NET.DDL and the section on GLOBAL.DDL, the requirement for uniqueness of subnet addresses and node addresses applies only within an N1 network. If you are configuring Multiple N1 networks using the M5 Workstation Multinetwork feature, you may reuse subnet and node addresses as long as they are not duplicated within the same network. However, IP addresses of nodes directly connected to the Ethernet/IP network may **never** be duplicated, even if the nodes are in different networks.

You must assign a unique subnet address for every node that is directly connected to the Ethernet/IP network. It is recommended that you use the Metasys node address number as the subnet address. If the node is not directly connected to the Ethernet/IP network but is connected via the Ethernet Router, the node’s subnet address would be the same as that of the Ethernet Router.

![Diagram of IP Network Connections Using an Ethernet Router](image)

**Figure 18: IP Network Connections Using an Ethernet Router**
**GLOBAL.DDL**

All *node* numbers, regardless of the network type (Ethernet or ARCNET), must be unique.

Each connection to the IP network must have a unique *subnet* address and a unique IP address. The IP address is defined using the IP subkeyword for Network Controllers (NCs) and PCs. Note that the IP addresses are segmented by commas, not periods.

ARCNET nodes share the subnet address and IP address of their Ethernet Router. This is because they are not directly connected to the Ethernet/IP network.

The following Global DDL file would be used to describe the network shown in Figure 18:

```plaintext
@GLOBAL "EXAMPLE1"
* The following Ethernet devices have unique subnet, node and IP addresses.
PC "OWS1", "Ethernet Workstation", 0, 0
N1Direct 100, 100
IP 192,9,205,40
NC "NCM27", "Ethernet NCM-27", 0, 0, 27, 27, "N2", "", "ENG", 9600
IP 192,9,205,41
* The Ethernet Router has its own unique subnet and IP addresses.
* The following ARCNET devices all share the subnet and IP addresses of the
* Ethernet Router. But they all have unique node addresses.
PC "OWS2", "Arcnet Workstation", 0, 0
N1Direct 28, 22
IP 192,9,205,42
NC "NCM20", "Arcnet NCM-20", 0, 0, 28, 20, "N2", "", "ENG", 9600
IP 192,9,205,42
NC "NCM21", "Arcnet NCM-21", 0, 0, 28, 21, "N2", "", "ENG", 9600
IP 192,9,205,42
. . . (etc.)
```

After checking over the .DDL files, follow the steps below:

1. Compile the NET.DDL and GLOBAL.DDL files and fix any compile errors.
2. Start the Metasys software and verify that it is operating properly.
3. Perform a global download.
Moving ARCNET Nodes to an Ethernet Connection or Changing Gate/Node Addresses of Existing Metasys Nodes

Use this process to modify the Metasys gate or node address of any defined Metasys node. This process defines the steps required to readdress Metasys nodes.

IMPORTANT: Do not skip steps or change the sequence of the steps to correctly change Metasys addresses. Failure to complete the steps in the correct order results in intermittent/unreliable operation of the Metasys Network.

This process does not apply if you are only changing the IP address of an existing Metasys node.

This process assumes required Metasys Ethernet Routers have been configured and connected to the network. A Metasys Ethernet Router is required if the resultant Metasys Network has a mix of Ethernet and ARCNET devices defined within the same Metasys Network. Please refer to the Metasys Ethernet Router Technical Bulletin (LIT-6295035) for information on installing and configuring these devices.

Modify all OWS nodes before any NCM nodes.

OWS

To change an OWS node address:

1. Obtain the IP address for the node, the subnet mask, and network router information.
2. Upload the global data and UNDDL the global database.
3. Rename the global.und file to global.ddl.
4. Edit the global.ddl file to add a new OWS. Do not remove or change the old OWS configuration at this time.

Note: All N1 nodes must have an assigned IP address. Any Metasys node on an ARCNET segment connected to a Metasys Ethernet Router needs to have the IP address of the Metasys Router assigned to it.

5. Edit the global.ddl file to change the report destinations, remove the old OWS device as the destination, and add the new OWS device as the destination.
6. Stop the Metasys software on the OWS. (Exit to the Program Manager.)
7. Compile the global.ddl file.
8. Start the Metasys software on the OWS.
10. Stop the Metasys software on the OWS. (Exit to the Program Manager.)
11. Remove the OWS from the old network connection and connect it to the new network connection.

12. Edit the net.ddl file to change the Metasys gate and node to the new parameters.

13. Compile the net.ddl file.

14. Start the Metasys software on the OWS.

15. Edit the global.ddl file to remove the old OWS definition.

16. Compile and download the global .ddl file.

**NCM**

To change NCM node address:

1. Obtain the IP address for the node, the subnet mask, and network router information.

2. Upload all NCMs and verify you have the current Graphic Programming Language (GPL) or JC-BASIC files available for all NCMs on the archive OWS.

3. Highlight the NCM and select Action > Archive Data to archive data for each NC which stores all trend and totalization data in the PC files.

4. Upload the global data.

5. Stop the Metasys software on the OWS. (Exit to the Program Manager.)

6. UNDDDL the global database and all of the NCM databases.

   (UNDDDL GLOBAL net_name; UNDDDL NC net_name nc_name)

7. Rename all of the new .und files using the .ddl extension.

8. Edit the global.ddl file with the correct information of the NCM being changed.

Note: Any Metasys node on an ARCNET segment connected to a Metasys Ethernet router needs to have the IP address of the Metasys Router assigned to it. Do not download the global file at this time.

9. Start the Metasys software on the OWS.

10. Run WNCSETUP to configure the NOVRAM data of the NCM that is being moved.

11. Select Command > IP address Configuration and add the correct IP address information in the pop-up window.
12. Define an IP address for the network router even if the device does not exist. Use an unused IP address. (Define an IP address for the network router by changing the value of the last octet to an unused host address.)

13. Select Command > NOVRAM and modify the archive device configuration data. If the archive device is an N1 device, remember to set the IP address of the archive device.

14. Select Command > NOVRAM and modify the node’s address configuration.

15. Disconnect the node from the ARCNET network and do not connect it to the Ethernet at this time. This node must be offline to all other NCMs until all of the other NCMs have had a new download.

16. Stop the Metasys software on the OWS. (Exit to the Program Manager.)

17. Compile the new global.ddl file.

18. Start the Metasys software on the OWS.


Note: It may take several minutes for global data to be sent to all of the nodes on the network.

20. Stop the Metasys software on the OWS. (Exit to the Program Manager.)

21. Compile the NCM .ddl files for all of the NCMs in the Metasys Network.

22. Start the Metasys software on the OWS.

23. Download all of the NCMs except the NCM being moved. (Data download is OK.)

24. Disconnect the battery from the moved NCM and cycle power to clear its memory.

25. Reconnect the NCM battery.

26. Connect the moved NCM to the Ethernet network. The NCM should ask for and receive a download from the archive OWS.

---

### Changing a Single Metasys Node IP Address

**OWS**

Follow this process to change the IP address of a single Metasys node. If the Metasys gate or node address is being changed, follow the process described above.

To change an OWS IP address:

1. On an OWS communicating with the rest of the Metasys Network (not the OWS you want to re-address), select Setup > IP address Configuration.
2. Modify the OWS’s IP address and save the changes. This configuration is automatically distributed to all of the other nodes on the network.
3. Go to the OWS with the new address.
4. Select Setup > IP address Configuration.
5. Modify this OWS’s IP address and save the changes.
6. Stop the Metasys software on the OWS. (Exit to the Program Manager.)
7. Change the IP address for the computer.
8. Select Start > Settings > Control Panel.
9. Double-click the Network icon.
10. Select TCP/IP.
11. Click the Properties button.
12. Change the IP address.
13. Verify the subnet mask definition in the METASYS.INI file matches the subnet mask defined in the Windows software network configuration settings.
14. Restart Windows software to implement the new IP address.
15. Start the Metasys software.
16. After normal communications has been restored between OWSs and NCMs, use WNCSETUP to reconfigure the archive configuration of any NCM that uses a re-addressed OWS as its archive.

To change an NCM IP address:

1. Run WNCSETUP to configure the NOVRAM data of the NCM being moved. (If you cannot communicate over the N1 network, connect directly to the NCM.)
2. Modify the IP address configuration to set the new values.
3. Use WNCSETUP to force a reset to the NCM.
4. Using an OWS communicating with the rest of the Metasys Network, select Setup > IP address Configuration.
5. Modify the IP address associated with the NCM being changed and save the changes. This configuration is automatically distributed to all of the other nodes on the network.
The following process applies when users are modifying their network and the changes require re-addressing all of the IP nodes on the network. The correct order of the devices to change depends on the communication between the Metasys nodes. If the devices are still able to communicate, re-address the NCMs before the OWSs. If the network structure has changed and the Metasys nodes are no longer able to communicate, start with the OWS devices. Re-addressed Metasys nodes may not be able to communicate to other nodes until after the network changes have been implemented.

To change the IP address of multiple OWS nodes:

1. Using an OWS communicating with the rest of the Metasys Network (not the OWS you want to re-address), select Setup > IP address Configuration.
2. Modify the OWS’s IP address and save the changes. This configuration is automatically distributed to all of the other nodes on the network.
3. Go to the OWS with the new address.
4. Select Setup > IP address Configuration.
5. Modify this OWS’s IP address and save the changes.
6. Stop the Metasys software on the OWS. (Exit to the Program Manager.)
7. Change the IP address for the computer.
8. Select Start > Settings > Control Panel.
9. Double-click the Network icon.
10. Select TCP/IP.
11. Click the Properties button.
12. Change the IP address.
13. Verify that the subnet mask definition in the METASYS.INI file matches the subnet mask defined in the Windows network configuration settings.
14. Restart Windows software to implement the new IP address.
15. Start the Metasys software.
16. Repeat Steps 4 through 10 for each OWS being re-addressed.
17. After normal communications has been restored between OWSs and NCMs, use WNCSETUP to reconfigure the archive configuration of any NCM that uses a re-addressed OWS as its archive.
NCM without Communication to the OWS

Note: This process requires a laptop computer configured as a direct connect OWS to the NCMs on the network.

To change the IP address of multiple NCM nodes without communication to the OWS:
1. Using an OWS communicating with the rest of the Metasys Network, select Setup > IP address configuration.
2. Modify the OWS’s IP address and save the changes. This configuration is automatically distributed to all of the other nodes on the network.
3. Connect a laptop computer configured as a direct connect OWS to the NCM.
4. Run WNCSETUP to configure the NOVRAM data of the NCM that is being moved.
5. Modify the IP address configuration to set the new values.
6. Use WNCSETUP to force a reset to the NCM.

NCM with Communication to the OWS

To change the IP address of multiple NCM nodes with communication to the OWS:
1. Run WNCSETUP to configure the NOVRAM data of the NCM being moved.
2. Modify the IP address configuration to set the new values.
3. Use WNCSETUP to force a reset to the NCM.
4. Select Setup > IP address Configuration.
5. Modify the IP address associated with this NCM and save the changes. This configuration is automatically distributed to all of the other nodes on the network.

Installing the Hardware at the NCM

Installing the Ethernet Adapter Card

Before installing the Ethernet Adapter Card, make sure the NCM is powered down.
1. Install the Ethernet Adapter Card in the NCM.
2. Attach the transmission media to the Ethernet Adapter Card.

IMPORTANT: Be sure to use an Ethernet Adapter Card instead of an ARCNET card with the Ethernet coax connector. This mistake can go unnoticed at first because both Ethernet and ARCNET use the same type of connector.
Installing the ROM150

If you are upgrading an NU-NCM300-1 (Version B or later) to an NCM350, you need to replace the existing NU-ROM101 Memory Module with an NU-ROM150 Module. Remove the old module and install the new module into the slot parallel to the ISA connector on the NCM. The module only fits with the socket/chip component facing away from the ISA slot. Seat the module carefully before pressing it into position. Detailed installation instructions are included with the NU-NCM300-1 to NU-NCM350-1 Upgrade Kit Installation Sheet (Part No. 24-8617-4).

If you have an NCM350, the NU-ROM150 is already installed.

Configuring the NCMs

The last two stages of setting up the NCMs on the Ethernet network involve configuring and powering up the NCMs. Complete both procedures on one NCM at a time.

If the NCM is already mounted in its permanent location and if the battery is not already connected, connect the battery at this time. If the NCM is being configured at a temporary location, either fully charge the battery (12 hour minimum charging time) or disconnect it.

Note: A partial charge may cause the NCM to malfunction after being downloaded and transported to its permanent location. If you experience this problem, disconnect the battery and cycle power on the NCM. The NCM requests a download. Reconnect the battery after the download has completed.

Use the NCSETUP for Windows program to configure the NCM. To do so, make a direct connection between the NCM and the OWS, and follow the instructions in the NCSETUP for Windows Technical Bulletin (LIT-6360251d). A laptop can also be used, if it is directly connected to the NCM and is loaded with Metasys software.

Directly Connecting the NCM and PC

To make a direct connection between the NCM and the PC, you need to define the PC as an unconfigured OWS. To do so, compile an appropriate @NET DDL file on the PC. If the NC NOVRAM contains a null (empty) network name (as should be the case with an NCM directly from the factory), then you may define any network name in the @NET file and still be able to connect using WNCSETUP. However, if the NCM contains a non-empty network name (e.g., XYZNET), then you must specify XYZNET as the network name in the @NET DDL file.

Note: Failure to specify XYZNET causes a Network Name Invalid message to be displayed in the NC Direct window. If you see this message, shut the Metasys system down and change the network name in the @NET file to match the name displayed in the NC Direct window.
If you are unable to communicate between WNCSETUP and the NC, check to make sure that the network name, Port 3 baud rate, gate address, and node address in the NCMs NOVRAM are set properly. Use the Windows HyperTerminal program to find the NCMs NOVRAM settings.

To view the NCM350 start up information that is generated on Port 4, follow these steps:

1. Shut down the Metasys software to avoid any possible conflict between the Metasys program and HyperTerminal.
2. Connect a null modem serial cable (the same cable used for OWS and NCM direct connection) from COM1 or COM2 (whichever is available) on the PC to Port 4 of the NCM (next to the NT RJ45 Port).
3. Run HYPERTRM.EXE from Windows Start-Run or from Start-Program-Accessories-HyperTerminal.
4. Enter a name for the HyperTerminal file you are creating (e.g., NC9600.HT).
5. Select OK.
6. From the drop-down menu in the Connect Using field, select either Direct to COM1 or Direct to COM2, depending on which PC port is being used. Select OK.
7. From the drop-down menu in the Port Settings field, select 9600 bps. Select OK.
8. Power up the NCM or press the NCMs Reset button if it’s already powered up. If the battery is connected and the NCM is in a downloaded (operational) state, you must press the Reset button.
9. Watch the HyperTerminal screen for information about the Network name, Port 3 baud rate, gate, and node address of the NCM. The IP address of the NC is displayed. A display of network = , indicates an empty (null) network name.
10. Other information displayed may include the Interrupt Number (or IRQ), I/O Port (or I/O Address), and Ethernet Address (or MAC Address).
11. Restart the Metasys system and try connecting with WNCSETUP.

To configure an NCM that has never been configured, select Gate 1, Node 99, and network name WNCSETUP in the NCM Address Entry dialog box. Click OK. The NCM Setup dialog box appears (Figure 19).
NCM Setup

WNCSETUP has detected that this NCM is using the NOVRAM factory defaults. You have the option to setup the NCM for either Arcnet or IP (NCM350 only).

Setup Type

☐ Arcnet  ☑ IP

OK  Cancel

Figure 19: NCM Setup Dialog Box

1. Select IP. Click OK.

2. When the IP address Settings dialog box appears (Figure 20), enter the IP address, subnet mask and network router (Gateway) numbers.

Notes: If there is no network router (because all Metasys nodes are on the same Ethernet segment), a network router address must still be defined. Use the same first three octets as the Metasys IP addresses and use a non-existent IP address for the fourth octet (but do not use 0 or 255 for the fourth octet).

An IP NCM cannot be used as a direct connect NCM if the network card is removed and an IP address is defined. An ARCNET NCM can be used as a direct connect (standalone) NCM if the network card is removed. The IP NCM can be used standalone only if the IP address is left at the 000 defaults and the network card is removed. If an IP address is defined, the NCM fails on startup.

3. If you are configuring multiple N1 networks and need to change the UDP port address, enter the address in the UDP port address field. Click OK.

Note: Obtain these numbers from the network administrator.
Figure 21: NOVRAM View and Modify Dialog Box

**IMPORTANT:** Be sure to fill in all of the values in the NOVRAM dialog box (as well as the applicable fields in the Archive Device Address section) before clicking OK to exit. When you change the gate and node addresses, the NCM reboots. If you have not filled out all of the information, the NCM may not communicate.

4. When the NOVRAM View and Modify dialog box appears (Figure 21).
   a. Set the NCM gate (subnet) and node addresses, the Network name and the Code Download Type.
   b. Select IP or the correct port number and fill in the gate, node, and IP address of the archive device.
c. Click OK.

5. The NCSETUP Windows Application dialog box (Figure 22) appears.

![NCSETUP Windows Application Dialog Box](ncwlnset)

**Figure 22: NCSETUP Windows Application Dialog Box**

If you modified the node address, the NCM reboots. Now go to Step 7 in the next section.

### Configuring a Previously Configured NCM

If the NCM has already been configured in the field, follow the steps below:

1. Start the NCSETUP for Windows program (WNCSETUP).

2. Select the NCM’s Gate and Node address in the NCM Address Entry dialog box and the network name from the NET.DDL file. Click OK. If you do not know the Gate and Node address, refer to the *Directly Connecting the NCM and PC* heading earlier in this section.

3. From the Command menu, select IP address Configuration. The IP Address Settings dialog box appears (Figure 20).

4. Enter the IP address, subnet mask, and network router (Gateway) numbers that you received from the network administrator. Click OK to save the settings and close the dialog box.

5. From the Command menu, select NOVRAM. The NOVRAM View and Modify dialog box (Figure 21) appears.

**IMPORTANT:** Make sure to fill in all of the values in the NOVRAM dialog box (as well as the applicable fields in the Archive Device Address section) before clicking OK to exit. When you change the gate and node addresses, the NCM reboots. If you have not filled out all of the information, the NCM may not communicate.

a. Set the NCM gate (subnet) and node addresses, the Network name and Code Download Type.
b. Select IP or the correct port number and fill in the gate, node, and IP address of the archive device.

**IMPORTANT:** If the archive gate address or IP address is not entered correctly, the NCM may be able to start a download, but it cannot finish one.

c. Fill in any remaining information.

6. Click OK to save. The NCM reboots if the node address was changed.

7. Repeat the procedure on the remaining NCMs.

After performing the configuration on all the NCMs, your NCMs and OWS are now ready to communicate on the IP network.

Note: If you defined your OWS as an unconfigured direct connected OWS during the NCM configuration process, reconfigure it now as an N1 Direct Ethernet OWS.

---

**Powering Up the NCMs**

Before you power up the NCMs, make sure you are running the Metasys software on your OWS. When the NCM is powered up, it should ask for a download at the OWS. As long as all of the files have been compiled for the NCM, the download is completed.

**Configuring Multiple N1 Networks**

The M5 Workstation Multinetwork feature can be used to monitor and control more than one Metasys N1 Ethernet Network simultaneously. See the *Using the Network Map* chapter in the *M5 Workstation User’s Guide (FAN 1153.2)* for a description of the Multinetwork feature. The configuration of multiple N1 networks is similar to the configuration of single Ethernet networks, but there are some special considerations. This section describes the additional steps required to configure a multiple N1 Metasys Ethernet network.

**Upgrading Before Reconfiguring Your Network**

If you are reconfiguring a Metasys Release 9.01 (or earlier) network from a single network configuration to multiple N1s, or if you are combining individual Release 9.01 (or earlier) networks into a multiple N1 configuration, you must upgrade all of the nodes in the existing configurations to Release 10.0 before reconfiguring for multiple N1s. This is because the Enhanced Report/Access Groups feature introduced at Release 10.0 does not allow global data to be modified during the upgrade from Release 9.01 to Release 10.0. Since the Multinetwork system reconfiguration process requires changing globals, it cannot be started until the upgrade to Release 10.0 is done.
As with a single Ethernet N1 network, IP addresses must never be duplicated. All Metasys nodes must have a unique IP address whether they are on the same N1 or different N1s.

**UDP Port Addresses**

Single Metasys Ethernet networks use a default value of 11001 for their UDP port address (UDPPA). The UDPPA is an element of the IP addressing scheme. Therefore, for single networks, the UDPPA does not have to be considered when configuring the network. With the M5 Workstation Multinetwork feature, the UDPPA is used as an additional addressing element to distinguish between the multiple N1 networks. Each N1 network must have a unique UDPPA. Refer to the IP Address Settings dialog box (Figure 20).

For multiple N1s, it is recommended that the network with the most NCs use a UDPPA value of 11001. NCMs automatically configure themselves to use this value, so configuration time is minimized by using other values on N1s with fewer NCMs.

Start numbering other networks in the Multinetwork configuration with 11003 and continue sequentially. **Do not use a UDPPA of 11002.** The value 11002 is used by the Metasys Ethernet Router, and should be avoided even if there are no Metasys Ethernet Routers in the system. The recommended addressing for five N1s would be 11001, 11003, 11004, 11005, 11006.

Check with the Network Administrator or the customer’s Ethernet network support provider. Determine if they know of any reason why any of the UDPPAs you’ve chosen should not be used on their network. It is very unlikely that there will be any objection to using these UDPPAs, but if necessary, you can use any UDPPA from 2050 to 65535 (but not 11002).

**Subnet and Node Addresses**

The rules for assigning subnet addresses (also known as Gate Addresses) and node addresses to Metasys NCMs and Workstations apply on a per network basis. As long as the rules for Subnet/Node addresses are followed on each N1, you need not be concerned about duplication of Subnet/Node addresses between N1s. For example, it is OK for two NCs on different N1s to each have a Subnet/Node Address of 15/15. The fact that they have different network names and use different UDPPAs prevents them from interfering with each other, but they are both able to communicate with the M5 Workstation with the Multinetwork feature.
Configuring an M5 Workstation to communicate with multiple N1s is similar, for example, to configuring a Metasys OWS to communicate with an N1 and a second network directly connected through an NCM. The Workstation must have a database for each network and a separate entry in the Net DDL file for each network.

The M5 Workstation must have the usual set of Global, NC, and Model DDL files for each network. The M5 Workstation must be included in each Global file, since it is a part of each network. There is no change in the format of Global, NC, or Model DDL files.

The Net DDL file must have a NET entry and an N1DIRECT entry for each N1 network. The N1DIRECT keyword now has an optional third parameter, which is used only if multiple N1s are being defined. The third parameter is the UDP port address.

Example:
```
@NET
NET "NETWORK1", "First N1 Network", "PC-240"
N1DIRECT 240, 240, 11001
NET "NETWORK2", "Second N1 Network", "PC-240"
N1DIRECT 240, 240, 11003
NET "NETWORK3", "Third N1 Network", "PC-240"
N1DIRECT 240, 240, 11004
```

An M5 Workstation named PC-240 using subnet/node Address 240/240 would use the example Net DDL file to define three N1 networks using UDPPA 11001, 11003 and 11004.

For an OWS that functions as a node on only one of the N1s (i.e., is not an M5 Workstation with Multinetwork feature talking to other N1s), you must define the UDPPA being used by the network of that OWS. To do this, add the UDPPA parameter to the N1DIRECT keyword line in the OWS Net DDL file.

Example:
```
@NET
NET "NETWORK2", "Second N1 Network", "PC-150"
N1DIRECT 150, 150, 11003
```

An OWS named PC-150 using subnet/node Address 150/150 on NETWORK2 would use the above Net DDL file.

As mentioned above, single Metasys Ethernet networks that are not part of a Multinetwork system use a default UDPPA of 11001. When configuring such a network, it is not necessary to put the third parameter on the N1DIRECT line of an OWS. The OWS uses 11001 by default. Remember that this is only true for N1s that are not part of a Multinetwork system. For Multinetwork system configurations, any OWS on one of the component networks must have a UDPPA specified on the N1DIRECT keyword line.
An NCM350 cannot belong to more than one Metasys N1 network. The network to which it belongs is defined in the NCM via the Network Name and the UDPPA. Both of these values are defined using WNCSETUP. The Network Name is defined as usual via the NOVRAM View and Modify dialog box (Figure 21). The UDPPA is defined in the IP Address Settings dialog box (Figure 20).

If the NCM is on a network that uses UDPPA 11001, you do not need to configure the UDPPA. The NCM uses 11001 by default.

If the NCM is on a network using a UDPPA other than 11001, you must configure the UDPPA. This requires that the flash memory code in the NCM be at Revision 8.02 or higher. You can see the Revision number by selecting the Information command in WNCSETUP. If the EPROM Release is reported as anything earlier than Release 8.02, you need to download the Release 8.02 flash code to the NCM. See the NCSETUP for Windows Technical Bulletin (LIT-6360251d) for instructions on how to download the flash code. Select filename FLASH802.FLH.

After upgrading the flash to Revision 8.02, use the IP address Settings dialog box to set the UDPPA to the desired value. When the NCM is restarted, it communicates on the network that uses the new UDPPA.

In a multi-network system configuration, one of the N1s may contain a segment of ARCNET nodes communicating with Metasys Ethernet nodes via a Metasys Ethernet Router or a Contemporary Control Systems, Inc. (CCSI) Metasys gateway.

If you are using the Metasys Ethernet Router, the Metasys Ethernet software must be at Version 2.0 or above. The ROUTER.CFG file must contain the “/U nnnnn” switch, which specifies the UDPPA of the network to which the Ethernet Router (and the ARCNET nodes) belong. Replace the nnnnn with the desired UDP port address.

If you are using CCSI embedded Metasys Ethernet Router, all versions of the CCSI device support multiple N1 Network features. The Switches, Subnets, Addresses text window must contain the “/U nnnnn” switch, which specifies the UDPPA of the network to which the Ethernet Router (and the ARCNET nodes) belong. Replace the nnnnn with the desired UDP port address.

If the router’s network is to be accessible from an M5 Workstation with Multinet network feature, add the subnet (gate) number and IP address of the M5 Workstation to the router configuration file. When the router is restarted, the ARCNET nodes communicates on the network that uses the UDPPA specified in the router configuration file.
**Example 1:**
*Reconfiguring a Single Ethernet N1 as Two or More Individual Networks*

This example assumes:

- There is an existing Ethernet N1 with network name NET1.
- The network has ten NCMs with node numbers from 1 to 10, and three PCs with node numbers from 101 to 103.
- All NCMs are archived at PC103.
- You want to split the network into two N1s called NET1 and NET2. (This example can be extrapolated to more than two networks - the procedure is similar).
- NET1 contains NCMs 1-7 and PC101.
- NET2 contains NCMs 8-10 and PC102.
- PC103 is an M5 Workstation with the Multinetwork feature and remains the archive for all NCMs.
- Even though Subnet and Node addresses may be duplicated between N1 networks, all Subnet/Node addresses remain unchanged to minimize disruption to the system and the time required to complete the job.
- NET1 (the original network name) remains the name of the larger of the two resultant networks to minimize disruption to the system and the time required to complete the job. The reconfiguration process goes more smoothly if you minimize the renaming of system components. If necessary, rename components as a separate project after the network has been successfully split up.
- NET1 continues to use UDP port address 11001 (the default address used by all single Ethernet N1s). UDP port address 11003 is used for NET2.

To reconfigure a single Ethernet N1 as two or more individual networks, so each network is accessible from an M5 Workstation with the Multinetwork feature.

1. Upgrade to Release 10.01 or later.
2. Upgrade the NCM350s on NET2 to EPROM Release 8.02.
3. Update the DDL files offline. The Net files look like this:

   **PC101 Net file:**
   
   NET "NET1", "Network 1", "PC101"
   N1DIRECT 101, 101, 11001

   **PC102 Net file:**
   
   NET "NET2", "Network 2", "PC102"
   N1DIRECT 102, 102, 11003

   **PC103 Net file:**
   
   NET "NET1", "Network 1", "PC103"
   N1DIRECT 103, 103, 11001
   NET "NET2", "Network 2", "PC103"
   N1DIRECT 103, 103, 11003
4. Create separate NET1 and NET2 global files. You can do this by starting with two copies of the NET1 global file and removing the NCMs and OWSs that are not part of the network, or by cutting NET2 devices from the NET1 global file and pasting them to a NET2 global file. All global data items must be split into their associated global data file; for example, System Names, PC Groups, Report Access Groups. The Multinet Workstation (PC103) must appear in both global files. Be sure that the @GLOBAL line contains the appropriate network name.

   PC101 appears within the global file for NET1 only.
   PC102 appears within the global file for NET2 only.
   PC103 appears within both global files, since it is part of both networks.

5. Shut down the Metasys software on PC103.

6. On PC103, compile the new Net file with both networks defined.

7. On PC103, compile the NET2 global file. Do not compile the new NET1 global yet. We want the NET2 devices to remain in the NET1 database for now.

8. Start the Metasys software on PC103.

9. Log onto NET2 using the Metasys password. Add a Level 1 password that also exists on the NET1 network. This allows switching between network maps without logging off and on. At this point, PC103 is talking to the NET1 network (including NET2 devices) on UDPPA 11001 and is trying to talk to the NET2 network using UDPPA 11003.

10. Bring up WNCSETUP on PC103. Verify the network name box contains NET1.

11. Connect to NC8.

12. Using WNCSETUP, change NC8’s Network Name to NET2 and its UDP port address to 11003.

13. From WNCSETUP, do a RESET (not a Reload) of NC8. If you do a Reload, an empty database is downloaded to the NCM, because it has not yet been uploaded to the NET2 network directory.

14. After a minute or two (when NC8 has completed resetting), select NC8 under the DEVICES system of the NET2 network map and select Action > Diagnostic > OK. The NC8 error log appears.

15. View the DEVICES system summary. Refresh the Devices summary until you see that NC8 is online.
16. Upload NC8 to PC103. This stores all the NC data (including Trend, Totalization, GPL, etc.) under the NET2 directory where it must be.

17. Do a Data Only download to NC8. This is necessary to make the new network name take effect in the NCM. Wait for the download to complete and the NCM to come online.

18. Repeat Steps 10 through 17 for NC9 and NC10.


20. Compile the Net, then the Global and start up the workstation.

21. Do a global download.

22. Repeat Steps 19 through 21 for PC101.

23. At PC103, shut down the Metasys system and compile the new NET1 global file. Do not restart the Metasys software.

24. If you want to copy all of the passwords from NET1 to NET2, copy the files PASSWD10.DOB, PASSWD10.NOB, and PASOID10.NOB from the %FMSDATA%\NET1.DOB directory to the %FMSDATA%\NET2.DOB directory.

25. At PC103, restart the Metasys system, log on to NET2, and do a global download.

26. Switch to the NET1 network map. (Use the M5 Change Network toolbar button to switch between network maps. Alternative methods for switching maps are the View-Change Network menu item on the network map or the Action-Activate Network menu item on the Network Summary.)

27. Do a global download on NET1.

28. Test PC103 to verify that both networks are accessible, and everything is working correctly.

This completes the example reconfiguration. There are some follow-up activities that may be necessary, depending upon your network configuration:

- If there are any other PCs that need to be configured as M5 Multinetwork workstations, upgrade them by creating a Net file similar to the one for PC103, but with appropriate PC Name, Gate, and Node addresses. Copy the Net file and both global files to the workstation. Compile the Net and global files, start Metasys software, and do a global download on both networks.
- PC Groups—If there are non-Multinetwork workstations on the original network that have not been reconfigured, they may now display obsolete PC groups on their network map because their global data contains PC groups for objects that have been moved to another network. Copy the global DDL file for the appropriate network from the M5 Multinet workstation to the non-Multinet workstation, compile it, and do a global download.

- To effectively organize your GPL strategy (source) files, you may wish to move the NET2 GPL strategy files from their location under NET1 to their new location under NET2.

**Example 2: Configuring Separate Networks as Multinetworks**

This example assumes:

- There are two existing (separate) Ethernet N1s with network name NET1 and NET2. Assume NET1 is the larger of the two. NET1 continues to use the default UDP port address 11001. NET2 (also presently using 11001) switches to 11003.

- The NCMs on each network continue to be archived at their present archive OWS assignments.

- An M5 Workstation on NET1 becomes a Multinetwork workstation capable of monitoring and controlling both networks.

If you have separate Ethernet N1 networks (electrically isolated from each other) and want to have the ability to monitor and control both networks from a single workstation, follow this procedure:

1. From any workstation on NET2, connect to an NCM on NET2.
2. Using WNCSETUP, change the NCM’s UDP port address to 11003.
3. From WNCSETUP, do a reset (not a Reload) of the NCM.
4. Repeat Steps 1 through 3 for the remaining NCMs on NET2. At this point, all of the NCMs are offline to NET2 workstations, but they are running standalone and controlling their trunks.
5. At any OWS on NET2, shut down the Metasys software and add the UDP port address 11003 as the third parameter on the Net file N1DIRECT line. For example:

   **PC102 Net file:**

   ```
   NET "NET2", "Network 2", "PC102"
   N1DIRECT 102, 102, 11003
   ```

6. Compile the Net file and restart the OWS.
7. View a summary of the DEVICES system of the NET2 network map. All NCMs should be online (provided they’ve had a few minutes to come back online after having been Reset).
8. Repeat Steps 5 through 7 for any other OWSs on NET2.
9. Physically connect the Ethernet media of the two networks.
10. At the M5 Workstation on NET1, shut down the Metasys software. Change the Net file to define both networks. For example:

**M5 Net file:**

```
NET "NET1", "Network 1", "M5OWS"
N1DIRECT 105, 105, 11001
NET "NET2", "Network 2", "M5OWS"
N1DIRECT 105, 105, 11003
```

11. Compile the NET file and restart the M5 Workstation. You should be able to monitor and control both networks.

12. Test the M5 Workstation to verify that both networks are accessible, and everything is working correctly.
Troubleshooting Procedures

This section highlights troubleshooting tools that you can use to solve communication problems across the N1 LAN. If you are not receiving any communication from a particular node, Windows software provides a number of programs that can help you isolate either a node or network fault.

If nodes are going offline frequently, the Windows tools does not help. In this situation, a network sniffer can be used to isolate the problem. You may also use a network analyzer, such as LANAlyzer by Novell®. It may help locate and correct problems faster than traditional methods. Contact your network administrator for help.

If ARCNET and Ethernet coexist on the same network, troubleshoot by dividing the network into sections. Figure 18 shows a mixed ARCNET and Ethernet network.

Using Windows Tools

The following tools can be used with the Microsoft Windows software operating system when:

- a node goes offline
- you added a new node to the IP network and it does not communicate

These programs help you determine how much of the network is functioning or not functioning. The programs are loaded onto your PC when you add the Microsoft protocol TCP/IP. More information is available in the Windows help files. Below are brief descriptions.

WINIPCFG.EXE

This command displays the IP configuration of the Operator Workstation.

Note: This command is called IPCONFIG.EXE in Windows NT and Windows 2000 software.

PING.EXE

The PING command verifies that messages can be sent and received over the IP network. The command format is:

```
PING xxx.xxx.xxx.xxx
```

where “xxx.xxx.xxx.xxx” is the Internet address of a computer on the IP network. Other OWSs and TCP/IP compatible computer systems send back a response. Failures are caused by cable problems, device driver configuration problems, or computers being offline. The display indicates if the PING was successful along with some Ethernet statistics. If there appears to be intermittent IP network failures, put PING into a continuous test mode using the following command:

```
PING -t xxx.xxx.xxx.xxx
```
In this mode, the PING program continually asks for a response from the remote computer system. If there are any IP network communications errors, they are noted. If the IP network is running properly, no errors are recorded. After testing the IP network in this mode for several minutes, type Ctrl C.

**TRACERT.EXE**

This command allows you to view the route a packet takes across the network, as well as displaying all the IP addresses. See the Help files for information on using this command.

**ARP.EXE**

This command views the Address Resolution Protocol (ARP) table, which is used to direct messages between IP network nodes. See the help files for information on using this command.

---

**Debugging OWS and NCM Failures**

**OWS Error Log**

The error log contains the following message:

Source node = local node  
File: c:\fms\bin\n1ethern.exe  
Module: n1ethern  
Line 606

Cause: METASYS.INI contains the line AcceptAllIP=Yes.

Solution: This line is reserved for Metasys Application Enabler (MAE) workstations only. Remove from all PMI workstations.

**Single IP Address Does Not Respond**

At a workstation that is communicating with other nodes, use the PING command to communicate to a known address on the IP network in the same network segment. Follow the paths of either two outcomes:

- **If your communication worked**, there is a problem with the node.  
  To troubleshoot, check the problem node’s configuration. For an NCM, direct connect an OWS and view the NC Error Logs. If you need to extract the NCM configuration, use HyperTerminal to connect to Port 4. As it initializes, the NCM downloads some of its configuration information into the terminal program. For an OWS, look at OWS Error Logs and PING other nodes. If you are unable to find the problem, contact Field Support Services in Milwaukee.

- **If your communication did not work**, there is a problem with the segment. You need to isolate the exact point of breakage and find out how much of the network is functioning. To do so, PING other nodes on the same segment. PING the Ethernet Router if one exists between the node you’re on and the failed node. Finally, use TRACERT.EXE.
Note: These next two sections cover situations where you have ARCNET devices being accessed through a Metasys Ethernet Router from an Ethernet OWS or Ethernet NCM.

If any other node on the same ARCNET segment responds normally, the Metasys Ethernet Router is not at fault. The problem could be caused by a Metasys device failure or an ARCNET cable problem. Check the device for any malfunctions, and use troubleshooting information from the *N1 ARCNET Local Area Network Technical Bulletin (LIT-636017)* to isolate the problem. To determine whether it is a network or node problem, use the Metasys diagnostic screen to verify. Try to read the N1 status of the failing nodes:

- From an ARCNET node: If you are able to communicate with other ARCNET nodes except for the failing node, then network communication is OK. Problem is isolated to that node.
- If you are able to communicate with other ARCNET nodes except for the failing node, then the Ethernet Router, IP network, and ARCNET network are OK. The problem is isolated to that node.

All the Devices on One ARCNET Segment Do Not Respond

If you are having a communication problem between the IP network and the ARCNET network, try the steps below.

1. If other ARCNET segments are working, the problem is isolated to the failing segment. Use PING to find out if the suspect router responds to Ethernet messages.
2. If the router responds, look at the ARCNET cable and Metasys equipment.
3. If the router does not respond, look at the router and the Ethernet network.

Troubleshooting a Single NCM Failure

When a single NCM (or a few sporadic NCMs) fail to communicate on the N1, it is most likely a commissioning problem with the NCMs, rather than a network problem. If all the NCMs on a given segment fail to communicate or have sporadic communication failures, the problem is more likely a network problem, and the routers should be investigated. Refer to the Troubleshooting section of the *Metasys Ethernet Router Technical Bulletin (LIT-6295035)* located in the *Metasys Connectivity Technical Manual (FAN 629.5)*.

If the N2 communication on the suspected NCM and the rest of the network are operating properly, network problems may be a result of the hardware configuration or incompatible hardware and driver.
A single NCM failure may be caused by the following:

- incompatible NCM and/or ROM
- improperly seated ROM150
- incompatible Ethernet Adapter Card and ROM150 Packet Driver
- use of ARCNET board and/or coax rather than Ethernet Adapter Card/coax
- insufficient Ethernet stub length
- replication of or incorrect IP address

**Troubleshooting an NCM**

If you have configured a new NCM on the IP network and it is not communicating, troubleshoot using the steps below.

1. Verify there are no errors in the NC Error Log. (Use a direct connect OWS to read the log.)

2. Verify that the IP configuration is correct, including the IP address, subnet mask, and router address.

3. Verify that the NCM’s archive device is properly configured in the NCM’s NOVRAM.

4. Verify that the Metasys GLOBAL.DDL is configured properly and downloaded.

5. Check the METASYS.INI file and make sure the changes for the IP network type and subnet address have been made.

6. Verify the NCM configuration is correct by the following:
   a. Connect a VT100 terminal or PC running HyperTerminal to Port 4 of the NCM through a null modem serial cable (i.e., same cable used to connect to Port 3) and cycle power. A DOS startup screen appears.
   b. Verify the network name, subnet address, IP address, and the output from the packet driver (program that drives the Ethernet card). The output from the packet driver indicates that it is talking to the network card. For an example of the packet driver startup information, see *Checking for Proper Ethernet Adapter Card Setup* later in this section.
   c. Verify that the packet driver loads and that there are no error messages.

7. Determine if the NCM responds to PING commands. If not, that could mean there is an IP stack problem or a NCM NOVRAM configuration problem.
8. Install the NCM’s Ethernet Adapter Card in a PC, and run the manufacturer’s diagnostic software that came with the card. This establishes whether the adapter card is working properly.

If you are unable to bring the NCM online after verifying the above information, contact Field Support Services in Milwaukee.

When many nodes fail, the problems tend to be systemic rather than related to a particular node. Call the network administrator to help resolve these problems. Typically, the network administrator has special network hardware, such as a LAN sniffer, that can quickly isolate the problem. If Simple Network Management Protocol (SNMP) is also employed on the network, use it to isolate problems.

The troubleshooting tips below are only general guidelines, since there is such a variety of IP network cards available. If the OWS is having problems communicating:

1. Verify that the IP stack is loaded and configured.
2. Use the Network Properties dialog box in Windows software to verify that the driver for your network card is bound to the IP stack.
3. Ensure the IP stack runs, or if not, troubleshoot accordingly.
   a. Verify that Windows software is talking to the Ethernet Adapter Card. To do so:
      - Click the right mouse button once on the My Computer icon.
      - Select Properties. Under the Device Manager tab, make sure the network card icon does not have a ! or X over it. Those symbols indicate a configuration problem between Windows software and the Ethernet Adapter Card.
      - If there is an ! or X over the icon, contact the Ethernet Adapter Card manufacturer to correct the configuration problem.
   b. Run the diagnostics program that comes with the network card to verify that the card is functioning properly.
   c. Use the PING.EXE command to try to communicate with other nodes on the network.
4. Verify that the METASYS.INI file contains the following lines:
   Network_Type=IP
   Subnet_Mask= (correct address)
5. Check the Metasys OWS error log.
The following is a list of other situations that may occur and what to do about them:

- If a particular NCM is not communicating over the N1 LAN, try bypassing the N1 by connecting to it directly. If the NCM can communicate, you know that the N1 cables or connections are faulty.

- If you are experiencing download problems over the N1, recompile the DDL software to see if that resolves the problems.

- If database definitions have changed, inspect the changes to ensure that referenced points haven’t been erased.

- If you are running the Slide Show (from Micrografx® Designer™) on your workstation, too short of an interval between slides causes the workstation to go offline. To eliminate this problem, temporarily extend the interval time to 200 seconds.

The network problems that may occur are most likely caused by the following:

- improper Ethernet Adapter Card setup
- improper network termination
- incorrect address assignments of the NCM, IP address, and/or subnet mask on the NCM NOVRAM.
- loose coax cable connectors
- malfunctioning hubs and repeaters
- not enough hard disk space on the Operator Workstation
- improper Ethernet Adapter Card for installed packet driver
- improper OWS setup of Windows Ethernet driver
The Ethernet Adapter Card must be configured for IRQ 10 and I/O address space of hexadecimal 320. Connect a VT100 Terminal (or equivalent) to Port 4 on the NCM. Cycle power to the NCM (force a reload). The packet driver start up information, which is outlined below, is displayed on the terminal:

**DOS Initialization**

Datalight miniBIOS (R) v6 (Revision 2.0)  
Copyright (c) 1989-1994 Datalight, Inc.  
Tested RAM 128K

**Driver List**

A: miniCMD>rem Allied Telesyn AT2000U+ Ethernet card  
A: miniCMD>rem Allied Telesyn packet driver  
A: miniCMD>rem Card is automatically configured as IRQ 10, I/O port 320h

**Adapter Card Configuration Tool**

A: miniCMD>diag /I10 /P320  
Ethernet Adapter Diagnostics Program V2.22a

**Flash Disk Files**

A: miniCMD>dir  
OUTADR.EXE  
COMMAND.COM  
AUTOEXEC.BAT  
ETHPK.COM  
DIAG.EXE

**NCM Configuration Information**

A: miniCMD>outadr  
network name = jchdqtrs, port 3 baud rate = 19200  
gate = 92, node = 92  
IP address = 159.222.20.99
**Packet Driver Output**

A: miniCMD>ethpk 0x60 10 0x320
E2k/E1k/PCMCIA Ethernet Packet Driver (940921) Ver 1.07
R.P.T. Intergroups International Ltd. Copyright 1994
Packet interrupt number 0x60 (96)
Interrupt number 0xA (10)
I/O port 0x320 (800)
Using 80[123]86 I/O instructions
Using 16 bits slot
My Ethernet address is 00:40:95:9A:34:AC
A: miniCMD>
A: miniCMD>

**Checking for Proper Termination (Thin Coax Only)**

To verify proper cable termination, complete the following steps:

1. Check all N1 LAN wiring, the placement of 50 ohm terminators, and the value of the terminators. All N1 LAN wiring must be electrically continuous (unbroken) from end to end. This requires that each N1 connection has a T-connector installed with two N1 cables connected, or one cable and one 50 ohm terminator cap connected.

2. Check to make sure only one 50 ohm terminator cap is installed at the ends of each bus segment. The components that can accept terminators include the N1 LAN coax connector on the NCM, the Operator Workstation N1 LAN board, and the active links.

3. You must have a 50 ohm terminator installed on the hubs. However, do not place terminators on nodes that are in the middle of the N1.

4. Place the 50 ohm terminators on end-of-line devices at all times. If the cable is disconnected from an end-of-line device, a 50 ohm terminator must be placed on the end of the cable.

Note: If this is not done, reflections from the unconnected end of the cable may disrupt communications.

Be sure to use only 50 ohm terminators on the N1 LAN. You can measure the resistance of a terminator with an ohmmeter. Place one lead on the male pin and the other lead to the body of the terminator. The reading should be 50 ohm.
Note: A properly connected N1 LAN has a resistance between 23 and 27 ohm as measured at any point on the LAN when all coax connectors to ISA Ethernet Adapter Cards, hubs, and repeaters are disconnected and both terminators are attached. To measure resistance:

1. Disconnect all coax connectors from ISA Ethernet Adapter Cards, hubs, and repeaters.
2. Insert a T-connector anywhere on the N1 LAN.
3. Connect it to an ohmmeter.
4. Measure between the center conductor and the metal housing.

Incorrect address assignments can cause communication problems. An incorrect address is either not properly defined or defined twice for two different nodes (i.e., duplicate address).

Ensure that each NCM is correctly addressed on the OWS by checking the NCM focus window. The NCM address must match the NCM address listed in the workstation and the NCM archive address must point to the appropriate archive PC.

A coax connector that is not properly crimped and installed can cause communication problems. An ohmmeter is required to check for bad connectors. To check for a short:

1. Measure the resistance across the cable at the connector.
2. Check for an open by shorting one end of the cable and measuring the resistance again.
3. Bend the cable back and forth at the connector when making these measurements, because sometimes the connection is marginal and gives proper readings in some positions.
4. If defective, cut off the old coax connector and install a new one.

Make sure you are using an Ethernet Adapter Card instead of an ARCNET card with the Ethernet coax connector. This mistake can go unnoticed at first, because both Ethernet and ARCNET may use the same type of connector.

The hubs and repeaters feature LEDs that indicate their status. When these devices are working properly, the LEDs are on. For detailed troubleshooting information, refer to the manufacturer’s literature.
When available space on the hard disk of the OWS is reduced to a few megabytes (2-3 MB), the workstation goes offline and is no longer able to communicate with other nodes. It is good practice to leave at least 10 MB of hard disk space available at all times. You can have the Metasys system automatically warn you when your hard drive space runs low in the METASYS.INI file on the Operator Workstation. (Refer to the README.OWS file for details.)

Refer to Step 6 under the heading *Troubleshooting an NCM* located earlier in this section.

Refer to *Verifying Card is in the System* under *Configuring the OWS, Loading Windows Software*, which is located in the *Setting Up the Metasys Network on Ethernet* section of this document.
## Appendix A: Glossary

| **10Base2** | A part of the IEEE 802.3 specification that uses coax cable, also called thin wire Ethernet. The “10” in this term indicates 10 Mbps baseband data transmission, and the “2” indicates that segments can be a maximum of 185 meters (607 feet) in length. |
| **10Base5** | A part of the IEEE 802.3 specification that uses thick coaxial cable, also called thick wire Ethernet. The “10” in this term indicates 10 Mbps baseband data transmission, and the “5” indicates that segments can be a maximum of 500 meters (1640 feet) in length. |
| **10BaseT** | A part of the IEEE 802.3 specification that uses twisted pair cable, also called twisted pair Ethernet. The “10” in this term indicates 10 Mbps baseband data transmission, and the “T” indicates twisted pair wiring. Segments can be a maximum of 100 meters (330 feet) in length. |
| **ACK** | Acknowledge or acknowledgment (ACK). Name given to network traffic that acts as an acknowledgment or the field in a network transmission unit that indicates it is an acknowledgment. A response from a host indicating that a previous transmission has been received. |
| **address** | A number or group of numbers that uniquely identifies a node on the network. |
| **API** | Application Programming Interface. A programming language and messaging format that allows one application program to interact with the functions of other programs, communications systems, or hardware drivers. |
| **application layer** | A logical entity of the OSI model, the top of the seven layer structure. |
| **ARCNET** | Attached Resource Computer Network (ARCNET) is a low-cost token passing network system developed by Datapoint in 1977. A local area network, it transmits digital signals one message at a time (i.e., baseband) and its worst case response time in transmissions between nodes can be predicted (i.e., deterministic). ARCNET communicates at a rate of 2.5 megabits per second. |
| **ARP** | Address Resolution Protocol (ARP). On Ethernet TCP/IP networks, each node is identified by a physical network address and an IP address. ARP determines which physical network address corresponds to a given IP address. |
| **asynchronous communications** | A form of communications in which information is transmitted as a serial stream of bits. Each character is represented as a string of bits separated by a “start bit” and a “stop bit.” No clock or other timing mechanism is used. |
| **ATM** | Asynchronous Transfer Mode (ATM). A general purpose switching method for carrying voice, data, image, and video. |
| **AUI cable** | Attachment Unit Interface (AUI) cable. An IEEE term for four twisted pair wire cable that connects an Ethernet device (e.g., adapter card) to an external Ethernet transceiver. Also called transceiver or drop cable. |
| **backbone network** | A segment of network that links several individual workgroup or department LANs together in a single building. It is also used to link several building LANs together in a campus environment. |
| **Balun** | BALanced UNbalanced. A device that allows interconnection between a balanced transmission line (e.g., twisted pair cable) and an unbalanced line (e.g., coax cable). |
| **bandwidth** | The data carrying capacity of a transmission line or channel, or the rate of information exchange between two data systems. |
| **baseband** | A transmission method that uses cable to transmit a single signal. On a baseband network, such as Ethernet, only one device can transmit at a time. Devices on a baseband network are permitted to use all the available bandwidth for transmission, and the signals they transmit do not need to be multiplexed onto a carrier frequency. |
| **baud** | The measure of signal changes per second in a device such as a modem. |
| **BNC connector** | A type of connector used to connect thin coax Ethernet and ARCNET cables. |
| **bridge** | A device that provides a communications pathway between two or more LAN segments (or rings). A bridge forwards frames between segments based on MAC (OSI Data Link Layer) addresses of the frames. |
**broadband**  
A method of conveying information over a local area network in which many channels can be carried simultaneously—voice, video, or data. The digital signals from the sending devices are modulated at different frequencies, allowing for multiple networks on a single cable.

**broadband services**  
Broadband services, sometimes called “fast packets” services, provide data rates at T1 (1.544 Mbps) or higher.

**broadcast**  
In shared medium networks, such as Ethernet, token ring, and FDDI, each frame is simultaneously broadcast to all stations on the network segment or ring.

**broadcast address**  
A unique address that tells all stations on the network or network segment to read a particular frame or packet.

**brouter**  
Bridge router. A hybrid device that represents the merging of bridge and router technologies.

**burst**  
A continuous transfer of data without interruption from one device to another.

**bus topology**  
A linear topology where nodes are daisy-chained together.

**carrier**  
A company that provides telephone and data communications services within a Local Access and Transport Area (LATA) or between LATAs in the United States. Primary inter-LATA carriers are AT&T, MCI, and Sprint.

**carrier services**  
Telephone and data communication services provided by carriers for a fee to users. Wide Area Networks (WANs) are often built by interconnecting LANs using carrier services.

**CAT5**  
Category 5 cable. CAT5 cable supports 10 MHz data applications.

**CCITT**  
Consultative Committee for International Telegraphy and Telephony (CCITT).

**collision**  
When two stations try to send packets at the same time, a collision occurs. Ethernet network collisions are considered normal events. The CSMA/CD access method is designed to quickly restore the network to normal activity after a collision occurs.
Contention occurs on shared medium networks that use a contention based network access method such as Ethernet. It occurs when two or more stations attempt to access the medium at the same time. Too much contention can reduce throughput.

**Carrier Sense Multiple Access/Collision Detect (CSMA/CD).** CSMA provides a means for all hosts on a baseband network to be able to access the network medium in turn; CD is a method each host uses to determine when another host is attempting to use the network.

A system configured with no other applications coexisting on the LAN (i.e., a network running only Metasys software). A dedicated network is characterized by high reliability.

Part of the TCP/IP protocol stack, DNS maps network addresses to logical names. Other TCP/IP protocols, such as Telnet and FTP, use DNS to resolve logical names to network addresses.

A software module that controls an input/output port or external device. Typically, a “driver” refers to software resident in one system, which is used to communicate to another system.

Non-volatile, electrically programmable, read-only memory that can be erased with electrical signals.

A baseband network medium that communicates at 10 megabits per second and uses the CSMA/CD access method.

A standard that defines the header information of an Ethernet message. This standard is based on Release for Comment (RFC) 894.

A local area network technology that transmits information between computers at 100 Mbps via twisted pair and fiber optic media. 100BaseT and 100VG-AnyLAN are two LAN standards that can carry Ethernet frames at 100 Mbps. The 100VG-AnyLAN system is standardized under a new number: IEEE802.12. Currently, Fast Ethernet is not as widely used as the 10 Mbps, twisted pair version of Ethernet. Fast Ethernet is typically used as a building backbone. The Metasys system is not supported on Fast Ethernet.

Fiber Distribution Data Interface (FDDI). A high-speed fiber optics LAN standard that uses token passing with a data transmission rate of 155 megabits per second.
**FTP**  
File Transfer Protocol (FTP). One of the protocols associated with the TCP/IP stack. FTP allows a TCP/IP “client” to download a file from a TCP/IP host over a LAN or WAN.

**Flash memory**  
Non-volatile memory that can be updated with software.

**frame**  
Sometimes referred to as “packet.” A method of packaging data or sets of bits for transmission.

**frame relay**  
A variable length frame based wide area transmission that runs at between 56 Kbps and 1.544 Mbps (T1) speeds and allows for a fully meshed network with multiple sites. Frame relay services are designed primarily for LAN-to-LAN communication.

**frame Type 802**  
An IEEE 802.2 standard that defines the header information of an Ethernet message.

**gateway**  
A multi-homed host used to route network traffic from one network to another, also used to pass network traffic from one protocol to another.

**hop**  
A transmission of a data packet through a router in a network of interconnected segments of subnetworks. A measure of a path through an internetwork is the hop count (the number of routers the packet passes through enroute to its destination).

**hub**  
A central location for the attachment of wires from the network stations. A 10BaseT Ethernet hub is essentially a multi-port repeater in which each port connects a single attached station. The term “hub” can refer to many types of wiring concentrators, including standalone, stackable, and chassis-based hubs for Ethernet, token ring, and FDDI networking.

**ICMP**  
Internet Control Message Protocol (ICMP). Part of the TCP/IP protocol stack, ICMP is the protocol used by IP routers and hosts to send control and error messages between themselves.

**IEEE**  
Institute of Electrical and Electronics Engineers. The IEEE is a professional society that develops and publishes standards for the electrical engineering and computer industry.
<table>
<thead>
<tr>
<th><strong>IEEE 802.3</strong></th>
<th>An Ethernet specification commonly defined by IEEE that covers rules for configuring Ethernet LANs, the types of media that can be used, and how the elements of the network should interact. The physical and transport layers of an 802.3 network use CSMA/CD on a bus topology and are identical to Ethernet V2.0.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>intelligent hub</strong></td>
<td>Intelligent hubs are wiring concentrators that can be monitored and managed by network operators.</td>
</tr>
<tr>
<td><strong>Internet</strong></td>
<td>The Internet refers to the World Wide Web of interconnected computers and computer networks that links schools, businesses, government agencies, research institutions, and other organizations. The Internet uses TCP/IP protocols.</td>
</tr>
<tr>
<td><strong>internet</strong></td>
<td>This term with a lower case “I” refers to any internetwork of LANs linked by routers and/or bridges; in other words, one building’s network of networks.</td>
</tr>
<tr>
<td><strong>interoperability</strong></td>
<td>The term generally refers to different computer systems, networks, operating systems, and applications that share information and work together. Levels of interoperability range from basic data exchange to cooperative computing.</td>
</tr>
<tr>
<td><strong>IP</strong></td>
<td>Internet Protocol is a Network Layer protocol that is used by IP routers to route data packets in an internetwork of LANs.</td>
</tr>
<tr>
<td><strong>IP address</strong></td>
<td>Internet Protocol (IP) address. A 32-bit network address that uniquely locates a host or network within its internetwork. The IP address is a 4-octet address that uniquely defines the node on the network. Each octet is in the range of 0 to 255; for example 122.51.35.113. These addresses, when registered, are unique worldwide. This assures connectivity compatibility if the network ever is connected on a public WAN such as the Internet.</td>
</tr>
<tr>
<td><strong>ISO</strong></td>
<td>International Standards Organization.</td>
</tr>
<tr>
<td><strong>ISDN</strong></td>
<td>Integrated Services Digital Network (ISDN). ISDN integrates data, voice, and video signals onto a digital telephone line.</td>
</tr>
<tr>
<td><strong>ITU</strong></td>
<td>International Telecommunications Union. A United Nations treaty organization based in Geneva, Switzerland.</td>
</tr>
</tbody>
</table>
**Jabber**
Random transmission of data onto a network cable by a faulty transceiver that can corrupt the transmission of other stations. Jabber control is a function built into transceivers to inhibit this activity.

**LAN**
Local Area Network. A LAN is a high-speed communications system designed to link computers and other data processing devices together within a small geographic area such as a workgroup, department, or a single floor of a multi-story building.

**LAN topologies**
Cable layouts for local area networks; for example bus, ring, and star. These layouts display the nodes, routers, gateways, bridges, and media being used.

**link**
A connection between two network entities.

**local network traffic**
Nodes on the same segment of a network. Packets that are sent locally do not need to traverse the network.

**M5 Workstation**
A Metasys OWS with added N1 OPC Server and Client capability.

**M5 Multinetwork Workstation**
A Metasys M5 Workstation utilizing the M5 Multinetwork feature. Communicates with multiple Metasys N1 Ethernet Networks. Retains the ability to communicate with Metasys direct connect and dialup networks.

**MAC**
Media Access Control (MAC). A sublayer of the Data Link Layer, which puts packets from higher protocol layers into the proper network frame format, handles error detection, and most importantly, implements the network access control method.

**MAC address**
Media Access Control (MAC) address. Each network adapter has a unique six byte address that is “burned in” to firmware on the card. The first three bytes denote the card manufacturer and the last three bytes are unique among all of the cards sold by that manufacturer. The MAC address is used to deliver MAC frames to stations attached to a shared medium LAN such as Ethernet.

**MAN**
Metropolitan Area Network (MAN). A backbone network that spans a metropolitan area and is provided as a public utility within that area.

**manageable hub**
Another term for intelligent hubs. Each of the ports on a managed hub can be configured, monitored, and enabled or disabled by a network operator from a hub management console.
<table>
<thead>
<tr>
<th><strong>media (network or transmission)</strong></th>
<th>The method used to propagate a signal over a network; the media used to transmit a signal.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>medium</strong></td>
<td>Any material or substance that can be, or is, used for the propagation of signals, usually in the form of modulated radio, light, or acoustic waves, from one point to another, such as optical fiber, cable, wire, dielectric slab, wave, air, or free space.</td>
</tr>
<tr>
<td><strong>message header</strong></td>
<td>The beginning of a message that contains required control and addressing information.</td>
</tr>
<tr>
<td><strong>multi-homed host</strong></td>
<td>A device containing addresses for multiple networks. May also contain multiple protocols.</td>
</tr>
<tr>
<td><strong>NAK</strong></td>
<td>Unacknowledge or unacknowledgment. The field in a network transmission unit that indicates the message has not been acknowledged. This indicates that the destination node cannot accept a message for which it has been addressed.</td>
</tr>
<tr>
<td><strong>NCSETUP for Windows Software (WNCSETUP)</strong></td>
<td>Metasys utility that runs under Windows software and sets up and modifies an NCM’s non-volatile RAM (NOVRAM) and flash configuration. This tool is necessary for commissioning an NCM.</td>
</tr>
<tr>
<td><strong>NDIS</strong></td>
<td>Network Driver Interface Specification (NDIS). Designed by Microsoft to give network users access to multiple higher layer protocols from a single network adapter card driver.</td>
</tr>
<tr>
<td><strong>network administrator</strong></td>
<td>The individual responsible for managing and maintaining the network.</td>
</tr>
<tr>
<td><strong>NIC</strong></td>
<td>The Network Interface Card (NIC) is used to make the physical connection to the network. The NIC is placed inside the computer and connected to the network cable. Once the physical connection is in place, it is up to the network software to manage communications between stations on the network. The NIC then transmits the packet onto the LAN. The packet is transmitted as a stream of data bits represented by changes in electrical signals. The packet is seen by all stations as it travels along the shared cable. The NIC in each station checks the destination address in the packet header to determine if the packet is addressed to it.</td>
</tr>
<tr>
<td><strong>node</strong></td>
<td>Any device connected to a network. A Metasys node is an OWS or NCM.</td>
</tr>
<tr>
<td><strong>NOVRAM</strong></td>
<td>Non-volatile RAM, or random access memory. NOVRAM retains the contents of its memory when power is turned off.</td>
</tr>
</tbody>
</table>
octet

A sequence of eight bits.

OSI

Open Systems Interconnection (OSI). A collection of international standards, controlled by the International Standards Organization (ISO). These standards define the protocols that enable interconnection and interoperation between systems connected to a local or remote network. OSI is described as the OSI reference model.

OSI reference model

The ISO structure for the ideal network architecture. The model is divided into seven layers of functionality: physical, data link, network, transport, session, presentation, and application layers.

packet

The envelope used by nodes to send messages to one another.

packet driver

The software that works with the hardware to send and receive Ethernet packets on a network. This driver provides a standard software interface between an application and a NIC. This standard was developed by FTP Corporation.

patch panel

Usually installed in a wiring closet, a patch panel is used to make network cabling easier. A patch panel contains rows of modular jacks that can be used to terminate cable runs from network stations to hub ports. A network administrator can easily connect, move, test, and disconnect network devices by plugging and unplugging patch panel connections.

peer-to-peer network

Peer-to-peer is a communication method that eliminates the need for a “master” polling computer or other central weak link. With a peer-to-peer network, nodes communicate equally to each other across the network. Each node stores its own programming, while it passes and receives information down the line.

PING

Packet Internet Groper. A network application that uses UDP to verify reachability of another host on the internetwork. This utility is used to assure a node can receive and transmit Ethernet messages.

PPP

Point-to-Point Protocol (PPP). PPP is a serial communication protocol designed to support transmission of packets over synchronous and asynchronous links. PPP can encapsulate different Network Layer protocols. PPP automatically assigns IP addresses, so that remote computers can connect into an IP network at any time.

protocol

A set of rules that specifies the behavior of interacting systems, particularly as characterized by the rules used to exchange information.
**protocol stack**
In most local and wide area networks, communications protocols are implemented in layers. The protocols at one layer use the services of the layer below it and provide services to the layers above it. Together they form a protocol stack, a set of protocols designed to work effectively together. There are several commonly used protocol stacks, including the ISO Open Systems Interconnect (OSI) stack, TCP/IP and their associated protocols, and Novell NetWare® stack.

**repeater**
A device used to extend the length, topology, or interconnectivity of the physical network medium beyond the limits imposed by a single segment.

**RG-58 coaxial cable**
Two conductor (copper center and braid connector) shielded coaxial cable used primarily in 10Base2 Ethernet LANs.

**RG-62 coaxial cable**
Two conductor (copper center and braid connector) shielded coaxial cable used primarily in ARCNET LANs.

**ring topology**
A closed loop network.

**RIP**
Routing Information Protocol (RIP). One of several path selection algorithms available for use by routers.

**RJ45**
An 8-pin modular connector used on unshielded twisted pair cable primarily for 10BaseT Ethernet and token ring LANs, also used for some multi-line phones.

**ROM150**
The NU-ROM150 Memory Module is included in the NCM350 and is required to upgrade a NCM300-1 for Ethernet support. The ROM150 contains a Flash memory chip, which can be downloaded with new programs if necessary. The memory includes the packet driver to support the AT-2000U Plus Ethernet Adapter Card.

**router**
Routers are internetworking devices. They are more complex and expensive than bridges. They use network layer protocol information with each packet to route communications from one LAN to another.

**router address**
This address is used in conjunction with the destination IP address and the subnet mask. Whenever the destination of the packet is not on the local network, the packet is routed to the router. This device has tables defined within it that deliver the packet to the appropriate destination.

**RTOS**
Realtime Operating System (RTOS). A proprietary realtime operating system created by Johnson Controls for Metasys products.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>segment</td>
<td>The network transmission unit used by TCP, also may refer to a single LAN that connects to an organizational internetwork.</td>
</tr>
<tr>
<td>shared network</td>
<td>A network configured with other applications on the LAN. Application support can be limited by bandwidth availability.</td>
</tr>
<tr>
<td>SIMM</td>
<td>Single Inline Memory Module (SIMM). A hardware packaging scheme that allows high density memory chips to be packaged onto a small board.</td>
</tr>
<tr>
<td>SLIP</td>
<td>Serial Line Internet Protocol. SLIP is a serial communication protocol designed to support transmission of IP packets over synchronous and asynchronous links such as dial-up telephone lines.</td>
</tr>
<tr>
<td>SMA</td>
<td>The fiber optic connector developed and manufactured by Allied Signal Amphenol Products Division.</td>
</tr>
<tr>
<td>SMTP</td>
<td>Simple Mail Transfer Protocol (SMTP). SMTP is a message transfer protocol used in conjunction with the TCP/IP protocols on the Internet and other TCP/IP networks. It provides a store-and-forward function between the mail systems of networked computers.</td>
</tr>
<tr>
<td>ST</td>
<td>Straight Tip (ST) connector. A fiber optic connector used to join single fibers together at interconnects or to connect them to fiber optic cross connects.</td>
</tr>
<tr>
<td>stackable hubs</td>
<td>Stackable hubs look and act like standalone hubs except that several of them can be stacked or connected together, usually by short lengths of cable. When they are linked together, they can be managed as a single unit.</td>
</tr>
<tr>
<td>star topology</td>
<td>A network topology where the central control point is connected individually to all stations.</td>
</tr>
<tr>
<td>StarLAN 10</td>
<td>A local area network that connects nodes to hubs in a star wired bus configuration using unshielded, twisted pair wire. The network communicates at ten megabits per second.</td>
</tr>
</tbody>
</table>
Shielded Twisted Pair (STP) cable, which has shielding around it to provide more protection against Electromagnetic Interference (EMI).

A physical or logical subdivision of the TCP/IP network. The subnet is also part of the Metasys address field. It is sometimes referred to as the “gate.”

A method of representing a portion of the IP network address that is devoted to subnet addresses. This mask is used in conjunction with the IP address to determine how packets traverse the network. An IP address can be divided into two parts: network address and host address. The subnet mask defines the dividing line between the two parts.

Switches link several separate LANs and provide packet filtering between them. A LAN switch is a device with multiple ports, each of which can support an entire Ethernet or token ring LAN.

T1 and T3 are synchronous transmission services for delivering digital data and voice over wide area networks. “T-carrier” services use time division multiplexing to multiplex multiple voice and data channels over a single T1 or T3 circuit. The transmission rate for T1 is 1.544 Mbps, which can support 24 64 Kbps channels (64 Kbps is the standard bandwidth requirement for one full duplex, uncompressed voice circuit). T3 runs at 44.736 Mbps and supports 28 T1 circuits.

Transmission Control Protocol/Internet Protocol (TCP/IP). The name usually given to the collection of network protocols used by the Internet protocol suite. The name is taken from the two primary network protocols of the Internet protocol suite.

The measurement of the amount of data to be transferred through a communications device or system, usually expressed in bits or bytes per second.

The process of passing a token to each node that allows the node to talk on the network.

A local area network architecture that uses a “token,” passed from one network node to the next, to grant permission to transmit on the network. The token ring daisy chains nodes together to form a ring topology.
transceiver

A transceiver, also called a media attachment unit, provides the interface between the adapter card and the network medium. It translates signals from the adapter to signal levels required by the medium.

transparent bridge

Transparent bridging is used to link Ethernet LAN segments. Transparent bridges use the destination MAC address of the frame to determine whether to forward it to one or more of the bridge’s other ports. The term transparent comes from the fact that no modification of the MAC frame is required to bridge frames between LAN segments.

UDP

User Datagram Protocol (UDP). A connectionless transport layer network protocol for the exchange of requests and replies between networked hosts but that does not by itself guarantee delivery of a message.

UDP header

Header information in a UDP data packet.

UDP Port Address

The User Datagram Protocol (UDP) port address. The Metasys network uses the UDP port address to communicate with all other nodes. The M5 Multinet feature uses multiple UDP port addresses to isolate and distinguish between Metasys N1 Ethernet Networks.

UTP

Unshielded Twisted Pair (UTP) wire; 4-wire 24/26 AWG with a RJ-45 telephone type connector. The type of wire used on 10BaseT networks.

VOP

Velocity of Propagation (VOP). The speed that signals travel down a cable. It is measured as a percentage of the speed of light in a vacuum.

WAN

Wide Area Network (WAN). Generally refers to a network that connects users and systems across large distances and usually employs telephone or other long range communications medium.

X.25

An ITU (CCITT) protocol used in wide area packet switched data networks. It uses an x.21 physical layer and Link Access Procedure-Balanced (LAPB) link access layer protocol. X.25 also defines the packet layer. This is not supported by the Metasys system.
Definitions for the designated terms were compiled from the following documents:


For further information on networks, connectivity and the like, refer to:


Several Ethernet sites and newsgroups exist on the World Wide Web. Many of these contain quick tutorials, frequently asked questions, and vendor information. Ethernet sites you may want to try are:

- http://www.blackbox.com/
- http://www.alliedtelesyn.com/
- http://www.ctron.com/
- http://www.usenet.com/
Appendix B: Ordering Information

Table 10: Johnson Controls Code Numbers

<table>
<thead>
<tr>
<th>Description</th>
<th>Code Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCM350 Network Control Module</td>
<td>NU-NCM350-8</td>
</tr>
<tr>
<td>ROM150 Memory Module</td>
<td>NU-ROM150-1</td>
</tr>
<tr>
<td>NCM361 Network Control Module (Europe only)</td>
<td>NU-NET361-8 (Essen Factory)</td>
</tr>
</tbody>
</table>

Table 11: Order Information for Johnson Controls Repair Parts

<table>
<thead>
<tr>
<th>Description</th>
<th>Order Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCM350 Network Control Module Repair</td>
<td>NU-NCM350-708</td>
</tr>
</tbody>
</table>

The following supplier models are provided for your convenience; there may be other equivalent models not included here.

Table 12: Ethernet Adapter Cards and Fiber Optic Transceivers and Cable

<table>
<thead>
<tr>
<th>Description</th>
<th>Part Number/Manufacturer</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethernet Network Card</td>
<td>NU-NET301-0</td>
<td>To contact Johnson Controls IT Acquisition Services, refer to the Computer Price List on The Advisor: The Advisor &gt; Business Support &gt; Strategic Procurement &gt; IT Acquisition Services &gt; Computer Price List</td>
</tr>
<tr>
<td>Fiber Optic Transceivers</td>
<td>AT-MX40F/ST, AT-MX50F/SM, AT-MX55F/SC</td>
<td>Allied Telesyn International Corp. 960 Stewart Drive, Suite B Sunnyvale, CA 94085 1-800-424-4284</td>
</tr>
<tr>
<td>ST Connector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMA Connector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC Connector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transceiver Cable</td>
<td>DCA1320</td>
<td></td>
</tr>
<tr>
<td>3 foot PVC Office Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCSI Embedded Metasys Ethernet Router (optional—used to connect ARCNET to Ethernet)</td>
<td>JC-EP-RG</td>
<td>Contemporary Control Systems, Inc. 2431 Curtiss Street Downers Grove, IL 60515 1-630-963-7070 <a href="http://www.ccontrols.com">www.ccontrols.com</a></td>
</tr>
</tbody>
</table>


Notes