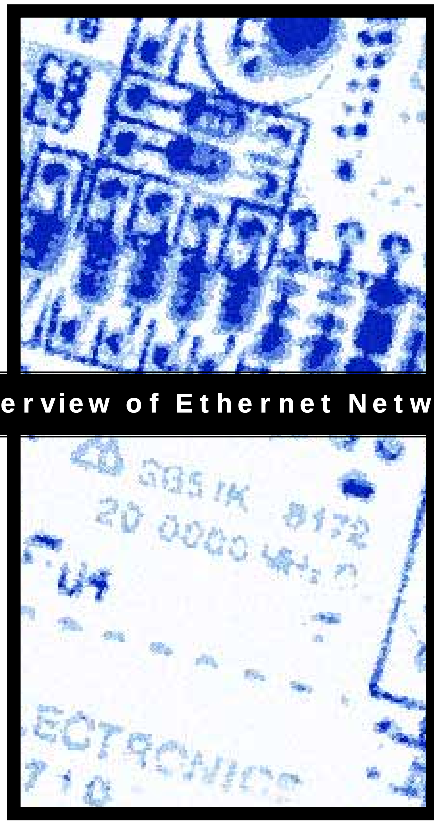
# An Overview of Ethernet Networking



# AN OVERVIEW OF ETHERNET NETWORKING

## INTRODUCTION

A computer network is a collection of computers and networking devices connected to share information and resources. Ranging from a couple of computers linked together to share peripherals to thousands of computers located around the world exchanging information, computer networks have become vital to the success of most businesses and organizations today.

The purpose of this document is to take some of the confusion out of networking. It is intended to educate the novice network manager as well as offer solutions to the more experienced network manager or systems integrator. It is divided into four parts:



- Part 1 provides a general introduction to networking basics.
- Part 2 delves into more specifics about Ethernet networking with an in-depth look at the Ethernet hub.
- Part 3 provides an overview of Asanté's Ethernet hub solutions.
- Part 4 provides examples of various network configurations.

If you need advice on building your Ethernet network, feel free to call Asanté at:

| | |
|---|---|
| phone: | **800-662-9686** |
| | 408-435-0706 |
| fax: | 408-432-6018 |
| Internet: | ales@asante.com |
| AppleLink: | asante.sales |
| Web Site: | http://www.asante.com |

We will answer your questions and/or direct you to a local systems integrator.

# • • • THE BASICS OF NETWORKING

**The physical layout of a network is its topology. Three prevalent types of network topologies are bus, star and ring. The topology of your network often depends on the media access method(s) it uses and type(s) of cables that are installed. Whereas small networks with clusters of network devices tend to employ only one topology, large networks that span a wide physical area or several floors of a building may use a combination.**

## N E T W O R K   T O P O L O G I E S

### Bus Topology

The bus topology (figure 1) consists of a continuous main cable, terminated at both ends. Each node attaches directly to this common cable. Signals travel in both directions along the cable from the sending computer. A distinct advantage of a bus topology is its low cost of set-up. All your computing devices connect to a common cable. No hub is required. However, if one node in the chain has a fault, the entire network goes down. This unstructured wiring scheme, meaning without a central point of concentration, often makes it difficult to troubleshoot.

### Star Topology

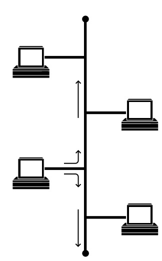
A star topology (figure 2), on the other hand, is relatively easy to troubleshoot due to its structured wiring scheme. With this topology, each node has a dedicated set of wires connecting it to a central network hub. If one of these connections fails, it will not usually affect the other nodes. And, since all traffic passes through the hub, the hub becomes a central point for isolating network problems and gathering network statistics. Some hubs even have LEDs and management software for simplifying troubleshooting.

### Ring Topology

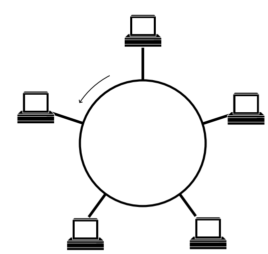
A ring topology (figure 3) is a logically closed loop of cable—a ring. Data packets, or groups of bits, travel in one direction around the ring from one network device to the next. Each network device acts as a repeater, meaning it regenerates the signal. If one device fails the entire network goes down. This disadvantage gave rise to a hybrid topology referred to as the star-wired ring.

### Star-Wired Ring Topology

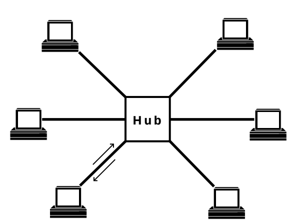
The star-wired ring (figure 4) has essentially replaced the ring topology in practical use. Networks based on star-wired ring topologies have nodes radiating from a wiring center, or hub. The hub acts as a logical ring with packets traveling in sequence from port to port. Just as in a star topology, if one node fails, the network will continue to operate.



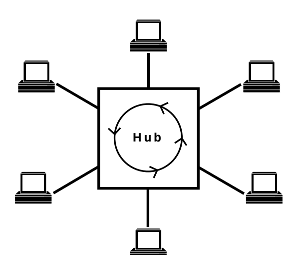
▶ Figure 1 - Bus Topology



▶ Figure 3 - Ring Topology




▶ Figure 2 - Star Topology




▶ Figure 4 - Star-Wired Ring Topology

# TRANSMISSION MEDIA (CABLING)

**Cables are what physically connect network devices together. They conduct information from one computing device to another.**

## Twisted-Pair Cable

Twisted-pair cable consists of two insulated wires that are twisted around each other. It is available in two varieties, shielded (figure 5) and unshielded (figure 6). Unshielded twisted-pair (UTP) is similar to the wire used for telephone systems. Because UTP is inexpensive and easy to install, it has become a very popular network media in the last few years.

UTP cabling is available in 3 types: Category 3 supports 10MHz, Category 4 supports 16 - 20MHz, and Category 5 supports 100MHz.

## Coaxial Cable

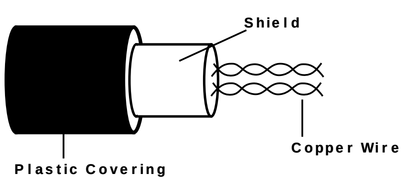
Coaxial cable (figure 7) includes a copper wire surrounded by insulation, a secondary conductor that acts as a ground, and a plastic outside covering. Because of its two layers of shielding, coaxial cable is relatively immune to electronic noise, such as motors, and can thus be extended long distances without degradation of performance. This makes it a good choice for running the lengths of  buildings as a network backbone.

Coaxial cable is available in a variety of sizes. LANs primarily use two sizes which are commonly referred to as thick and thin. Thick coaxial cable was a popular backbone cable in the 1970s and 1980s. It can extend longer distances than thin, but is harder to work with and more expensive. Today, thin is the most common type of coaxial cable used. (It looks similar to the cable for your cable TV connection.)

## Fiber-Optic Cable

Fiber-optic cable (figure 8) is constructed of glass and plastic. It transmits information via photons, or light. Because fiber-optic cable is much more immune to electronic interference than the other media types, it is ideal for environments with a lot of noise. And since fiber-optic cable can extend further than coaxial and twisted-pair, more and more organizations are installing it as a backbone in large facilities and between buildings. Nevertheless, the cost of installing and maintaining fiber-optic cable remains high, keeping it from making its way to the desktop computer.

Figure 5 - Shielded Twisted Pair



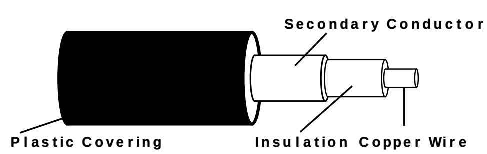
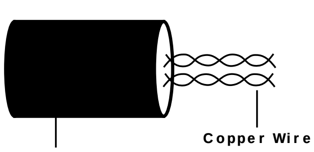




Figure 7 - Coaxial Cable

Figure 6 - Unshielded Twisted-Pair



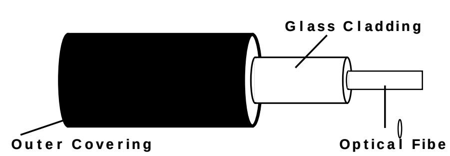




Figure 8 - Fiber Optic Cable

# NETWORK COMPONENTS

**The components that make up a network are the hardware and software. Whether a network employs all of the components listed below depends primarily on its size and purpose.**

## Network Adapters

The network adapter is the physical link to the network. Typically, it is a card that slides into an expansion slot of your computing device (computer, printer, server, etc.) to provide a connector to the appropriate network cable type. In some cases, network adapters are external (e.g. Asanté Desktop EN/SC for connecting slotless Macintoshes to an Ethernet network) and some are built onto the motherboard (e.g. built-in Ethernet on the Zenith Data Systems portables).

## File Server and Client/Server

The file server is a high-speed, large capacity computer that acts as a central repository of data and/or application programs for the network. In most file server network environments the server does not perform computations. Instead, it sends data to the workstations upon request, and the workstations perform computations by executing programs.

In Client/Server networks, on the other hand, computations are performed at the server and only necessary data is sent to the workstations.

## Network Operating System

The network operating system (NOS) is a supervisory software program. It controls how the network operates by defining who can use the network and how information and resources (printers, modems, etc.) are shared among users. Without a NOS, your computing devices would remain isolated even when physically linked. NOSs run on top of and depend on the computer's operating system. Common NOSs in-clude Novell NetWare, Microsoft LAN Manager, Microsoft Windows for Work-groups, AppleShare and Banyan Vines.

## Hubs/Concentrators/ Repeaters

A hub, concentrator or repeater is found in star and star-wired ring topology networks. It serves as a central meeting place for cables from computers, servers and peripherals. The hub can be a non-intelligent repeater which re-times and re-amplifies signals. The hub can also offer intelligence, via network management software, to monitor and control network traffic. (For more information on network hubs, refer to Part 2 of this document.)

## Bridges

As the number of nodes and amount of traffic on a network increase significantly, data transfer can become slow and inefficient. Bridges divide these overburdened networks into smaller segments to ensure better traffic control and more efficient use of bandwidth. The segments remain part of a single logical network. Connecting similar networks, bridges have access to physical address information only. They replicate and transmit all packets destined for another segment using the same protocol. Bridges require minimal configuration and are best suited to small, less complex networks. (For more information on bridging, refer to the side bar entitled "What is a Bridge?" in Part 2 of this document.)

## Ethernet Switch

An Ethernet switch is a multi-port bridge that provides a dedicated 10 Mbps Ethernet connection for each port. With switches, multiple 10 Mbps connections can be established simultaneously, thus increasing the aggregate bandwidth of the network.

## Routers

Routers, like bridges, also link two or more physically separate network segments, but the network segments remain logically separate and can function as independent networks.

Routers have access to more network level knowledge than is available to bridges. Information on source addresses, destination addresses, path distances, and in some cases, segment bandwidth and segment status are contained in the router's routing table. With this knowledge, routers can perform advanced functions such as calculating the shortest, most economical path between source and destination nodes.

Routers are generally more expensive than bridges and require more expertise and management. They are best suited for large, enterprise networks where traffic must be segmented and isolated based on protocol.

### Gateways

Gateways are highly complex devices used to link two or more networks with different network architectures. For example, a gateway would provide conversion and translation from Ethernet to IBM's SNA architecture when a PC workstation on a LAN wants access to an IBM mainframe.

## The OSI Model

A network is a collection of interconnected computing devices. In order for the network to function, these devices (both hardware and software) must work together and communicate in a common language. Communication would be a simple task if a single manufacturer created all of the components of a network. As you well know, however, thousands of companies offer networking hardware and software products. How, then, does this communication remain consistent?

The answer is the OSI (Open System Interconnection) Model developed by the ISO (International Standards Organization) in the late 1970s. This model defines a universal standard for designing data communication protocols so that equipment from different manufacturers can communicate. It divides data communication into 7 functions, or layers, which describe how information flows from one end-user to another. Each layer prepares information for and communicates with the one above or below (figure 9). The higher layers of the model are software oriented whereas the lower layers are more hardware dependent. Most network equipment manufacturers now build their networking products in compliance with the OSI Model.

| | | |
|---|---|---|
| **Layer 7:** | **Application Layer** | interfaces with the software running on the computer. |
| **Layer 6:** | **Presentation Layer** | translates data to a language the user can understand. |
| **Layer 5:** | **Session Layer** | synchronizes communication between computers; controls when users can send and receive data. |
| **Layer 4:** | **Transport Layer** | makes sure data makes it intact to its destination; asks for retransmission if data not intact. |
| **Layer 3:** | **Network Layer** | translates addresses and routes data from one node to another. |
| **Layer 2:** | **Data Link Layer** | consists of two sublayers:<br>**Logical Link Control** (LLC) defines how data is transferred over the cable and provides data link service to the higher layers.<br>**Medium Access Control** (MAC) defines who can use the network when multiple computers are trying to access it simultaneously (i.e. Token passing, Ethernet [CSMA/CD]). |
| **Layer 1:** | **Physical Layer** | deals with the properties of the cable and connectors; responsible for transmitting data across a cable. |

**Figure 9 - The OSI Model**

*Communication between one computer and another begins at the Application Layer. Data travels down through the layers, across the cable to its destination, and up through the layers to the receiving computer's application.*

# M E D I A   A C C E S S   M E T H O D S

**A media access method defines how computing devices access the network cable and send data. Where Ethernet, Token Ring and LocalTalk media access methods are used primarily for connecting desktop machines (computers, printers, etc.) to the network; Fast Ethernet, FDDI, TP-PMD, and ATM are used primarily for high-speed backbones, high-speed network access (e.g. file servers) and very high-speed workgroup applications.**

**Media Access Methods**

| | Topology | Most Common Cables Used | Transmission Rate |
|---|---|---|---|
| **Ethernet** | Bus or star | Twisted-pair, coaxial, fiber | 10 Mbps (Mega bits per second) |
| **Token Ring** | Star-wired ring | Twisted-pair, fiber | 4 and 16 Mbps |
| **LocalTalk** | Bus | Twisted-pair | 230 Kbps (Kilo bits per second) |
| **Fast Ethernet** | Star | Twisted-pair | 100 Mbps |
| **FDDI** | Dual ring<br>Star-wired ring | Fiber | 100 Mbps |
| **TP-PMD** | Star-wired ring | Twisted-pair | 100 Mbps |
| **ATM** | Star | Fiber, twisted-pair | 155+ Mbps |

*Media access methods can be differentiated by the topologies they employ, the cables they employ and the rates at which they transmit data.*

## Ethernet

In the 1970s, Digital Equipment Corporation (DEC), Intel and Xerox established the first specifications for Ethernet (DIX Ethernet). In the early 1980s, the Institute of Electrical and Electronics Engineers (IEEE)—a neutral standards making body comprised of representatives from a variety of computer companies—published Project 802. Project 802 instituted many of the Ethernet standards used today.

Ethernet has emerged over the last several years as the most popular media access method. Since this non-proprietary industry standard has been embraced by network equipment manufacturers everywhere, Ethernet network components from multiple vendors will work together and communicate effortlessly.

You will find the Ethernet media access method in very small and very large network environments. Set up in star and/or bus configurations, Ethernet networks transmit data over UTP, thin-coaxial, thick-coaxial and fiber-optic cables at rates of 10 or 100 Mbps.

On an Ethernet network, each computer listens to the cable before sending data packets. If the cable is clear, the computer will transmit. If not, the computer waits and tries again. If two or more computers decide to transmit simultaneously, a collision occurs. A collision is when the signals from two devices run into each other. Each device will then attempt to resend its data when the line is silent. This process is referred to as CSMA/CD (Carrier Sense Multiple Access with Collision Detection) media access control mechanism. With the CSMA/CD control mechanism, it is normal to have some collisions, as long as the number remains low compared to the number of signals that transmit successfully.

### What are 10Base-5, 10Base-2, 10Base-T, 100Base-T & 10Base-F?

In Project 802, the IEEE established specifications for cables carrying Ethernet signals. 10BASE-5, 10BASE-2, 10BASE-T, 100BASE-T and 10BASE-F refer to thick coaxial, thin coaxial, unshielded twisted-pair and fiber-optic cables respectively.

The "10" and "100"refer to the Ethernet transmission speed - 10 and 100 Mbps. The "Base" refers to baseband (single communications channel on each cable). Originally, the last character referred to the maximum cable distance in hundreds of meters. This naming convention changed, however, with the introduction of 10Base-T and 10BASE-F. In these instances, the T and F refer to the cable types (twisted-pair and fiber-optic).

Originally, Ethernet fiber cable was called FOIRL (Fiber-Optic Inter Repeater Link). This standard was limited to 500 meters, but was redefined to 10BASE-F and 1000 meters.

"Link Integrity" and "Auto-partition" are part of the 10Base-T specification. This means that all network equipment that claims compliance with 10Base-T must support Link Integrity and Auto-partition.

Link Integrity is concerned with the condition of the cable between the network adapter and the hub. If the cable is broken, the hub will automatically disconnect that port. Auto-partitioning occurs when an Ethernet hub port experiences more than 31 collisions in a row. When this happens, the hub will turn off that port, essentially isolating the problem.

## Token Ring

The Token Ring media access method was developed by IBM Corporation in the mid 1980s and subsequently defined by the IEEE in Project 802. Since Token Ring is IBM's preferred method for networking, it is found primarily in large IBM mini and mainframe installations.

Token Ring networks use a star-wired ring topology over shielded and unshielded twisted-pair wiring. A central hub (referred to as a MAU) is at the center of the ring. Two versions of Token Ring are available. One transfers data at 4 Mbps and the other transfers data at 16 Mbps.

**Ethernet Cable Specifications**

| | Media Type | Max. Segment Length | Max. # Nodes/Segment |
|---|---|---|---|
| **10Base-5** | Thick coaxial | 500 meters | 100 |
| **10Base-2** | RG58 (thin) coaxial | 185 meters | 30 |
| **10Base-T** | UTP | 100 meters | 1 per link |
| **10Base-F** | Fiber-optic | 2 kilometers | 1 per link |
| **100Base-T** | UTP, STP fiber-optic | 100 and 400 meters | 1 per link |

Token Ring networks use a token passing process to circulate packets around the ring. An electronic token travels from station to station in a single logical direction. If the token is free, a station can attach data to the token, change the token's status to busy, and then send the token on to the next station. Each consecutive station then checks the destination address of the data to see if it should process the data. It then passes the token on. When the station that originated the token receives it back, it removes the data from the token and changes the token status back to free.

### LocalTalk

LocalTalk is a proprietary media access method built into Apple Macintosh computers and LaserWriter printers. With LocalTalk, computers are set up in a bus configuration using both shielded and unshielded twisted-pair wiring. Data transmits at only 230 Kbps, or about 1/40 the rate of Ethernet. For this reason, many companies are upgrading their LocalTalk Macintosh installations to Ethernet in order to better handle large file transfers.

LocalTalk uses the CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance) media access control mechanism for transmitting data. CSMA/CA is similar to CSMA/CD in that a computer listens to the cable before transmitting data, awaiting a clear line. If the computer does not detect a signal, it will send out its own signal saying, "I'm about to transmit so stay off the line."

### Fast Ethernet (100Base-T)

Fast Ethernet refers to 100 Mbps Ethernet. 100Base-T Fast Ethernet uses the same Carrier Sense, Multiple Access/Collision Detection (CSMA/CD) media-access method developed for “standard” Ethernet. What 100Base-T does differently than 10Base-T is to increase the speed of the MAC layer by a factor of 10.

100Base-T Fast Ethernet supports virtually any 10Base-T cabling plant, whether it’s fiber, two- or four-pair UTP or two-pair STP. 100Base-T4 supports Category 3 UTP cable, using four pairs of wire. The disadvantage with 100Base-T4 is using Category 3 cable which is a low grade cable and offers poor transmission performance at frequencies above 25MHz where high-speed transmission occurs.

100Base-TX supports Category 5 cable, using two pairs of wire. Category 5 wire offers stringent electrical characteristics which make it ideal for high-speed data transmission. 100Base-FX supports fiber-optic cable, and similar to 100Base-TX, both offer symmetrical links which may be configured to run in full-duplex mode. This capability permits 100Base-T networks to extend beyond their initial topology limitations.

For a more in-depth discussion of Fast Ethernet, please refer to Asanté’s Fast Ethernet Primer.

### FDDI/TP-PMD

The Fiber Distributed Data Interface (FDDI), which delivers standards-based 100 Mbps performance over fiber-optic cable, is widely deployed in backbone installations. Its copper-based derivative, TP-PMD (Twisted-Pair Physical Medium Dependent), uses a variation of the FDDI MAC to provide 100 Mbps over copper cabling.

FDDI/TP-PMD’s primary strengths are redundancy, built-in management and guaranteed network access. A clear disadvantage of FDDI/TP-PMD is that the cost per port remains too high for it to be considered a viable networking solution for typical desktop computers.

### ATM

An ATM (Asynchronous Transfer Mode) network is set up in a star configuration using fiber-optic (and in some newer incarnations, twisted-pair) cables. ATM is a scalable technology, offering data rates from 25 Mbps to 622 Mbps and more. A switch at the center of the star establishes a dedicated circuit between the sending and receiving stations. ATM is intended to carry real-time interactive multimedia applications that combine voice, video and data.

ATM, however, requires new network adapters and, in most instances, fiber-optic cable connections. Furthermore, its implementations are limited and proprietary.

## NETWork SERVICES

**We’ve described what networks look like physically, in terms of topologies, cabling and components. Now let's take a look at the benefits networks deliver to the users.**

### File services

File services allow users to share information and resources over a network. For example, you may want to access a file on another computer, use a site-licensed application program or look up the latest monthly sales figures in a shared database. These tasks are accomplished through file services.

### Mail services

Mail services let you send and receive electronic mail (e-mail). Electronic mail facilitates inter and intraoffice communications. Using an e-mail package, you can schedule meetings with your co-workers, send files to other departments and disseminate information to an entire organization.

### Print services

Print services let you print your documents to a printer. Some networks are set up so that you print to a print queue on a server. The server then handles the printing, taking the load off your computer. In addition, print services give each network user access to multiple printers, expanding your printer sharing capabilities.

### FAX SERVICES

Fax services give you the ability to send and receive faxes directly from your workstation. One or more modems with dedicated phone lines are connected to a server on the network and provide fax services to all LAN users.

### Terminal emulation services

Terminal emulation services give you access to different types of workstations with different operating systems. For example, you might want to tap into information contained on the network's mainframe from your Macintosh. Terminal emulation services give you this access.

### Communication services

Communication services let remote users dial into the network, using a modem, to access the other network services. They also let users dial out to other communication services like Compuserve or AppleLink.

Popular network operating systems like Novell NetWare, Microsoft LAN Manager, AppleShare and Banyan Vines provide some, if not all, of the network services listed above in a single package. Products are also available that specialize in each of these areas.

# AN IN-DEPTH LOOK AT ETHERNET HUBS

**The preceding section provided an overview of the basics of networking with concepts that are universal to all computer networks. The remainder of the document focuses on a specific network media access method—Ethernet.**

**In Part 2 we will offer a more detailed description of the Ethernet hub by delineating the features you should look for when purchasing one.**

## E t h e r n e t

As stated earlier, Ethernet is today's most widely employed media access method. This type of network can be set up in star or bus configurations using thick coaxial, thin coaxial, twisted-pair or fiber-optic cabling.

The most popular way to connect end-user computers to an Ethernet network is in a star configuration using UTP (10Base-T) cables and a central hub. This method has been popular due to the relatively low cost of 10Base-T cabling and the ease of installation. 10Base-T Ethernet always runs in a star topology and requires a hub/repeater to function. To expand the number of nodes on the network, multiple hubs can be linked together in a variety of ways.

Ethernet hubs of the plug-and-play variety simply re-time and re-amplify signals and were thus dubbed "non-intelligent." In contrast, the "intelligent" hubs of today monitor networks via network management software, and thus provide a proactive trouble-shooting mechanism.

When evaluating a hub for an Ethernet environment, features you should look for include:

### Expandability

If you anticipate network growth, or if you think you may want to add functionality to your network in the future, the hub you choose should allow for expansion. Expansion translates into a variety of things.

Some hubs offer expansion slots for option cards. These option cards not only let you increase the value of your hub by adding functions like SNMP and bridging (see side bars entitled “What is a Bridge?” and “What is SNMP?”), but, as technology progresses, they allow you to integrate new functions into your hub at lower costs.

Hubs are also available with either stand-alone or chassis-based architectures (figure 10). In a chassis design, the hub holds multiple modules, including repeater, management and bridge modules. The user, not the manufacturer, decides the ultimate configuration of the hub. Not every slot of a chassis-based hub needs to be filled immediately. This leaves room to add nodes to your network without adding more "boxes" to your wiring closet.

In both stand-alone and chassis-based architectures, your hub should offer connections to a variety of backbone media types (including thick, thin and fiber-optic) to accommodate network growth. It should also let you cascade other hubs off of ports for easy incorporation of smaller networks into larger ones (figure 11).

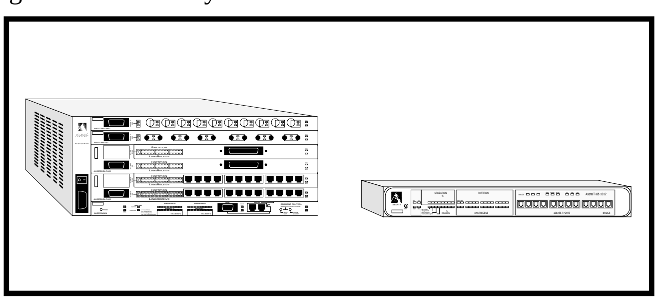


Figure 10 - Chassis-Based Hub vs. Stand-Alone Hub

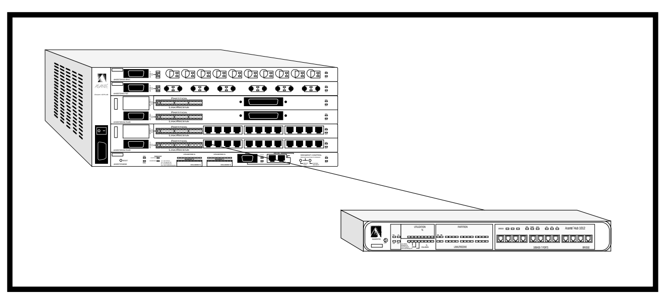


Figure 11 - Cascading Hubs

## What is a Bridge?

Bridges are used to divide networks into smaller segments to ensure better traffic control and more efficient use of bandwidth. They isolate traffic between the different segments of the network by examining the destination addresses of the packets and forwarding only those destined for stations on the other side of the bridge. The simplest bridges use a manually entered table of addresses to determine where a packet needs to go. More intelligent bridges, known as learning bridges, build their own tables.

Learning, forwarding and filtering are the three basic functions of learning bridges. When a learning bridge receives a packet, it decodes the source address. If the source address is not already in the database, the bridge adds it to the database (i.e. it "learns" the address). The bridge then checks the packet's destination address. If the packet is destined for another network segment, the bridge sends it out the appropriate port (i.e. it "forwards" the packet). If the destination address is not yet in the bridge's database, the bridge sends the packet out all ports. If the packet's destination address is on the original network segment, the bridge ignores the packet to reduce unnecessary network traffic. For security, the bridge can also disregard or "filter" packets based on pre-programmed criteria other than destination address, such as source address or type of packet.

A bridge will operate smoothly as long as only one path exists between network nodes. This, however, is not always the case. In some instances, network managers purposely create multiple paths between network segments as a back-up mechanism. In other instances, managers inadvertently create multiple paths as their networks becomes more complex. These active loops created by multiple bridges will degrade network performance as duplicate packets flow onto segments. For this reason, the IEEE standardized the Spanning Tree Algorithm (IEEE 802.1d). Most bridges manufactured today support the Spanning Tree Algorithm.

The Spanning Tree Algorithm establishes a unique path for data running over a network containing multiple bridges. Some bridge ports forward packets, whereas others block them. Thus, data is prevented from taking several paths to reach a destination (figure 12). If a problem arises with the preferred path, the algorithm allows the bridges on the network to communicate with each other to establish an alternate path.

For multi-bridge network environments, you should purchase learning bridges that support the Spanning Tree Algorithm to ensure the most efficient use of your network resources.

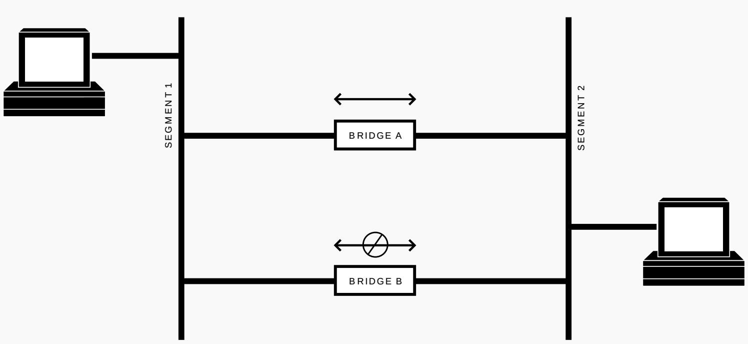



**Figure 12 - Spanning Tree Algorithm**

## What is SNMP?

SNMP stands for Simple Network Management Protocol. First defined by the Internet Engineering Task Force (IETF) in 1989, it has become a de facto industry standard for controlling multiple vendors' networking devices from a single management application.

SNMP consists of two parts: the Manager and the Agents.

The Manager is a software application that runs on a UNIX, DOS or Macintosh computer (designated as the management station). The Agents reside on network devices (workstations, hubs, servers, routers, bridges etc.). They generate information (such as Ethernet addresses, TCP/IP addresses and traffic statistics) about the devices on which they reside and store the information in their MIBs (Management Information Bases).

Managers contain descriptions of the data contained in the MIB which they use to poll the Agents for information. They then display the information in a way that is meaningful to the user.

To better understand this concept, think of the MIB as a collection of food prepared by the Agent (the chef) and described by a menu. The Manager has the menu and orders "vanilla ice cream with bits of chocolate." When the dessert tray arrives, the Manager picks out the chocolate chip ice cream.

Most networking devices that support SNMP support MIB II. MIB II is a published set of data definitions; so in theory, any SNMP Manager can access MIB II data (all restaurants offer the standard foods). Individual vendors have also created their own sets of definitions (specialties of the house) in order that their own Managers can gather more product specific information than is available from MIB II.

### Upgradability

To ensure the hub you buy today won't become obsolete as your organization grows and new technologies arise, you should choose a hub that allows for firmware updates to add functionality. Most often, you can update your hub by swapping a PROM or, even better, by upgrading the PROM using software. The upgradable PROM (or flash EPROM) makes updating easy. The network manager can simply download microcode upgrades directly from a computer. This is especially helpful when you have multiple hubs on your network that require upgrading.

### Simplicity

The level of simplicity you desire in a hub depends upon your level of expertise and the demands of your network environment. Hubs can be as simple as the plug and play “non-intelligent” variety which allow you to simply plug the cables in and, with no software or switches, automatically connect your network devices.

### Media Flexibility

Your office may be prewired with twisted-pair or fiber-optic cable. Or, you may want to run a thin coaxial backbone between floors. Are your computers clustered together or spread apart? Whatever the scenario, be sure your hub can accommodate cable types that meet your immediate and future cabling needs.

### Reliability

Reliability is one of the most important features in a network hub.

With intelligent hubs, reliability includes establishing redundancy so if a vital component fails, a back-up component will pick up the slack. Imagine if the power supply of your chassis-based hub fails. An entire department or company would quickly wind to a halt. With a back-up power supply, the network would continue to function normally while you repair the defective component.

Reliability also means locating a problem before it affects the network's performance. A comprehensive, informative set of LEDs on the front of a hub permits troubleshooting at a glance. Intelligent hubs offer the additional ability to troubleshoot from your desktop through management software.

### Network Management Software

With a network management software package, you can troubleshoot an intelligent hub right from your desktop computer (in-band). Some network management software applications even let you access vital network statistics via modem (out-of-band) from a remote site (see side bar entitled “What is the difference between In-band & Out-of-band?”). For a network that has expanded beyond 25 nodes, a network management software package is recommended to ensure smooth and efficient network operation. While researching a network management software package, be sure it will run on a computer platform with which you are familiar.

### Standards-Based

To ensure your intelligent Ethernet hub integrates smoothly with other vendors' products, the hub you choose should adhere to all industry standards.

## What is the difference between In-band & Out-of-band?

In-band and out-of-band refer to the way the network management workstation accesses the hub.

In-band (SNMP) network management software lets you manage a hub from a computer connected to the network. If the network goes down, however, the in-band connection goes with it.

Out-of-band, on the other hand, lets you manage a hub from a computer linked through a secondary communications connection, either directly or via modem. This connection acts as a redundant network management connection, providing a way to access the hub even if the Ethernet network becomes locked or saturated. It also lets you manage the network from a remote site.

Unfortunately, many out-of-band management applications are text based, making it difficult to gather and use information. Top-of-the-line out-of-band applications, however, offer powerful features that are graphically based.

Ideally, your network management software application should provide both in-band and out-of-band versions. These versions should offer similar capabilities with user-friendly, easy-to-use, easy-to-understand graphical interfaces.

Part Three

# ASANTÉ'S ETHERNET HUB SOLUTIONS

**Asanté's standards-based networking products lead the industry in bringing both powerful high-end network management features along with simple plug-and-play unmanaged hub features to the departmental LAN product class. When considering a managed hub, whether you are installing your first network or expanding an existing one, we offer flexible, expandable, reliable and affordable network management systems that support local and remote management from both Windows PCs and Apple Macintoshes. And when considering unmanaged hubs, Asanté offers the best price/performance with plug-and-play simplicity.**

## MANAGED ETHERNET HUBS

### THE ASANTÉHUB 1016-IQ

The AsantéHub 1016-IQ is a 16-port, cascadable, intelligent, 10Base-T Ethernet hub that delivers sophisticated features at an affordable price. Engineered in strict compliance with all relevant IEEE 802.3 specifications, the AsantéHub 1016-IQ not only integrates smoothly into established networks, but also provides a solid platform for small and growing networks.

#### Flexible Cabling Scheme

The AsantéHub 1016-IQ comes equipped with 18 ports; 16 RJ-45 ports, one self-determining BNC port and one AUI port, all located on the front panel. These ports support unshielded twisted pair, thin coaxial and thick coaxial cabling. Use all 18 ports simultaneously to connect users or use the BNC to interconnect multiple hubs and the AUI to fiber as a backbone connection. The AsantéHub 1016-IQ can be rack-mounted or placed on a desktop.

#### Expandable Architecture

The AsantéHub 1016-IQ's built-in support for SNMP – the industry standard for network management– means it will incorporate easily into already existing enterprise networks as well as form a solid platform for growing departmental networks and eliminate the need for an add-on management module. With SNMP, you can control the AsantéHub from an AsantéView network management station or virtually any third-party SNMP management console including HP OpenView, SunNet Manager and IBM Net View.

#### Upgradable Architecture

The AsantéHub 1016-IQ has Flash EPROM memory for easy microcode upgrades by the user.

#### Reliable Connections

The AsantéHub 1016-IQ supports redundant 10Base-T-to-thin backbone cabling so you can re-establish network services quickly should the main operating cable fail. And its comprehensive set of LEDs – that can be viewed both on the front panel and in real-time from an AsantéView management station – let you monitor network vital signs at a glance.

Comprehensive LED indicators show hub/network status at a glance.

Sixteen RJ-45 ports for connecting Ethernet devices over UTP cabling.


Available BNC and AUI can be used simultaneously for backbone or multiple hub interconnections.

## THE ASANTÉHUB 2072

The AsantéHub 2072 is a seven-slot, two-segment, intelligent Ethernet concentrator designed with enterprise-level features yet priced for departmental networks. In combination with AsantéView network management software, it gives you an easy-to-use and powerful way to manage your network.

### Modular, Expandable Architecture

The Asanté Multiport Repeater Modules, Network Management Module (NMM) and AsantéBridge Module slide into the AsantéHub 2072 chassis. As your network grows, you add nodes and expand capabilities simply by inserting additional modules. And with our Hot Swap capability, you can easily swap or replace modules without powering down the network or interrupting service to end-users attached to other modules.

### Flexible Cabling Options

Repeater Modules for the 2072 are available with 10Base-T (RJ-45 and RJ-21), 10Base-2 (BNC) and 10Base-F (ST fiber-optic) connections for linking your computers, printers and other network devices to your Ethernet network. The chassis can accommodate up to 72 10Base-T nodes. And, for up-linking to an Ethernet backbone, the Repeater Modules deliver an AUI port and a recessed MAU slot for UTP, thin, thick or fiber-optic cables.

### Dual Segment Backplane

The AsantéHub 2072 offers a dual segment backplane for establishing two separate Ethernet networks. This backplane lets you assign repeater modules to either of two segments. You may choose to do this to help balance traffic or to separate a module from the rest of the network during the testing of other network equipment.

### Intelligent Network Management

The Network Management Module (NMM) is the intelligence of the AsantéHub 2072. With built-in support for SNMP, MIB II and Asanté's published AsantéMIB, the NMM serves as the point of access for monitoring and controlling all Repeater Modules on both of the chassis' dual segments. This is accomplished through AsantéView network management software or any SNMP management console. Moreover, upgrading the AsantéHub 2072 is easy with the NMM's Flash EPROM memory.

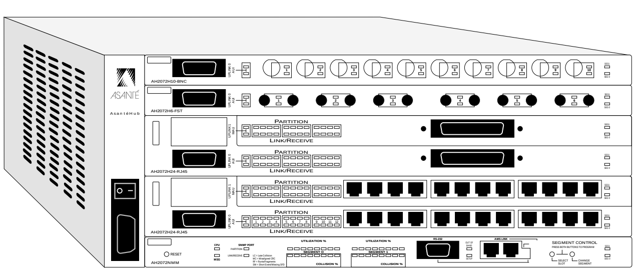
### Remote Network Management Control

The AsantéHub 2072 is ideally suited for LAN managers seeking to control networks at other sites. The NMM offers an RS-232 port to which you can connect a modem. You can then remotely manage up to twelve AsantéHubs linked together via the NMM’s AMS (AsantéView Management System) Link ports.

### Reliable Performance

For installations that cannot risk downtime, the AsantéHub 2072 delivers powerful reliability features. You can order the AsantéHub 2072 chassis with two redundant power supplies which, when both are functioning properly, share the power load. If one power supply should malfunction, the other will automatically support the AsantéHub 2072's full power requirements without affecting performance. The failed power supply can then be hot-swapped without powering down the chassis.

Furthermore, the hot-swappable Repeater Modules offer LEDs for Link and Partition so you can view the status of your network from your wiring closet. The NMM provides dual sets of LED displays (for both internal Ethernet segments) for viewing warnings for late collisions, misalignments, fragments and short events, as well as bar graphs for percent utilization and percent collision.



# THE ASANTÉ NETSTACKER

The Asanté NetStacker is a two-segment Ethernet concentrator that integrates the flexible features of a multi-slot chassis with the convenience and low cost of a stackable hub.

### Modular Expandability and Flexibility

Whether you need a single, unmanaged, stand-alone hub or a stack of hubs which are fully manageable using SNMP, the NetStacker is versatile enough to handle the most dynamic networking requirements. You can start modestly by installing an unmanaged chassis with 24 10Base-T ports. When network management becomes necessary, simply install the NMM Lite on your repeater module and load the AsantéView application on your management station. As your connectivity requirements grow, you can stack two additional NetStacker hubs on top of the first, increasing total capacity to 72 users. Because of the NetStacker's Smart Snap connector, the three stacked NetStackers act as a single logical repeater on the network and can be managed as a single unit.

In addition to 10Base-T repeater modules (with either RJ-45 ports or RJ-21 Telco connectors) and the NMM Lite, Asanté offers 10Base-F (fiber-optic) and 10Base-2 (thinnet) repeater modules, two-port Ethernet bridge modules and a full-sized NMM. The NetStacker is a flexible, cost-effective solution that accommodates significant growth and expansion.

For uplinks to unshielded twisted-pair, thinnet, thick-coaxial or fiber-optic network backbones, every double-slot repeater module offers an extra attachment unit interface (AUI) port and a recessed AUI port which accepts the Asanté Mini MAU. Single slot repeater modules offer the extra AUI port only. And since all cables attach to the front of the modules, you can easily access network connections in rack-mount, wall-mount and table-top installations.

### Dual Segment Backplane Option

When using a dual-segment Network Management Module, the NetStacker can create two separate Ethernet networks within the same stack. This dual backplane lets you balance network traffic or separate a module from the main network during the testing of other network equipment.

### Hot-Swappable Modules

When you need to make changes or repairs to the network, you can easily swap or replace modules from any slot in the stack of NetStackers without powering down. Users connected to a remaining module will not experience an interruption in service. You can also add a NetStacker to the top of the stack while the network is operating.

### Plug-In Modules

Repeater Modules. Multiport repeater modules supporting 10Base-T, 10Base-2 and 10Base-F slide easily into the NetStacker chassis. 10Base-T modules offer RJ-45 or RJ-21 connectors to support 12 to 24 nodes. The 10Base-2 module with BNC connectors is available in a 10-port configuration, while the 10Base-F modules feature a choice of 6 or 12 ST fiber-optic connectors.

Network Management Module (NMM). While the NetStacker can accommodate a full-sized network management module, you'll save a chassis slot by using the compact, zero-slot lite network management module (NS-NMM). Residing as a daughtercard on a special 24-port 10Base-T repeater module, the NS-NMM lets you monitor and control all modules and hubs on a single segment in the NetStacker hierarchy. The full-sized NMM will control and monitor modules on both segments. Regardless of which NMM you use, you'll be able to proactively manage your network through AsantéView network management software or from any generic SNMP management console.

Bridge Module. Asanté also offers the AsantéBridge, a two-port, RISC-based Ethernet bridge module. When installed in a NetStacker, the AsantéBridge filters and forwards data frames between the hub and an external Ethernet segment or between the NetStacker stack's two internal segments.

# THE ASANTÉVIEW MANAGEMENT SOFTWARE

AsantéView is a powerful and easy-to-use management application that lets you proactively monitor and control all Asanté intelligent hub, bridge and remote access products. It is the industry's first network management application that delivers a graphical user interface for local (in-band) and remote (out-of-band) management from both Windows PC and Apple Macintosh platforms. With AsantéView, network managers can optimize network performance, investigate traffic bottlenecks, and identify network problems before they become critical.

## In-Band and Out-of-Band Graphical Management

AsantéView is unique in the industry in that it offers easy-to-use, graphical user interfaces with similar capabilities for both in-band and out-of-band management modes.

AsantéView In-Band software lets you locally manage an Asanté intelligent hub, bridge or remote access server from a computer linked to the network via a standard Ethernet connection. AsantéView Out-of-Band software lets you locally manage an Asanté intelligent hub from a computer linked directly through the hub's AMS (AsantéView Management System) Link port, or remotely via modem through the hub's RS-232 port. This out-of-band connection, which is password protected, ensures that you can access your hub even if the network becomes locked or saturated. It also lets you simultaneously manage up to twelve AsantéHubs and/or NetStackers spanning a distance of 2,000 feet from a single AsantéView management station.

## Comprehensive Network Monitoring

Whether accessed over an in-band or out-of-band connection, AsantéView's network health meters, performance monitoring statistics and network utilization monitor keep you in touch with your network. The three dashboard-like health meters provide real-time displays of good packets, bad packets and state of network health—even while other applications run on your desktop. The seventeen performance statistics can be displayed as graphs, tables and charts, monitor network conditions. And the network utilization monitor shows you how much of your network's bandwidth is being utilized.

## Database Logging

Database logging records and replays any of the performance monitoring or network utilization statistics, allowing you to establish a baseline of network performance. For analysis, you can then export the data in ASCII file format to most popular spreadsheet and database applications. This makes it easy to identify when the network is behaving abnormally and thus target potential problem areas.

## Bridge Management

AsantéView can simultaneously manage multiple Asanté Bridges. With AsantéView, the network manager can set spanning tree parameters, view the dynamic forwarding table, set the range filtering table by source address, destination address and packet (protocol) type, and add, delete or modify the static formatting table. The network manager can also enable and disable bridge ports and monitor bridge port statistics. Transmit, receive and collision LEDs for each bridge segment, as well as activity, standby and status can be viewed on-screen from the Macintosh or Windows PC management station.

## Powerful Security Features

AsantéView delivers two powerful security features to help ensure the integrity of your network. While password protection restricts AsantéView access to only authorized individuals, port intrusion controls maximize security by letting the network manager specify the physical address for each node attached to an Asanté hub. If a device is added to the network or moved without the network manager's permission, port intrusion controls will trigger an alarm. This alarm can partition off the node, notify the network management station, and/or page the network manager.

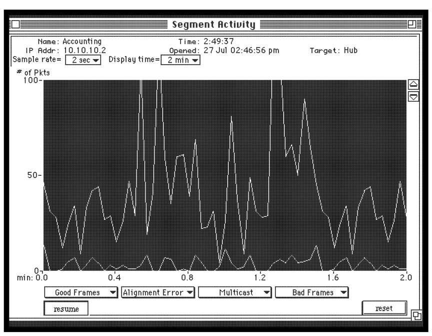
**Informative Mapping.**

AsantéView's mapping features help you to manage and organize your network better. The map editor feature lets you dynamically edit parameters of the map objects. And AsantéView's hierarchical mapping feature lets you build a "tree" of maps where the primary map consists of icons representing logical subgroups of the network. Users can then select various management windows via group icons.

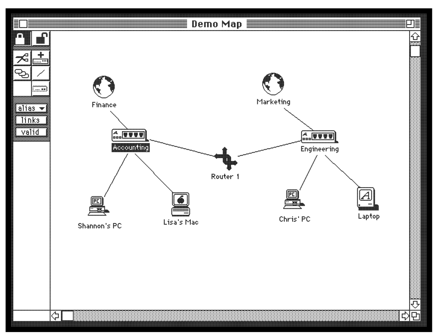
**Managing SNMP Devices.**

AsantéView can map third party SNMP devices, determine whether they are up or down and retrieve MIB II statistics from them.

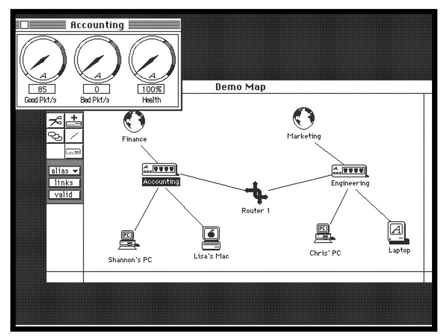
From your choice of a Windows PC or Apple Macintosh management station, AsantéView provides an easy, powerful and intuitive way to monitor and control your entire network.



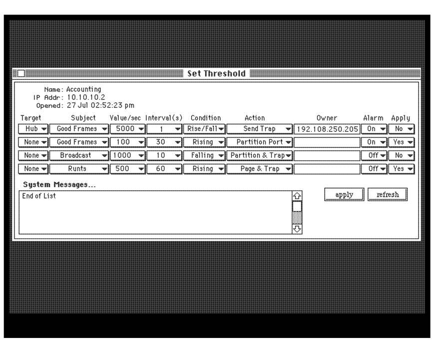

17 performance monitoring statistics give you all the information you need to troubleshoot your network.



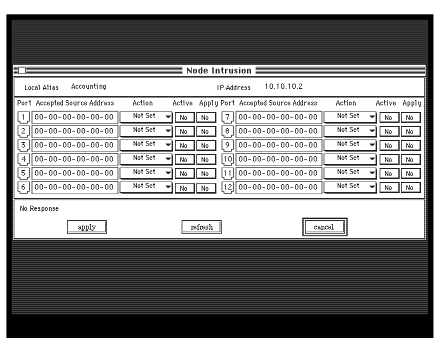

Topological map editing function allows you to graphically create detailed network maps.



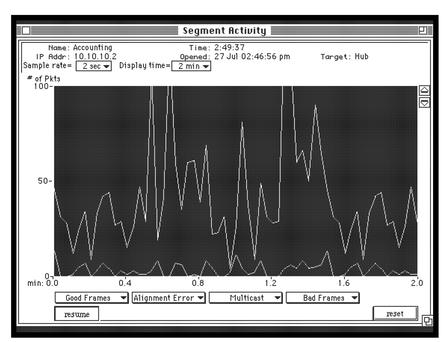

3 network health meters display critical network information–good packets, bad packets and aggregate state of network health–all in real time.




User-defined alarm thresholds and traps on all statistics let you detect network problems before they escalate.




Password protection and port intrusion controls provide maximum network security.




Port control panel lets you turn individual ports on and off from your management station to isolate specific areas of your network.

## AsantéView's 17 Performance Statistics

**Good Frames** Counts frames that are error free (i.e. greater than 64 bytes and less than 1518 bytes with good Start Frame Delimiters and good Frame Check Sequences).

**Multicast** Counts packets that have multiple destination addresses (does not count broadcast packets).

**Broadcast** Counts packets destined for all addresses on the network.

**Long Frames** Counts packets that are greater than 1518 bytes and therefore are greater than the maximum legal length. Usually indicates a problem with the software driver.

**Runts** Counts packets that are less than 64 bytes and therefore shorter than the minimum legal length.

**Alignment Error** Counts data frames that are not multiples of eight bits. This error is usually caused by a hardware problem and thus is useful to track. Usually not more than <0.2% of overall utilization.

**Fragments** Counts frames that are greater than 2 bytes and less than 64 bytes, with a Start Frame Delimiter but a bad Frame Check Sequence. Normally <0.2% of overall utilization.

**FCS (Frame Check Sequence) Errors** Counts frames that fail the Cyclic Redundancy Check (CRC). Generally indicates a hardware problem, possibly a hub problem. Normal rate < 0.1%.

**IFG (Interframe Gap) Errors** Counts time periods between data frames that are less than 5.5 micro seconds. The IEEE specifies that the minimum gap should be greater or equal to 9.6 micro seconds. Usually indicates a hardware problem.

**Data Rate Mismatch** Counts incoming data with rates outside of specified tolerance (10MHZ ± 0.01%).

**Short Events** Counts data that is greater than 10 bytes.

**Collisions** Counts number of collisions. Should not exceed 2% of good frames. A good parameter to monitor.

**Late Collisions** Counts collisions which occur after the 64 byte collision window. Usually a result of excessive delay in the network due to too many repeaters or excessively long cables.

**MAU Jabber Lockup Protection (MJLP)** Flag that indicates the hub repeater is in a lockup state. All hub ports are partitioned.

**Auto-Partitions** Counter that indicates that a port received 31 or more continuous collisions. Usually caused by a jabbering network interface card.

**Start Frame Delimiter Missing/JAM** Counts number of events where the Start Frame Delimiter is missing. Caused by collisions. Should not be excessive compared to Good Frames.

**Bad Frames** Counts the summation of errored frames (those that are too long, runts, misalignments, or have a bad FCS).

## PLUG-AND-PLAY AND NETEXTENDER ETHERNET HUBS

### PLUG-AND-PLAY ETHERNET HUBS

Asanté offers four cost-effective Ethernet hubs for connecting PCs, Macintoshes, workstations (including UNIX), network printers and other network resources to an Ethernet network. Ideal for creating small networks or extensions to existing networks, the Asanté Plug-and-Play Ethernet hubs provide the best price/performance with easy installation and unparalleled Asanté support.

With the Asanté 10T Hub/8, 12 and 24, network managers can use inexpensive unshielded twisted-pair (UTP) telephone wire to connect their network resources. The BNC Hub/6 uses thin coaxial cable to connect resources in a local area network.

For ultimate flexibility, Asanté Plug-and-Play Ethernet Hubs let you easily accommodate stand-alone networks as well as connect the hub to an existing network with the use of an “OUT” uplink port. The 10T Hub/12 even has the option of using an RJ-21 connector for those users who prefer to connect all 12 ports with one cable.

### NETEXTENDER PORTABLE 10Base-T ETHERNET HUBS

Asanté's portable NetExtender Hubs let you easily and inexpensively create a five node 10Base-T standalone network, or connect four nodes to an existing Ethernet network.

Two versions are available. One offers an AUI port and four RJ-45 ports; the other offers an AAUI (i.e. FriendlyNet) port and four RJ-45 ports. Simply plug a NetExtender Hub into any PC, Macintosh, computer workstation, network printer or other device with an AUI or AAUI Ethernet port, and then connect the other devices using unshielded twisted-pair cable.

NetExtender Hubs do not require an external power supply. This portability makes them ideal for small networks, temporary networks, or extensions to existing networks. And since NetExtender Hubs are 10Base-T hubs, the network nodes are connected in a star topology. This topology is more reliable than daisy-chain and bus topologies, and lets you add, change or delete nodes without disrupting the rest of the network.

# SAMPLE ETHERNET NETWORKS

# DESIGNING A SIMPLE NETWORK

### Example #1 - Small Office

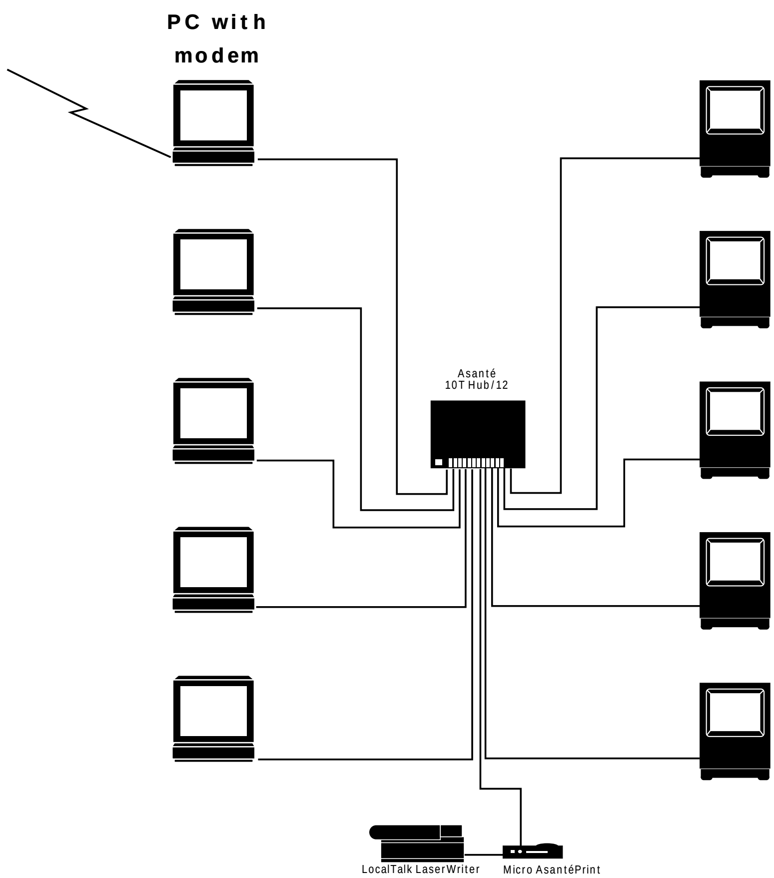
Baskets-R-Us started out of Rose Giving's garage as a side job and slowly grew into a small business. Although Baskets-R-Us consisted of no more than Rose and a few additional employees, they found they could maximize the usage of their computer resources by networking them. This way one laser printer, one fax software package, one modem, etc., could be shared by everyone.

### Solution:

Rose checked around with a couple of friends who advised her to install a simple Ethernet network and a popular networking software. She then went down to her local computer supply store and picked up an Asanté Plug-and-Play 10T Hub/12 along with Ethernet adapter cards from Asanté for her mix of PCs and Macs.

Within minutes, the cables were snapped into all the Ethernet adapter cards in the computers and then to the hub (figure 13). The hub required no additional software for installation, and there were no tricky switches or jumpers to set.

With easy to read LED lights, Rose is able to take a quick glance at the hub to make sure everything is in working order. The small size of the hub made it easy to mount inconspicuously by her desk where it is out of the way but easy to monitor.




▲ Figure 13 - A Small Office Network

### Example #2 - Wiring to a Central Hub

Creative Systems, a small manufacturing company, is expanding rapidly. Computer equipment has been purchased on an as needed basis, but no organization exists. It is now time to maximize their investment and increase departmental productivity by adding a company wide network.

Having decided upon an Ethernet hardware-based network, Creative Systems is looking for a cost effective method for organizing the connectivity of their equipment.

### Solution:

To create a company wide Ethernet network (figure 14), Creative Systems purchased an Asanté NetStacker as their Ethernet hub. The NetStacker, with its stackable-chassis architecture, lets them cost-effectively add nodes, management capabilities and bridging functionality as their needs require.

Creative Systems began with the NetStacker base unit and a 24-port 10BASE-T module. As their budget permitted, Creative Systems purchased additional NetStacker expansion chassis units, repeater modules, a network management module and network management software.

As the diagram illustrates, Creative Systems ran UTP cables directly from the hub to the Manufacturing, Sales, Accounting, and Marketing departments. The computers link directly to the hub. To keep cable costs down, only one cable was run to the Engineering department where an Asanté 10T Hub/12 unmanaged hub connects all the computers to the network.

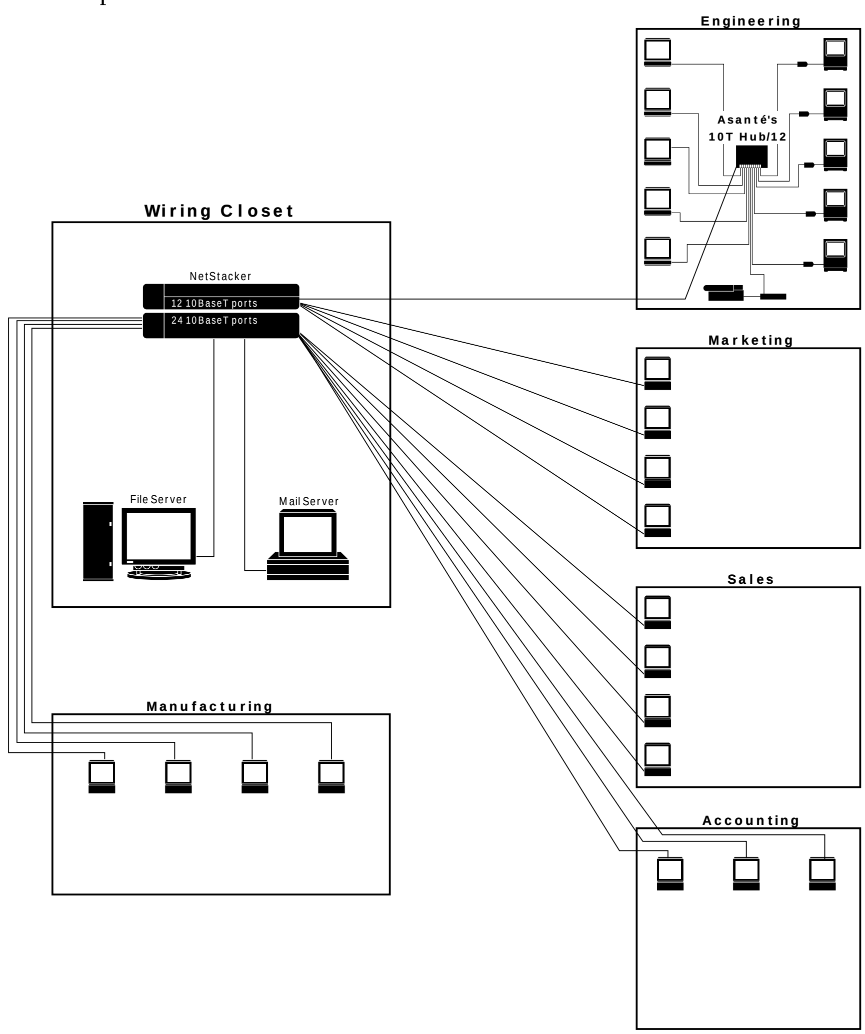



Figure 14 - The Central Wired Network

### Example #3 - Adding Network Management Capabilities

Creative System's network has grown to over 50 nodes and they realize they need a more efficient way to monitor, control and troubleshoot the network. Their network manager wants to be able to configure the NetStacker hub ports from his desk instead of trekking to the wiring closet each time he adds or moves a device. When a node starts misbehaving, he wants to be notified by the hub itself, instead of by the employee or manager who notices the problem. And he wants to track how much the network is being used in order to anticipate future needs.

### Solution:

Creative Systems needs a standards-based network management software application to work in combination with its NetStacker intelligent hub. Network management software makes managing, controlling, configuring and troubleshooting a network easier.

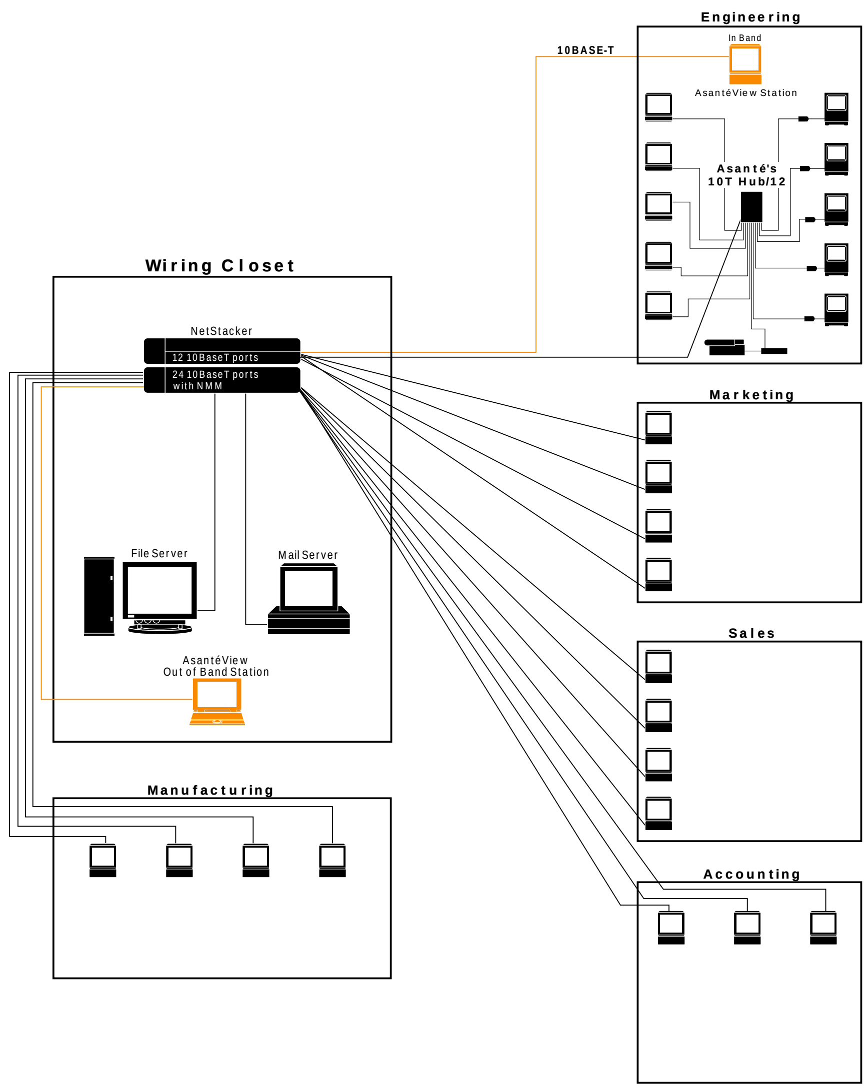
As shown in the diagram (figure 15), to add intelligence to the NetStacker hub stack, the network manager purchased Asanté's lite network management module (NS-NMM). Approximately one sixth the size of Asanté's full-size NMM module, the NS-NMM is designed to mount directly on the 24-port 10BASE-T repeater module and thus free up a NetStacker chassis slot. This unique, zero-slot, space-saving approach maximizes NetStacker resources in the most cost-effective manner possible. Furthermore, the NS-NMM's built-in support for SNMP means the NetStacker can be managed from any generic SNMP console or from any station on the network running AsantéView.

By loading AsantéView on his computer (which he connected to the NetStacker via a standard UTP connection), the network manager can manage the network via an in-band connection right from his desk. AsantéView is a powerful, SNMP-based, easy-to-use management application that lets you proactively monitor and control the NetStacker as well as Asanté's other intelligent hub, bridge and remote access products. It delivers a graphical user interface for local and remote management from both Windows PC and Apple Macintosh  platforms.0

AsantéView provides the network manager with numerous real-time displays of 17 network statistics in the form of graphs, tables and charts. He can define threshold conditions for any of the statistics, and if exceeded, the NetStacker will send an alarm to his management station, page him and/or partition off the offending node. In addition, node intrusion controls and password protection ensure only authorized individuals gain access to the network.

If the network ever becomes locked or saturated with traffic so that this in-band connection does not work, the network manager can connect his portable computer to the AMS Link port on the back of the NetStacker and gain access to the hub using the out-of-band version of AsantéView. AsantéView's out-of-band version offers nearly the identical user-interface and capabilities as its in-band counterpart.

# MANAGING THE NETWORK




▲ **Figure 15 - Managing the Network**

### Example #4 - Wiring Buildings to a Fiber-Optic Backbone

The network manager at Good Grapes Winery has been asked to provide Ethernet connectivity to each of the company's ten buildings and create a company-wide network. Some of the buildings already have their own small departmental Ethernet networks with dedicated servers, but most facilities are not networked. Each facility would initially need only a small number of 10BASE-T ports; yet as connectivity to the company-wide network becomes a greater necessity, additional ports will be needed. The communications center will be housed in an administrative building located a mile from most of the other buildings.

### Solution:

As shown in figure 16, the network manager equipped those facilities requiring 16 or fewer nodes with AsantéHub 1016-IQ intelligent Ethernet hubs. For facilities that had (or were anticipating) more than 16 nodes, the network manager installed AsantéHub 2072s and NetStackers—Asanté's intelligent, chassis-based and stackable, Ethernet hubs. The chassis architecture of these two products lets the network manager incrementally add ports as connectivity requirements grow.

Since many of the buildings at the winery were located a mile from the communications center, the network manager instructed the wiring technicians to install a fiber-optic cable plant to connect each building to the communications center. This fiber-optic cable would support the current data and voice requirements of the winery, as well as provide the capacity to support higher speed technologies, such as FDDI or ATM, in the future. For unanticipated future applications, the wiring technicians installed extra fiber-optic cables.

The main hub from each building was then networked to the communications center's hub via Ethernet over the fiber-optic cable. Since the network manager used an AsantéHub 2072 and an Asanté fiber repeater module (which complies with the newer 10BASE-FL protocol) as the hub in the communications center, Ethernet signals could run over the fiber-optic cables for up to 2 km.

Centralized resources, such as file servers, mini computers and high capacity printers, were connected to the central AsantéHub 2072 in the communications center via 10BASE-T. The winery's router to the Internet was also connected to this central hub giving all users access to the Internet.

To isolate the traffic of the existing department networks from the winery backbone, the network manager installed bridges in those facilities. Segmenting the network kept extraneous traffic off the winery's backbone, making access to the centralized services in the communications center faster for all users.

# THE FIBER-OPTIC BACKBONE

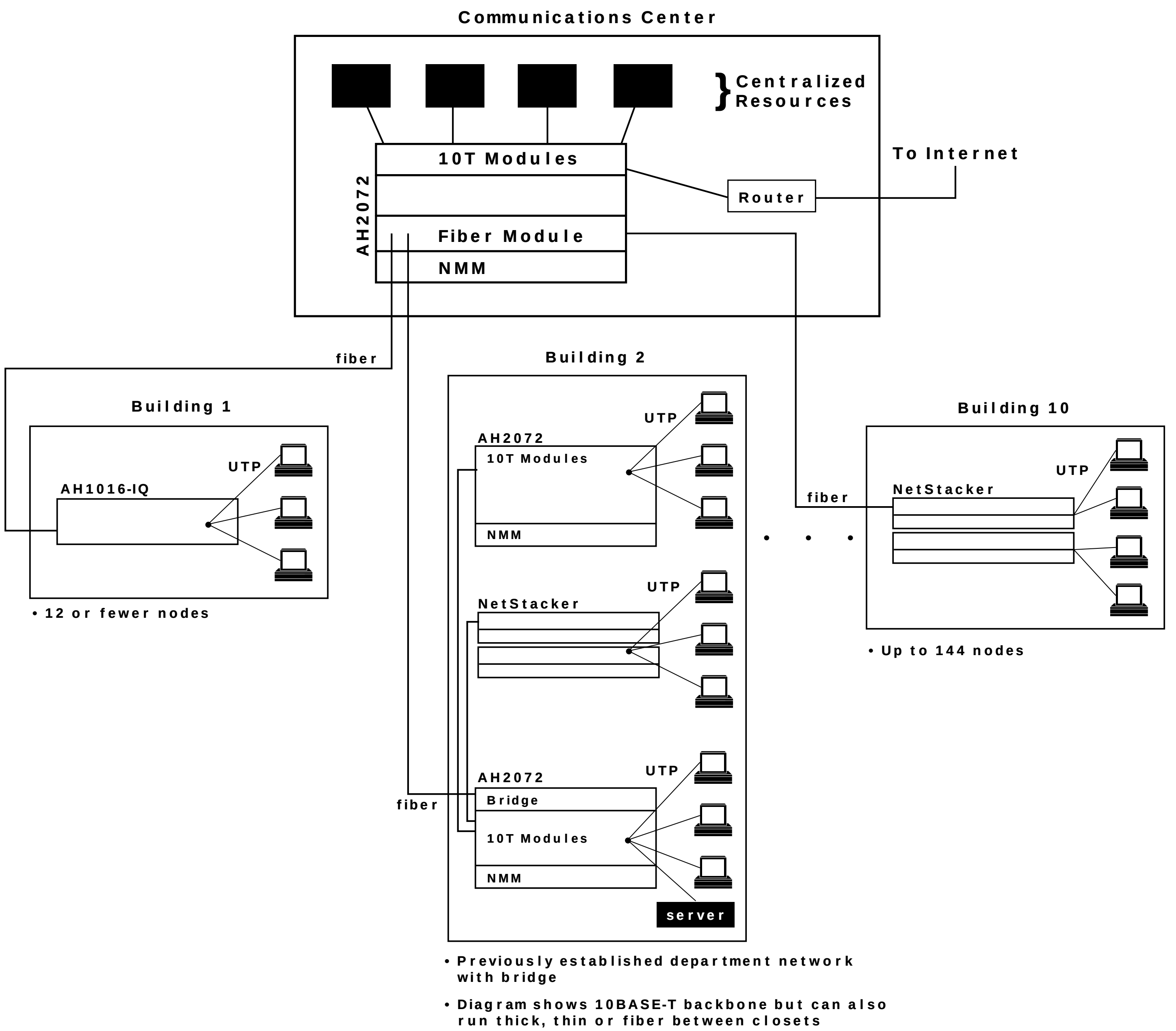



Figure 16 - The Fiber-Optic Backbone

### Example #5 - Centralized Segmentation Using Routers

ABC Communications has thousands of nodes located throughout dozens of buildings on its company-wide network. The network manager wants to alleviate congestion on the network by localizing network traffic to the departments when possible.

### Solution:

In a large-sized network with thousands of nodes, routers are essential. Routers enable a network manager to establish separate sub-networks that correspond to the logical organization of a company. So, for example, the finance network can be completely separate from the sales network. The router's functions are to route traffic between the sub-networks, provide security between sub-networks as needed, and isolate network problems to the local sub-networks.

There are two fundamental approaches for deploying routers: a distributed router environment with a low-capacity router installed in each building, and a centralized router environment with a small number of high-capacity routers in a communications center (or a few strategic facilities) connected to a high-speed backbone. This latter approach is commonly referred to as a "collapsed backbone" and offers a number of benefits over the former.

The collapsed backbone environment is more cost effective than a distributer environment since the cost of purchasing a small number of high-capacity routers is lower than the cost of purchasing a large number of low-capacity routers. Also, it is generally easier to manage a small number of routers in a few central locations rather than a large number dispersed throughout the network environment. Furthermore, upgrading the backbone in a central location is easier than upgrading one which spans between many facilities or departments.

As shown in figure 17, the network manager implemented a collapsed backbone network strategy for ABC Communications. The main Ethernet hub in each building connects via fiber-optic cable to a backbone router. The routers connect to a high speed backbone (Ethernet, Switched Ethernet, FDDI, or ATM).

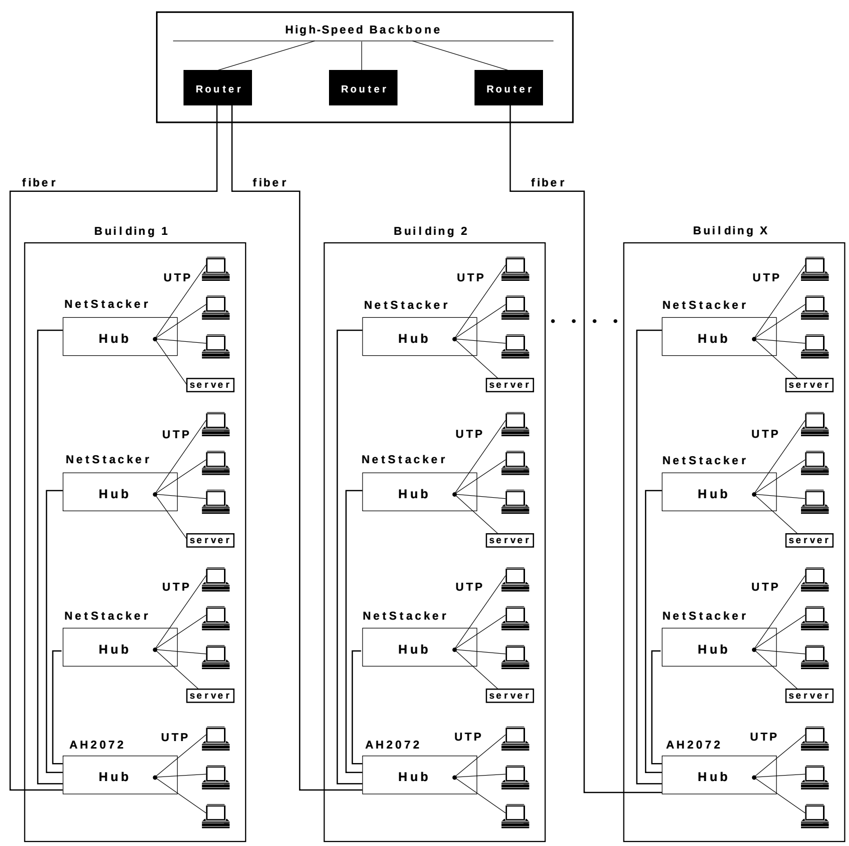



Figure 17 - Segmenting the Network

# increasing bandwidth of traditional 10 mbps ethernet lans

### Example #6 - Ethernet Switch

The employees in Compressed Semiconductor's Engineering department frequently move large CAD (graphics) files to and from departmental file servers. In addition, many of the employees access Internet resources both inside and outside the company. Utilization of the Engineering department's 10 Mbps Ethernet network regularly exceeds 60%, significantly slowing response time.

### Solution

To increase the bandwidth of the Engineering department's traditional 10 Mbps Ethernet network while retaining the investment in their current technology, the network manager installed an Ethernet switch.

An Ethernet switch is essentially a multi-port bridge that provides dedicated 10 Mbps Ethernet connections between ports. With switches, multiple 10 Mbps connections can be established simultaneously, thus increasing the aggregate bandwidth of the network. An Ethernet switch not only reduces overall network congestion, but also, with some products, provides a high-bandwidth uplink connection (like FDDI or ATM) to a network backbone.

As illustrated in figure 18, the Engineering department's intelligent Ethernet hubs and centralized resources, including NFS and Novell servers, connect directly to the Ethernet switch. This provides dedicated 10 Mbps Ethernet "pipes" and additional bandwidth between the Ethernet hubs and the centralized resources.

Since the majority of the Engineering Department's network traffic is local to the building, the network manager connected the Ethernet switch to the company network backbone via a standard Ethernet connection. However, the switch he purchased offers an optional high-speed port in the event increased bandwidth between the Engineering department and the company backbone ever becomes necessary.

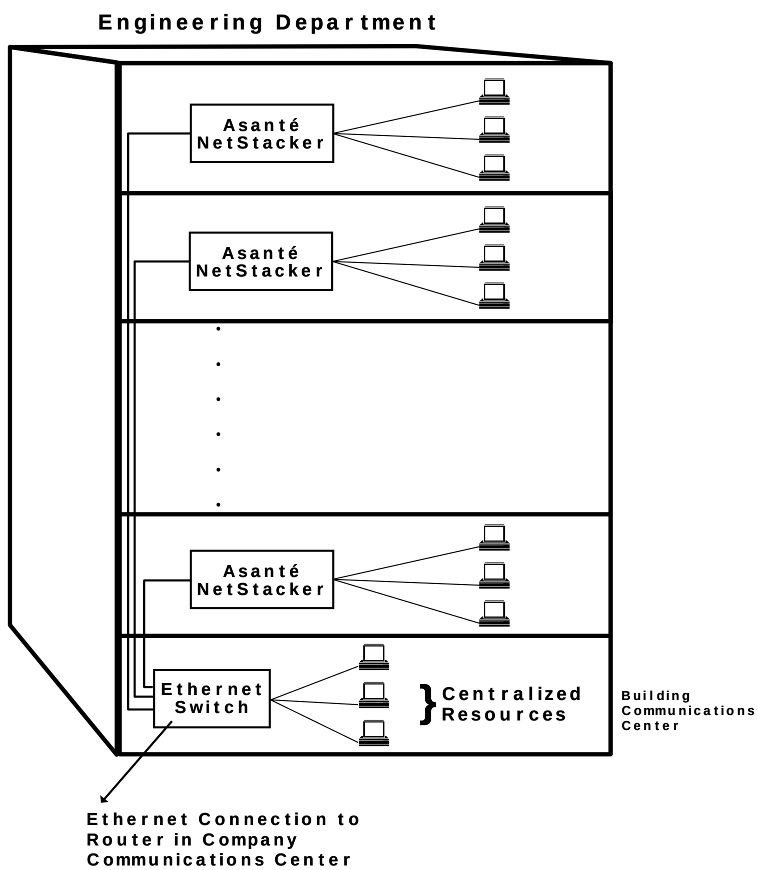



Figure 18- Increasing Bandwidth

### Example #7 - The Dual Segment Backplane

The network manager at State Tech has been asked to find a cost-effective way to secure the administrative network (which includes the file servers, printers and computers of the faculty and administration) from students. He needs to ensure that students do not "see" administrative network resources, and prevent them from eavesdropping on administrative network traffic. Some campus facilities at State Tech house only administrators, some house only students, whereas some house both.

### Solution:

A network with a secure administrative sub-network as illustrated in figure 19.

As shown in the diagram, the network manager created completely independent administrative and academic sub-networks linked by a router. The router serves as a "fire wall." The fire wall is configured to prevent the students from accessing services on the administrative network, from sniffing administrative network traffic, and from hacking into the administrative network to gain user IDs and passwords.

Facilities which exclusively house the administrative network resources are connected to hubs on the administrative sub-network. Accordingly, facilities which exclusively house the academic network resources are connected to hubs on the academic sub-network.

For the facilities that house both administrators and students, the network manager installed AsantéHub 2072 chassis-based intelligent hubs. The dual-segment capability of the AsantéHub 2072 lets the network manager create entirely independent administrative and academic sub-networks within the same chassis. As illustrated in the diagram, all administrative network resources are attached via UTP to the 10BASE-T modules on backplane segment #1, whereas all academic network resources are attached via UTP to the 10BASE-T modules on backplane segment #2.

One fiber-optic, 10BASE-FL Ethernet connection from each of the independent sub-networks connects to an AsantéHub 2072 in the campus communications center. This AsantéHub 2072, populated with 10BASE-FL repeater modules, serves as a fiber repeater. The fiber repeater modules for the administrative network are connected to backplane #1, and the fiber repeater modules for the academic network are connected to backplane #2. A router connects the sub-networks.

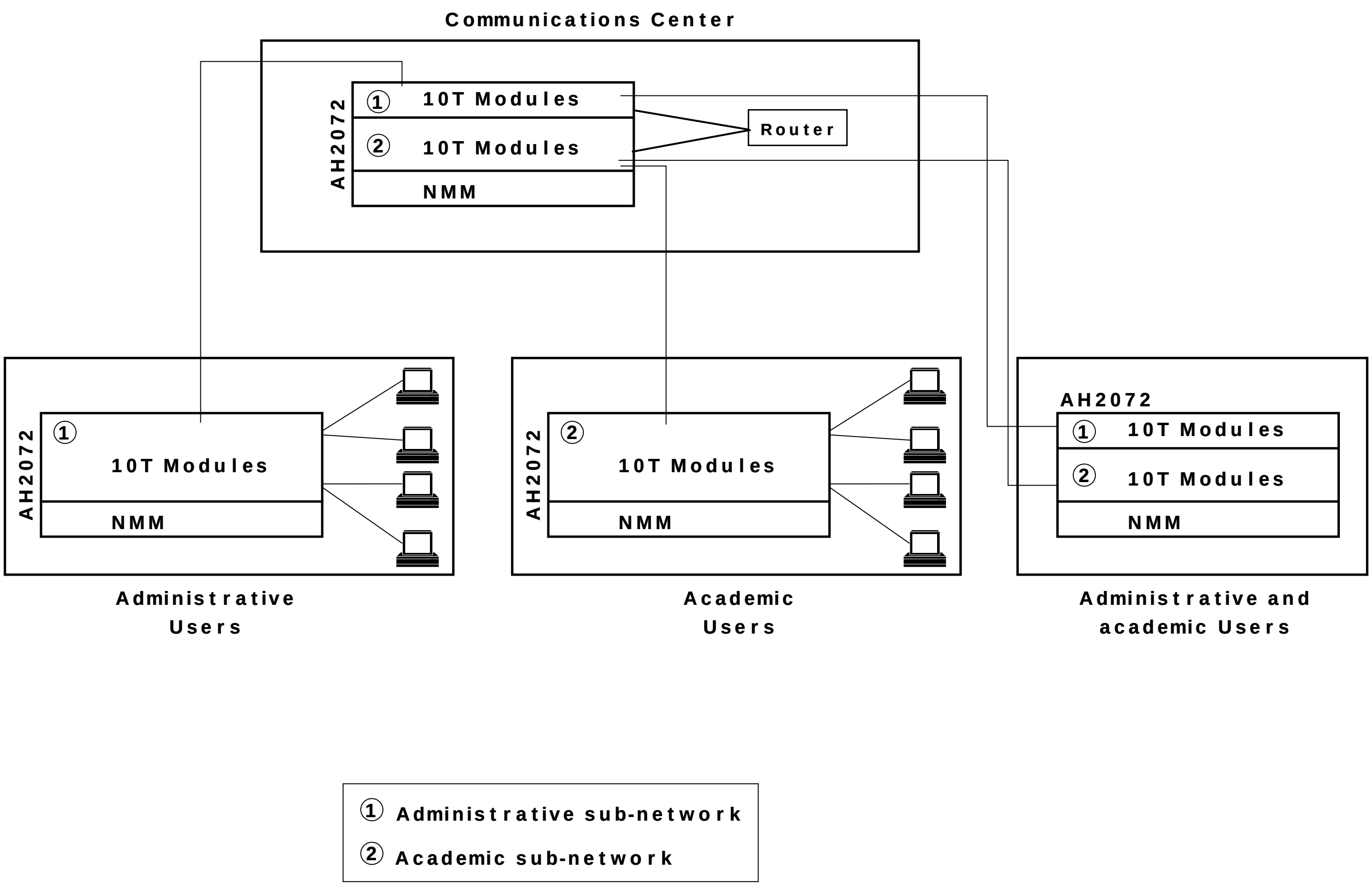



Figure 19 - Increasing Bandwidth

## Fast Ethernet Products

**Asanté Fast 100 Hub**
*Stackable Fast Ethernet Hub*

The Asanté Fast 100 Hub is a high-speed, stackable Fast Ethernet hub that provides ten times the performance over existing 10 Mbps networks. Available in two configurations: the Asanté Fast 100 TX Hub provides twelve 100Base-TX ports, while the Asanté Fast 100 TX/FX Hub provides eight 100Base-TX ports and one 100Base-FX port.

- Connect from eight to 180 users per stack.
- Stackable architecture allows linking of 2 stacks and supports up to 358 ports in one collision domain.
- Hubs stack together via an expansion card. No cabling is required.
- Built-in fiber connection on the Asanté Fast 100 TX/FX Hub provides reliable and cost-effective fiber connection to servers or backbones.
- Asanté Fast 100 Management Module snaps onto the hub stack for full SNMP management.
- Auto-partitions problem ports.

**Plug-and-Play Fast Ethernet Hubs**
*Unmanaged 100Base-TX Hubs*

The Asanté Plug-and-Play Fast Ethernet Hubs are high-speed six and twelve port 100Base-TX hubs that provide simple and risk-free introduction to Fast Ethernet performance.

- Plug-and-play – ready to run in minutes.
- 10 times the performance of 10Base-T.
- Supports cascading to another hub.
- Low port-to-port latency – traffic congestion and delays are minimized.

**Asanté Fast 10/100 Bridge**
*10Base-T to 100Base-TX Bridge*

The Asanté Fast 10/100 Bridge is a simple and affordable way to install a high-performance network for power-users while maintaining access to services on the 10 Mbps LAN, such as e-mail and printing. Also increases overall network bandwidth by segmenting workgroups. Automatically configures the 10/100 port for 10 Mbps or 100 Mbps operation, half or full duplex mode.

- Automatically performs speed-matching between the 10 Mbps and 100 Mbps segments and transfers data smoothly.
- Forwards data packets at full-wire speed for instant transfer with no delays.
- IEEE standard NWay Auto-negotiation feature crash proofs your network against incompatible connections.
- Automatic packet filtering only forwards data destined for the other segment.

**Asanté Fast 10/100 Adapter**
*Fast Ethernet Adapters for PC and Macintosh Computers*

The Asanté Fast 10/100 Adapter provides all-in-one compatibility to 10Base-T and 100Base-TX Ethernet networks. The adapter will function at 10 Mbps today and when the time comes, simply plug the network cable into a Fast Ethernet hub and the adapter will automatically reconfigure for 100 Mbps operation.

- Automatic migration from 10 Mbps to 100 Mbps networking.
- Models available for PCI-bus PC and Power Macintosh computers as well as NuBus Macintosh computers.
- Nway Auto-negotiation feature determines 10 Mbps or 100 Mbps operation.

## Switch

**Asanté ReadySwitch 5104**
*10Base-T Ethernet Switch with 100Base-T or 100Base-FX Fast Ethernet Link*

The Asanté ReadySwitch 5104 is a 4-port, 10Base-T Ethernet switch with a 100Base-T or 100Base-FX Fast Ethernet link. The ReadySwitch 5104 is simple to install on your existing network – no need for new wiring, adapters or a new management system. The ReadySwitch 5104 is ideal for networks with a high demand for server access. The ReadySwitch 5104 increases bandwidth dramatically and is an inexpensive, low risk solution to bandwidth problems.

- Instantly increases aggregate bandwidth.
- Plug-and-play installation is transparent to users.
- Supports simultaneous packet transfers at full Ethernet bandwidth.
- Fast Ethernet link to servers, backbone or power workgroups.
- High-performance CPU switching processor.
- 10 Mbps ports leverage existing network infrastructure.
- Manageable from any SNMP network manager or Telnet.
- Data packets forwarded at full wire-speed for instant transfer with no delays.
- Can be rack mounted; kit included.

## Intelligent Ethernet Hubs

**AsantéHub 2072**
*Chassis-Based Intelligent 10BaseT Hub*

The AsantéHub 2072 is a seven-slot, intelligent Ethernet concentrator expandable to 72 ports. Its chassis-based architecture gives you the flexibility to customize your network according to your needs. The AsantéHub 2072, combined with AsantéView network management software, offers a powerful and flexible system to intelligently manage your entire network.

The chassis design of the 2072 accommodates a network management module, repeater modules (10BaseT, 10Base2 and 10BaseF), and a bridge module, each of which will slide into any of the 2072's slots. The modules are hot-swappable so they can be easily replaced in the chassis without powering down the network.

- Dual-segment backplane that can create two completely separate networks within the AsantéHub 2072 chassis to segment traffic and optimize network efficiency.
- Asanté's unique out-of-band management feature, AMS LINK, which allows management of up to 12 AsantéHubs simultaneously.
- Chassis can be ordered with an optional redundant power supply.
- 10BaseT, 10Base2 and 10BaseF Mini MAUs slide into the recessed slots of the 2072 repeater modules to provide additional network connections.

**NetStacker**
*Stackable Multi-Segment Ethernet Hub*

The Asanté NetStacker is a stackable, multi-segment Ethernet hub. Designed for growing small to medium-sized networks, the NetStacker combines the modular growth capabilities, manageability and cabling flexibility of chassis-based hubs with the low entry cost of stackable hubs.

Up to three NetStacker chassis can be snapped together to build 24-, 48- and 72-port 10BaseT hubs. Since the NetStacker chassis accommodates the same 10BaseT, 10Base2 and 10BaseF hot-swappable repeater modules and 2-port bridge module as the AsantéHub 2072 chassis, making cabling and topology changes is easy.

- Multiple chassis snap together to build 24-, 48- and 72-port configurations.
- Operates as both managed and unmanaged hub. Add SNMP-based management module and AsantéView software at a later time.
- Two-segment backplane for creating two separate networks within the stackable configuration.
- Two-port bridge module for bridging the NetStacker’s two internal segments or an internal and external segment.
- Supports 10BaseT, thin and fiber-optic hot-swappable repeater modules.
- AUI and MAU ports on the repeater modules provide uplinks to thin, thick, UTP or fiber-optic network backbones.
- Managed via AsantéView management software from PC or Mac.

**AsantéHub 1016-IQ**
*Intelligent Ethernet Hub*

The AsantéHub 1016-IQ is a 16-port, intelligent 10BaseT hub that brings enterprise-level hub capabilities to departmental Ethernet networks. Working with AsantéView network management software, it offers power, flexibility and reliability at a very economical price. Start with the basic AsantéHub 1016-IQ and, as your network grows, add the AsantéView out-of-band and/or in-band management software, and the optional bridge and/or SNMP hardware modules. You only pay for what you need, when you need it.

- 10BaseT hub/bridge with 16 RJ-45 ports, one BNC and one AUI port.
- Manageable from AsantéView or any SNMP-compatible or Telnet console.
- Comprehensive LED display.
- Built-in SNMP support.
- Two uplink ports provide connections to thick, thin, UTP or fiber backbones.
- Flash EPROM allows for future software upgrades.

## Unmanaged Ethernet Hubs

**Asanté Plug-and-Play Hubs**
*Non-intelligent 10BaseT Hubs*

Asanté offers four non-intelligent, 10BaseT Ethernet concentrators for connecting your Macs, PCs and other workstations to a 10BaseT network. These hubs provide the most cost-effective way to build 10BaseT networks. All hubs are fully compliant with the IEEE 802.3 specifications for 10BaseT Ethernet.

- Asanté 10T Hub/24 offers 25 ports (24 UTP, 1 AUI).
- Asanté 10T Hub/12 offers 14 ports (12 UTP, 1 AUI, 1 BNC).
- Asanté 10T Hub/8 offers 9 ports (8 UTP, 1 BNC/AUI).
- Asanté BNC Hub/6 offers 7 ports (6 BNC, 1 AUI).
- No installation software required.
- Built-in auto-partitioning.
- Easily visible LEDs offer quick and easy troubleshooting.

**NetExtender**
*Portable 10BaseT Ethernet Hubs*

Asanté's portable NetExtender Hubs let you easily and inexpensively create a five node stand-alone Ethernet network, or connect four nodes to an existing 10BaseT network. Simply plug a NetExtender Hub into the AUI or AAUI Ethernet port of any PC, Macintosh, computer workstation, network printer or other device with Ethernet installed. Then connect additional 10BaseT Ethernet devices using UTP cable. The compact design of the NetExtender Hubs makes them ideal for small networks, temporary networks or extensions to existing networks.

- 100% compliant with IEEE 802.3 10BaseT Ethernet specifications and topologies.
- Support for either AUI or AAUI Ethernet ports.
- No external power adapter is required.
- Utilizes star topology.

## Network Management Software

**AsantéView**
*Network Management Software*

AsantéView is a network management software package designed to support all intelligent Asanté hub and bridge products. AsantéView allows network managers to gather network statistics and monitor network performance. With this information, managers can identify network problems before they become critical, investigate traffic bottlenecks and optimize the overall performance of their networks.

AsantéView is the industry's first graphical network management software package with both in-band (local) and out-of-band (remote) management capabilities from either Macs or PCs.

- Network health meters provide an overall picture of your network status in a single window on your desktop.
- 17 performance monitoring statistics make it easy to pinpoint errors and correct them quickly.
- Database logging establishes a baseline of performance statistics against which to compare network deviations.
- Built-in bridge management software can simultaneously manage multiple Asanté network bridges.
- Supports the widely accepted Simple Network Management Protocol (SNMP).
- Graphical out-of-band software lets you manage up to 12 AsantéHubs at once.
- Port intrusion controls and password protection provide network security.
- User-defined alarm thresholds and traps notify network managers of problems before they escalate. The software will even trigger your pager.
- Auto-discovery SNMP mapping polls the network and configures a network map with all AsantéHubs and their network addresses.
- AsantéView supports all Asanté SNMP-based products.

## Ethernet Adapters

**AsantéNIC-PCI**
*10 Mbps Ethernet PCI-bus Adapter for PC and Power Macintosh Computers*

The AsantéNIC-PCI Ethernet adapter is ideal for bandwidth-intensive applications which need high performance matched with low CPU utilization. Users can gain up to three times the processing speed when transferring large files across the network.

- Cost-effective solution for increased network performance.
- 32-bit bus mastering design provides maximum throughput without loading the host CPU.
- Easy to install – plug-and-play self configuration and auto-sensing for RJ-45 or AUI connection.
- Remote boot ROM socket allows diskless workstation to boot from the LAN server.

**EtherPaC**
*Ethernet Adapters for PC*

Asanté's EtherPaC adapter cards bring thick, thin and 10BaseT Ethernet connectivity to IBM and compatible personal computers. These cards are fully compatible with the industry-standard Novell NE2000 drivers and support Novell NetWare, Microsoft LAN Manager, NetBIOS (ISA only) and other popular network operating systems and protocols.

- Ethernet adapters supporting ISA personal computers.
- No jumpers or switches to set – fully software configurable.
- Remote boot PROMs allow diskless workstation to boot form a LAN file server.

**MacCon**
*Ethernet Adapters for Macintosh*

Asanté's award-winning MacCon adapter cards bring every type of Ethernet to every type of Macintosh.

- Support for all Macintosh platforms.
- MacCon-*i* cards for NuBus and LC Macs are designed with CHAMP technology, delivering optimal network performance.
- Auto-sensing ports and Asanté EtherTalk Installer software make installation easy.
- Support all popular network operating systems and protocols.

**FriendlyNet PC Card**
*Ethernet Adapters for Powerbooks*

Asanté's FriendlyNet PC Card provides superior performance and increased value when connecting Macintosh Powerbooks to Ethernet networks. Simply slide the card into the PCMCIA slot, snap on the connector, connect your Ethernet cable and you're set.

- Install in minutes – no software.
- Hot swap feature allows for insertion and removal of the card without turning off power.
- Maintains network connection during sleep mode.

**Desktop EN/SC and Micro EN/SC**
*SCSI-to-Ethernet Adapters*

The Asanté family of SCSI Ethernet adapters connect Macintosh PowerBooks and slotless Macs to an Ethernet network.

- Micro EN/SC measures a mere 3" x 2.5" x 1" and connects PowerBooks to thin and 10BaseT Ethernet networks.
- The Micro EN/SC does not require a SCSI cable or power supply.
- Desktop EN/SC includes two SCSI cables for slotless Macs.
- 100% compliant with the IEEE 802.3 specifications for Ethernet.
- Supports all popular network operating systems and protocols.

**FriendlyNet**
*Media Adapters for Built-In Ethernet*

Asanté's FriendlyNet media adapters connect any Macintosh, IBM PC, PC-compatible or printer with built-in Ethernet to an Ethernet network. FriendlyNet's plug-and-play design makes connecting to an Ethernet network simple.

- External media adapters for computers and printers with built-in Ethernet (AAUI port) support.
- Plug-and-play design makes installation a snap.
- Full family of adapters that support thick (AUI), thin (BNC) or UTP (10BaseT) networks.

**Micro AsantéPrint**
*Ethernet-to-LocalTalk Converter*

Micro AsantéPrint is an inexpensive Ethernet-to-LocalTalk converter that connects up to 8 LocalTalk printers (or other devices) to an Ethernet network. Because it does not have switches to set or software to load, it works right out of the box. And when you add Micro AsantéPrint management software you can assign passwords to any or all of the connected LocalTalk devices.

- Connects up to 8 LocalTalk devices to an Ethernet network.
- Includes AsantéPrint management and security software (System 6.0.7 or later).
- Supports AppleTalk Phase 1 and Phase 2.
- Supports all popular network operating systems and protocols.