

# **ATM Networking**

by

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Submitted to  
the Faculty of the Information Engineering Technology Program  
in Partial Fulfillment of the Requirements  
for  
the Degree of Bachelor of Science  
in Information Engineering Technology

University of Cincinnati  
OMI College of Applied Science

March 2000

# ATM Networking

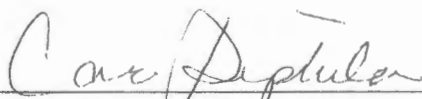
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## **Acknowledgements**

I would like to thank the NTS department of Cinergy for giving me the opportunity to complete this project within the company. I would like to thank my supervisors Grant Powell and Dennis Hulsman for giving me the responsibility of completing the ATM for Cinergy. I would like to thank Eric Bittlinger and Michael Slupski for working with me and providing me the ATM information that I needed throughout the project implementation. I would especially like to thank Dr. Ashraf Saad for guiding me through Senior Design as my advisor. I would like to say thanks to Dr. Sam Geonetta, Dr. Vladimir Uskov, Robert Schlemmer, and Kim Myers.

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## Abstract

This documentation discusses the aspects of design and implementation needed to develop an ATM network. The project's purpose was to stop network failures at *Cinergy's* Oxford office by implementing an ATM network, using *Cisco's* MC3810 multiaccess concentrator (a.k.a. Router). *Cinergy* originally planned to send both voice and data over the same network line by using the MC3810 Router. As *Cinergy* employees tested the other *Cinergy* networks throughout Indiana, they found that the quality of voice was much lower than expected. For this reason, only data—not voice—was implemented in Oxford, Ohio.

The MC3810, the LightStream 1010 Switches, and the 7513 Routers were configured to employ an ATM networking technology, which would transfer data from the main office in Cincinnati to the remote office in Oxford. The 2501 Router and the CSU/DSU were removed from the Oxford office, and one MC3810 Router replaced both devices. The ports and cables were connected properly at both Cincinnati and Oxford, and the network was tested. The ATM network was implemented correctly, and network failures have ceased.

This document explains the *Problem* and *Solution*, in terms of network design, Web site design, and user profiles. A *Review of Literature* contains the history, functionality, and characteristics of ATM. The "deliverables," budget, time line, software, and hardware are discussed. The *Proof of Design* includes *Visio Technical* drawings to visually document the physical characteristics and connections of each device within the ATM network. This document also describes the Web site, conclusion, hardware configurations, and ATM terminology.

# ATM Networking

## 1. Statement of the Problem

*Cinergy* was using Cincinnati Bell's LAN Advantage networking architecture to serve its site in Oxford, Ohio. This architecture was causing network failures to occur and leaving Oxford clients unable to connect to the network. *Cinergy* felt it needed to change the networking architecture, but a great deal of money, preparation, and time would be needed. In response, it needed to decide whether the *need* outweighed the time and cost necessary to build an efficient network. *Cinergy* was also planning to rid its network of the outdated *Cabletron* products it was using. Managers at *Cinergy* judged it necessary to have a uniform network with completely compatible hardware.

To solve this problem, *Cinergy* required a new network architecture to transfer data over the LAN and WAN. The network needed to support a maximum of 15 end-users at the *Cinergy* site in Oxford, OH. If the new hardware was compatible with old hardware, *Cinergy* would not need to purchase extra equipment to implement an ATM network. This network would have to be compatible with the devices shown in *Figure 1*, because *Cinergy* presently uses the devices at its main site in Cincinnati.

<b>Hardware</b>	Cisco LightStream 1010 #1	Cisco 7513 Primary Router
	Cisco LightStream 1010 #2	Cisco 7513 Secondary Router
	3 Com Intelligent Ethernet Hub	Cisco Catalyst 5500 #1
	Cincinnati Bell Smartbox (Phonebox)	Cisco Catalyst 5500 #2
<b>Cabling</b>	Shielded/Unshielded Twisted Pair- Category 5	Multimode Fiber 62.5-- optical cables
<b>Interfaces</b>	100 Base T—(Fast Ethernet)	10 BaseT—(Ethernet)
	OC-3—(SONET)	T1 leased lines—(DS-1)
	RJ45	RJ48x
	SC—Straight Connectors	

**Figure 1. This table shows the hardware, cabling, interfaces, and connectors used to design this project.**

## 2. Review of the Literature

The following sections review information about ATM networking. Section 2.1 has information about companies using ATM to implement voice and data within their network. Section 2.2 contains detailed information about the characteristics and functions of ATM.

### 2.1 Companies in history using ATM

*Ashton Communications Corporation* is a supplier of networking services it uses its own network to distribute advanced networking services to companies in Texas and Mexico. It offers ATM services, high-bandwidth Internet to transfer voice, video, and data. It uses the *Cisco MC3810* as a cost-effective solution. R.S. Ashton, the president of *Ashton Communications*, said, "With the deployment of a single box, a customer gains the full benefit of our ATM network. The *Cisco MC3810* installed easily and allowed us to quickly introduce data, voice and video services to a wide range of customers" (2, pg 1-2).

In 1997, *Burlington Coat Factory* decided to move from a satellite network to a multiservice network in order to gain more bandwidth for Web applications. It economically chose to use voice, data, and video integration to add speed to their network. The CIO of *Burlington Coat Factory* stated that multimedia integration cut the costs of the network in half. It has saved the company an estimated \$50,000 a month and has increased its bandwidth.

*Hannaford Brothers* chose to use the MC3810 Router to increase its bandwidth and to use an OC-3 line to bring 155 Mbps into the corporate office. Forty-six of the stores have been reconfigured to use the ATM network. It has 80 times more bandwidth than before, and the data transmission has risen from 19.2 Kbps to T1 speed.

*Amcore* realized that sending voice and data over *separate* networks was not economical. Managers realized they could save money if they changed to voice-over-IP implementation. Due to this change, they have saved over \$70,000 a year (15, pg 1-2).

## **2.2 ATM – Detailed Information about Characteristics and Function**

ATM (Asynchronous Transfer Mode) is a high-speed, packet-switching network technology that uses short fixed-length packets called cells. Fixed-length cells reduce the delay and jitter for delay-sensitive services such as voice and video. These short cell lengths allow switches to know where (in the cell) to split the header and where to forward the cell. Also, the cell contains data that allows each switch or router to know the start and destination of each cell.

ATM is designed for both LANs and WANs and it supports data, voice, and video. ATM uses switches that establish a logical pathway from end to end. This pathway guarantees that each data or voice cell will be transmitted with a Quality of Service

(QoS). In comparison, telephone switches dedicate circuits end to end, but ATM switch appropriate bandwidth whenever it is available. With ATM, data and voice packets can choose the correct path allowing them to arrive at their destination quickly and reliably. ATM is also scalable and supports transmission speeds of 1.5, 25, 100, 155, 622, and 2,488 Mbps. The subtopics 2.2.1 – 2.2.15 that follow discuss how ATM functions in further detail.

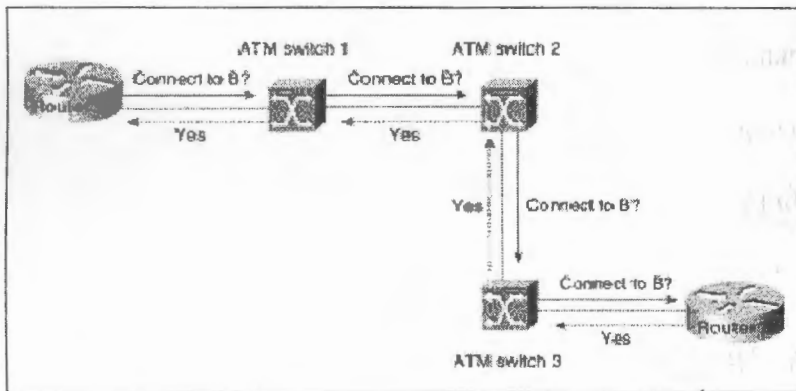
## 2.21 ATM Signaling and Connection Establishment

ATM routing protocols route connections based upon destination addresses, source addresses, traffic parameters, and QoS parameters requested by the source end-system. When an ATM device needs to establish a connection with another device on a network, such as a router or switch, it sends a signaling request packet to its directly connected ATM switch. This signaling request contains the ATM address of the desired ATM endpoint and the QoS parameters required to establish the connection. Refer to *Figure 5* to view a diagram that shows how routers and switches use ATM signaling to setup a connection. Basically, the switch segments the information into fixed-length cells (packets), transports it to its destination, and reassembles it at the destination. The signaling and connection process is explained below:

1. The source end-system sends a connection-signaling request.
2. The connection request is generated through the network.
3. The switch segments the original data into smaller packets.
4. The switch labels the packets with a sequence order and a destination address.
5. The switch sends each individual packet on a network path to its destination.

6. The switch, router, or end-system reads the packet header when it is received.
7. The destination either accepts or rejects the connection request.
8. The data packets are reconstructed and missing packets are re-sent.

Only the packets containing errors must re-send data and it not necessary to retransmit large amounts of data. This simplifies error recovery and accelerates communication. The small, 53-byte size of these packets also reduces the time required by each switch or router to receive, analyze, and retransmit them (13, p 1-2).



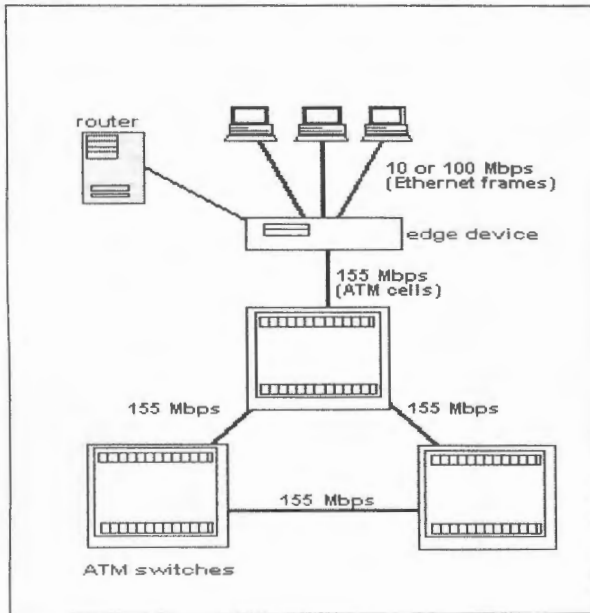
**Figure 2. This diagram shows how routers and switches use ATM signaling to setup a connection.**

### 2.2.2 Virtual Channel Connections and Virtual Paths

A virtual channel connection is a series of virtual channel links between two ATM points. Virtual channel links transport ATM cells between their starting point and their ending point. At the starting switch, a virtual channel identifier (VCI) value is assigned. As the cell travels through the network, it stops at several devices and receives a VCI. This VCI either sends the cell to another location or terminates its movement.

VCC's are sometimes transported within virtual paths. A virtual path identifier (VPI) identifies its virtual path. Virtual paths provide bundle traffic (cells of traffic) directed in the same destination or requiring the same Quality of Service (QoS) in the

network. Refer to *Figure 3* for a visual topology of an ATM network containing switches and routers.



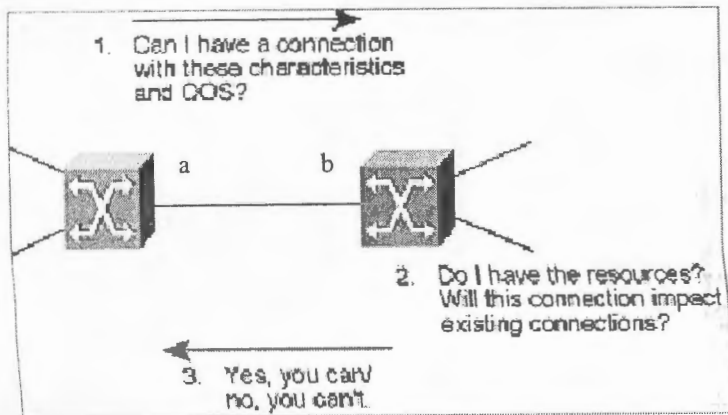
**Figure 3.** This diagram represents the ATM topology.

### 2.2.3 ATM System Architecture

ATM is a layered architecture that allows voice, data, and video to be mixed over the same network. Three lower layers specifically implement the ATM features: the adaptation layer, ATM layer, and physical layer. The Adaptation layer ensures the Quality of Service characteristics and divides data into the 48-byte payloads that makes up the ATM cell. The ATM layer adds a 5-byte header to the data being sent and ensures that the cell is sent on the right connection. The Physical layer defines the electrical characteristics and network interfaces by putting either data or voice through the cabling.

## 2.2.4 Quality of Service (QoS)

ATM is able to specify a Quality of Service to transmit voice and video smoothly over the network. There are five parts to QoS: Constant Bit Rate (CBR), Available Bit Rate (ABR), Unspecified Bit Rate (UBR), and Realtime Variable Bit Rate (rt-VBR), and non-realtime variable bit rate (nrt-VBR). CBR guarantees bandwidth for voice and video. ABR adjusts bandwidth according to congestion levels for LAN traffic. UBR provides the best route between the two devices. Rt-VBR supports interactive multimedia that requires minimal delay, and nrt-VBR is used for bursty transaction traffic. *Figure 4* shows two switches: *Switch a* and *Switch b*. *Switch a* sends a message asking *Switch b* for a connection. *Switch a* gives its characteristics and QoS requirements to *Switch b*. *Switch b* checks to see if it can accommodate *Switch a*; and it checks whether the new connection will impact any other connections on *Switch b*. If *Switch b* has the correct resources, and if the new connection will not effect other connections, then, yes, *Switch a* can send its data or voice packets to *Switch b* (and vice versa).



**Figure 4.** This diagram represents the QoS that occurs with an ATM architecture.

### 2.2.5 Comparing Networking Technologies

ATM (Asynchronous Transfer Mode) contrasts with STM (Synchronous Transfer Mode) because it designates channels throughout the network. STM divides network channels into frames (fixed time periods). STM assigns each network user a designated time slots within each frame. The time slots designated to each user occur at the same time in every frame; these time slots are synchronous.

With STM, users can access the network channel only when a time slot that has been originally designated to them is available for use. For example, *User A* can send messages over the network channel only during the time slot(s) designated for *User A*. If *User A* is not ready to send traffic when the designated time slot occurs, the time slot is unused. If *User A* has a burst of traffic that exceeds the capacity of the designated time slots, additional slots cannot be used, even if the other time slots are inactive. Therefore, a long delay could occur before the burst of traffic is sent over the STM network channel.

With ATM, access to the network channel is more flexible. Any user needing the network channel can use it whenever it is available. In contrast to STM, ATM does not force a fixed pattern on the way users are given access to the network channel. ATM is known for providing bandwidth on demand, because the user does not need to wait for their designated channel to be open for use.

In other packet-handling technologies, such as High-Level Data Link Control (HDLC), any user can gain access to the network channel. However, a user sending long message can prevent others from gaining channel access until the entire message has been passed through the channel. With ATM, every message is divided into small, fixed-length cells. Thus, no single user can monopolize the network channel.

## 2.2.6 The ATM Cell – In Greater Depth

The ATM cell is the fixed-length transmission unit. The ATM cell consists of two types parts: the payload and the header. The payload carries the data or voice information to be transferred through an ATM network. The header carries the information that routes the cell through the network and ensures that the cell is forwarded to its correct destination.

Every ATM cell is 53 bytes long. The first five bytes contain header information, which contains several different fields. The remaining 48 bytes contain the payload, which contains user data. The following two figures show the parts of an ATM cell, *Figure 5*, and the parts of the cell header, *Figure 6*.



**Figure 5. This figure is a diagram of an ATM cell.**

Part of Header	Description
VPC (Virtual Path Connection)	A group of virtual connections carried between two points
GFC (Generic Flow Control)	Controls traffic flow across the network interface.
VPI (Virtual Path Identifier)	Identifies a particular VPC VPIs provide a way to bundle traffic heading to the same destination.
VCI (Virtual Channel Identifier)	Identifies a particular VCC.
VCC (Virtual Channel Connection)	A connection between two active, communicating ATM entities.
PT (Payload Type)	Indicates the type of information in the payload field.
CLP (Cell Loss Priority)	CLP indicates the eligibility of the cell for discard by the network under congested conditions.
HEC (Header Error Control)	Contains an error-correcting code. It detects multiple-bit header errors and corrects single-bit errors.

**Figure 6. This table shows the parts of an ATM cell header.**

### **2.2.7 OSI Layers**

ATM uses protocols that operate at the data link layer of the seven-layer Open Systems Interconnection (OSI) reference model. The data link layer is concerned with transmitting data between two network switches. The data link layer transports *portions* of messages (fixed-length cells) between two points in the network. The data link layer may also divide higher-level data into smaller cells, whose sizes are compatible with overall network requirements.

### **2.2.8 Data Placement into ATM Cells**

Before frames can be sent across an ATM network, the frames must be divided into ATM cells. The processes of dividing the frames into cells occur at the two parts of the data link layer, the ATM adaptation layer (AAL) and the ATM layer. Once frames are divided into ATM cells, the cells are ready to be transferred to the physical layer.

### **2.2.9 The ATM Adaptation Layer**

The AAL accepts frames from higher OSI layers and adapts them to the 48-byte segments that are placed into the payload field of ATM cells. The ATM layer accepts the 48-byte segments, adds the 5-byte header, and produces the entire ATM cells to be transferred to the physical layer.

The AAL is divided into two sublayers: the convergence sublayer (CS) and the segmentation and reassembly sublayer (SAR). The convergence sublayer (CS) accepts higher layer traffic for transmission across the network. The SAR segments the packet. When the AAL receives the cell payloads, the AAL removes any AAL-specific information from each payload and reassembles the entire packet before passing it the ATM layer.

## 2.2.10 The ATM Layer and the ATM Physical Layer

The ATM layer accepts the 48-byte SAR protocol data units from the SAR process. This layer adds a 5-byte header to each. Lastly, it produces ATM cells and transfers the cells to the physical layer. At the physical layer, the cells are placed onto a physical transport medium (i.e., fiber optic cable). This process of placing cells onto the physical medium occurs in two sublayers: the physical medium dependent (PMD) sublayer and the transmission convergence (TC) sublayer.

Each PMD sublayer is specific to a physical medium and includes standards of cabling and bit timing. The TC sublayer generates/receives transmission frames and performs all of the following functions associated with the transmission frame: cell delineation, cell rate decoupling, header error control, and various operation/maintenance functions.

## 3. Description of the Solution

The following two sections describe *what* the solution is and *why* this solution was chosen.

### 3.1 What is the Solution?

The solution was to implement an ATM (Asynchronous Transfer Mode) network between Oxford and Cincinnati, Ohio. The ATM network is capable of integrating data, voice, and video, while improving speed, bandwidth, and traffic management.

Integrating voice and data over the same network is less expensive than using separate implementation. *Cinergy* is already using *Cisco* products; as a result, their goal is to completely change to all *Cisco* products. For *Cinergy*, implementing ATM using *Cisco* products is affordable and efficient because the *Cisco* hardware pieces will already be compatible. To fully implement ATM between Oxford and Cincinnati, it was only

necessary to add one piece of hardware to the network: the *Cisco* MC3810 Multiservice Access Concentrator. It replaced the *Cisco* 2501 router and the CSU/DSU located in Oxford, Ohio. The MC3810 is capable of routing data, voice, and video over the same network connection. *Cinergy's* present network is compatible with both the MC3810 router and the ATM architecture. Because of this compatibility, network costs remain low and extra time is not needed to restructure the entire network.

### **3.2 Why This Solution?**

ATM (Asynchronous Transfer Mode) is a high-speed cell switching technology designed to combine the benefits of circuit switching with those of packet switching. Cell switching combines the two by creating ATM fixed-sized cells from packets after the packet switching occurs. The packet switching process concerns splitting large data into many smaller packets before it is transmitted over the network. This process accelerates the communication process because it makes error recovery simple. By segmenting large packets into smaller packets, *only* the packets containing errors must be re-sent. It is not necessary to retransmit large amounts of data; this makes the process of recovering from errors fast and easy. Circuit switching promises guaranteed bandwidth capacity. ATM cell switching also improves bandwidth, and provides multimedia integration and traffic management. The following benefits of ATM are listed below:

1. A Single Network -- ATM provides a single network allowing integration, efficiency, and manageability of all traffic types-voice, data, and video.
2. Voice Integration using MC3810 -- Before *Cisco* created the MC3810 a single voice channel consumed the entire 64 Kbps of bandwidth available on each network link. With *Cisco's* compression technology, voice can be compressed to eight Kbps; compressing voice into packets reduces the amount of bandwidth used, while maintaining its high quality and leaving bandwidth available for data and video transmission.

3. Networking advantages -- ATM is a switching and routing process based on the virtual channel identifier (VCI) in the cell address, which increases message-handling speed.
4. Enables new applications -- Due to its high speed and the integration of traffic types, ATM enables the creation and expansion of new applications such as multimedia and video to the desktop.
5. Overall compatibility -- Because ATM is not based on a specific type of physical transport, it is compatible with currently deployed physical networks.
6. Compatible with T1 lines and Multiplexing -- ATM is compatible with the T1 lease lines, which have 24 individual channels that are capable of transmitting data. The multiple channels allow a signal to subscribe to one or more channels depending on the amount of bandwidth needed. ATM allows this bandwidth to be shared through multiplexing. Multiplexing enables several communication streams to travel simultaneously over the same cable network.
7. Optical Carrier Levels -- Optical Carrier Levels (OC) define data rates. OC technology offers transmission speeds in multiples of 51.84 Mbps using fiber-optic cabling. Within *Cinergy's* network, OC-3 provides a transmission speed equivalent to 3 times the rate of 51.84, which equals 155.52 Mbps.
8. TCP/IP compatible -- *Cinergy* uses TCP/IP (Transmission Control Protocol/Internet Protocol) to provide addressing and routing information, error checking, re-transmission requests, and rules for communicating in a particular network environment. It handles message fragmentation/reassembly and guarantees that packets are correctly reassembled.
9. Provides a Quality of Service -- Quality of Service (QoS) is a key component of ATM. It handles traffic, congestion avoidance, policy-based routing, and compression techniques.
10. Scalability -- ATM is a network that is prepared for more complex, high-speed requirements, and more equipment as the company/institution grows.
11. Simplified Network Management -- ATM is evolving into a standard networking technology. This uniformity simplifies network management.
12. Bandwidth Efficiency -- ATM provides better use of bandwidth by allowing any user network access whenever resources are available. By breaking traffic into small, fixed-length cells, ATM prevents a user with a long message from blocking network access.

### 3.3 User Profile

Many audiences will view the ATM project and Web site; however, some audiences may have a different understanding of the project than others. Out of the six groups listed, it is likely that most users will find it easy to navigate through the Web site using hyperlinks.

The **average student/professor** will be able to use the database information within the site, but the user may not fully understand the networking information.

**Information Technology (IT) students** will be able to utilize the database information within the site, and they will be familiar with the networking terms, and coding for Web sites. **IT professors** will probably have more knowledge than an IT student, because of more experience in the IT field. They will be familiar with networking terminology, databases, and coding for Web sites. **IT students and professors with networking skills** will have the most knowledge about networking terms and functions, hardware, configurations, interfaces, cabling, and connections. They will be familiar with using a database and coding for Web sites. **IT students and professors with database skills** will have more knowledge concerning how Visual InterDev is integrated with a SQL Server database. They will be familiar with database information, networking terms, and coding for Web sites. **IT students and professors with programming skills** will have most knowledge about writing code for a Web site. They will be familiar with Visual InterDev and database integration, and networking terms

### 3.4 Design Protocols

The network and software design protocols are listed and described in the following two sections 3.2.1 and 3.2.2.

### 3.4.1 Network Design

The table in *Appendix C* lists the hardware, cabling, and interfaces used for the networking side of the Senior Design Project.

### 3.4.2 Web Site (Software) Design

The table in *Figure 7* explains the design of the Web site, which was created in *Microsoft Visual InterDev*. This program integrated *SQL Server*, *Visio Technical*, *Visual Basic Scripting*, and *HTML* to create a functional Web site. This Web site will help explain all concepts concerning the ATM project.

<b>Color Scheme</b>	--Located within <i>MS InterDev Style Sheets</i> . The style sheets set a consistent design for the Web pages created. --Background: Light gray --Main heading: Firebrick red capitol letter at 65-point <i>Times New Roman</i> font. Followed by Black lowercase letters in 30pt <i>Times New Roman</i> font.
<b>Graphical Navigation</b>	Graphical symbols will not be used for navigation. A global navigation bar will be used to replace the graphical navigation symbols.
<b>Graphical Images</b>	Images of hardware will be inserted into the hardware information pages. <i>Visio Technical</i> will display detailed drawings of each piece of hardware.
<b>Font</b>	<i>Arial</i> font will primarily be used for the text in paragraphs.
<b>Site Diagram</b>	A <i>site diagram</i> will be used within MS InterDev as a flow chart to keep record of the navigational organization (Refer to <i>Appendix B</i> )
<b>Database Integration</b>	<i>SQL Server</i> will be used to integrate ATM database information into <i>MS InterDev</i> .
<b>Hardware Drawings</b>	<i>Visio Technical 2000</i> software will be used to display drawings of the network & hardware.

**Figure 7. This table shows the Web site (software) design of the ATM project.**

## 4. Objectives of the Project (“Deliverables”)

I will design and implement an ATM network for the *Cinergy Corporation* between the *Cinergy* sites in Cincinnati, Ohio and Oxford, Ohio. Network installation and configuration will be completed in a timely manner. Drawings will also be created to

document the hardware used and the connections made during the installation of the network. The ATM network will do the following:

- Integrate voice and data while maintaining the quality of communication
- Use QoS to maintain and increase data quality
- Maximize bandwidth using QoS and voice compression
- Improve the data sharing across multiple types of computers
- Carry all traffic types: data, voice, video
- Support multimedia and high-speed communications (OC-3)
- Be cost-effective and scalable.

To explain how I designed and implemented the ATM network, I will design a Web site using *Microsoft Visual InterDev 6* software. This Web site will be developed in such a way that the user can navigate through the pages in an organized manner. Most of the main Web pages will contain information that is explained in an explanatory manner for all audiences. However, other pages containing subtopics may be considered complex to an individual who is not familiar with ATM. This site will also contain a *Help* section, which will provide ATM definitions, resources, and indexes for the user.

The *Microsoft Visual InterDev* software will use HTML, design concepts, and *Visio Technical* software to create an educational Web site about ATM. The site will also integrate *SQL Server* and *Visual Basic Scripting* to establish a dynamic and/or static environment where the user can navigate through the database.

The site will explain the design process the ATM project. For example, the site will explain the original problem, the solution, the problems with the original solution, and the procedures and methods used. The site will compare the ATM architecture to other architectures and it will compare the MC3810 to other routers. These comparisons will help explain why the ATM architecture and the MC3810 were chosen. The Web site will list and explain the benefits of ATM and how ATM functions.

*Visio Technical* will show the network map layout and the intricate details of each piece of hardware used for the network, and these drawings will be presented in the Web site. The configurations will show how each piece of hardware was configured (programmed) so that data could be transmitted through the network. A conclusion will be provided to give a summary of the problem, solution, action taken, and the result.

## 5. Design and Development

The next four subtopics discuss the budget, the timeline (tasks and schedule), software, and the hardware used as guidelines and tools to complete this project.

### 5.1 Software Budget:

The following software was used to complete the ATM Web site:

Software Type	Access to Software
Microsoft Visual InterDev 6	Owned by the College of Applied Science—IET Department
SQL Server	Owned by the College of Applied Science— IET Department
Visio Technical	Must be purchased for the Information Technology Department

**Figure 8. This table shows the software needed to complete the project.**

#### 5.1.2 Hardware Budget

All hardware costs were handled by the IT—NTS department at *Cinergy*. *Figure 9* list the costs associated with the MC3810. *Figure 10* shows maintenance and lease line.

Cost	Detail
\$ 1,600.00	3810 Chassis
\$ 1,500.00	3810 IOS Software for: ATM, Voice, IP & IPX
\$ 400.00	16M flash upgrade
\$ 400.00	Multiflex Trunk with RJ48 and BRI interface
\$ 400.00	Voice compression module
\$ 64.00	E&M analog personality module
\$ 64.00	FXS analog personality module
\$ 250.00	6-port analog voice interface
<b>\$ 4,678.00</b>	<b>TOTAL</b>

**Figure 9. This table shows costs for the MC3810: Data and Voice**

<b>Annual Maintenance</b>	\$ 160.00	Per year
<b>T1 lease lines</b>	\$ 500.00	Per month

**Figure 10. This table shows maintenance and lease line**

## 5.2 Timeline (Tasks and Schedule)

The following three sections explain the time frames in which the research, design, and analysis of the ATM project were completed.

### 5.2.1 Research – February-June 1999

- Preliminary research for choosing project topic: February/March 1999
  - ♦ Network type, size, speed, and scale and hardware requirements
  - ♦ Network cabling, hardware compatibility and interface requirements
  - ♦ Characteristics and benefits of network structures
- Research used for the project proposal: April/May 1999
  - ♦ History of networking structures
  - ♦ Characteristics, functions, and benefits of an ATM network and hardware
  - ♦ Timeline, budget, installation/configuration of hardware: June 1999.

### 5.2.2 Design – June-July 1999

- Map out cable and hardware layout
- Produce Visio drawings for cable/hardware documentation

- Removing old hardware and install/configure new hardware equipment.
- Testing the hardware and the network

### 5.2.3 Analysis -- October-February 2000

- Configuration details concerning each hardware piece: October 1999
- Database created to deliver ATM facts to the public: November 1999
- Web site created to deliver the project to the public: November 1999-February 2000
- Visio drawings of all pieces of hardware completed in detail: February 2000
- Proof of design and conclusions completed: February 2000
- Professional copies of project documentation created: February 2000

### 5.3 Software

Function of the Software	Software
Web Site Development	<i>Microsoft Visual Interdev.</i> Web Site located at <a href="http://129.137.100.161/CaraDB/ATM Home Site">http://129.137.100.161/CaraDB/ATM Home Site</a>
Database Development	<i>Microsoft SQL Server</i>
Hardware & Network Drawings	<i>Visio Technical 2000</i>
Hardware Configurations	<i>Hyperterminal</i>

**Figure 11. This table reviews the software and its functions used for the ATM project.**

### 5.4 Hardware

The table in *Appendix D* lists the hardware, cabling, and interfaces that were used to complete the ATM project. Sections 5.4.1 through 5.4.7 explain the hardware in greater detail.

#### 5.4.1 The 2501 Router

The *Cisco 2501 Router* provides communication solutions for remote office sites. The 2501 supports many interfaces, but it does not support ATM. The data traveling across the network cannot travel 155 Mbps, which is the minimum speed of an ATM network. Extra hardware, such as the CSU/DSU, is needed transmit data across the network when using a 2501 Router. The 2501 Router was replaced by the MC3810.

### **5.4.2 3Com Intelligent Ethernet Hub**

The 3Com Intelligent hub is designed for remote offices that are conscious of networking costs. For the Oxford site, the standard hub is ideal because the cost is low. The 3 Com Hub offers 10 to 100 Mbps allowing users to migrate to higher speeds when needed. This hub has a compact design, which saves space. This hub allows small offices to share information, connect to remote offices, and access the Internet. Networking allows the Oxford office to modernize their operations, manage cost and resources, and increase communication between offices.

### **5.4.3 The 7513 Router**

A router is a hardware device that connects separate networks that function separately. However, the users can exchange information between the networks. Routers can connect networks using different media and networking architectures. The router uses the node and network addresses of each computer to route information packets from their source address to their destination address. When routers receive packets, they analyze the packet's destination address, repackage the data into frames, and send the data onto the network. For this project, *Cinergy* uses the *Cisco* 7513 Router. It is a 13-slot router that supports multiprotocol, multimedia routing using the TCP/IP protocol and Asynchronous Transfer Mode (ATM).

### **5.4.4 Catalyst 5500 Switch**

The Catalyst 5500 is uses a switching platform and integrates extremely well with the LightStream 1010 switch. It supports and provides up to 800 Mbps point-to-point connections between Catalyst 5500 switches and switches to routers. The Catalyst 5500 Switch uses a clean migration path to support the Ethernet, switches, and high-speed

ATM modules. This means that the Catalyst is able to deliver the bandwidth and scalability required for large network and mission-critical environments.

#### **5.4.5 CSU/DSU**

A CSU/DSU (Channel Service Unit/Data Service Unit) is a device that converts digital data frames used on a LAN into frames to be transmitted to a WAN (vice versa). The Data Service Unit (DSU) manages line control, and converts input/output between the frames from the LAN and the frames on the T-1 line. The DSU manages timing errors and signal regeneration. The Channel Service Unit (CSU) receives and transmits signals from/to the WAN and provides a barrier for electrical interference. This CSU/DSU device provided isolation between *Cincinnati Bell's* network and *Cinergy's* 2501 Router in Oxford, Ohio. However, the MC3810 replaces the CSU/DSU at Oxford, because a CSU/DSU actually exists within the MC3810 router.

#### **5.4.6 The LightStream 1010 Switch**

A switch is a hardware device that keeps track of which hardware addresses are located on which network segment. An ATM switch is responsible for cell transit through an ATM network. A switch only sends a packet down a network segment on which a computer is located. The switch can dedicate 10 Mbps of bandwidth to each port on the switch. This ensures that the maximum bandwidth is always available to all computers on the network.

The LightStream 1010 Switch serves as the medium (conduit) for end-systems and routers. The switch contains slots, which specifically control specific device functions. The main slot is dedicated to an ATM switch processor (ASP) module that supports 5 Gbps to 40 Gbps of shared memory and switch fabric. The central slot has a

high-performance processor, and two upgradeable feature cards that provide the routing intelligence for this ATM switch architecture. One feature card supports traffic management and provides flexibility for client/server traffic patterns. The other feature card which supports traffic shaping and QoS policies. The LightStream 1010 supports traffic management, signaling, and routing. It specifically supports the following mechanisms, which help deliver QoS on demand: connection admission control, support and congestion control, intelligent packet discard, and traffic pacing.

#### **5.4.7 The MC3810 Multiservice Access Concentrator**

The *Cisco* MC3810 is a multiservice access concentrator that integrates voice, data, and video onto private ATM networks. It is used as a T1 router and a serial data device that allows for *Cisco* based multiprotocol routing. The *Cisco* MC3810 contains two serial ports for packet data protocols, and its quality of voice compression is set as low as 8 kbps. The MC3810 provides echo cancellation for voice channels using voice activity detection (VAD). VAD halts voice traffic during the silence between words and sentences in speech to conserve bandwidth. However, this feature was not apparent when the MC3810 was tested. The MC3810 is effective for changing technology because it can be reconfigured without making changes to the hardware. It is most effective when it is used with other *Cisco* products, because it shares the same software management interface as other *Cisco* products.

### **6. Proof of Design**

The following subtopics concern the ATM Web site that was designed and developed to thoroughly explain the ATM networking project. The ATM Web site is

located at the following url: <http://129.137.100.161/CaraDB/ATM Home Site.htm>. A

brief paragraph below each subtopic explains how the topic is relevant to the Web site.

## **6.1 Web Site – Site Diagram**

The Site Diagram is a page within *MS Visual InterDev* that allows the Web site creator to organize the Web site pages. The Site Diagram can be found in Appendix B.

## **6.2 ATM Home Site**

This is the *home* page of the Web site. This page has hyperlinks to the main topics throughout the ATM Web site. The following sections of the Web site listed in a table are *Project Design Process*, *ATM & MC3810 Information*, *ATM Hardware Used*; *Hardware Configurations*; *Cinergy's Network map & Visio Technical Drawings*; *Cabling, Connections, & Device Locations*; and a *Help* section. The subtopics are also provided in outline form on this page; however, there are no hyperlinks to the subtopics (due to organizational purposes). This page also provides a hyperlink to a page containing information about the *Cinergy Corporation*.

## **6.3 Project Design Process**

This page has links to the *Problem & Solution*; *ATM Integration Process & Solution Complications*; *Procedures/Methods*; *Conclusions*; and *Abstract*. On these pages, the each topic is explained in detail. The *Project Design Process* allows the thought process of project implementation to be reviewed. This entire section explains where the problem was derived from, what the proposed solution was, how ATM should function and why the proposed solution was a problem, what procedures and methods were used to implement the ATM project, and the conclusion.

## 6.4 ATM & MC3810 Information

This page has links to the subtopics *ATM Information* and *MC3810 Information*. The ATM section explains ATM in both general and detailed terms. The history and the benefits of ATM are explained and the ATM architecture is compared to other architectures. Comparing the architectures helps the user understand why ATM was the networking architecture chosen.

The section concerning the MC3810 explains why using the MC3810 Router was a better choice than using another router. It provides both general and detailed information about the MC3810, and explains why the MC3810 is considered the network's key hardware piece. This section identifies the MC3810's parts and their costs. An active server page within this section lists the characteristics, ports, and cables of the MC3810. All of these subtopics explain why implementing ATM by using the MC3810 was more effective than other routers.

## 6.5 Active Server Pages (Cabling, Connections, and Visitors' Page)

This section has a many active server pages (ASP's) that contain either dynamic or static information, which resides in a SQL Server database. The ASP pages explain the characteristics, cabling, connections, ports, interfaces, and locations of the ATM network. The ASP pages allow the user to scroll through the records listed in the database. This section documents the devices that are connected and how they are connected to each other. The pages document the amount of bandwidth provided, the network pathways used, and the other characteristics of the connections. There is also a dynamic ASP page that allows the user to add, delete, or update their *Visitor Information* in the database.

## 6.6 Configurations

The Configuration main page links to other pages that document and explain the configuration commands, network functions, and configurations of the following devices: *MC3810 Router*; *LightStream 1010 #1 and #2 Switch*; and the *Primary* and *Secondary 7513 Router*. The configurations are listed in Appendices *E*, *F*, *G*, and *H*.

## 6.7 Hardware

This section has an image map, in which parts of the image link to various pages containing information concerning a particular device used for the ATM project. This map allows the user to navigate to the hardware device that they would like to learn about. The following subtopics are presented: *MC3810 General Information*; *LightStream 1010 Switch*; *CSU/DSU*; *Catalyst 5500 Switch*; *2501 Router*; *3Com Ethernet Hub*; *7513 Router*; and *Cincinnati Bell Smartbox*.

## 6.8 Network Layout and Visio Hardware Drawings

This page has hyperlinks to the Cincinnati networking site, Oxford networking site, and the overall network layouts. The overall network layout section contains the following two drawings: (1) *Cinergy's* wide area network and (2) the hardware connections between the Cincinnati and Oxford sites. On the second drawing, the following details are documented: network interfaces, cable types, and PVC's. The other drawings all document the visual details of each hardware device used for the *Cinergy* and Oxford sites. The user can also view complete drawings of the entire network in Cincinnati, and the entire network in Oxford.

## 6.9 Help

The help page has four subtopics: *Links to Resources*; *Term Index*; *Site Navigation*; and *alphabetized definitions*. The alphabetized hyperlinks are provided in a table; the user can click on the appropriate letter of the alphabet that will help them find the definition of an ATM term. The Term Index gives a listing of all the terms defined within the glossary section. The site navigation page explains the hyperlinks, buttons, and global navigation bars used to help the user navigate throughout the site and learn more about ATM.

## 7. Conclusions

I designed and implemented an ATM network for the *Cinergy Corporation* between Cincinnati, Ohio and Oxford, Ohio. Network installation and configuration was completed within the two to three months. The ATM network was initially implemented to integrate voice and data, while maintaining the quality of both types of communication. The ATM network was originally planned to compress voice to use 8 Kbps of bandwidth. Prior to implementing the ATM network in Cincinnati, the ATM network was installed at the *Cinergy* sites in Indiana. The Indiana network was used as a trial network used to test both voice and data transmitted simultaneously over the same connection. The MC3810 multiservice access concentrator was the device used to send voice and data over the same connection. In Indiana significant problems arose when the voice packets were compressed to 8Kbps. When compressed, the voice packets were separated and divided; therefore, the voice packets were no longer recognized as "voice" (ringing, voices, dial tones, etc. could not be heard). Compressing voice to use 8 Kbps of bandwidth caused too much degradation. To resolve the problem, the MC3810 router was configured to transmit voice at 32 Kbps. This seemed as if it might work; however,

the same problems occurred. Unfortunately the quality of voice was proven to be poor when integrated with data using the MC3810. The ATM networks were installed at *Cinergy* sites throughout the state of Indiana. *Cinergy* used the MC3810 to integrate both voice and data. The MC3810 was not efficient when transferring voice and data simultaneously. For this reason, voice communication was not integrated with data at the Oxford site. However, the MC3810 was still used for data to be transmitted from Cincinnati to Oxford.

This network now maximizes bandwidth and supports high-speed data communication. The network is scalable. The cost of materials and labor was reasonable and *Cinergy* now benefits from the new network. At this point, the Oxford network was entirely *Cisco* based and contained no other hardware products (such as the outdated *Cabletron* products managers had been using) besides updated *Cisco* products. Adding the *Cisco* MC3810 to its network in Oxford has put *Cinergy* one step ahead in the pursuit of changing their entire network to ATM and *Cisco* hardware and TCP/IP protocol. The installation and configuration procedures were completed in a timely manner; it did not take much longer than two months. Finally the network at Oxford has not failed since the ATM network has been installed.

The network uses QoS to maintain and increase data quality and it also maximizes bandwidth using QoS. The network does not use voice compression, because voice was not implemented. The ATM network has improved data sharing across multiple types of computers, and the network failures are no longer occur. The network is able to carry all traffic types (data, voice, and video); however, data is the only one that is currently

implemented. The network supports multimedia and high-speed communication (OC-3).

The installation and hardware were cost-effective. The network is scalable.

I designed a Web site using *Microsoft Visual InterDev 6* software, which is located at <http://129.137.100.161/CaraDB/ATM Home Site>. This Web site is used to thoroughly explain how I designed and implemented the ATM network. The Web site user can navigate through the site in an organized manner. For example, a *Help* section within the site explains how to navigate through the site. A Global Navigation Bar is located at the bottom of most pages, so that the user can navigate to one of the main topics at any time. This *Help* section also provides ATM definitions, resources, and indexes for the user.

This site is easy to use for both professors and students. Most of the main Web pages contain information explained in a general manner, but other pages contain subtopics that may seem detailed and complex to an individual who is not familiar with ATM and networking concepts. I use *Microsoft Visual InterDev* software, HTML, design concepts, and *Visio Technical* software to create an educational Web site about ATM. This site also integrates *SQL Server* and *Visual Basic Scripting* to establish a user interactive development. The users are able to type in facts and comments that can be added to, updated in, or deleted from the server. The users are also able to look at the records in the database concerning facts about the characteristics, connections, locations, interfaces, and hardware used for the ATM network.

The site explains the design process of the ATM network. For example, the site explains the original problem with the *Cinergy* network at Oxford. The site describes the original solution of using the MC3810 to aid in providing an ATM network. The site

explains the problem with the original solution of using the MC3810 and why this solution was not effective for the network. The site contains pages concerning the procedures and methods used to complete the project. It compares the ATM architecture to other architectures and it compares the MC3810 to other routers. These comparisons help explain why the ATM architecture and the MC3810 were chosen. The Web site lists and explains the benefits of using an ATM network, and it explains how ATM networks function.

*Visio Technical* drawings were created to document the hardware used and the connections made during the network installation. These drawings are now used to show the network map layout and the intricate details of each piece of hardware used within the ATM network. The hardware configurations are presented and explained in this Web site. The configurations show how each piece of hardware was configured (programmed) so that data is transmitted through the network. The site also provides a conclusion that gives a summary of the problem, solution, action taken, and the result.

## **8. Recommendations**

I recommend that ATM Web site visitors use Internet Explorer instead of using Netscape. Also, the visitor must be aware that a message may appear when trying to open a *Visio* drawing. The message will notify the user that they are not able to open the file. At this time, click *OK* and the file will open. In other words, I recommend that the user bypass this message. I also would like to explain that *Microsoft Visual InterDev* is not the best tool for developing a Web site—especially when dealing with fonts and spacing. For example, the fonts/spacing may look great within the *Microsoft InterDev* program, but the fonts/spacing do not look the same when viewed in the browser.

# Appendix A

## Glossary

**ABR Support and ATM Congestion Control** -- Defines the congestion-control mechanisms that switches use to control the amount of traffic sent across connections. This traffic control helps minimize cell loss.

**Asynchronous Transfer Mode (ATM)** -- A form of digitized data transmission based on fixed-length cells that can carry data, voice, and video at high speeds.

**ATM Adaptation Layer (AAL)** -- It performs Segmentation and Reassembly; translates data into ATM cell payloads, and translates incoming cells into a readable format.

**ATM Endpoint** -- The point in an ATM network where an ATM connection is terminated or initiated. This includes ATM-attached workstations, ATM-attached servers, ATM-to-LAN switches, or ATM routers.

**Available Bit Rate (ABR)** -- An ATM service type in which the ATM network makes a "best effort" to meet the transmitter's bandwidth requirements.

**Cell Loss Priority (CLP)** -- A one-bit descriptor found in ATM cell headers, indicating the relative importance of a cell. If set to 0, the cell should not be discarded. If set to 1, the cell can be discarded if necessary.

**Cell delineation** -- The extraction of cells from the bit stream received from the PMD

**Cell rate decoupling** -- The adaptation of the speed of the ATM layer cell stream to the rate of the physical interface

**Chassis** -- It is a physical structure that holds everything or that everything is attached to. A computer's cabinet is often called the chassis.

**Cisco** -- (Cisco Systems, Inc., San Jose, CA, [www.cisco.com](http://www.cisco.com)) A leading manufacturer of networking equipment, including routers, bridges, frame switches and ATM switches, dial-up access servers and network management software.

**Connection Admission Control (CAC)** -- The set of actions taken by the network during the connection setup phase in order to determine whether a connection's requested QoS can be accepted or should be rejected.

**Connection-Oriented** -- A type of communication in which a connection must be established between senders and receivers before data transmission can occur.

**Header** -- The five bytes in an ATM cell that supply addressing and control information, including generic flow control, virtual path identifier, virtual circuit identifier, payload type, and cell-loss priority.

**Header error control (HEC)** -- It is performed when the TC sublayer checks where each received cell starts and ends by calculating the HEC for that cell

**Interface** -- The connection and interaction between hardware, software and the user. Every interface implies a function. At the hardware level, electronic signals activate functions; data is read, written, transmitted, received, analyzed for error, etc. At the software level, instructions activate the hardware (access methods, data link protocols, etc.).

**Intelligent Packet Discard** -- Helps feature helps distinguish which packets must be dropped.

**Multiplexing** -- Transmitting multiple signals over a single communications line or computer channel.

**Optical Carrier (OC-n)** -- OC indicates an optical signal and n represents increments of 51.84 Mbps. Thus, OC-1, -3, and -12 equal optical signals of 51, 155, and 622 Mbps.

**Payload** -- Information portion of an ATM cell, exclusive of header. ATM cells typically have 48-byte payloads, but size can vary depending upon type of data and AAL.

**Payload Type Identifier (PTI)** -- A 3-bit descriptor found in ATM cell headers, indicating what type of payload the cell contains.

**Permanent Virtual Connection (PVC)** -- A logical (rather than physical) connection between endpoints established by an administrator that stays intact until manually torn down.

**Point-to-Point** -- A unidirectional or bidirectional connection with only two endpoints. See Point-to-Multipoint.

**Protocol Data Unit (PDU)** -- A discrete piece of information (such as a packet or frame) in the appropriate format to be segmented and encapsulated in the payload of an ATM cell.

**Quality of Service Classes** -- A networking term that specifies a guaranteed throughput level.

**Routing Protocol** -- A formula used by routers to determine the appropriate path onto which data should be forwarded.

**Scalable** -- Defines that a network is prepared for more complex, high-speed requirements, and more equipment as it grows.

**Site Diagram** -- A feature of *MS Visual InterDev* that allows the user to organize their web pages in a very orderly fashion – somewhat like a flow chart.

**T1** -- A high-speed digital line that employs two two-wire pairs to transmit full duplex data signals at a maximum rate of 1.544 Mbps. One pair of wires is used to transmit data and the other pair is used to receive data. It has a transmission rate of 1.544 Mbps, which allows it to support data, voice, and video.

**Traffic Policing** -- A mechanism used to detect and discard or modify cells/traffic that violate the traffic contract agreed to at connection setup.

**Traffic Shaping** -- A mechanism used to shape or modify bursty traffic characteristics in order to match a desired traffic contract.

**Traffic Pacing** -- Allows the rate that traffic travels across ports to be limited to specific peak traffic rates.

**Unspecified Bit Rate (UBR)** -- An ATM service type in which the ATM network makes a "best effort" to meet the transmitter's bandwidth requirements; essentially a "send and pray" service like that available from today's networks.(see ABR)

**Variable Bit Rate (VBR)** -- A data transmission that can be represented by irregular grouping of bits or cell payloads followed by unused bits or cell payloads.

**Virtual Channel** -- A defined route between two end-points in an ATM network that may pass through several virtual paths.

**Virtual Channel Connection (VCC)** -- A concatenation of virtual channel links between to endpoints where higher-layer protocols are accessed.

**Virtual Channel Identifier (VCI)** -- A connection-identifying value found in the header of each ATM connection cell.

**Virtual Connection** -- A connection between end users that has a defined route and endpoints.

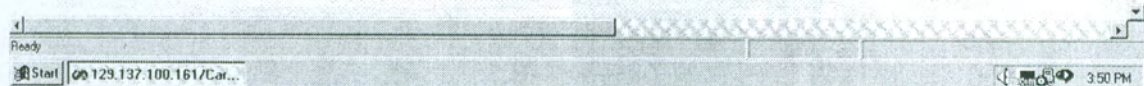
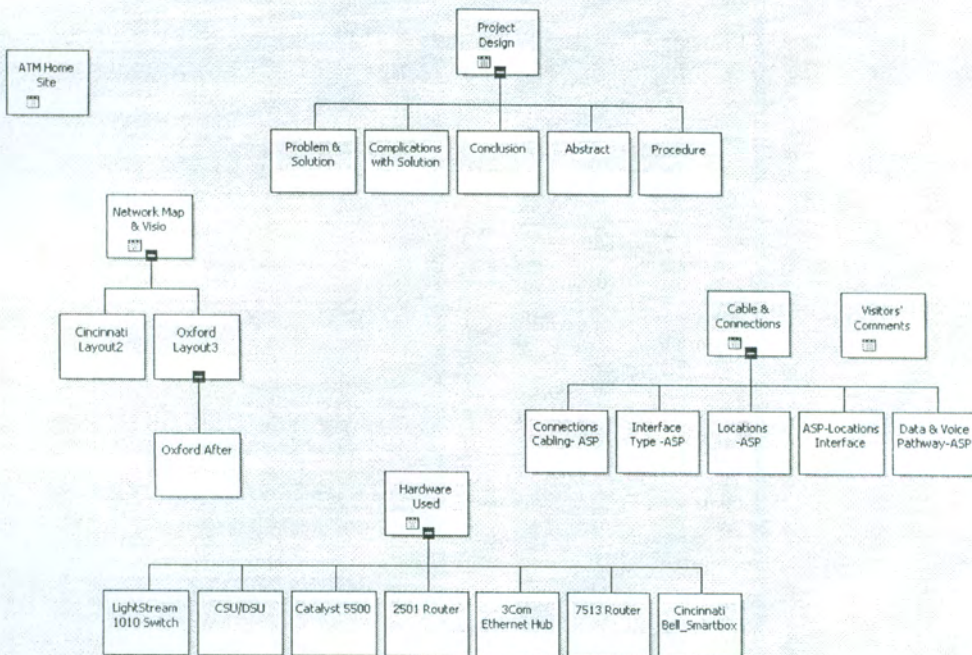
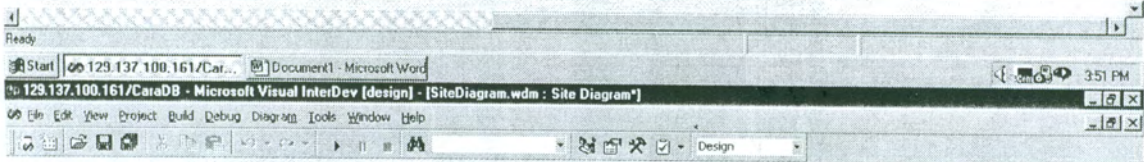
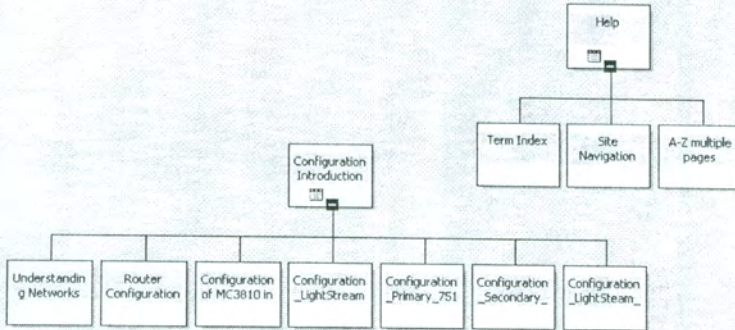
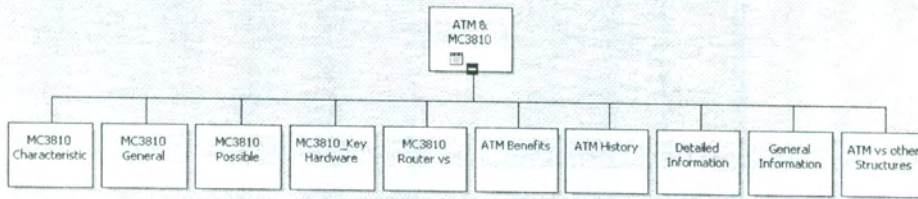
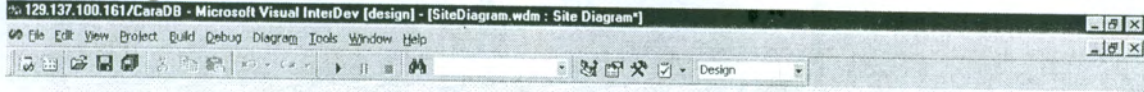
**Virtual Path Connection (VPC)** -- A concatenation of virtual path links between to points where the VCI values are either reassigned or terminated.

**Virtual Path Identifier (VPI)** -- A connection identifying value found in the header of each ATM cell (3, pg 3-20).

**Wide Area Network (WAN)** -- It is an internetwork that connects multiple sites (13, p 1-5).

# Appendix B

## Site Diagram within MS Visual InterDev



## Configuration Notes

- **PVC (path)**-- A point-to-point connection that is established in advance. For example, Oxford's path = 5  
For example, PVC 5 34; "5" = path identifier; "33" = circuit identifier
- **VPI**-- Identifies a particular ATM interface/module/port, and VPI/VCI value for destination end of the hard PVC.
- **VCI** -- Indicates whether it is a primary or secondary device.

### General configuration commands

- After the user is logged in:
- Type: ENA and enter password
- SHO CONFIG- show configuration of router, need to be in ena mode
- CONF T- Configure Terminal - CTRLZ to get out of config mode
- Once in CONF T
  - INT EO, INT E1, INT S0 etc. to configure a particular section.
  - Example: Router EIGRP 1
- Once out of CONF T, need to save changes
  - WR T- Writes to Terminal-without doing this, if you do a SHO CONF the changes you made will not be displayed.
  - WR MEM- Writes to Permanent Memory-without doing any changes will be lost when router is turned off.
  - SHOW IP Route- several routes should display if TCP/IP is configured correctly.
  - SHOW INT S0 (or S1, E0, E2) to see if interface is up and line protocol is up.

### Router Configuration Commands

1. Plug in the power cord of the Router being configured.
2. Plug in the male end of the blue flat cord in router
3. Plug the female end into the |0|0|0| port of the PC.
4. To start the *Hyperterminal* program, first click on *Start... Programs*
5. *Accessories... Hyperterminal*.
6. The *Hyperterminal* dialog box appears. Type the name of the piece of hardware for connection: "Name: Cisco Router."
7. Click the *OK* button.
8. The *Phone Number* dialog box appears.
9. From the list box choose *Connect using: Direct to Comm*.
10. The *COM1 Properties* dialog box appears
11. In the *COM1* box, Set the port settings.
12. Set *Bits per Set Data bits* to "8." *second* to "9600".
13. Set *Parity* to "None." Set *Stop bits* to "1."
14. Set *Flow Control* to "Hardware."
15. Click the *OK* button.
16. The *hyperterminal* configuration screen appears prompting the user for *password 1*.
17. *Enter password 1 (xxxxxxxx)*.
18. The Oxford prompt appears. Type *enable*.
19. The *password 2* prompt appears. Enter *password 2 (xxxxxxxx)*.
20. The *Oxford#* prompt appears once the user is in *enable* mode.
21. Type *show config*. This command show the entire configuration.

## Appendix D

<b>Hardware</b>	<i>Cisco</i> * LightStream 1010 #1	<i>Cisco</i> 7513 Primary Router
	<i>Cisco</i> LightStream 1010 #2	<i>Cisco</i> 7513 Secondary Router
	3 Com Intelligent Ethernet Hub	<i>Cisco</i> Catalyst 5500 #1
	Cincinnati Bell Smartbox (Phonebox)	<i>Cisco</i> Catalyst 5500 #2
	<b>CSU/DSU</b>	<b><i>Cisco</i> 2501 Router</b>
<b>Cabling</b>	Shielded/Unshielded Twisted Pair-Category 5	Multimode Fiber 62.5-- optical cables
<b>Interfaces</b>	100 Base T—(Fast Ethernet)	10 BaseT—(Ethernet)
	OC-3—(SONET)	T1* leased lines—(DS-1)
	RJ45	RJ48x
	SC—Straight Connectors	

Figure 12. This table shows hardware used before the ATM project was implemented. The CSU/DSU and 2501 Router are not located in Figure 13.

<b>Hardware</b>	<i>Cisco</i> * LightStream 1010 #1	<i>Cisco</i> 7513 Primary Router
	<i>Cisco</i> LightStream 1010 #2	<i>Cisco</i> 7513 Secondary Router
	3 Com Intelligent Ethernet Hub	<i>Cisco</i> Catalyst 5500 #1
	Cincinnati Bell Smartbox (Phonebox)	<i>Cisco</i> Catalyst 5500 #2
	<b><i>Cisco</i> MC3810 multiservice access concentrator</b>	
<b>Cabling</b>	Shielded/Unshielded Twisted Pair-Category 5	Multimode Fiber 62.5-- optical cables
<b>Interfaces</b>	100 Base T—(Fast Ethernet)	10 BaseT—(Ethernet)
	OC-3—(SONET)	T1* leased lines—(DS-1)
	RJ45	RJ48x
	SC—Straight Connectors	

Figure 13. This table shows the networking/hardware design of the ATM project.

## Configuration of the Mc3810

- The IP address of the primary sub-interface to Oxford is one less than the IP address of the interface of the MC3810. The sub-interface address is (314.380.458.54).
- The IP address of the MC3810 interface ATM0.1 is 314.380.458.55
- This IP knows it is in the same Range as the IP address for Oxford.

```
Oxford_3810#sho conf
Using 1713 out of 262144 bytes
!
hostname Oxford_3810
Type "hostname Oxford_3810" [Return]
logging buffered 4096 debugging
enable secret xxxxxxxxxxxx Password
Type "The password"
```

```
network-clock base-rate 64k
network-clock-select 1 T1 0
```

← These 2 lines deal with the T1 circuit.  
The T1 line is broken up into 64K sections  
There are 24 64K pipes in a T1 line.

```
no ip subnet-zero
ip domain-name cinergy.com
ip name-server 314.13.434.61
ip name-server 314.13.434.403
clock timezone EST -5
clock summer-time EST recurring
```

To configure type the following and hit [Return] at the end of each line.

```
controller T1 0
framing esf
linecode b8zs
mode atm
loop-detect
description ATM T1
```

Concerns how the phone company frames the line

These lines deal with the T1 circuit/line coming from the phone company.

```
interface Ethernet0
ip address 394.42.02.4 477.477.442.2
ip helper-address 394.42.91.588
no ip directed-broadcast
no ip mroute-cache
```

The IP Address of the port  
IP address of the Ethernet and Gateway for Oxford  
The Smaller Range

```
interface ATM0
no ip address
no ip directed-broadcast
atm pvc 3 0 16 ilmi
```

Port located on box. Subinterfaces on this port go in 2 different directions.

```
interface ATM0.1 point-to-point
bandwidth 1536
ip address 314.380.457.55 488.488.488.484
no ip directed-broadcast
atm pvc 1 5 33 aal5snap
```

If 1<sup>st</sup> line fails, the 2<sup>nd</sup> line is used.  
1<sup>st</sup> Subinterface on this port  
Bandwidth of T1 phone company line. 1.5Mb  
IP of MC3810 and the Subnet mask

1010 #1

```
interface ATM0.2 point-to-point
bandwidth 1536
ip address 192.168.236.26 488.488.488.484
no ip directed-broadcast
atm pvc 2 5 34 aal5snap
```

1010 #2

2<sup>nd</sup> Subinterface on this port

```
interface FR-ATM20
no ip address
no ip directed-broadcast
shutdown
!
```

```
router eigrp 1
network 392.42.2.3
network 314.380.458.2
no auto-summary
!
```

```
ip http server
ip classless
ip default-network 314.13.434.3
logging 394.47.57.438
line con 0
password xxxxxxxxx
transport input none
```

**To configure type: line con 0 [Return]**  
**password xxxxxxxxx [Return]**  
**transport input none**

```
line aux 0
password xxxxxxxxx
line vty 0 4
password 7 xxxxxxxxx
login
!
```

```
ntp server 394.42.86.1
Secondary 7513.
!
end
```

**Protocol heading**

**Relates back to Ethernet corporate backbone**

**Relates back to 1010 at interface ATM0.1 & ATM0.2**

**Range of WINS servers**

**Command collects the date and time. This is the address of the**

# Appendix F

## Configuration of the LightStream 1010 Switch #1

Cincy\_1010\_#1#sho conf

Using 8690 out of 126968 bytes

! Last configuration change at 07:28:17 EST Wed Jul 7 1999

! NVRAM config last updated at 07:28:58 EST Wed Jul 7 1999

hostname Cincy\_1010\_#1 **The hostname was changed from default "condor4" to "Cincy\_1010\_#2"**

!

enable secret xxxxxxxxxxxxxxxxxxxx. **This is password needed to configure device.**

!

network-clock-select revertive

**This command sets up different ports to be used by a clock.**

network-clock-select 1 ATM0/0/0

**This command establishes the ATM0/1/0 port as the priority 1 network clock source for the LightStream 1010 #2.**

**The chassis slot is "0". The PAM slot is "1". The Port is "0".**

network-clock-select 2 system

network-clock-select 3 ATM0/1/0

**This command establishes the ATM0/1/0 port as the priority 1 network clock source for the LightStream 1010 #2.**

**The chassis slot is "0". The PAM slot is "0". The Port is "0".**

ip subnet-zero

ip domain-name cinergy.com

ip name-server 314.13.434.61

ip name-server 214.13.434.403

**DNS (Domain Name Servers)**

!

atm connection-traffic-table-row index 101 vbr-rt pcr 56 scr0 16 mbs 4

**Default configuration.**

atm address xxx

atm router pnni

node 1 level 56 lowest

redistribute atm-static

!

clock timezone EST -5

**Command set device clock with the Eastern time zone.**

clock summer-time EST recurring

!

interface ATM0/0/0

description To Plainfield, IN

no ip address

interface ATM0/0/1

no ip address

shutdown

**This interfaces is "shutdown." It does not exist.**

interface ATM0/1/0

description To Cincy 1010 #2

**LightStream 1010 #2.**

no ip address

!

**When in CONFIG T mode ...**

**After "#OXFORD#" type "INT ATM0/1/0" to configure particular interface.**

**Hit [Return]. Type "description To Cincy 1010 #2".**

**Hit [Return]. Type "no ip address".**

interface ATM0/1/1

no ip address

shutdown

!

interface ATM0/1/3

**The ATM0/1/3 interface is physically connected to the LightStream**

**1010 #1**

description To Cincy 7513 Primary

no ip address

**to indirectly connect to the 7513 Primary.**

**Physically connected to Module 0, Slot 1, and Port 3 on LightStream 1010 #2.**

```
atm pvc 5 33 interface ATM0/1/0 5 33
!
```

Oxford is physically connected through Path 5. The VPI is "5".  
The VCI is "33". The ATM1/0/5 33 interface connects to Oxford  
The number "33" represents a *Primary* or #1 device.  
The number "34" represents a *Secondary* of #2 device.

When in CONFIG T mode ...

After "#OXFORD#" type "INT ATM0/1/3" to configure particular interface [Return].

Type "description To Cincy 7513 Primary".

Type "no ip address" [Return].

Type "no ip address" [Return].

Type "atm pvc 5 33 interface ATM0/1/0 5 33" [Return].

```
interface ATM1/0/0
```

```
description Miami Fort Station
```

```
no ip address
```

```
atm pvc 1 33 interface ATM0/1/3 1 33
```

```
atm pvc 1 34 interface ATM0/1/0 1 34
```

```
clock source loop-timed
```

```
framing esfadm
```

```
lbo gt_600
```

```
interface ATM1/0/1
```

```
description Beckjord Station
```

```
no ip address
```

```
atm pvc 2 33 interface ATM0/1/3 2 33
```

```
atm pvc 2 34 interface ATM0/1/0 2 34
```

```
clock source loop-timed
```

```
framing esfadm
```

```
!
```

```
interface ATM1/0/2
```

```
no ip address
```

```
shutdown
```

```
framing esfadm
```

```
!
```

```
interface ATM1/0/3
```

```
no ip address
```

```
shutdown
```

```
framing esfadm
```

```
interface ATM2/0/0
```

```
ip address 314.380.422.36 600.600.600.547
```

```
map-group core1
```

```
atm esi-address 000000000014.01
```

```
atm maxvp-number 0
```

```
!
```

```
interface Ethernet2/0/0
```

```
ip address 394.42.86.19 88.600.684.5 Telnet uses this IP address to connect to the LightStream 1010 #1
```

```
!
```

```
router eigrp 1
```

```
network 395.42.2.3
```

```
no auto-summary
```

```
!
```

```
ip default-gateway 394.42.86.4
```

```
ip classless
```

```
ip default-network 304.03.434.4
```

```
ip route 0.0.0.0 0.0.0.0 392.32.86.4
```

```
ip http server
```

```
!
```

```
map-list core1
```

```
t
```

The Miami Fort Location is connected to Path "1".

This is the timing on the T1 circuit.

The Miami Fort Location is connected to Path "2".

This interface is physically connected to the Catalyst 5500.  
Telnet uses this IP address to connect to the LightStream 1010 #1

This is a routing protocol

This number is the IP address of the 7513 gateway router.  
This command allows routing into smaller subnets  
The addresses direct traffic to corporate Backbone (Ethernet cable)  
The "392.32.86.4" number is the netmask.

# Appendix G

## Configuration of the LightStream 1010 Switch #2

```
Cincy_1010_#2#sho conf
Using 8459 out of 126968 bytes
! Last configuration change at 11:37:25 EST Wed Jul 14 1999
! NVRAM config last updated at 11:37:53 EST Wed Jul 14 1999
hostname Cincy_1010_#2          The hostname was changed from default "condor4" to
"Cincy_1010_#2"
!
enable secret xxxxxxxxxxxxxxxxxxxxxxxxxx This is the password need to configure the device.
network-clock-select 1 ATM0/1/0          This command establishes the ATM0/1/0 port as the priority 1
network clock source                    for the LightStream 1010 #2.
                                          The chassis slot is "0". The PAM slot is "1". The Port is "0".

network-clock-select 2 system
network-clock-select 3 ATM0/0/0          This command establishes the ATM0/1/0 port as the priority 1
network clock source                    for the LightStream 1010 #2.
                                          The chassis slot is "0". The PAM slot is "0". The Port is "0".

ip subnet-zero
ip domain-name cinergy.com
ip name-server 392.32.86.4
ip name-server 392.32.86.4
!
atm connection-traffic-table-row index 101 vbr-rt pcr 56 scr0 16 mbs 4          Default configuration.
atm addressxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
atm router pnni
!
interface ATM0/0/0
description To Columbus, IN
no ip address
!
interface ATM0/0/1
description
no ip address
shutdown
!
interface ATM0/1/0
LightStream 1010 #1
description To Cincy 1010 #1
no ip address
!
When in CONFIG T mode ...
After "#OXFORD#" type "INT ATM0/1/0" to configure particular interface.
Hit [Return]. Type "description To Cincy 1010 #1".
Hit [Return]. Type " no ip address".

interface ATM0/1/1
description
no ip address
shutdown
!
interface ATM0/1/3
Secondary 7513.
description To Cincy 7513 Secondary
no ip address
```

```
atm pvc 1 34 interface ATM0/1/0 1 34
atm pvc 2 34 interface ATM0/1/1 2 34
```

!

```
interface ATM1/0/0
description Oxford, OH
no ip address
```

**Interface ATM1/0/1 connects from Oxford, OH to the LightStream 1010 #2.**

**IP address is not necessary because it uses PVC's. Addresses are stored in MC3810.**

```
atm pvc 5 33 interface ATM0/1/0 5 33
```

**Interface is physically connected from LS 1010 #2 to LS #1.**

```
atm pvc 5 34 interface ATM0/1/3 5 34
```

**Interface physically connected from LS 1010 #2 to Secondary 7513.**

```
framing esfadm
```

**"Esfadm" is the term for how the phone company configures the T1 circuit.**

!

**Oxford is physically connected through Path 5. The VPI is path "5".**

**The VCI is "33". The ATM1/0/5 33 interface connects to Oxford**

**The number "33" represents a *Primary* or #1 device.**

**The number "34" represents a *Secondary* of #2 device.**

**When in CONFIG T mode ...**

**After "#OXFORD#" type "INT ATM1/0/0" to configure particular interface [Return].**

**Type "description Oxfor,OH". [Return]**

**Type "no ip address" [Return]**

**Type "atm pvc 5 33 interface ATM0/1/0 5 33" [Return]**

**Type "atm pvc 5 34 interface ATM0/1/3 5 34" [Return]**

**Type "framing esfadm" [Return]**

!

```
interface ATM2/0/0
```

```
ip address 314.380.522.13 488.488.488.325
```

```
map-group core1
```

```
atm esi-address 000000000013.01
```

```
atm maxvp-number 0
```

!

```
interface Ethernet2/0/0
```

```
ip address 394.42.86.96 488.488.462.3
```

!

```
router eigrp 1
```

```
network 394.42.2.3
```

```
no auto-summary
```

!

```
ip default-gateway 394.42.86.4
```

```
ip classless
```

```
ip default-network 314.02.434.3
```

```
ip route 0.0.0.0 0.0.0.0 172.20.64.1
```

```
ip http server
```

!

```
map-list core1
```

**added.**

```
ip 144.148.240.1 atm-n
```

```
logging 146.24.35.465
```

!

```
snmp-server community public RO
```

```
snmp-server community ypri7go RW
```

**Management servers. Protocol management to get into a box (ie. router).**

!

```
line con 0
```

**Console cable**

**to connect to the console use this password**

```
password 7 xxxxxxxxxxxxxxxxxxxxxxxx .
```

```
line aux 0
```

**AUX cable**

```
password 7 xxxxxxxxxxxxxxxxxxxxxxxx
```

**Password**

```
line vty 0 4
```

```
password 7 xxxxxxxxxxxxxxxxxxxxxxxx
```

```
login
```

!

```
end
```

## Appendix H

### Configuration of the Primary 7513

```
!  
interface ATM12/0  
description Primary 7513 ATM Port  
no ip address  
atm pvc 1 0 5 qsaal  
atm pvc 2 0 16 ilmi  
!  
interface ATM12/0.1 multipoint  
description Primary 7513 ATM Subinterface  
bandwidth 10000  
map-group core1  
atm esi-address 000000000011.01  
!  
interface ATM12/0.101 point-to-point          PVC 1  
description primary subinterface to Miami Fort  
ip address 302.380.458.7 488.488.488.484  
bandwidth 1536  
atm pvc 3 1 33 aal5snap  
!  
interface ATM12/0.102 point-to-point          PVC 2  
description primary subinterface to Beckjord  
ip address 314.380.236.13 488.488.488.484  
bandwidth 1536  
atm pvc 4 2 33 aal5snap  
!  
interface ATM12/0.105 point-to-point          PVC 5  
description primary subinterface to Oxford, OH  
ip address 214.280.236.43 488.488.488.484  
bandwidth 1536  
atm pvc 5 5 33 aal5snap  
!  
Bandwidth of the T1 line
```

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