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ATM LAN Access Switch (ALAX): Protocol Architecture () -0.018723 0 762 4

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CENTER FOR SATELLITE AND HYBRID COMMUNICATION NETWORKS

ATM LAN Access Switch (ALAX) :Protocol Architecture

(LAN Emulation Version)

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1. Introduction

This document describes the protocol architecture of the LAN Emulation version of the ATM LAN Access Switch (ALAX) that is designed at the Laboratory for Advanced Switching Technologies(LAST) by the collaborative research project team which consists of Protocol Engineering Center (PEC) of Electronics and Telecommunications Research Institute (ETRI), Institute for System Research (ISR) of the University of Maryland at College Park (UMCP) and Modacom Co., Ltd. The main function of the ALAX is to provide the interface between legacy LAN and ATM world giving network managers the option of gradually integrating ATM technology into their existing networks. To provide this functionality to the ALAX system, we decided to implement two versions of the ALAX system. One is the LAN Emulation version and the other is Multi Protocol Over ATM version. The LAN Emulation protocol is now on the standardization procedure at the LAN Emulation SWG Drafting Group of the ATM Forum Technical Meeting Committee. The MPOA protocol is also on the standardization procedure at the Multiprotocol Sub-Working Group of the ATM Forum Technical Meeting Committee.

The most important design characteristics of the ALAX is the adoption of the IEEE P1355 Standard for Heterogeneous Inter Connect(HIC)[1] as the data communication paths within the ALAX switching system. This makes it possible for this project team to design the PC-based parallel architectured high performance switching system in conformance with emerging open technologies and related standards. The protocols needed within the LAN Emulation version of the ALAX include LAN Emulation, Bridging Relay function, P1355, MAC Mapping Layer (MML), MAC, LAN Physical, AAL5, ATM and ATM Physical layer. Some other protocols needed in the ALAX include the ATM signaling which is defined in ATM Forum UNI 3.0[2], Network Management(SNMP or CMIP)[3], Graphic User Interface and some main control functions of the ALAX. The details of all these protocols, the relationship among these protocols and the implementations of these protocols are described in this document.

The system hardware architecture of the ALAX system is described in the documentation titled "ATM LAN Access Switch: System Architecture."[4] The protocol architecture of the Multi Protocol Over ATM(MPOA) version of the ALAX is described in the another documentation titled "ATM LAN Access Switch: Protocol Architecture (MPOA Version)."[5]

2. Overview of the ATM LAN Access Switch (ALAX)

The main function of the ALAX is to provide the interface between legacy LAN and ATM world. Therefore, ALAX should have the packet conversion and packet relay capability between ATM and legacy LANs. The network environment where the ALAX resides are shown in Figure 1. The ALAX should be able to route the packets not only between LAN and ATM but also between LAN and LAN.

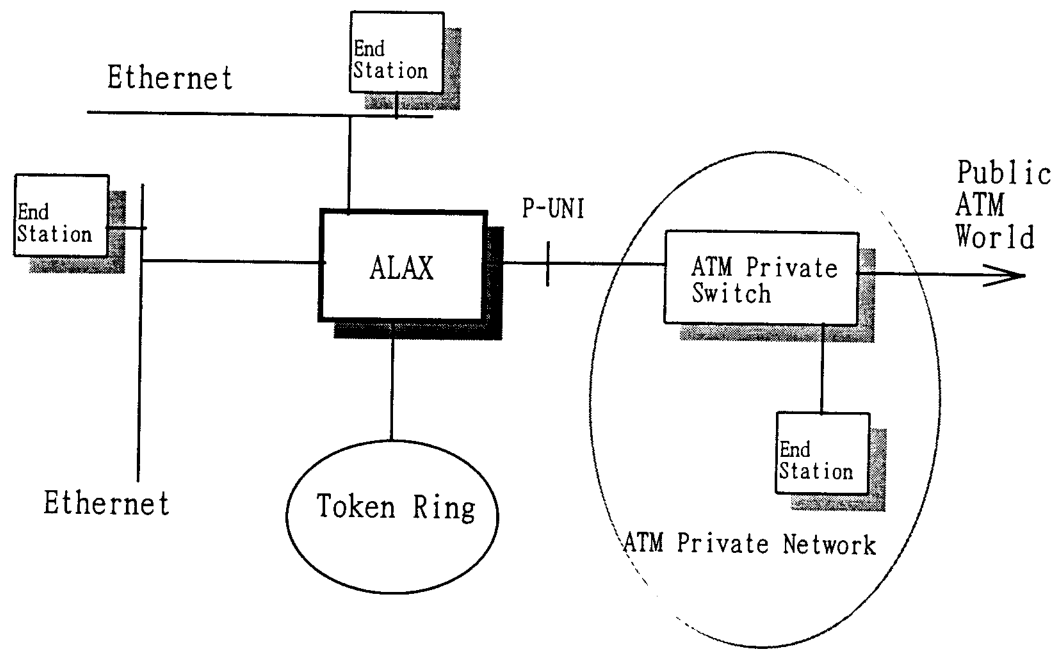

Figure 1. The network environment of the ALAX

Figure 2 illustrates the proposed final version of the ALAX system. This system will be built on the PCI Bus[6][7][8][9] based IBM PC with the IEEE P1355 serial bus data communication capability in it. The IEEE P1355 is a new serial bus standard that provides the data interconnect between communication modules with scalability, flexibility and simplicity. The purpose of P1355 standard is to enable the high-performance, scalable, modular, parallel systems to be constructed with low system integration cost; to support communications system fabric; to provide a transparent implementation of a range of high level protocols; to support links between heterogeneous systems.[10] By adopting the P1355 serial bus into this system, the bottleneck problem within the high-speed communication system can be solved.

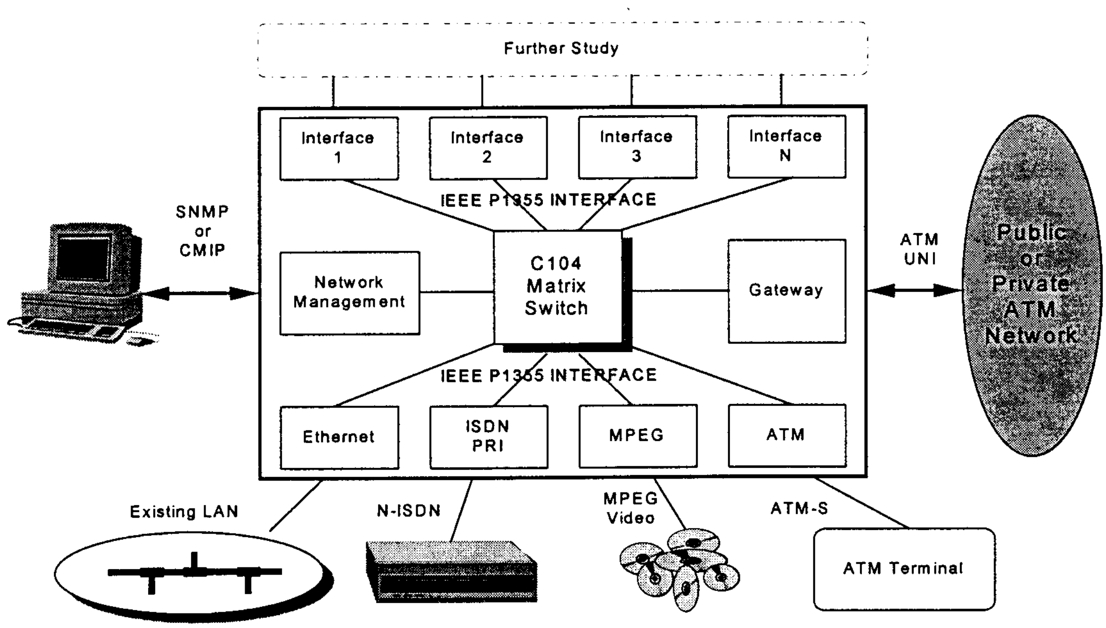

Figure 2. System Architecture of the ALAX

The ALAX system will provide easy expandability by adopting the modularity design concept in it. Many applications can be added to the system by inserting the interface modules into the slots of the ALAX. Therefore, the modular design is a very important feature of this system. The new interfaces can be inserted into this system without changing of entire architecture with the help of scalable, modular and parallel structure of IEEE P1355 serial bus. The future interfaces which will be implemented in this system include the interfaces to the MPEG2 over ATM, NISDN, Multiprotocol over ATM, ATM terminal interface, Satellite communication, PCS and Circuit Emulation etc..

The first phase design target of the ALAX system is to build the ATM hub system that has the capability of LAN Emulation Over ATM for the Ethernet LAN. The system modules which are needed to build the first LAN Emulation version of the ALAX are as follows;

- ATM to IEEE P1355 Interface
- IEEE P1355 Virtual Switch Fabric
- Ethernet to P1355 Interface

3. Protocols of the ALAX in LAN Emulation Environment

3.1 Network Architecture of the ALAX

Some significant progress for the inter networking problem between legacy LAN and ATM was done in the ATM Forum. They are Multi Protocol Over ATM(MPOA) and LAN Emulation(LANE). The first phase of the ALAX design is focused on the LAN Emulation environment. The function of the ALAX will be the ATM hub which conveys the LAN packets to the ATM world as well as the ATM cells to the legacy LAN environment. ALAX will also connect two separate legacy LANs by conveying the LAN packets between those legacy LANs. The LAN to ATM interface protocol of the first phase ALAX will be the LAN Emulation which is now documented as LAN Emulation Over ATM Specification - Version 0 by the LAN Emulation SWG Drafting Group at the ATM Forum[11]. The legacy LAN which we are considering in the first phase is the IEEE 802.3 Ethernet LAN[12][13]. The network architecture of the LAN emulation environment is shown in Figure 3. In this Figure, the packet conversion protocol to P1355 is omitted because P1355 has the meaning only with the internal packet transmission within the ALAX. This protocol is named MAC Mapping Layer (MML) Protocol and described in detail in Chapter 5.

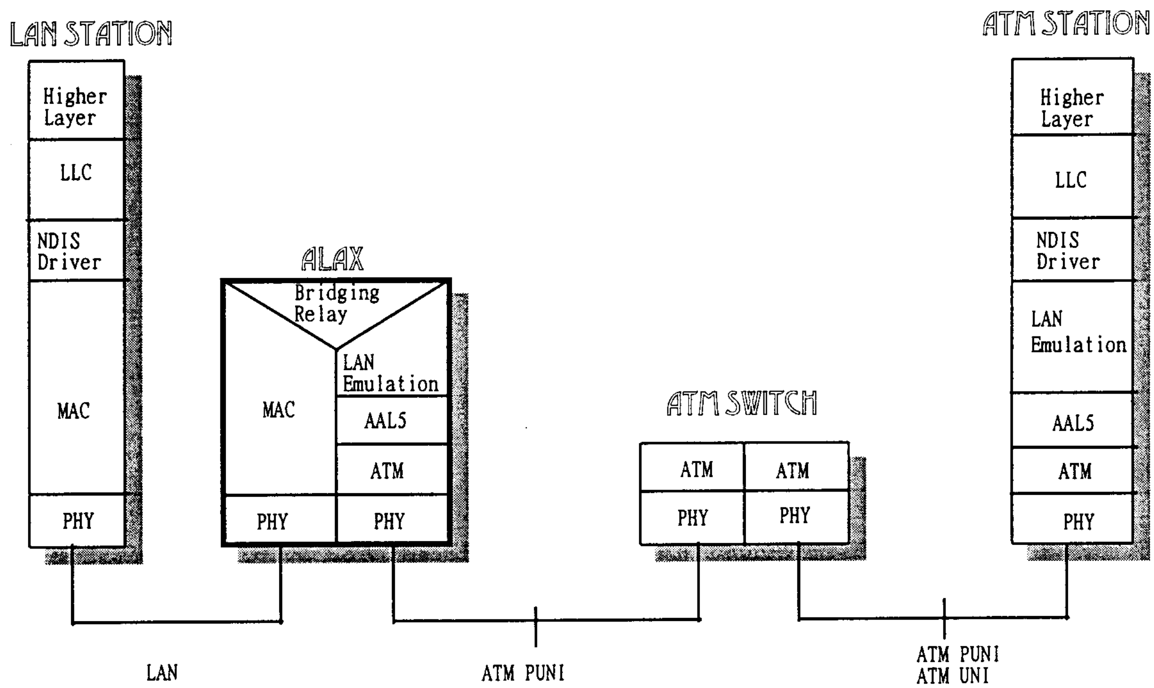

Figure 3. Network Architecture of the ALAX in LAN Emulation Environment

3.2 Protocols of the ALAX

The protocols needed within the LAN Emulation version of the ALAX include LAN Emulation, Bridging Relay function, P1355, MML, MAC, LAN Physical, AAL5, ATM and ATM Physical layer[14][15][16]. The conversion protocol between P1355 and MAC which is named MAC Mapping Layer (MML) protocol are also needed. Other protocols needed in the ALAX include the ATM signaling which is defined in ATM Forum UNI 3.0, Network Management(SNMP or CMIP) and some control functions of the ALAX. Figure 4. shows where these protocols actually reside and run within the ALAX.

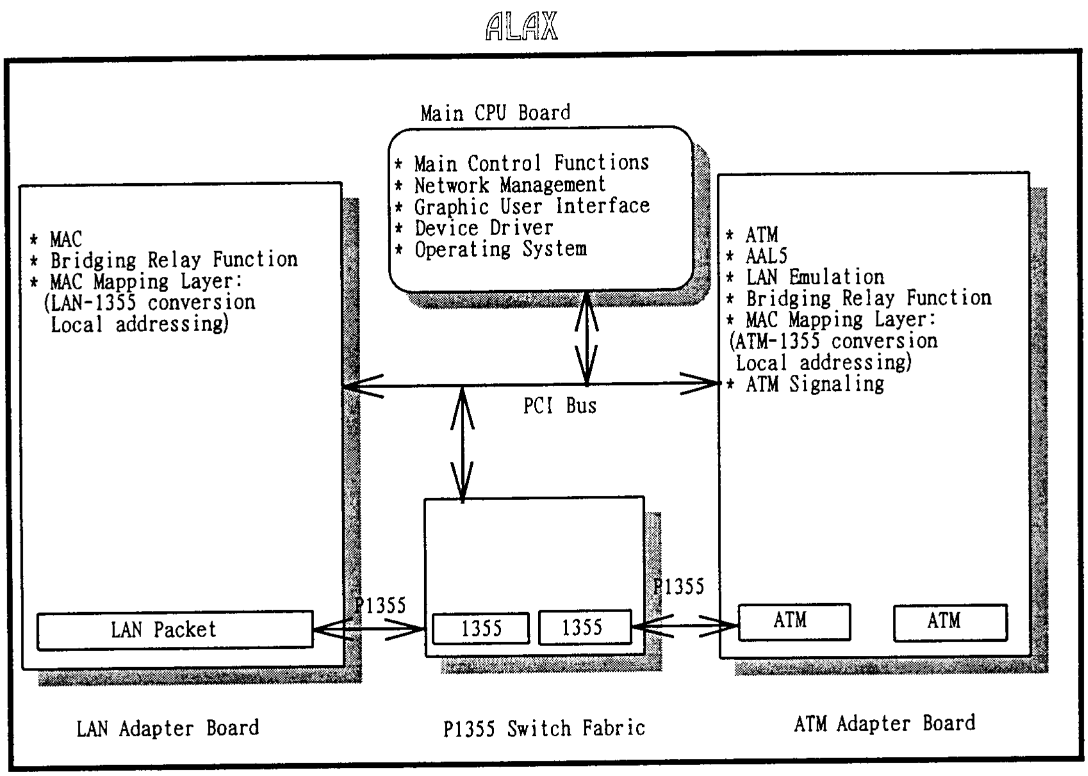

Figure 4. Protocols of the ALAX in LAN Emulation Environment.

3.2.1. Locations of the Protocol Processing

All the protocols described above should be divided and run among many adapter boards. Allocating the protocols into the proper adapter boards is one of the most important ALAX system's design issues. The main control functions and network management functions will be performed at the main CPU board of the IBM PC. The other protocols will be executed within each adapter board as shown in Figure 4. Some protocols which run in many places of the system in common are described in this section. The other protocols which run in each specific individual board are explained in the next sections.

3.2.2. IEEE P1355 Protocol

IEEE P1355 is the standard for Heterogeneous InterConnect (HIC) which is the low cost, low latency scalable serial interconnect for parallel system construction. This protocol was also submitted to the ISO/IEC JTC1 standard committee and accepted as the standard. IEEE P1355 specifies the physical connectors and cables to be used, the electrical properties of the interconnect and a cleanly-separated set of logical protocols to perform the interconnection in the simplest possible way. The purpose of this standard is to enable high-performance, scalable, modular, parallel systems to be constructed with low cost, where 'cost' must include not only the price of components, but also the engineering effort required to use them successfully. In ALAX, the P1355 is used to interconnect many modules within the system.

3.2.3. MAC Mapping Layer (MML) Protocol

MML protocol is the interface protocol between LAN and P1355 which is being developed within this project team. The main functions of the MML are like followings;

- Local Addressing
- Conversion to the P1355 packet format

Local addressing function is used to get the local address from the MAC address. This local address is one to one matched to the port number of the C104 Asynchronous Packet Switch fabric chipset. The conversion to or from the P1355 packet format is performed at the DS Link module of the T9000 Transputer[17][18][19][20][21]. The details of the MML protocol is described in Chapter 5.

3.2.4 Bridging Relay Function

The bridging relay function inside the ALAX is very simple. This protocol just relay the MAC packet from the LAN side to the ATM side and vice versa. Actually the complete bridging function within the ALAX is performed by the combination of the LAN Emulation protocol and the Bridging Relay function.

3.3 Software in Main CPU board

3.3.1. Main Control Function

ALAX needs the centralized control function to manage all the adapter boards installed within the system and main CPU board has the responsibility to do this role. These control functions include the system initialization, board status monitoring, boards reconfiguration and network management. The control commands and status reportings will be conveyed between the main CPU board and the adapter boards through the PCI bus. ALAX has the System Control Processor which supports the main CPU to control the whole system. The System Control Processor is located in the P1355 Switch Fabric board. The communication between the main CPU and the System Control Processor is performed through the PCI bus and the communication between many adapter boards and the System Control Processor is performed through the P1355 DS Links.

The Main Control Terminal is the interface between the ALAX system and the user of the system. All the communication between the ALAX and system administrator will be performed through the Main Control Terminal. The Main Control Terminal is not a separate computer system but only the display and keyboard of the ALAX system itself. The system administrator can get the system status from the Main Control Terminal and give the commands to the system using this terminal. The control signal flow within the ALAX is shown in Figure 5.

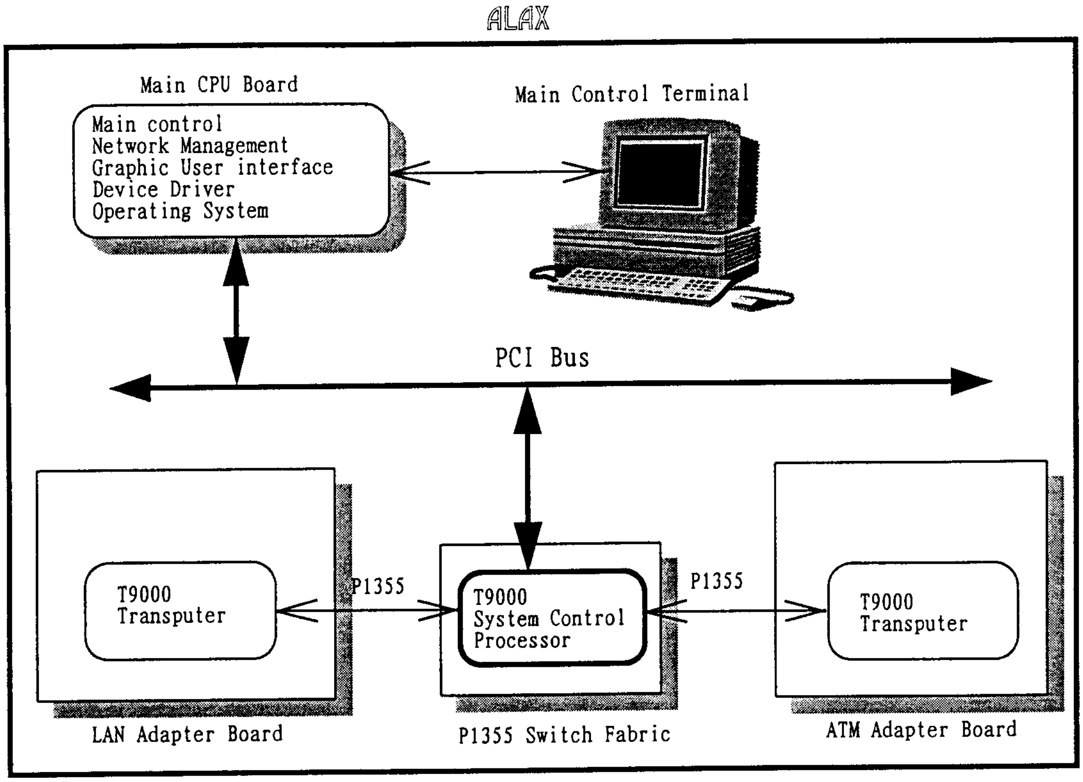

Figure 5. Control function flow of the ALAX

3.3.2. Network management functions

As the networks grow in scale, many things can go wrong, disabling the network or a portion of the network or degrading performance to an unacceptable level. In this large network environment automated network management tools are needed because network cannot be put together and managed by human effort alone. There are many kinds of network management tools available now. Currently two of the most important standardization efforts are underway. They are Simple Network Management Protocol(SNMP) and OSI system management. SNMP was adopted as the standard for TCP/IP based internets in 1989 and has enjoyed widespread popularity. In our ALAX system, SNMP will be used as the network management protocols. SNMP will reside and run within the main CPU board.

3.3.3. Graphic User Interface

In order to provide good user interface to the user of the ALAX, the graphic user interface is needed at the Main CPU Board. This graphic user interface runs to activate the Main Control Terminal which provides the display to the user. All the interactions between the ALAX and system administrator will be performed through the Main Control Terminal.

3.3.4 Device Driver

For the main CPU to communicate with many adapter boards of the ALAX, device driver programs are needed to be developed. The type of the device driver depends on the Operating System used. The NDIS device driver will be developed as the common device driver for all the adapters of the ALAX.

3.3.5 Operating System

The operating system of the ALAX system should support the multiprocessing capability and good graphical user interface. Because the ALAX system is designed based on the PC System, the Operating System which is widely used in the current PC System will be used. The Microsoft Windows NT or Windows 95 are the good candidates for the ALAX system's O.S.

3.4 Software in ATM Adapter Board

3.4.1 LAN Emulation

In order to use the vast base of existing LAN application software, it is necessary to define an ATM service, called "LAN Emulation," that emulates services of existing LANs across an ATM network and can be supported via a software layer in end systems. In the first phase of the ALAX design, we decided to use the LAN Emulation as the conversion protocols between the legacy LANs and the ATM. If such a LAN Emulation service is provided for an ATM network, then end systems can connect to the ATM network while the software applications interact as if they are attached to a traditional LAN. Also, this service will support interconnection of ATM networks with traditional LANs by means of today's bridging methods. Therefore, ALAX will allow interoperability between software applications residing on ATM-attached end systems and on traditional LAN end systems. Currently, "LAN Emulation Over ATM Specification - version 0" was finished in the LAN Emulation SWG Drafting Group and many companies began to provide the LAN Emulation software to the market.

3.4.2 ATM Signaling

As shown in Figure 1., ALAX is connected to the ATM network using the Private UNI(P-UNI) specification defined in the ATM Forum. Private UNI will typically be used to interconnect an ATM user with an ATM switch that is managed as part of the same corporate network. ATM signaling specifies the procedures for dynamically establishing, maintaining and clearing ATM connections at the User-Network Interface. The procedure are defined in terms of messages and the information elements used to characterize the ATM connection and ensure interoperability. One of the way we can implement the ATM signaling is to modify the VINCE(Vendor Independent Network Control Entity)[22][23][24] which is a publicly available software package for the development of protocols in ATM networks. The other way is to purchase the ATM signaling software and port it to the ALAX system.

3.4.3 ATM Protocol

ATM protocol of the ALAX will be executed by the ATMizer[25][26][27]of the ATM Adapter board. The ATMizer from the LSI Logic corporation is a single-chip segmentation and reassembly ATM network controller. The ATM Physical layer protocol used in ALAX is 100 Mbps Multimode Fiber interface which is executed by the Am7968/Am7969 TAXIchip™ [28]. The details of these chipsets are described in the "ATM LAN Access Switch: System Architecture" by Man-Geun Ryu.

3.4.4 AAL5 Protocol

The AAL5 is one type of the AAL protocol which maps the user/control/management PDUs (Protocol Data Unit) into the information field of one or more consecutive ATM cells of a virtual connection, and vice versa. AAL5 was specified by the ATM Forum to offer a service with less overhead and better error detection below the CPCS layer. AAL5 is suitable for the high-speed, connection oriented data service users. AAL5 protocol will also be executed by the ATMizer of the ATM Adapter board.

3.5 Software in LAN Adapter Board

3.5.1 MAC Layer Protocol

MAC layer protocol used in the ALAX is the IEEE 802.3 standard which defines the carrier sense multiple access with collision detection (CSMA/CD) medium access protocol for bus topology. This MAC layer protocol is executed automatically by the Ethernet LANCE chipset of the LAN adapter board.

4. Packet Conversion within the ALAX

The format of the packets in the LAN environment and ATM environment are different. Therefore, the main function of the ALAX is to convert the input packet to the proper output packet format. All the packets which are transferred through the ALAX should have the P1355 packet format. The packet from the LAN side has the IEEE 802.3 Ethernet MAC format. Therefore, this packet should be converted to the P1355 packet first then it should be converted to the ATM cell format before it is sent out to the ATM network. On the other hand, the ATM cells arrived at the ALAX should also be converted to the P1355 packets then to LAN packets. There are many things that should be considered during this procedure. They are addressing, routing, packet format etc. In this section, the packet conversion within the ALAX is described in detail. Figure 6. shows the network architecture of the ALAX which defines the relationship of the packet conversion protocols within the ALAX system.

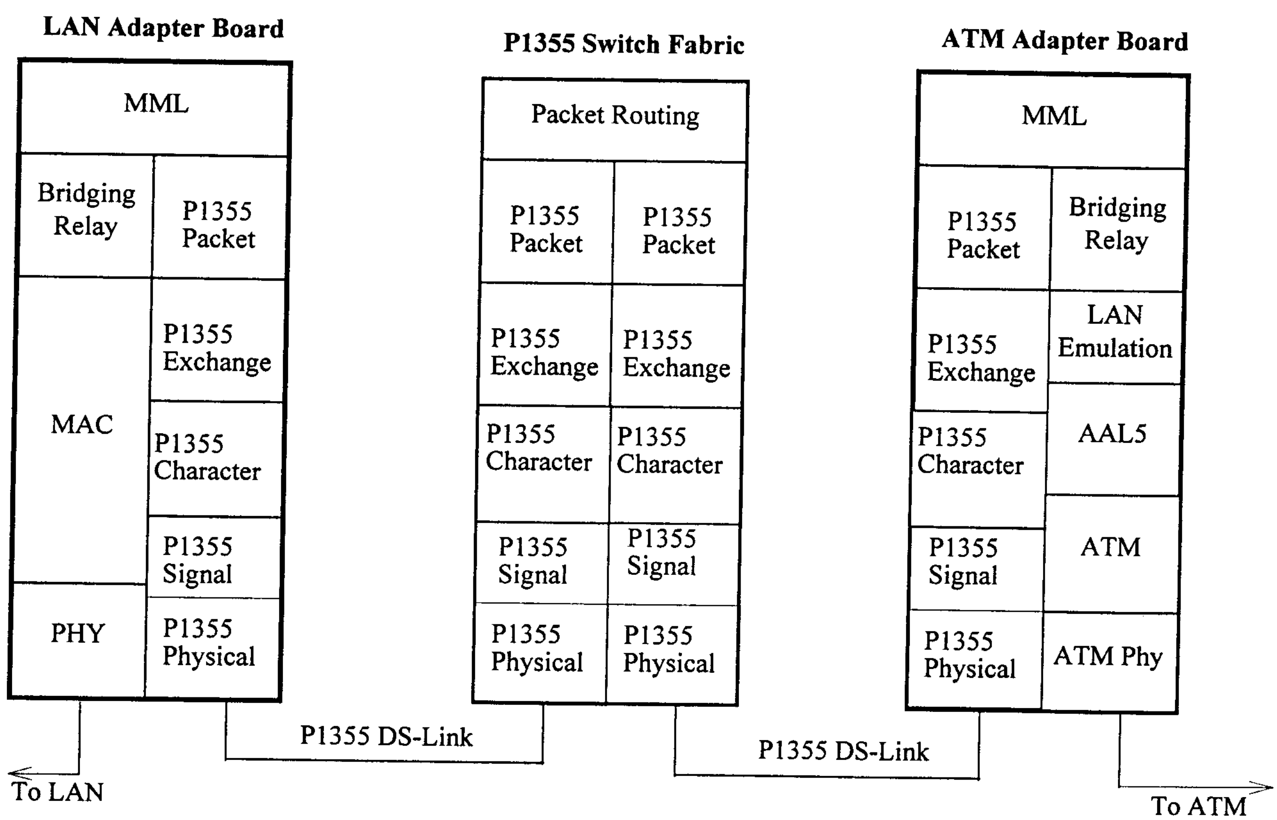

Figure 6. P1355 Packet Conversion within the ALAX

4.1 Packet transmission within the ALAX

All the packets which go through the ALAX should have the P1355 packet format. Therefore, as shown in Figure 6., packets which arrive at one of the interface adapter board should be changed to the P1355 packets. The P1355 protocol stack consists of 6 levels which are Physical, Signal, Character, Exchange, Packet and Transaction Level. The functions of each level are explained in the IEEE P1355 Standard. Most of the protocol layers of the P1355 are executed automatically in the DS-Link modules of the C104 Asynchronous Packet Switch[29][30][31], C101 Parallel Interface Adapter and T9000 Transputers of the ALAX system. Transaction level and part of the Packet level of the P1355 are executed by the program execution of the T9000. The name of this program is called MML which is described in detail in Chapter 5.

The routing functions within the P1355 network are handled by the C104 Asynchronous Packet Switch. The C104 uses wormhole routing in which the routing decisions are taken as soon as the header of the packet has been input. If the output link is free, the header is output and the rest of the packet is sent directly from input to output without being stored. If the output link is not free the packet is buffered. The behaviors of the packet transmission within the ALAX will be simulated and analyzed by this project team and the optimal architecture of the ALAX system will be designed with the results of this study.

4.2 Packet conversion within the LAN adapter board

The LAN adapter board converts the packet between LAN world and P1355 world. Figure 7. shows how the packets are converted within the LAN adapter board. When the LAN MAC packets arrive at the LAN adapter board, they should be converted to the P1355 packets. In order to get the local address which is needed when the packets go through the C104 switch fabric, the local addressing function should be performed in the LAN adapter board. On the other hand, when the packets arrive from the P1355 switch fabric to the LAN adapter board, they should be converted to the appropriate LAN packet. The reassembly of the P1355 packets to the LAN packet should be performed in the LAN adapter board. The detailed packet conversion procedure between MAC and P1355 is described in detail in Chapter 5.

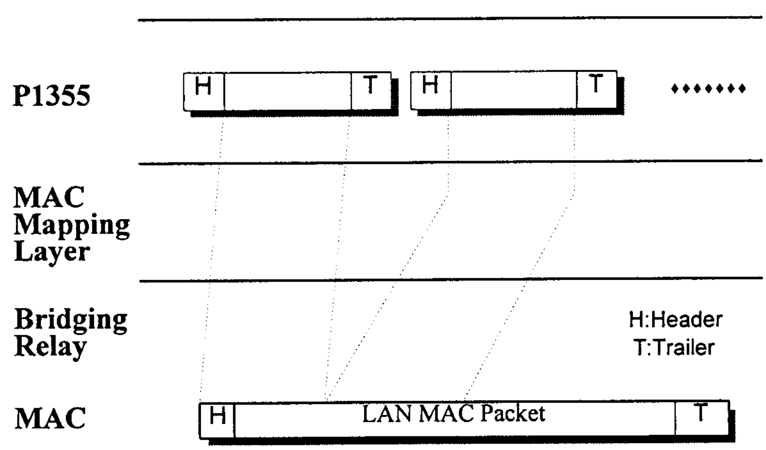

Figure 7. Packet conversion within the LAN Adapter Board.

4.3 Packet conversion within the ATM Adapter Board

The ATM adapter board converts the packet between ATM world and P1355 world. Figure 8. shows how the packets are converted in the ATM adapter board. When the ATM cells arrive at the ATM adapter board, they should be converted to the P1355 packets. The ATM cells first go through the AAL5 then the AAL-SDU which is the LAN Emulation frame is created. This LAN Emulation frame is processed by the LAN Emulation protocols. Then LAN Emulation frame is changed to the MAC packet which is eventually divided into many P1355 packets to go through the P1355 switch fabric. In order to get the local address which is needed when the packets go through the C104 switch fabric, the local addressing function also should be performed in the ATM adapter board.

On the other hand, when the packets arrive from the C104 switch fabric to the ATM adapter board, they should be first reassembled to the original MAC packet. It is then processed by the LAN Emulation protocols which eventually creates the LAN Emulation frame. After finishing the LAN Emulation functions, this LAN Emulation frame goes through the AAL5 and ATM layer protocols. Within these layers the LAN Emulation packet is converted to some ATM cells then sent to the ATM world. The detailed packet conversion procedure between MAC and P1355 is described in detail in Chapter 5.

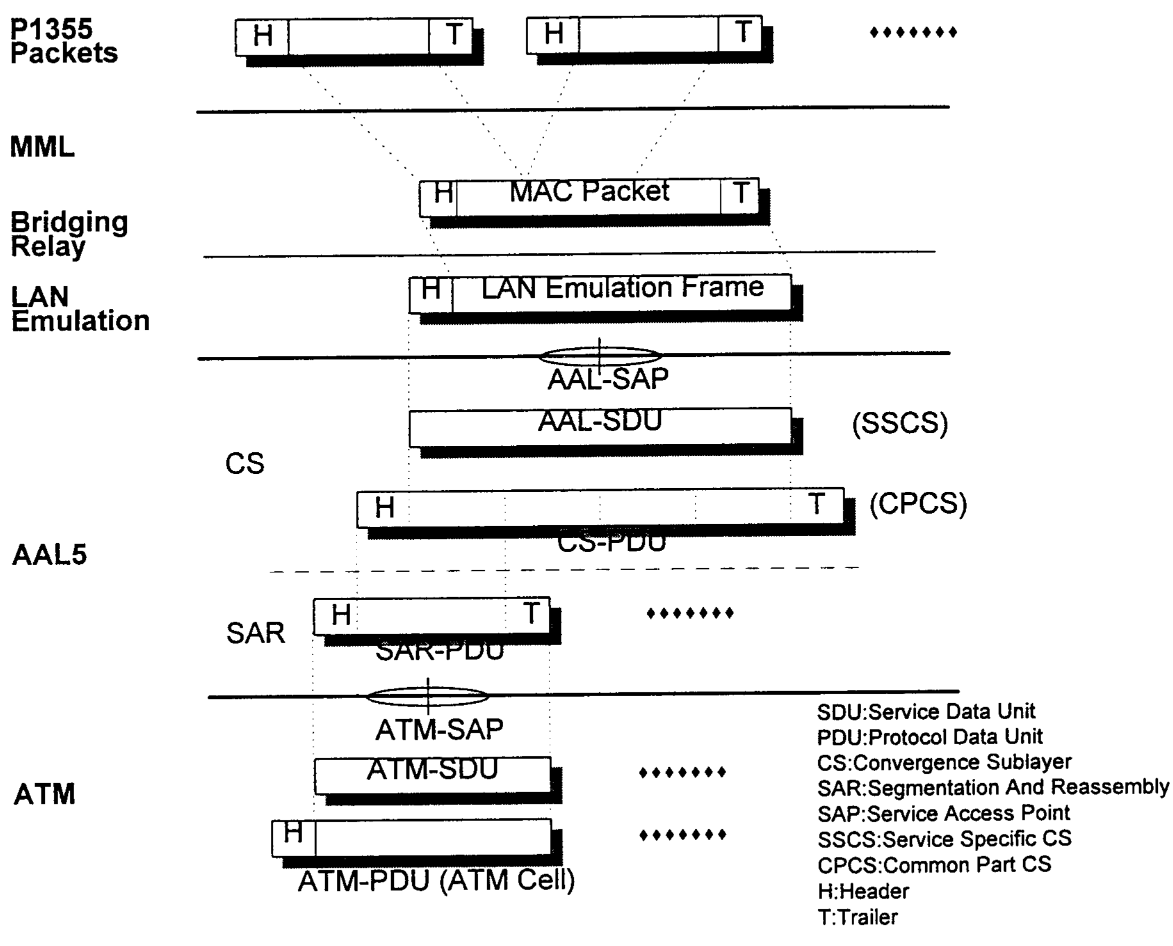

Figure 8. Packet conversion within the ATM Adapter Board.

5. MAC Mapping layer(MML) Protocol

5.1 The functions of the MML

MML protocol is the conversion protocol between MAC and P1355 which is being developed within this project team. The MML protocol is needed within the ALAX, because all the packets should be converted to the P1355 packets before they go through the switch fabric of the ALAX. The location of the MML protocol within the ALAX is shown in Figure 7 and Figure 8. The main functions of the MML are Local Addressing and the P1355 Packet Conversion.

5.2 Local Addressing

5.2.1 The function of the Local Addressing

The function of the Local Addressing is to obtain the local address which is the P1355 packet destination port number of the C104 switch fabric of the ALAX system. The term "local" in this usage means the location of the sending and receiving ports are located within the same products system enclosure. The local address can be obtained using the Local Address Look-Up Table(LALUT) which contains the address mapping between the local address and the MAC address as shown in Figure 9 . Obtained local address value is inserted into the header of the P1355 packet. This local address is one to one matched to the port number of the C104 switch fabric chipset and used when the P1355 packets go through the C104 switch fabric. The format of the P1355 header should be decided based on the P1355 Standard.

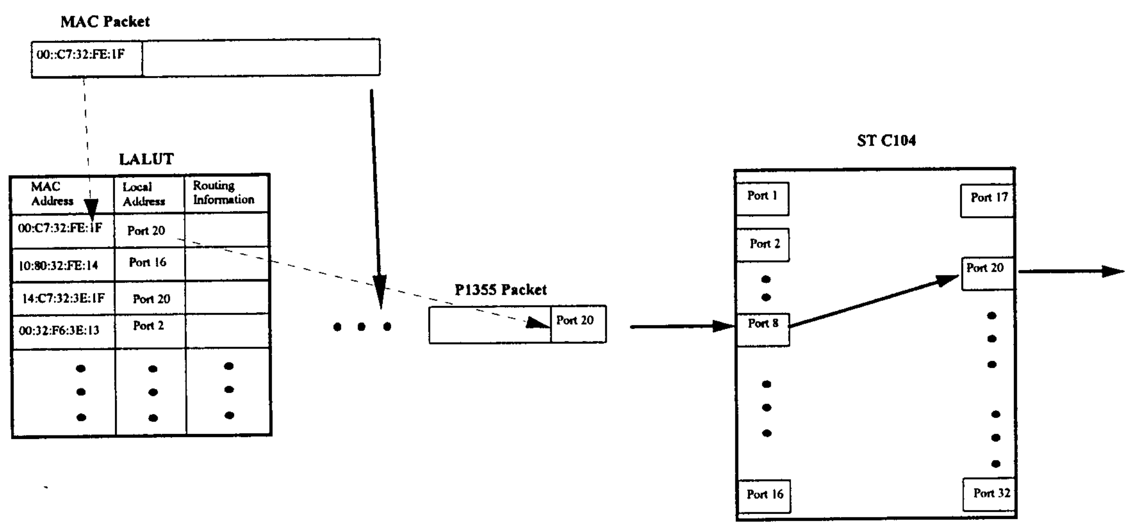

Figure 9. Local Addressing of the ALAX

5.2.2 Local Address Look-Up Table(LALUT)

In ALAX system, the Local Address Look-Up Table is used to map the MAC address into the local address. At the system booting time, the main CPU finds the network configuration information of the attached network and the information of the all adapter boards within the ALAX system. Then it uses these informations to fill the LALUT with the MAC address, local address and some routing information of the adapter boards. To get the information needed to fill the LALUT, network configuration information of the attached LAN is needed. This information can be get and inserted into the LALUT by the network system manager manually or by the network management program automatically.

5.3 P1355 Packet Conversion

In order to go through the C104 Switch Fabric, all the packets within the ALAX system should be converted to the P1355 packet . The conversion between the MAC packet and the P1355 packet format is performed at the DS Link hardware module of the T9000 Transputer automatically. The procedure needed in converting to the P1355 packet is shown in Figure 10. The MAC packet is divided into many small size of P1355 packets and the headers which are decided after executing the Local Addressing functions are attached to the every P1355 packets. All the P1355 related protocols like Signal, Character, Exchange and Packet layer protocols are automatically performed at the DS Link module of the T9000 Transputer. The headers of the P1355 packets are actually the port numbers of the C104 switch fabric and decided after executing the Local Addressing functions, then inserted into the P1355 packet header location by the T9000.

The Packet Routing protocol is performed at the C104 Switch Fabric and the MML protocol is performed by means of the execution of the T9000 software. By programming the T9000, we can define the size of the P1355 packets. In this ALAX implementation, the size of the P1355 packet is 32 bytes which is the maximum packet size the T9000 Transputer can handle. If the maximum size which can be handled by the P1355 chipsets are increased, the optimal size can be decided by the performance analysis study.

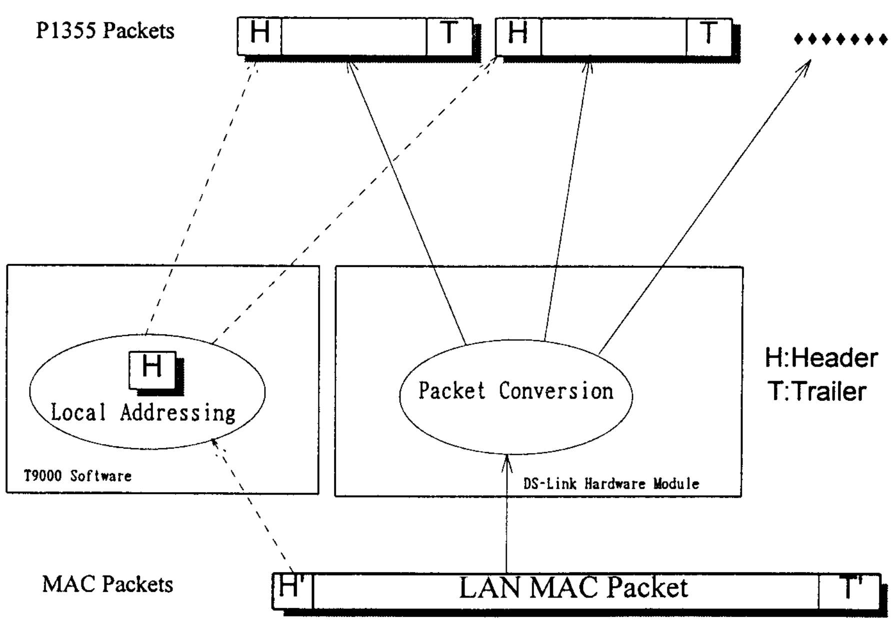

Figure 10. Packet Conversion Procedure in MML

6. Conclusion.

The protocol architecture of the LAN Emulation version of the ATM LAN Access Switch (ALAX) was described that is designed at the Laboratory for Advanced Switching Technologies(LAST) by the collaborative research project team which consists of Protocol Engineering Center (PEC) of Electronics and Telecommunications Research Institute (ETRI), Institute for System Research (ISR) of the University of Maryland at College Park (UMCP) and Modacom Co., Ltd.

The main function of the ALAX is to provide the interface between legacy LANs and ATM world giving network managers the option of gradually integrating ATM technology into their existing network. The most important design characteristics of the ALAX is the adoption of the IEEE P1355 Standard for Heterogeneous Inter Connect(HIC) as the data communication paths within the ALAX switching system. This makes it possible to design the PC-based parallel architectured high performance switching system in conformance with emerging open technologies and related standards. The protocols needed within the LAN Emulation version of the ALAX include LAN Emulation, Bridging Relay function, MAC, LAN Physical, AAL5, ATM and ATM Physical layer. The MAC Mapping Layer (MML) protocol that is the conversion protocol between P1355 and MAC are also needed. Some other protocols needed in the ALAX are the ATM signaling which is defined in ATM Forum UNI 3.0, Network Management(SNMP) and some control functions of the ALAX.

This system will provide easy expandability by adopting the modularity design concept in it. Many applications can be added to the system by inserting the interface modules into the slots of the ALAX. Therefore, the modular design is a very important feature of this system. The new interfaces can be inserted into this system without changing of entire architecture with the help of scalable, modular and parallel structure of IEEE P1355 serial bus.

Many research works are under way from many research institutes regarding the high-performance system fot the ATM network and its new applications for the ATM network[32][33][34][35]. In our joint project, we expect to expand our research areas to many of the new ATM network service applications. To make them possible, many interfaces to the proper applications and networks will be needed. The future interfaces which will be implemented in this system include the interfaces to the MPEG2 over ATM, NISDN, Multiprotocol over ATM, ATM terminal interface, Satellite communication, PCS and Circuit Emulation etc. as shown in Figure 2. At the same time, the standardization activities will be performed by this project team in order to contribute the protocol design results of the ALAX system to the IEEE P1357 Working Group of the Bus Architecture Standards Committee[36].

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