CANKAYA UNIVERSITY

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CENG 331 – DATA COMMUNICATIONS

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Subject: ATM is a high-speed networking standard designed to support both voice and data communications. Compare ATM with Ethernet and express its expected developments in future.

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CHAPTER 1: ASYNCHRONOUS TRANFER MODE (ATM)

1. Preview About Asynchronous Transfer Mode

Asynchronous transfer mode is a switching technology which transfers datas by fixed size cells which are just as big as 53 bytes. It is also known as ATM in short way. Basicly it's using cell relay technique for transferring data. This technique makes virtual circuits and effetively uses it's benefits.

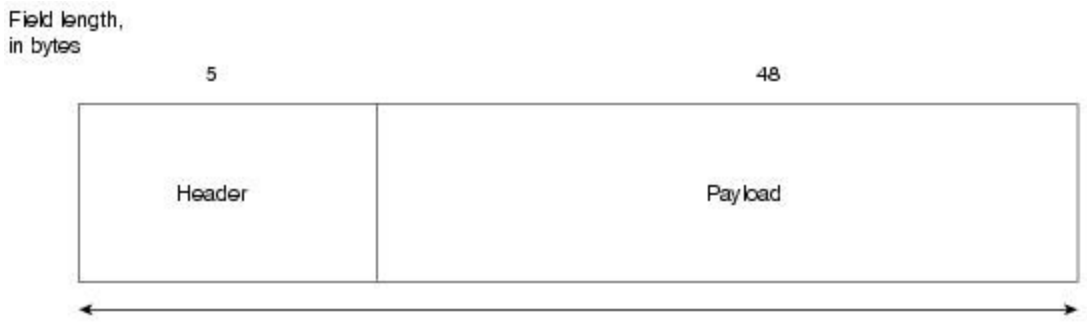
The Asynchronous transfer mode is one of the most preferred technologies because of its efficiency of use, especially with different hardware components. Unlike other types of technology, the speed and efficiency used in asynchronous transfer mode makes it one of the most common network protocol standards in use today. Most common standart speeds are 155 Mbps (for High Definition Televisions) and 622 Mbps. It's even possible to get 10 Gbps speed for transferring data with ATM

The point about the asynchronous transfer mode technology is, transferring several types of data at the same time. This is because of all bandwith is utilized, as long as it is available. Other types of technologies will often not allow all the bandwidth to be used once a particular function got started. Hence, asynchronous transfer mode technology provides very effective way to transfer e-mails, picture files, videos, and even live streaming audio and video.

2. ATM Cells

Asynchronous transfer mode technique's data transferring method is based on cells which consist 53 bytes of size. First 5 bytes constain cell-header information and the rest of all (48 bytes) contain the payload. Small, fixed-length cells are pretty suitable for transferring voice and video files because data traffic on network is intolerant of delays that result from having to wait for a large data packet to download, among other things.

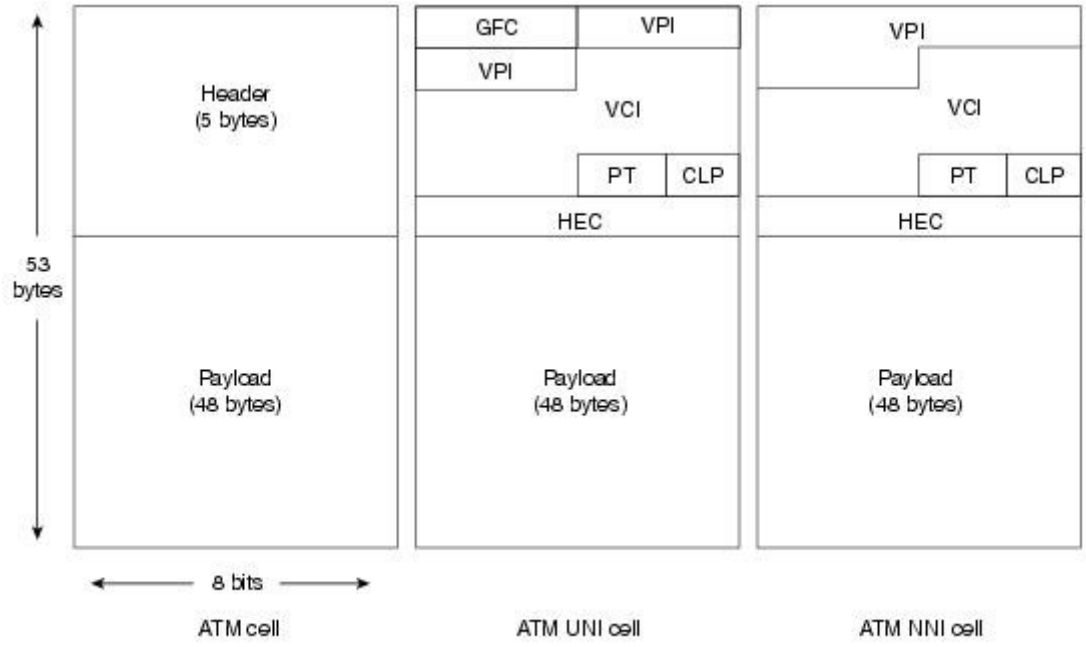
Figure 01: A Simple Figure of Asynchronous Transfer Mode Cell's Parts



In the management of Asynchronous Transfer Mode, data communication channels' places are not constant. To provide faster service, several time pieces which might come after another as it's possible to same channel's data might be send ,to set speed of cells empty cells might be send. And also, to transfer network's business or resource management informations, checking cell might be send too.

ATM specifies 2 different cell formats, which are Network-Network Interface (NNI) and User-Network Interface (UNI) . Most ATM links are using UNI cell format.

Figure 02: Another figures of ATM Cells, which are more specific about Header part of it. Such as, NNI and UNI specifications desings defferences.



Extraction of the cell fields short names which are in Figure 02, are like this:

1. **CLP Cell Loss Priority :** Indicates whether the cell should be discarded if it encounters extreme congestion as it moves through the network. If the CLP bit equals 1, the cell should be discarded in preference to cells with the CLP bit equal to 0.

2. **PT (Payload Type) :** Indicates in the first bit whether the cell contains user data or control data. If the cell contains user data, the bit is set to 0. If it contains control data, it is set to 1. The second bit indicates congestion (0 = no congestion, 1 = congestion), and the third bit indicates whether the cell is the last in a series of cells that represent a single AAL5 frame (1 = last cell for the frame).

3. **VCI (Virtual Channel Identifier) :** In conjunction with the VPI, identifies the next destination of a cell as it passes through a series of ATM switches on the way to its destination.

4. **VPI (Virtual Path Identifier) :** In conjunction with the VCI, identifies the next destination of a cell as it passes through a series of ATM switches on the way to its destination.

5. **HEC (Header Control Error) :** Calculates checksum only on the first 4 bytes of the header. HEC can correct a single bit error in these bytes, thereby preserving the cell rather than discarding it.

6. **GFC (Generic Flow Identifier) :** Provides local functions, such as identifying multiple stations that share a single ATM interface. This field is typically not used and is set to its default value of 0 (binary 0000).

3. Virtual Circuits

Asynchronous Transfer Mode technology is capable to build virtual circuits and virtual paths in two different way, ehich would make circuits either statical or dynamical. Static circuits (permanent virtual circuits or PVCs) or paths (permanent virtual paths or PVPs) require that the provisioner must build the circuit as a series of segments, one for each pair of interfaces through which it passes.

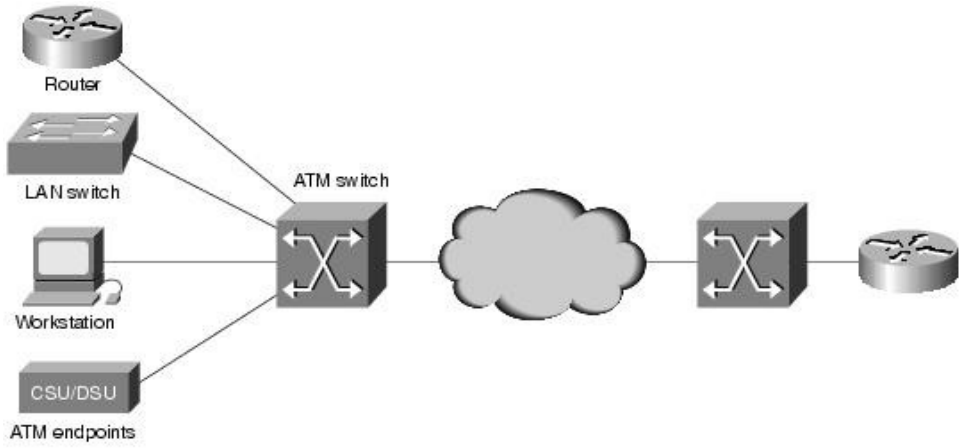
PVPs and permanent virtual circuits, though logically easy, and requires significant effort in big networks. They also don't support the re-routing of service in the event of a failure. Dynamically built PVPs (soft permanent virtual paths s or SPVPs) and PVCs (soft permanent virtual circuits or SPVCs), in contrast, are built by specifying the characteristics of the circuit (the service "contract") and the two endpoints.

So, ATM networks build and tear down switched virtual circuits on demand when requested by an end part of the equipment. One application for SVCs is carrying individual phone calls when the network of phone switches are inter-connected by ATM. SVCs were also used in attempts to replace LANs (Local Area Networks) with ATM.

4. Asynchronous Transfer Mode Devices

An ATM network is composition of ATM switches and endpoints. An ATM switch is responsible for ATM's cell transit through an ATM's network. And the duty of an ATM switch can be defined like this: ATM switches accept the incoming cell from an ATM endpoints or another ATM switches. Then ATM switch reads and updates the ATM cell's header information and quickly switches the cell to an output interface toward its destination. And, an ATM endpoint comprises an ATM network interface adapter.

Figure 03: An ATM Network Comprises ATM Switches and Endpoints



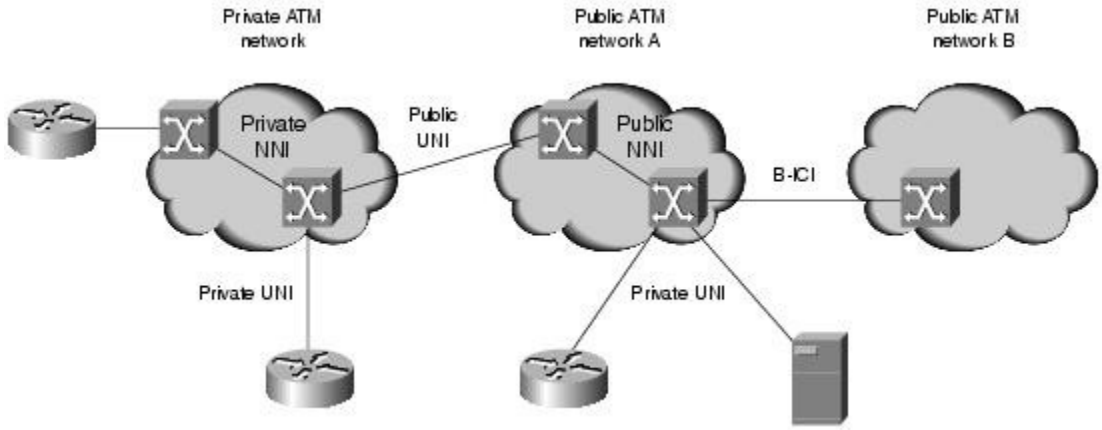
5. ATM Network Interfaces

An ATM network consists of a set of ATM switches interconnected by point-to-point ATM links or interfaces. ATM switches support two types of interfaces: UNI and NNI. The UNI connects ATM end systems like hosts and routers to an ATM switch. The NNI connects two ATM switches.

Depending on whether the switch is owned and located at the customer's premises or is publicly owned and operated by the telephone company, UNI and NNI can be further subdivided into public and private UNIs and NNIs. A private UNI connects an ATM endpoint and a private ATM switch. Its public counterpart connects an ATM endpoint or private switch to a public switch. A private NNI connects two ATM switches within the same private organization. A public one connects two ATM switches within the same public organization.

An additional specification, the broadband intercarrier interface (B-ICI), connects two public switches from different service providers.

Figure 04: ATM Interface Specifications Differ for Private and Public Networks



6. Shortly Other Benefits & Qualities Of ATM

The reason of ATM's high speed performance is, they have hardware-based utilities and all packages have standartized and canstant little sizes. Switching fixed sized little packages is easier and faster than swiching non-fixed sized packages by using softwares. In Addition, because of packages' sizes are fixed and small, they do not take the bandwith busy for a long time.

ATM is one of the primary subjects of B-ISDN. (B_ISDN : Broadband Integrated Services Digital Network)

7. Summary

To Sum up, ATM allows devices to be connected over very wide distances to create WANs (wide area networks) that behave like LANs. However, for an inexpensive network located in a single building, Ethernet is a well-established standard with a solid record, boasting over three decades of providing reliable networking environments.

CHAPTER 2: ETHERNET

1. Preview About Ethernet

As I mentioned previous chapter;

"ATM allows devices to be connected over very wide distances to create WANs (wide area networks) that behave like LANs. However, for an inexpensive network located in a single building, Ethernet is a well-established standard with a solid record, boasting over three decades of providing reliable networking environments."

Ethernet is data link layer technology for Local Area Networks . Ethernet supported a maximum theoretical data rate of 10 megabits per second (Mbps). More recently, Fast Ethernet standards have extended traditional Ethernet technology to 100 Mbps peak, and Gigabit Ethernet technology extends performance up to 1000 Mbps. After many developments like these, it got started to named according to it's physical qualities, to specify what kind of it, and what are it's qualities. IP and some other high level network protocols are using Ethernet as their transmission medium. The data is traveling all over ethernet in the form of frames. So some collisons may occur when multiple devices on the line attepmts simultaneously transmitting. The run length of Ethernet cables is limited (to roughly 100 meters), but various special-purpose devices exist that make Ethernet a cost-effective option for networking such area as school or office building, in other word local area networks.

2. Ethernet's Specifications

Ethernet specifications are defined low-level data transmission protocols and the technology needed to support them. In the OSI model, Ethernet technology exists at the physical and data link layers (layers 1 and 2).

A low-level network technology, Ethernet supports IP and most of higher-level protocols. Ethernet (traditional one) provides data transfers at the rate of 10 Megabits per second. Over time, as the performance needs of local area networks have increased, ans related techniques like Fast Ethernet and Gigabit Ethernet have been developed that extend traditional Ethernet to 100 Mbps and 1000 Mbps speeds, respectively.

As i mentioned above, ethernet species are names according to their physical qualities, to the different names. Here are some **encyclopedic** informations about various of ethernet:

<u>Traditional Ethernet</u>

Often referred to as Thicknet, 10Base5 technology was the first incarnation of Ethernet. It was used in the 1980s until 10Base2 "Thinnet" with more flexible cabling appeared. The most common form of traditional Ethernet, however, is 10Base-T due to the inherent advantages of unshielded twised pair over coaxial cabling and its low cost compared to alternatives like fiber.

The following table lists these well-known forms of Ethernet technology. Besides the type of cable involved, another important factor in Ethernet networking is the segment length. A single uninterrupted network cable can only span a certain physical distance before its electrical characteristics are critically affected by factors such as line noise or reduced signal strength.

Name Segment Length (Max.) Cable

10Base5 500m / 1640ft. RG-8 or RG-11 coaxial

10Base2 185m / 606ft. RG 58 A/U or RG 58 C/U coaxial

10Base-T 100m / 328ft. Category 3 or better unshielded twisted pair

Several other less well-known Ethernet standards exist, including 10Base-FL, 10Base-FB, and 10Base-FP for fiber optic networks and 10Broad36 for broadband (CATV) cabling.

Fast Ethernet

In the mid-1990s, Fast Ethernet achieved its design goal of increasing the performance of traditional Ethernet while avoiding the need to completely re-cable existing networks. Fast Ethernet comes in two major varieties:

• 100Base-T (using unshielded twisted pair cable)

• 100Base-FX (using fiber optic cable)

By far the most popular of these is 100Base-T, a standard that includes 100Base-TX (Category 5 UTP), 100Base-T2 (Category 3 or better UTP), and 100Base-T4 (100Base-T2 cabling modified to include two additional wire pairs).

Gigabit Ethernet

Wheareas Fast Ethernet improved traditional Ethernet from 10 Megabit to 100 Megabit speed, Gigabit Ethernet offers the same order-of-magnitude improvement over Fast Ethernet by offering speeds of 1000 Megabits (1 Gigabit). Gigabit Ethernet was first made to travel over optical and copper cabling, but the 1000Base-T standard successfully supports it as well. 1000Base-T uses Category 5 cabling similar to 100 Mbps Ethernet, although achieving gigabit speed requires the use of additional wire pairs.

3. How Ethernet Stations Communicate?

Ethernet stations communicate by sending each other data packets, blocks of data that are individually sent and delivered. As with other IEEE 802 LANs, each Ethernet station is given a 48-bit MAC address.

The MAC addresses are used to specify both the destination and the source of each data packet. Network interface cards or chips normally don't accept packets addressed to other Ethernet stations. Adapters come programmed with a globally unique address.

Despite the significant changes in Ethernet from a thick coaxial cable bus running at 10 Mbit/s to point-to-point links running at 1 Gbit/s and end beyond, all generations of Ethernet use the same frame formats, and can be readily interconnected through bridging.

4.Media Sharing And Ethernet

Ethernet was originally based on the idea of computers communicating over a shared coaxial cable acting as a broadcast transmission medium. The methods used were similar to those used in radio systems, with the common cable providing the communication channel likened to the ether, and it was from this reference that the name "Ethernet" was derived.

Original Ethernet's shared coaxial cable (the shared medium) traversed a building or campus to every attached machine. A scheme known as carrier sense multiple access with collsion detection (CSMA/CD) governed the way the computers shared the channel. This scheme was simpler than the competing token ring or token bus technologies.

Computers were connected to an Attachment Unit Interface (AUI) transceiver, which was in turn connected to the cable (later with thin Ethernet the transceiver was integrated into the network adapter). While a simple passive wire was highly reliable for small networks, it was not reliable for large extended networks, where damage to the wire in a single place, or a single bad connector, could make the whole Ethernet segment unusable.

Since all communications happen on the same wire, any information sent by one computer is received by all, even if that information is intended for just one destination. The network interface card interrupts the CPU only when applicable packets are received: The card ignores information not addressed to it. Use of a single cable also means that the bandwidth is shared, so that network traffic can be very slow when many stations are simultaneously active.

Collisions reduce throughput by their very nature. In the worst case, when there are lots of hosts with long cables that attempt to transmit many short frames, excessive collisions can reduce throughput dramatically.

5. Ethernet Frames

A data packet on the wire is called a frame. A frame begins with Preamble and Start Frame Delimiter, following which each Ethernet frame features an Ethernet header featuring source and destination MAC addresses.

The middle section of the frame consists of payload data including any headers for other protocols (such as Internet Protocols) carried in the frame. The frame ends with a 32-bit cyclic redundancy check, which is used to detect any corruption of data in transit.

COMPARISON OF
ETHERNET AND ASYNCHRONOUS TRANSFER MODE

Following sub-titles include comparions of Ethernet and Atm technologies in different views.

General

ATM is a complicated technology. There are a lot of standards covering various aspects of asynchronous transfer mode. One can imagine that the complexity is very much due to the nature of asynchronous transfer mode of trying to be one-solution-fits-all, technology from local area network to wide area network, for all data types. The connection-orientation also largely contributes to the overall complexity, because it requires the existence of specific signalling and routing protocols. The complexity is driven by the powerful capabilites in asynchronous transfer mode , nut not all need them.

In contrast, the beauty of Ethernet is its simplicity. Only a few standards cover the whole technology. The technology is easy to understand and deploy. This is the primary reason for the popularity and wide adoption of Ethernet.

A great benefit for asynchronous transfer mode is that it is independent of the underlying transport mechanism. asynchronous transfer mode does not define Media Access Control (MAC) mechanism or the physical layer, whereas Ethernet does define these. As a consequence, asynchronous transfer mode can run on top of different transport mechanisms and can adapt to new transport technologies and greater speeds. Without physical independency, the final goal of asynchronous transfer mode running everywhere would simply be impossible.

Bandwith

The routing and switching technology has improved and asynchronous transfer mode alone can not take advantage of simple and also fast hardware switching. The new gigabit speeds put burden on the back-end servers, and the server processing speed is becoming the bottleneck rather than the network.

Management

Asynchronous transfer mode network management is more difficult than Ethernet local area networks, due to many parameters of asynchronous transfer mode networks and interoperability issues. In an essential role is the Interim Local Management Interface which uses SNMP (simple network management protocol, which is simply messages without User Dataram Protocol (UDP) and IP) across User-Network Interface(UNI) and Network-Network Interface (NNI) to access status and configuration information within each network node. The Interim Local Management Interface (A protocol defined by the ATM Forum for setting and capturing physical layer) and Asynchronous Transfer Mode networking in general is still evolving.

Conclusion Of The Comparison and Contrast Between ATM and Ethernet

Asynchronous transfer mode has a well established position in Internet backbones, and local area networks are dominated by Ethernet. Neither is disappearing any time soon. Both technologies will co-exist for time to come. There are huge investments on both sides to the infrastructure and no matter how superior any technology is, migrations from one technology to another always takes time.

Looking at the sheer number of installations, price and easy of use reveal that Ethernet is the dominating technology in the local area network, and asynchronous transfer mode can hardly change this. In the backbones, the competition seems to be harder. Ethernet is a not real threat but there are experimental transport technologies that asynchronous transfer mode has to face.

Quality of service will have its effect in the development. There is a clear trend that Internet is increasingly being used to run real-time communication services such as voice over IP. Quality of service will matter in the future. Asynchronous transfer mode already has quality of service, though not fully implemented, that puts it ahead in this sector. Ethernet does not have quality of service, but development is active. While Ethernet may not achieve the "state of the art" quality of service of asynchronous transfer mode, it may well provide good enough mechanisms to satisfy most of the needs.

The unified factor in the future networking seems to be IP rather than asynchronous transfer mode. Comparing and contrasting these two technologies could provide an answer, but due to the fundamental differences of the two, other alternatives are being seeked as well. Running IP directly over backbones is a viable technology, but at the current state it is somewhat limited and cannot provide as comprehensive solutions as asynchronous transfer mode. On the whole, somehow it makes sense to believe that the winning technology will be the one that integrates most efficiently with IP.