Asynchronous Transfer Mode (ATM) Network

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Abstract

This paper begins with a discussion of current trends in networking. This leads us to discussing the new technology that takes care of the weaknesses in the existing network technologies by combining all the application requirements of various networks into one (ATM Network). Issues on the concepts of ATM (virtual circuits, fixed-size packets, time-division multiplexing), as a very high speed network, are presented. The characteristics of this network and its applications are also reviewed. These ideas allow the building of networks that can carry different classes of traffic with guaranteed quality-of-service (QoS) for each of the traffics.

Keywords: *Switching, Virtual circuit, Network, QoS, Packet, Multiplexing*

1.0. Overview

Everyday the world seems to be moving at a faster pace with new technologies occurring constantly. The most prominent area of faster and exciting technology is in telecommunications. Different services of various networks such as voice and video, as well as more bandwidth are needed for the increasing volume of data [18]. The network that presents a common format for applications with different network requirements is called Asynchronous Transfer Mode (ATM). Just as the Internet revolutionized world-wide communications, ATM brings a new meaning to high speed networking. Also, as the need for a flexible network and the progress in technology and systems concepts led to the basis of ATM principles [5].

ATM provides a heterogeneous mixture of network to support transmission of voice, data and video in a single network, using cell-relay and circuit switching methods. ATM transports all applications in fixed-size packets, called cells, each containing 5 bytes of header information and 48 bytes of user information [23].

ATM is also connection-oriented. This is, virtual connection has to be established before any call can take place, (a call is defined as the transfer of information between two or more end-points). Lastly, ATM is asynchronous. That is, time is slotted into cell-sized intervals, and slots are assigned to calls in an asynchronous, demand based manner.

2.0. Networking

Networks and associated computing and communication devices enable users to access voice, video, and data resources at anytime and from anywhere. The accelerating demand for remote data access, web services, great computing capabilities regardless of user location and mobility require a communication infrastructure with higher and more bandwidth. Different networks like Asynchronous Transfer Mode (ATM), Integrated Service Digital Network (ISDN), Digital Subscriber Line (DSL) and Fibre Distributed Data Interphase (FDDI) can be used to interconnect a large number of (possibly distant) autonomous computers that operates in a distributed computing environment.

2.1. Some available networks

2.1.1. Fiber-Distributed Data Interface (FDDI) - is a standard for data transmission on fiber optic lines in that it can extend in range up to 200 km (124 miles). The FDDI protocol is based on the Token Ring Protocol. In addition to being large geographically, an FDDI local area network can support thousands of users.

2.1.2. Integrated Services Digital Network (ISDN) - is comprised of digital telephony and data-transport services offered by regional telephone carriers. ISDN involves the digitization of the telephone network, which permits voice, data, text, graphics, music, video, and other source material to be transmitted over existing telephone wires. The emergence of ISDN represents an effort to standardize subscriber services, user network interfaces, and network and internetwork capabilities. ISDN applications include high-speed image applications, additional telephone lines in homes to serve the telecommuting industry, high-speed file transfer, and videoconferencing. Voice service is also an application for ISDN [26].

2.1.3. Asynchronous Transfer Mode Network (ATM) - is a technology that has its history in the development of broadband ISDN in the 1970s and 1980s. Technically, it can be viewed as an evolution of packet switching. ATM integrates the multiplexing and switching functions, is well suited for bursty traffic (in contrast to circuit switching), and allows communications between devices that operate at different speeds. ATM is designed for high-performance multimedia networking. ATM technology has been implemented in a very broad range of networking devices [27].

2.1.4. Frame Relay - which was developed to solve communication problems that other protocols could not: the increased need for higher speeds, an increased need for large bandwidth efficiency, and the need to connect LANs and WANs. Frame Relay is a packet-switched protocol, the Frame-Relay process is streamlined. There are significant differences that make Frame Relay a faster, more efficient form of networking. The intelligent network devices connected to a Frame-Relay network are responsible for the error correction and frame formatting. Processing time is minimized, so the transmission of data is much faster and more efficient. In addition, Frame Relay is entirely digital, which reduces the chance of error and offers excellent transmission rates. Frame Relay typically operates at 56 kbps to 1.544 mbps.

2.1.5. Digital Subscriber Line (DSL) - is also called xDSL .The x stands for various versions of DSL that are being proposed and in a small but growing number of cases, actually being offered by a few local telephone companies. "xDSL" refers to a variety of Digital Subscriber Line technologies designed to enable Internet/Intranet access at speeds many times faster than today's 56 Kbps modems or 128 Kpbs [28].

2.1.6. Synchronous Optical Networks (SONET) - are high-speed fiber-optic networks that are similar to FDDI. They generally use a minimum 1Gbps transfer rate, and are capable of 10Gbps ATM applications. All SONET networks work off a base 51.84Mbps rate, with all connections being multiples of that transmission rates.

3.0. Asynchronous transfer mode (atm) network

ATM Network is a technology that combines the flexibility f the Internet with the per-user quality of service guarantees of the telecommunication networks [18]. The interest in ATM technology was sparked by the ability to integrate voice, data and television traffic into one standard network. Its fast switching capability enables transmission at high data rates which is essential for tomorrow's large bandwidth services.

3.1. Why atm network?

Most networks of today are characterized by transporting just a service for which it was specially designed for, and is often not at all applicable to transporting another service. However, the developing trends in the networking field has brought about a large number of communication services (applications) with different service requirements, which may sometimes have unknown requirements. Most customers are always looking forward to getting a network that will take, possibly in a single system, the ever increasing number of new services. This large span of new requirements need widely accepted network that is flexible enough to cater for all of these services in the same way.

Moreover, data communication works more efficiently if packets are large, which minimizes the amount of segmentations and reassembly that had to be carried out. However, this might not be very suitable for real time traffic (e.g. voice and video) as large packets will introduce long delays creating problems for real time traffic. By forcing the packets length to 53 bytes, which is a characteristic of ATM, and giving priority to real time traffic, this traffic need not wait long before being given access to the communication channel. Flexibility and the advancement in technology concepts has therefore led to the development of the Asynchronous Transfer Mode (ATM) network.

3.2. Enabling features of an atm network

ATM has a higher performance feature over the other networks, which are given below:

- ATM is a high-speed network that uses fibre-optic cables. It is a switched point-to-point network, that uses central devices called switches and are directly connected to end stations and to each other.
- ATM uses no shared wires or fibre. Based on the architectural design of ATM, each computer has its own direct link to a switch. Other networks like, Ethernet allows several computers to share one wire. Though is less expensive, but the wire easily becomes overloaded when everyone uses it at once. Other compwters using the network don't directly affect ATM networks, since no one else can use a computer's direct connections to a switch. Users only experience overloading if they are competing with other machines for limited resources, like time or bandwidth to sources outside the network.
- ATM high-speed advantage comes from vransmitting uniform data packets that are sub-divided into cells, with an addressable size of 53-bytes, and routed by hardware switching. The switching achieves very high-speed data transmission rate. Therefore, ATM offers fast, real-time and demand-responsive switching for efficient use of network resources.
- Every station in an ATM network is always transmitting. However, most of the cells transmitted are empty cells that can be discarded at the switch. If a cell that is not empty enters the switch, the virtual path identifier (VPI) and virtual channel identifier (VCI) are read to determine where the cell will go next. The cell is then sent out in the next available slot, according to the type of cell it is.
- ATM is compatible most widely used cable media such as twisted-pair, coaxial, and fiber-optic, as well as a great deal of LAN and WAN technology. However, some cable media lacks sufficient bandwidth to fully realize ATM's potential. The point that slows ATM conversions is that ATM networks require consistent, compatible hardware throughout.
- No link-by-link error (flow control). Instead of relying on slower software switching and error checking at every node, which is applicable in some other packet switching network, ATM uses hardware switching at the data link medium access layer of the OSI model. Its high-quality, nearly noise-free dedicated digital lines doesn't require the burden of error checking associated with other packet-switching lines; the destination computer assumes that burden.

3.3. ATM concepts

The concepts behind ATM network are: point-to-point architecture, fixed-size packets (cells), routing, virtual circuits, and statistical multiplexing:

3.3.1. Switched point-to-point Architecture

The principle of switched point-to-point architecture employed by an ATM network includes both meshed point-to-point and hierarchical point-to-point architectures. In a switched point-to-point network, each endpoint is connected to a switch by a single point-to-point link. Each switch is connected with other switches by one or more point-to-point links to provide full connectivity among all endpoints on the network. This provides the basis for flexibility in supporting different bandwidth for different links, and allows independent improvement in link bandwidth for different links.

The main function of the switch is to forward information received from each input port destined for a particular receiving endpoint to the right part across the network to reach that destined endpoint. Each link can be shared by multiple sets of communicating endpoints on the network. This provides a set of shared network resources for all endpoints to be allocated on demand. The sharing includes the connectivity between each endpoints and the network.

3.3.2. Fixed-size packets (cells)

ATM uses a fixed-sized packet, called ATM cells, to transfer information. Each cell consists of 53 bytes. The first 5 bytes contain header information and the remaining 48 bytes contain the user information. The header identifies cells belonging to the same virtual channel and to perform the appropriate routing. Small, fixed-length cells are used because of the way ATM networks carry voice traffic: the transmitter digitizes voice samples, puts them in a cell (containing a cell header), before handling the cell to the network for transmission. On the other hand, the receiver removes the samples, converts them to analog form before playing them. Therefore, the delay between speaking and hearing depends on the number of voice samples that transmitter collects in each cell.

The reasons behind the use of a small size packet are: The small size packets avoid the problem of excessive delay experienced by small packets destined to an output port while the switch is transmitting a long packet on the same output port. The small packets reduce the queuing delay of each packet. Lastly, fine grain multiplexing at the ATM switch is allowed and that supports finer specification of data rates.

3.3.3. Routing

ATM networks are fundamentally connection-oriented, which means that a connection has to be set up (establish) across the ATM network prior to any data transfer. The way the connection is set up by the network is by signaling, i.e by transmitting a set-up request, which passes across the network to the destination. The switches ensure that there are sufficient resources before accepting a connection. If the destination agrees to form a connection, the virtual channel connection (VCC) is set up between the two end-systems. A VCC may consist of a concatenation of different ATM virtual circuit links. All communication follows along this route that preserves cell sequence and a guaranteed quality of service (QoS).

A virtual path is a bundle of virtual channels carried between two ATM entities and may also involve many ATM virtual path (VP) links, all of which are switched transparently across the ATM network based on the common Virtual Path identifier (VPI). As the cell address mechanism uses both the virtual circuit identifier (VCI) and the VPI, different VPs can also use the same VCI without conflict (figure 3). A cell may not be associated with any VP. In this case it would have a null VPI and only a unique VCI. With the use of VCs and VPs, virtual circuits can be permanently established, thereby guaranteeing a level of access, or set up temporarily just for the duration of the communication. For each call, the user application specifies some parameters. By setting these parameters, network designers can ensure that all the traffic types get the required quality of service (QoS).

3.3.4. Virtual Circuits

A technique for packet switching in which short identifiers in the header (also called VCI) of a packet identify the destination of a packet. Virtual circuits are connection-oriented (a source must establish a circuit or connection before it can transfer any data) [18]. There are two benefits of virtual circuits: they simplify routing once a path has been established; and they allow components within the network to distinguish amongst various traffic flows for the purposes of admission, congestion control, billing, security, etc.

Virtual circuits, in a broader view, support the separation of an in-band and out-of-band communications and thus the separation of the network transfer and policy mechanisms [16].

3.3.4.1. Virtual Channels and Virtual Paths

In an ATM network, each physical link is conceptually divided into a number of virtual channels. A virtual channel can be a local name for a particular link, identified by a virtual channel identifier (VCI). Any communication across a physical link must be given a virtual channel before any data (user load) is communicated over it. A virtual connection between two endpoints is a combination of different virtual channels on the links along the physical route of the connection between the endpoints. Therefore, a virtual channel connection (VCC) is identified by a unique VCI on each link along the path and can vary from link to link [10].

Virtual path (VP) handles to a group of virtual channels having certain similar characteristics. The VP increases the flexibility and facilitates connection management in the ATM network. In relation to VCC, a virtual path connection (VPC) consists of a concatenation of virtual paths in the physical links along the route. Each VP on a link has a number of virtual channels, identified uniquely by a virtual path identifier (VPI). VPI and VCI are the two identifiers used in an ATM virtual connection. The VPI identifies which VP it belongs to, while the VCI identifies which virtual channel among the VP it actually represents. VCCs are usually terminated at the ATM endpoint, whereas VPC are (but not always) terminated between ATM switches (Fig. 1).

3.3.5. Multiplexing

Asynchronous transfer mode (ATM) network uses both the methods of switching and multiplexing. Time division multiplexing (TDM) being used by an ATM, is a methodology of putting multiple applications on a transmission link by separating the link into many segments, each having a very short time slot, with a guaranteed QoS of each application [19].

The principle of TDM is based on a time slotted transmission algorithm whereby different applications' data are multiplexed according to their bandwidth delay and loss requirements. Each time slot carries one ATM cell. Therefore, the higher the bandwidth needed by an application, the greater the number of time slots needed in a given period of time by the application. One feature of TDM is its flexibility. It allows for variation in the number of links sent along the line, and adjusts constantly the time intervals for optimum use of the available bandwidth. Time slots are allocated first to those connections that might be affected by delay, to satisfy their QoS requirement, whilst the remaining is shared by connections without QoS requirements [12].

TDM is implemented at each output port of the ATM switch. There, it determines how each application, identified by a connection identifier on each cell, multiplexes and shares the output link bandwidth with other applications.

3.3.6. Admission Control (Resource Reservation)

To ensure guaranteed QoS to support multimedia and collaborative applications, reservation of networking resources is required. Some new connections have to be turned down when the network becomes heavily loaded, as to maintain the quality of service of existing applications. Connection-oriented approach handles resource reservation by including additional information like bandwidth and QoS requirement in the call set up message. The network then determines if sufficient resources are available otherwise it turns down the offer or proposes a lower quality or bandwidth connection.

To facilitate connection-oriented service, call connections need to be established before a call is allowed to progress. To maintain network integrity and to provide agreed-upon quality of service, *call level admission control* must be enforced.

For *in-progress calls*, the cell-level traffic needs to be policed to control the amount of data allowed to enter the network by regulating violators. The policing of the individual traffic sources is a cell level control.

The usage parameter controlled traffic from the different users are multiplexed and scheduled for transmission onto the outgoing link to attain a prescribed level of quality of service. The multiplexing and scheduling of multiple traffic streams for transmission onto an outgoing link is a *burst level control*.

Call Control - It is necessary for the network provider to achieve network performance objectives. Based on the traffic descriptor and the QoS requirements, the network has to decide whether or not a new call should be admitted. Once a call is admitted and a connection is established, it is incumbent upon the network provider to allocate sufficient network resources to satisfy the agreed upon QoS. When a request for a new connection is initiated, a probing signal is dispatched along potential paths to establish a virtual connection. Each of the nodes through which the probing signal traverses needs to compute its residual resource, defined as the total available nodal resource less the total resource already allocated to support in-progress calls. The amount of nodal resource allocated to support a given cell shall be referred to as the *schedulable envelope*. That is, user traffic which is allowed to enter the network must be within the limit specified by the schedulable envelope. Therefore, backbone network defines and calculates the schedulable envelope, while the controller at the network access point enforces call admission control based on the limit specified by the schedulable envelope. Scheduling and admission control can be viewed as separable functions, which are linked to the extent that the scheduler provides the schedulable envelope and the admission controller observes this limit when admitting new calls.

Cell Control - Some in-progress calls may attempt to send more than the agreed-upon traffic load, i.e. exceeding the limit specified by the schedulable envelope. If not controlled, the network can be driven into a chaotic state. It is therefore beneficial, and necessary, for the network provider to exercise cell-level control to police violators. Cell-level policing is to be exercised on a per-connection basis. Because of the high-speed, the transit delay between a boundary node and a potential bottleneck node can be very large, which can render reactive type of control for policing ineffective. Most traffic policers are of the preventive rate control variety.

Burst Control - The link transmissions speed of an ATM network is large compared to that of an individual user. To make efficient use of the network bandwidth, many individual user traffic are multiplexed at the network boundary for transmission over a single high-speed link. Through proper scheduling of service, statistical multiplexing enhance link utilization to permit the asynchronous transfer mode to support a large number of sources than the synchronous transfer mode. Thus, scheduling is the key to enhancing utilization while maintaining a certain degree of fairness among the participating users [12].

3.4. ATM devices

An ATM network is made up of an ATM switch and ATM endpoints, which fundamentally supports two types of ATM connections:

- **Point-to-point connection –** connects two ATM end-points. This type of connection could be unidirectional or bidirectional.
- **Point-to-multipoint connection –** This connection allows a single source end-point to multiple destination end-points. ATM switches handle cell replication within the network when the connection splits into branches. Such connections are unidirectional, permitting the source to transmit to the destination, but not the destination to transmit to the source, or to each other, on the same connection [15].

An ATM switch is responsible for cell transit through an ATM network. The job of an ATM switch is well defined: It accepts the incoming cell from an ATM endpoint or another ATM switch.

It then reads and updates the cell header information and quickly switches the cell to an output interface toward its destination. An ATM endpoint contains an ATM network interface adapter.

3.4.1. ATM Network Interfaces

It is envisioned that the ATM network service providers may offer several types of interfaces to their networks. One interface that is likely to be popular with companies that build routers and bridges for local area networks is a Frame based interface. One or more of the FDDI frames may be supported at the user network interface (UNI), with frame to ATM cell conversion and reassembly being done inside the UNI at the source and destination end points respectively. Thus a gateway host on a local area network might directly connect its Ethernet, Token Ring, FDDI, or other LAN/MAN interface to the UNI, and thus bridge two widely separated LANs with an ATM backbone network. This will preserve the existing investment in these standards and equipments, and enable a gradual transition of the ATM networks into the market place.

An alternate interface likely to be more popular in the longer run, and for which the concept of Broadband-ISDN really makes sense, is direct interface at the UNI with standard ATM cells. Such a streaming interface can hook subscriber telecom, and computer equipment directly to the network, and allow orders of magnitude greater performance and bandwidth utilization for integrated multimedia traffic of the future.

It is quite likely that companies may crop up (if they have not already done so) to design ATM multiplexers for interface to the UNI of a larger ATM backbone network. Especially if the CCITT succeeds in standardizing an interface definition for UNI, it will be an additional boom to this market. The multiplexers with multiple taps on the user side can connect to one fat ATM pipe at the network side. Such a multiplexer would hide the details of ATM network interface from the user, and provide simple, easy to use, low cost ATM cell taps to hook the user equipment into.

Companies with investment in existing synchronous transfer mode (STM) networks such as T1 and T3 backbones, are likely to want a direct T3 interface to the UNI, thus allowing them to slowly integrate the newer ATM technology into their existing one. Thus it is possible to see a flurry of small startups in the future rushing to make large T3 multiplexers for connecting several T3 pipes into one large ATM pipe at the UNI.

Typically, an ATM network will require a network management agent or proxy to be running at every UNI which can communicate and exchange administrative messages with the user attachments at the UNI for connection setup, tear down, and flow control of the payload using some standard signalling protocol. A direct user attachment at the UNI is likely to cost more and be more complex, then a user attachment to something which in turns interfaces to the UNI.

An ATM network consists of switches that are interconnected in point-to-point architecture form. The switches serve as an interface between endpoints. The two interfaces are: UNI and NNI. The UNI connects ATM endpoints (e.g routers and hosts) to an ATM switch. The NNI connects two ATM switches. UNI and NNI can further be divided into private and public UNIs and NNIs. Private UNI connects ATM endpoint and a private ATM switch. Also, a private NNI connects two ATM switches within the same private organization. Moreover, public UNI connects an ATM endpoint or private switch to a public switch. And a public NNI connects two ATM switches within the same public organization (fig. 2)

3.5. Quality of service (QoS) and ATM network

ATM networks supports different types of applications - connection oriented as well as connection less. It can handle applications that are delay or loss sensitive It can further reserve and allocate a fixed bandwidth for a connection carrying a continuous bit stream for isochronous traffic (e.g voice), allocate a bandwidth range for a variable bit stream for plesiochronous traffic (e.g interactive compressed video), as well as allocate no specific amount of bandwidth and rely on statistical sharing among bursty sources. It may also provide multiple priorities to applications whether it is delay or loss sensitive.

Thus the performance that one might get from ones ATM connection is very much dependent on the parameters that are specified at connection setup time. If an application is given a link bandwidth, it does not necessarily mean that the end to end payload bandwidth that the ATM interface can sustain will be the same throughout the connection. In fact, it may considerably be lower based on connection setup parameters and the quality of service request, and whether bandwidth was reserved or statistically multiplexed, and the load on the ATM network [20].

Due to the reasons given above, ATM uses three general methods to perform QoS when servicing any connection:

(i) If a ***required*** level of QoS of connection is needed, ATM guarantees and enforces that the required level of service is met by all devices providing the connections.

(ii) If a ***preferred*** QoS is requested for a connection, ATM tries to gather resources where available in the network to accommodate the requested level of service, while preserving and maintaining service guaranteed for connections that require them.

(iii) If QoS is ***unspecified*** for a connection, ATM tries to use available network resources in a *best-effort* attempt to provide a form of service similar to what is available in other LAN/WAN transfer modes needed.

All these QoS guarantees are achieved by a combination of the mechanisms of resource reservation, admission control and asynchronous time-division multiplexing.

3.6. ATM switching techniques

The operation of an ATM switch is very simple: to receive a cell across a link on a known VCI or VPI value; to look up the connection value in a local translation table to determine the outgoing port (or ports) of the connection and the new VPI/VCI value of the connection on that link; and to then retransmit the cell on that outgoing link with the appropriate connection identifiers (Fig. 3).

The switch operation is so simple because external mechanisms set up the local translation tables prior to the transmittal of any data. The manner in which these tables are set up determine the two fundamental types of ATM connections:

Permanent Virtual Connections (PVC): A PVC is a connection set up by some external mechanism, typically network management, in which a set of switches between an ATM source and destination ATM system are programmed with the appropriate VPI/VCI values. ATM signaling can facilitate the set up of PVCs, but, by definition, PVCs always require some manual configuration. As such, their use can often be cumbersome.

Switched Virtual Connections (SVC): An SVC is a connection that is set up automatically through a signaling protocol. SVCs do not require the manual interaction needed to set up PVCs and, as such, are likely to be much more widely used. All higher layer protocols operating over ATM primarily use SVCs.

Information is segmented into fixed sized packets, and each packets are transmitted asynchronously through the network. The switching technique reduces the protocol processing overhead in order to meet up with the transmission speed of the network links

4.0. The benefits of using ATM

Many application areas will benefit from the use of an ATM network:

Medical images such as x-ray may require up to 10 gigabits of digital representation. To enable real-time collaborative discussion between physicians separated by a distance, this large digitized x-ray image has to be transmitted at multigigabit speed. This could be achieved using **B-ISDN** as it incorporates **ATM** technology which allows transmission of information at high speeds.

Another application area that would benefit from **ATM** is the applications that are carried out in supercomputer centre. During the visualization of three dimensional images, a user may wish to interact with it in real time that is, the effects of changing the image's parameters should be simultaneous. This would require a network capable of high data rate and low latency which could be provided by **B-ISDN**.

Enables new applications due to its high speed and the integration of traffic types, ATM will enable the creation and expansion of new applications such as multimedia to the desktop.

Compatibility - Because ATM is not based on a specific type of physical transport, it is compatible with currently deployed physical networks. ATM can be transported over twisted pair, coaxial and fiber optics for business needs.

Simplified Network Management - ATM is evolving into a standard technology for local, campus/backbone and public and private wide area services. This uniformity is intended to simplify network management by using the same technology for all levels of the network.

Long Architectural Lifetime - The information systems and telecommunications industries are focusing and standardizing on ATM. ATM has been designed from the onset to be scalable and flexible in: Geographic distance, Number of users and access and trunk bandwidths. This flexibility and scalability assures that ATM is applicable to all other networks [20].

5.0. ATM and other environments

Majority of the world's carriers use ATM in the core of their networks. The flexibility of an ATM network has made it widely adopted in supporting different forms of technologies as a platform to future applications. These make ATM to appear in several networking environments. It can also act as a unique bridge between legacy equipment and the new generation of operating systems platforms.

ATM in the telecommunications infrastructure - Telecommunication networks are designed with a series of layers. A configuration of it may employ the use of ATM or IP with time division multiplexing. In a network, some carriers have selectively used the features of ATM with other technologies like SONET/SDH to carry their telephony.

ATM and Frame Relay Internetworking - A connection-oriented packet switching technology is efficiently designed to transmit data traffic without connection and traffic management overhead. The actual technology used to provide frame-relay services is the ATM. Frame-relay service providers are now using ATM technology, to meet up with their fast growing rate of services, as a networking infrastructure for a range of data services.

ATM and LAN Emulation - A standard defined by the ATM Forum, LAN Emulation (LANE), gives to stations attached via ATM the same capabilities obtainable from the normal LANs like token ring and Ethernet. This appears to shelter the headaches associated with high-volumes of traffic that affect larger networks. When there is s need for high-speed transport in the core coupled with the security of a guaranteed level of QoS, most carriers turn to the use of ATM. The reason is because the transport signal is maintained even when several types of traffic are traversing the same network [14].

ATM and WAN - ATM has a universal support and enviable management features. A mixture of ATM, IP and Ethernet abound in WAN. When there is a need for high-speed transport in the core network, coupled with the security of a guaranteed QoS, carries always employ ATM. If carriers expand to WAN, majority use an ATM layer because distance is not a problem with ATM. Even when different kinds of applications are traversing the same network, the integrity to scale up, thereby various services at varying speeds and performance levels can be offered.

ATM and DSL INTERNETWORKING - ATM is unique for its breadth of services and applications with which it easily interfaces. Linking ATM and Digital Subscriber Line (DSL) shows the best characteristics of each technology. DSL uses ATM's flexibility to reliably deliver a variety of services to the user via one of the DSL variants like ADSL, HDSL, and VDSL. ATM allows bandwidth to be dynamically allocated between a broad array of voice and data services reliably and with little overhead on the per definition over-subscribed.

ATM and Wireless Applications - Wireless applications access offers variety of online services, application's and deliver a true, unlimited mobility. Enabling third generation (3G) mobile services, also known as Universal Mobile Telecommunications System (UMTS), offers a variety of transport and switching mediums.

Asynchronous Transfer Mode (ATM) serves in the Radio Access Network (RAN) and the core network of UMTS infrastructures, carrying both voice and data traffic efficiently, with a guaranteed quality of service (QoS). In addition, ATM also serves as integration platform for 2G (GSM) and 3G (UMTS) on a common, multi-service access, giving the operators increased flexibility and investment protection.

Residential Broadband Networks - ATM is the networking infrastructure of choice for carriers establishing residential broadband services, due to the higher scalability of the network.

6.0. Challenges

The high speed characteristic of an ATM network offers some issues that have to be considered by the designers and users for the success of the network.

Economy of Scale - Networking technology seems to be far ahead of the applications today. High-speed fibres have been installed but there is not enough video traffic to fill them. Therefore there is a need to make up for a high bandwidth. In this case, the primary motivator will be a low cost technology. If the high-speed technology is proportionately cheaper than low-speed technology, the buyers will think of dividing their application networks into multiple of low-speed links but will prefer a single high-speed link with low cost. This seems to be one of the major issues that must be considered by the designers of the network.

Achieving a Desired Quality of Service - ATM supports different kinds of traffics which may have different characteristics based on the application. An important issue that must be resolved is how application programs determine and indicate their expected bandwidth requirements to the network. Applications may specify parameters such as peak and average data rate, maximum delay, and cell-loss probability. It is then up to the network to allocate its resources to satisfy the application's requests. It is still unclear how this is being achieved.

Performance - In a high speed environment, the performance goals currently set for ATM may make the system too compnex to implement since supporting statistical multiplexing and a continuous bit rate requires elaborate congestion and rate-control schemes that must be executed on a real-time basis inside the network. Special hardware is required to carry out these functions at high speeds. Whether all of the design goals set for ATM will be realized in practice is still an issue for debate [25].

Bandwidth Management and Congestion Control - ATM is based on the premise of a homogeneous network where all the traffic is transformed into a uniform 53-byte packet. This allows the network to carry a wide variety of different traffic types more suitable to the expected amount of heterogeneous user data that is expected to be present in these networks. The following problems are encountered in allocating bandwidth and controlling congestion in ATM networks.

- *Peak rate allocation* : In this case, the user simply specifies the maximum rate at which cells are to be sent to the network. The network must assign Virtual Channels so that on every link the sum of the rates on the Virtual Channels is no more than the link's maximum cell rate. If the traffic exceeds the specified rate, cells are simply discarded. Peak rate allocation offers a strong performance guarantee and is easy to implement, but it may make poor use of the network bandwidth in the case of bursty traffic.
- *Minimum Throughput Allocation* : The user specifies the throughput that is needed when the network guarantees the specified throughput. This approach can provide high efficiency, but the performance guarantee is weak.
- *Bursty Traffic Specification* : This allows the user to specify the peak rate, the average cell rate, and the maximum burst size. These parameters are then used to ensure that the specified allocation can be met. The main drawback of this approach is that it may take a long time to compute when a new Virtual Channel can be safely multiplexed with other Virtual Channels (i.e., the procedure is computationally intensive)[5].

Conclusion

There are different networks available these days but ATM has received a lot of attention recently because of its exciting features. ATM has several superior advantages over the current networking techniques as they were discussed. With ATM, the bottlenecks (overheads) of the current networks will be solved, even, multimedia applications like video conferencing will be brought to the desktops.

The high-speed characteristic and the ability to support traffic of different types (voice, data, and video can be transported on the same network), will enable the network to accommodate the upcoming new teleservices easily even if the requirements for these services are unknown. It also improves the efficiency and simplifies the management of the network by using the same technology for all levels of the network. There is therefore no doubt about the advantages of ATM.

Despite some of the issues mentioned above that are yet to be resolved, the only thing that is uncertain is whether the general public will become interested in such a high level of service. The speed with which people join the system will play an important role in the speed of transition to ATM.

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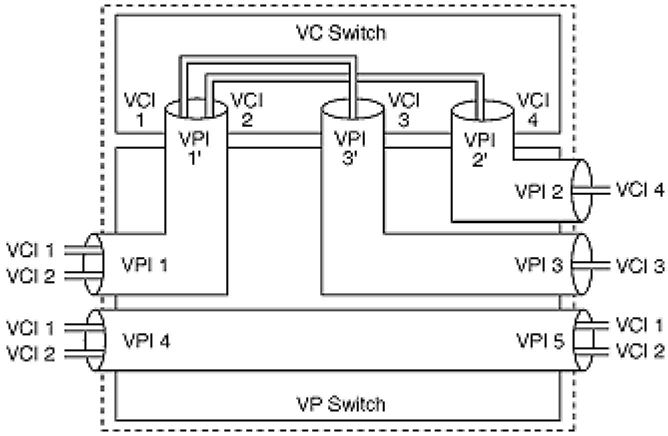

Figure 1: Virtual Circuit and Virtual Path Switching [15]

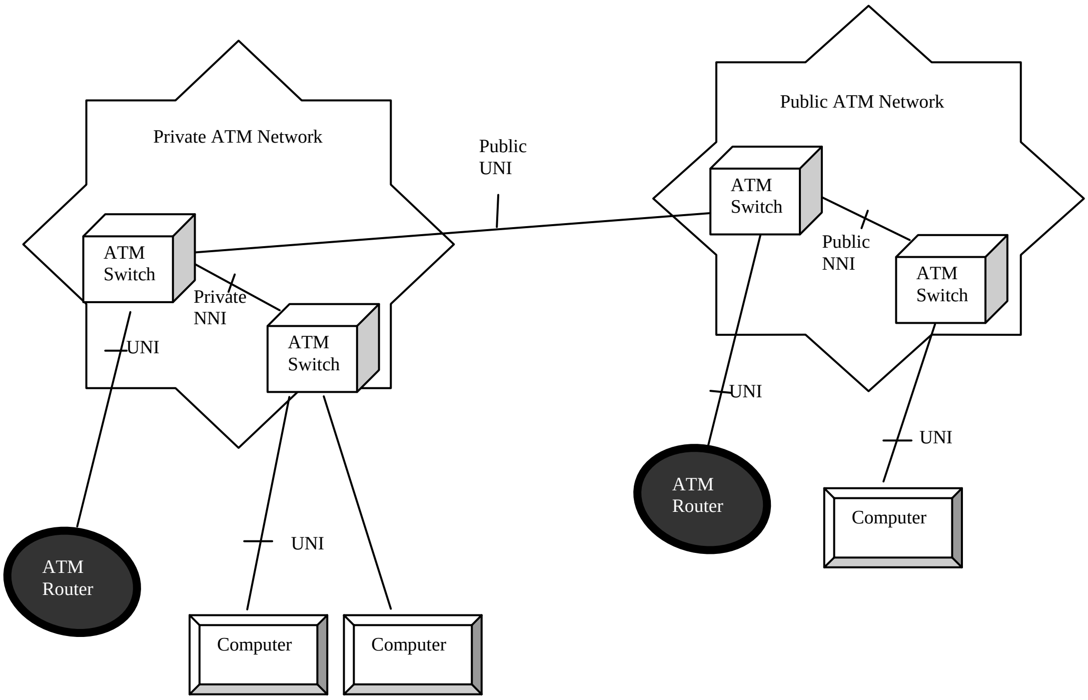

Figure 2: ATM Network Interfaces

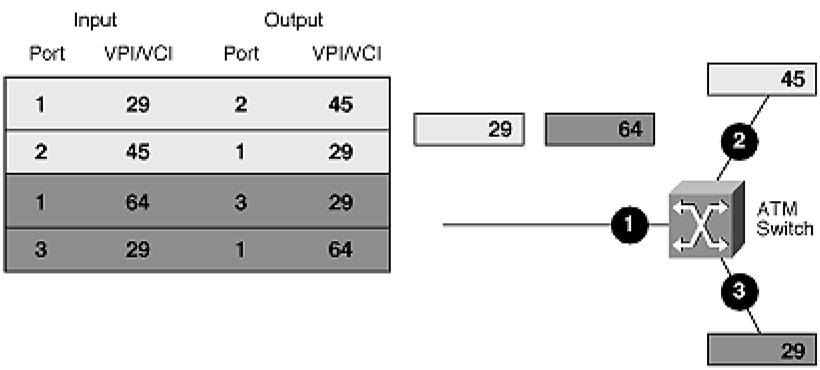

Figure 3: ATM Switch Operations [15]

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