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ATM Network: A High-speed Communication Network

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Abstract

Next-generation computers and communications will use asynchronous transfer mode (ATM). ATM networks employ compact, predetermined cells for message transmission, enabling them to efficiently utilize the same network for transmitting voice, video, and data across extensive distances. Most computer and telecommunications companies focus on ATM products and services. The building can also manage different and regular costs. Therefore, it is suitable for many vehicle types and has end-to-end encryption. ATM uses mobile phones or packet switches and electronic equipment to transfer data. The primary aim behind the development of ATM was to enhance the efficiency of multimedia communication. This article offers insights into the current landscape of ATM technology, addressing its key challenges and highlighting prevalent issues. It delves into an overview of ATM, examines the design and performance of both current systems and future iterations, elucidates on ATM connectivity within regional networks, explores traffic management challenges in ATM networks, and sheds light on common obstacles encountered in ATM implementation. ATM networks have played a significant role in improving communications and data transmission over the past few decades. This literature review is designed to provide an overview of ATM networks, including their history, basic concepts, architecture, functional details, advantages, and applications. Furthermore, the examination of the influence of emerging technologies on ATM networks and their prospective implications is also explored.

Keywords: Asynchronous transfer mode (ATM), telecommunication, networking, data transmission, technologies, local area network (LAN), wide area network (WAN)

INTRODUCTION

Presently, a significant challenge in networking pertains to the proliferation of numerous networks, each customized to meet specific service demands. Voice transmission in public settings often relies on private branch exchanges (PBX), while local area networks (LANs) utilize a variety of technologies such as ethernet, fast ethernet, gigabit ethernet, and token ring networks for data transfer [1].

Asynchronous transfer mode (ATM) networks were born from the need to integrate servicers and meet performance requirements from both telephony and data networking. This vision, known as the "broadband integrated service vision" (B-ISON), aimed to combine the best of both worlds.

ATM surfaced as a technology capable of accommodating diverse service qualities at an affordable price, aiming to encompass both telephone networks and the internet.

The goal is to replace these numerous networks with a unified platform capable of accommodating diverse requirements, thereby improving network management efficiency and reducing operational expenses. ATM was developed precisely to meet this demand by offering a unified and integrated platform for a wide array of network services [2].

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ATM has attracted the attention of computer users and internet businesses worldwide. ATM employs innovative technology poised to transform both LANs and wide area networks (WANs). ATM, an advanced electronic technology, emerged in the late 1980s and early 1990s to meet the increasing demand for enhanced transmission of both data and voice. ATM needs to become an important technology for both the region and the wider area in the coming years [3]. ATM networks have many advantages, including low latency, high bandwidth, and quality of service (QoS) guarantees. This introduction paves the way for a more in-depth examination of ATM networks by delving into their historical development, principles, architecture, features, and applications.

In the early 1990s, ATM became popular as a high-speed, broadband data communications technology. It is considered a compact technology that provides the best in circuit and packet switching in a single technology. Data will be fed into the network in the form of packets or circuits and then split into headers into fixed symbols.

The history of ATM networks can be traced back to the work of the International Telecommunication Union (ITU), which defined the ATM standard in the late 1980s. It aimed to create a unified platform for both voice and data traffic, offering a highly efficient and versatile solution for communication. As we journey through the intricate web of ATM technology, we uncover the layers of innovation and significance that have made it a landmark in the landscape of modern networking [4].

ATM is seen as a promising technology that will revolutionize local and regional markets. However, it ultimately failed to gain widespread adoption due to its complexity and the rise of alternative technologies such as frame relay and ethernet. Despite this, ATM is still used in some applications, such as in telecommunications networks and in certain industrial control systems.

Despite being a broadband fast-packet switching technology, ATM is anticipated to become more cost-effective compared to current circuit-switched systems as economies of scale are achieved. Consequently, numerous networking professionals foresee ATM becoming the preferred technology not only for broadband services but also for narrowband services like voice, messaging, and other low-speed data services [5].

REVIEW OF LITERATURE

ATM stands for "Asynchronous Transfer Mode". It is defined as a transmission mode that organizes data into units. It is a high-speed networker designed for LAN and WAN use. It can transmit voice, data and video separately or simultaneously. It consists of long-length packets called cells and allows multiplexing of multiple communications. ATM is a connection-oriented virtual channel with minimal errors and capable flow control [6].

The ATM layer, functioning as the second layer, handles tasks such as cell multiplexing/demultiplexing and cell relaying, which also applies to the adaptation layer. The adaptation layer is responsible for a diverse range of tasks essential for transporting information streams from different applications. For instance, in voice applications, it manages functions like source clock recovery, compression, and silence suppression. For data applications, segmentation and reassembly are handled, while for video applications, it manages coding and decoding of video signals. However, the execution of these functions may vary depending on the type and implementation of the adaptation layer utilized [7].

The Lower Three Layers of the ATM Reference Model

The lower three layers of the ATM reference model include the physical layer, which handles transmission of raw cells over a physical medium; the ATM layer, responsible for cell relay, addressing, and multiplexing; and the ATM adaptation layer (AAL), which ensures proper data formatting and reassembly for various applications as shown in Figure 1.

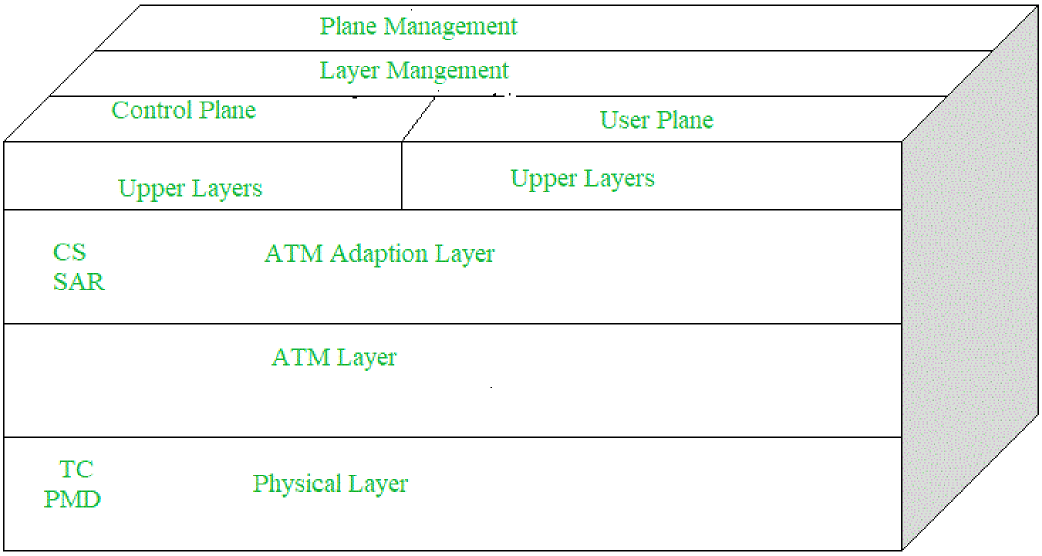

Figure 1. Asynchronous transfer mode (ATM) layers.

Physical Layer: This layer's functions are divided into two main categories: physical medium department (PMD) functions and transmission convergence (TC) functions. PMD functions are tailored to the characteristics of the underlying physical medium [8]. Examples of PMD functions encompass tasks like bit transfer, bit alignment, electrical-optical transformation, and line coding. On the other hand, Transmission Convergence functions entail tasks such as cell rate decoupling, cell delineation, cell header processing, scrambling/descrambling, and frame generation and recovery.

ATM Layer: The primary responsibilities of the ATM layer involve tasks such as cell multiplexing/demultiplexing, cell virtual path identifier/virtual channel identifier (VPI/VCI) translation, and cell header generation/extraction. Additionally, it performs other functions like generic flow control, usage parameter control/network parameter control (UPC/NPC), congestion notification, and managing connection establishment and termination.

ATM Adaption Layer (AAL): The AAL undertakes a diverse range of functions based on the specific application it serves. It comprises two sub-layers: segmentation and reassembly (SAR) sub-layer, and the convergence sub-layer (CS).

ATM standard uses two kinds of associations. That is, virtual path connections (VPCs) consist of bundled virtual channel connections (VCCs), serving as a fundamental unit transporting a single stream of cells from one user to another [9]. An ATM network allows for the creation of a virtual path spanning from end to end without confining cells to a particular virtual circuit. In case of a major failure, all cells associated with a specific virtual path are uniformly rerouted throughout the ATM network, facilitating quicker recovery.

In an ATM network, there is no record maintained of the origins or destinations of cells. Instead, it relies on user to network interface (UNI) or network to network interface (NNI) signaling protocols to set up virtual paths (VPs) and virtual circuits (VCs) between the source and destination devices prior to any data transmission. This illustrates that ATM operates as a connection-oriented network. Once the connection is established, network resources are assigned, and VPI and VCI values are configured at each intermediate ATM switch along the flow to ensure quality of service for data transmissions. Once established, cells can begin to flow from one place to another [10]. Only VPI and VCI values are used to determine the output connector to which the signal will be sent when the signal element reaches the switch as shown in Figure 2.

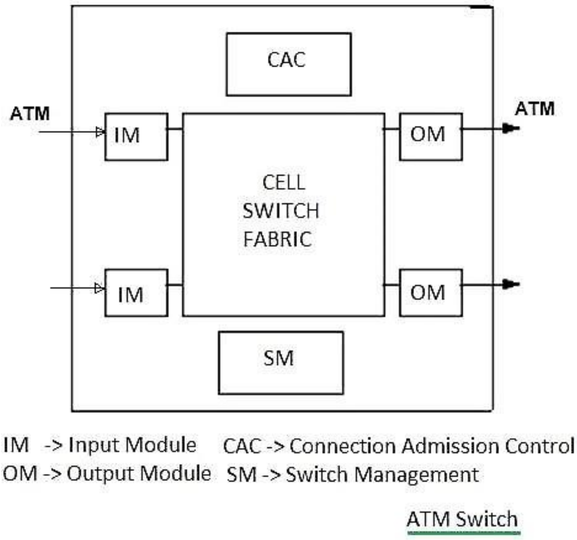

Figure 2. Asynchronous transfer mode (ATM) switch architecture.

The change involves the supporter using VPI and VCI to transfer units, which are virtual paths and virtual links with different virtual channels shared between them, effectively virtual switch circuits that can be used as different products. Its fundamental activity is direct by looking into the association esteem in the nearby interpretation table deciding the active port of the association and the new VPI/VCI worth of association on that connection.

ATM switches are sophisticated routers used in packet-switching systems, enabling the transmission of voice, data, images, and video traffic through high-speed single access. It fragments the comparison information into 48 bytes of the same size and adds the header (5 bytes in size) before transmission. Here, 48 bytes contain data and 5 bytes contain control data. ATM switches operate on cells of the same size, so cell delays are reasonable and noticeable [10].

ATM switches differ from conventional switches primarily in their high-speed interfaces, ranging from 50 Mbps to 2.4 Gbps. The switch is expected to manage broadband applications similarly as to manage specific kinds of traffic subject to require through ATM association. Voice traffic cannot tolerate significant delay and should therefore be given higher priority compared to email.

ATM Versus DATA Networks (Internet)

1. ATM relies on "virtual circuits," where the route is pre-allocated prior to transmission. Although it is internet protocol (IP) wireless and cannot use peer-to-peer booking.
2. Resource reservation protocol (RSVP) is a new direction on the internet. ATM cells are uniform and compact, facilitating the exchange of both voice and data, while IP packets exhibit varying sizes.
3. *Address:* ATM uses a 20-byte global network service access point (NSAP) address and a 32-bit local identifier in the signal to send the signal. IP uses a 32-bit public address in each packet.

Figure 2 shows the structure of an ATM machine. It is made out of input modules, yield modules, CAC (affiliation affirmation control), switch the chiefs and cell switch surface.

ATM network made out of more than one ATM switches among source and target structures. The switch contains data ports and yield ports. These ports interact with customers, other ATMs, and other connected devices.

ATM transfer limit applies for three airline divisions: aircraft operators, aircraft controllers, aircraft carriers. ATM machines are divided into data and control room.

User plane: ATM transfers data from the committed port to the given port. This change applies to mobile phones, not payments. The load can be clarified by switching. When a cell appears on the input port, the switch will control the VPI/VCI and direct the cell to the output port.

- *Control Plane:* Information regarding the payload part of the control unit is not clear here. It is recognized and controlled by the ATM machine and evaluated for similar installation. The aircraft controls the configuration and management of the respective VP and VC.
- Management plane arrangements with screen and control of the ATM association.

ATM gives remarkable information transmission that is particularly fitting for well-endowed traffic. Since all equipment is entered into non-descript rooms, equipment changeover is easy, coordinated and straightforward. Its compact size makes it the perfect combination. Fewer predictive headers reduce packaging overload, resulting in efficient bandwidth usage. ATM networks are flexible in terms of scale and speed.

ATM has found applications in a range of fields, benefiting from its unique attributes such as high-speed data transmission, quality of service (QoS) guarantees, and efficient multiplexing. In the realm of telecommunications, ATM networks have historically been employed for voice and video transmission, providing low latency and minimal packet loss, making them indispensable for applications like real-time video conferencing and voice over IP (VoIP) [7]. In the financial sector, ATM technology has facilitated secure and high-speed transaction processing, enhancing the efficiency of electronic banking and financial services. Moreover, healthcare systems have harnessed the reliability of ATM networks to support the transfer of medical images, such as radiological scans and patient records, ensuring the swift and accurate exchange of critical health data. The scalability and robustness of ATM have also made it suitable for use in large-scale enterprise networks, where diverse data types, including business-critical applications and data storage, can coexist efficiently. While the prominence of ATM has diminished in some areas due to the ascendancy of IP-based technologies, its legacy and influence endure in sectors requiring steadfast and dependable communication services.

ATM Applications

ATM applications provide convenient and secure access to banking services, allowing users to perform transactions such as withdrawals, deposits, and account inquiries directly from automated teller machines.

1. *ATM WANs:* It can serve as a WAN for transmitting cells across extensive distances, with a router functioning as an endpoint bridging between the ATM network and other networks, equipped with two protocol stacks.
2. *Multimedia virtual private networks and managed services:* It assists in the administration of ATM, LAN, voice, and video services, offering comprehensive virtual private networking solutions with integrated multimedia access.
3. *Frame relay backbone:* Frame relay services serve as a networking foundation for various data services, facilitating the interconnection of frame-relay ATM services with inter-networking services.
4. *Residential broadband networks:* ATM is intentionally chosen as the networking infrastructure for deploying residential broadband services, seeking highly scalable solutions.
5. *Operator infrastructure for telephones and private phones:* Make the most of the use of synchronous optical networking/synchronous digital hierarchy (SONET/SDH) fiber optic infrastructure by creating an ATM machine to carry public telephone and private lines.

CONCLUSION

In conclusion, ATM networks have left an indelible mark on the landscape of telecommunications and networking. Born out of the need for high-speed, reliable, and quality-oriented data transmission, ATM networks have found applications in various sectors, ranging from telecommunications and finance to healthcare and enterprise networking. Their significance is underpinned by the ability to offer QoS guarantees, efficient multiplexing, and scalability.

The purpose of this article is to provide an overview and current status of asynchronous transfer mode networks. It is unclear whether ATM can deliver on its promise as a global high-speed network technology. However, it is clear that ATM is still an important part of many companies' future business plans. No other network technology has spread as quickly as ATM. As ATM gains prominence as a primary communications technology, it encounters various technical and strategic hurdles that need to be addressed. These challenges encompass switch-fabric design, traffic control, signaling, support for multiple protocols, application programming interfaces, network management, QoS concerns, and adaptation for wireless environments.

Although ATM networks have faced challenges, particularly in the face of emerging IP-based technologies, they have played a pivotal role in shaping the evolution of networking, with their influence evident in concepts such as QoS and virtual circuits. As we continue to navigate the ever-connected world, understanding the legacy of ATM networks serves as a testament to their enduring importance and the foundation they laid for the networks of today and tomorrow. While they may not be as prevalent as in the past, ATM networks continue to demonstrate their relevance in niche applications that demand robust, high-performance communication services.

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