



THE ROLE OF ATM TECHNOLOGY IN FUTURE DATA COMMUNICATION SYSTEMS

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ABSTRACT

Demand for quick access to Web-based applications and real-time delivery of multimedia transmissions via an integrated network infrastructure drives implementation of ATM (Asynchronous Transfer Mode) broadband solutions. ATM is a high-performance technology that provides bandwidth on-demand for seamless transport of full-motion video, audio, data, animations, and still images in local and wider area environments. Asynchronous transfer mode (ATM) is a cell-oriented switching and multiplexing technology that utilizes fixed-length packets to carry different types of traffic and also ATM will enable carriers to capitalize on a number of revenue opportunities through multiple ATM classes of services; high-speed local-area network (LAN) interconnection; voice, video, and future multimedia applications in business markets in the short term; and in community and residential markets in the longer term. ATM reduces infrastructure costs through efficient bandwidth management, operational simplicity, and the consolidation of overlay networks. Carriers can no longer afford to go through the financial burden and time required to deploy a separate network for each new service requirement (e.g., dedicating a network for a single service such as transparent LAN or frame relay). ATM technology will allow core network stability while allowing service interfaces and other equipment to evolve rapidly.

Keywords:. *The International Telecommunications Union–Telecommunications (ITU–T), Synchronous Digital Hierarchy(SDH), Synchronous Optical Network (SONET), Virtual Path Connections (VPCs), Virtual Channel Connections (VCCs), Permanent Virtual Circuits (PVCs), Switched Virtual Circuits (SVCs), Broadband Intercarrier Interface (B–ICI), Quality of Service (QoS), Public Network-To-Network Interface (P–NNI), Institute of Electrical and Electronic Engineers (IEEE), American National Standards Institute (ANSI), Transmission Control Protocol [TCP]/Internet Protocol [IP]), European Telecommunications Standards Institute (ETSI).*

1. INTRODUCTION

Asynchronous transfer mode (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. Like packet switching for data (e.g., X.25, frame relay, transmission control protocol [TCP]/Internet protocol [IP]), 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. Unlike packet switching, ATM is designed for high-performance multimedia networking [2][4][5].

ATM technology has been implemented in a very broad range of networking devices:

- workgroup and campus ATM switches
- ATM enterprise network switches
- ATM multiplexers
- ATM–edge switches
- ATM–backbone switches
- PC, workstation, and server network interface cards
- switched-Ethernet and token-ring workgroup hubs

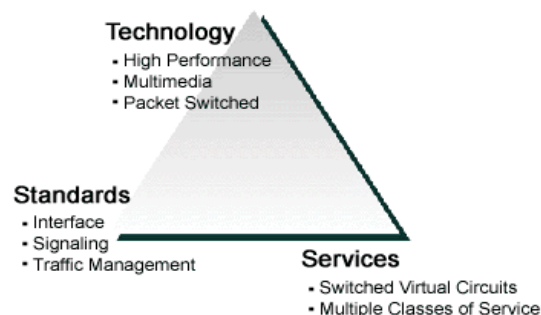
2. PURPOSE

ATM is also a capability that can be offered as an end-user service by service providers (as a basis for tariffed services) or as a networking infrastructure for these and other services. The most basic service building block is the ATM virtual circuit, which is an end-to-end connection that has defined end points and routes but does not have bandwidth dedicated to it. Bandwidth is allocated on demand by the network as users have traffic to transmit. ATM also defines various classes of service to meet a broad range of application needs[1]-[7].

ATM is also a set of international interface and signaling standards defined by the International Telecommunications Union-Telecommunications (ITU-T) Standards Sector (formerly the CCITT). The ATM Forum has played a pivotal role in the ATM market since its formulation in 1991. The ATM Forum is an international voluntary organization composed of vendors, service providers, research organizations, and users. Its purpose is to accelerate the use of ATM products and services through the rapid convergence of interoperability specifications, promotion of industry cooperation, and other activities. Developing multivendor implementation agreements also furthers this goal [3][5][9].

Changes in the structure of the telecommunications industry and market conditions have brought new opportunities and challenges for network operators and public service providers. Networks that have been primarily focused on providing better voice services are evolving to meet new multimedia communications challenges and competitive pressures. Services based on asynchronous transfer mode (ATM) and synchronous digital hierarchy(SDH)/synchronous optical network (SONET) architectures provide the flexible infrastructure essential for success in this evolving market (see *Figure 1*)

Figure 1.



ATM, which was once envisioned as the technology of future public networks, is now a reality, with service providers around the world introducing and rolling out ATM and ATM-based services. The ability to exploit the benefits of ATM technology within the public network successfully will provide strategic competitive advantage to carriers and enterprises alike [1]-[9].

3. BENEFITS

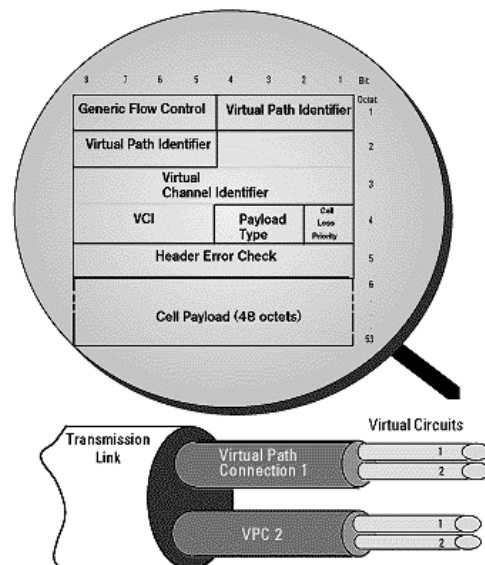
The benefits of ATM are the following:

- international standards compliance
- high performance via hardware switching
- dynamic bandwidth for bursty traffic
- class-of-service support for multimedia
- scalability in speed and network size
- common LAN/WAN architecture

4. TECHNOLOGY

In ATM networks, all information is formatted into fixed-length cells consisting of 48 bytes (8 bits per byte) of payload and 5 bytes of cell header (see *Figure 2*). The fixed cell size ensures that time-critical information such as voice or video is not adversely affected by long data frames or packets. The header is organized for efficient switching in high-speed hardware implementations and carries payload-type information, virtual-circuit identifiers, and header error check.

Figure 2. Fixed-Length Cells





ATM is connection oriented. Organizing different streams of traffic in separate calls allows the user to specify the resources required and allows the network to allocate resources based on these needs. Multiplexing multiple streams of traffic on each physical facility (between the end user and the network or between network switches)—combined with the ability to send the streams to many different destinations—enables cost savings through a reduction in the number of interfaces and facilities required to construct a network.

ATM standards defined two types of ATM connections: virtual path connections (VPCs), which contain virtual channel connections (VCCs). A virtual channel connection (or virtual circuit) is the basic unit, which carries a single stream of cells, in order, from user to user. A collection of virtual circuits can be bundled together into a virtual path connection. A virtual path connection can be created from end-to-end across an ATM network. In this case, the ATM network does not route cells belonging to a particular virtual circuit. All cells belonging to a particular virtual path are routed the same way through the ATM network, thus resulting in faster recovery in case of major failures.

An ATM network also uses virtual paths internally for the purpose of bundling virtual circuits together between switches. Two ATM switches may have many different virtual channel connections between them, belonging to different users. These can be bundled by the two ATM switches into a virtual path connection. This can serve the purpose of a virtual trunk between the two switches. This virtual trunk can then be handled as a single entity by, perhaps, multiple intermediate virtual path cross connects between the two virtual circuit switches.

Virtual circuits can be statically configured as permanent virtual circuits (PVCs) or dynamically controlled via signaling as switched virtual circuits (SVCs). They can also be point-to-point or point-to-multipoint, thus providing a rich set of service capabilities. SVCs are the preferred mode of operation because they can be dynamically established, thus minimizing reconfiguration complexity [7]-[9][15].

5. STANDARDS

The following two ATM networking standards have been defined that provide connectivity between network switches and between networks:

- broadband intercarrier interface (B-ICI)
- public network-to-network interface (P-NNI)

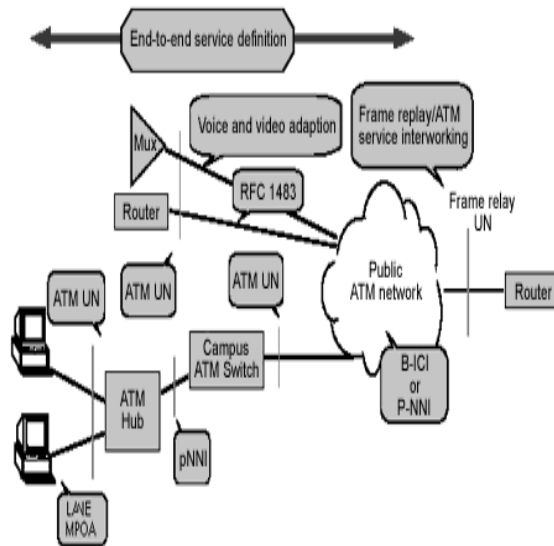
P-NNI is the more feature-rich of the two and supports class of service-sensitive routing and bandwidth reservation. It provides topology-distribution mechanisms based on advertisement of link metrics and attributes, including bandwidth metrics. It uses a multilevel hierarchical routing model providing scalability to large networks. Parameters used as part of the path-computation process include the destination ATM address, traffic class, traffic contract, QoS requirements and link constraints. Metrics that are part of the ATM routing system are specific to the traffic class and include quality of service-related metrics (e.g., CTD, CLR) and bandwidth-related metrics (e.g., PCR). The path computation process includes overall network-impact assessment, avoidance of loops, minimization of rerouting attempts, and use of policy (inclusion/exclusion in rerouting, diverse routing, and carrier selection). Connection admission controls (CACs) define procedures used at the edge of the network, whereby the call is accepted or rejected based on the ability of the network to support the requested QoS. Once a VC has been established across the network, network resources have to be held and quality service guaranteed for the duration of the connection [2]-[12].

All ATM traffic is carried in cells, yet no applications use cells. So, specific ways of putting the data into cells are defined to enable the receiver to reconstruct the original traffic.

- RFC1483, which specifies how interrouter traffic is encapsulated into ATM using ATM adaptation Layer 5 (AAL-5); AAL-5 is optimized for handling framed traffic and has similar functionality to that provided by HDLC framing in frame relay, SDLC, and X.25
- ATM LAN emulation (LANE) and multiprotocol over ATM (MPOA), which are designed to support dynamic use of ATM SVCs primarily for TCP/IP; LANE, which is a current standard that is widely deployed and will be a subset of the MPOA standard (which is targeted for standardization only in mid-1997), will be discussed later in the tutorial
- voice and video adaptation schemes that can use AAL-1, which is defined for high efficiency—for traffic that itself has no

natural breaks, such as a circuit carrying bits at a fixed rate

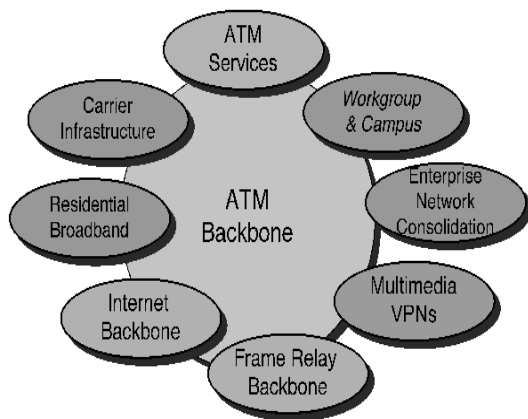
Figure 3. Data Insertion in Cells



6. APPLICATIONS

ATM technologies, standards, and services are being applied in a wide range of networking environments, as described briefly below (see Figure 4):

Figure 4. ATM Technologies Standards, and Services



- **ATM services**—Service providers globally are introducing or already

offering ATM services to their business users.

- **ATM workgroup and campus networks**—Enterprise users are deploying ATM campus networks based on the ATM LANE standards. Workgroup ATM is more of a niche market with the wide acceptance of switched-Ethernet desktop technologies.
- **ATM enterprise network consolidation**—A new class of product has evolved as an ATM multimedia network-consolidation vehicle. It is called an ATM enterprise network switch. A full-featured ATM ENS offers a broad range of in-building (e.g., voice, video, LAN, and ATM) and wide-area interfaces (e.g., leased line, circuit switched, frame relay, and ATM at narrowband and broadband speeds) and supports ATM switching, voice networking, frame-relay SVCs, and integrated multiprotocol routing.
- **Multimedia virtual private networks and managed services**—Service providers are building on their ATM networks to offer a broad range of services. Examples include managed ATM, LAN, voice and video services (these being provided on a per-application basis, typically including customer-located equipment and offered on an end-to-end basis), and full-service virtual private-networking capabilities (these including integrated multimedia access and network management).
- **Internet backbones**—Internet service providers are likewise deploying ATM backbones to meet the rapid growth of their frame-relay services, to use as a networking infrastructure for a range of data services, and to enable Internet class-of-service offerings and virtual private intranet services[11]-[15].

7. CONCLUSION

ATM technology is uniquely suited for supporting error-free multimedia transport in high-speed network configurations. Moreover, ATM is an enabler of network traffic consolidation, thereby streamlining network management operations and optimizing utilization of high-speed network connections. In addition, ATM provisions networking services via twisted copper pair, optical fiber, and hybrid optical fiber and coaxial cable



(HFC) wireline media and wireless technical solutions. National and international standards organizations such as the ITU-T, the Institute of Electrical and Electronic Engineers (IEEE), the American National Standards Institute (ANSI), and the European Telecommunications Standards Institute (ETSI) endorse ATM specifications. ATM networks offer a specific set of service classes, and at connection set-up, the user must request a specific service class from the network for that connection. Service classes are used by ATM networks to differentiate between specific types of connections, each with a particular mix of traffic and QoS parameters, since such traffic may need to be differentiated within the network, for instance, by using priorities to allow for the requested behavior. One of the primary benefits of ATM networks is that they can provide users with a guaranteed Quality of Service (QoS). To do this, the user must inform the network, upon connection set-up, of both the expected nature of the traffic that will be sent along the connection, and of the type of quality of service that the connection requires. The former is described by a set of traffic parameters, while the latter is specified by a set of desired QoS parameters. The source node must inform the network of the traffic parameters and desired QoS for each direction of the requested connection upon initial set-up; these parameters may be different, however, in each direction of the connection.

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