**Asynchronous transfer mode**

**Definition**

**By**

**Anthony Woods**

**Successes and failures of ATM technology**

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**DEFINITION AND OVERVIEW**

Asynchronous transfer mode (ATM) is a high-performance, cell-oriented switching and multiplexing technology that utilizes fixed-length packets to carry different types of traffic. ATM is a technology that 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.

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.

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. In addition to revenue opportunities, 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. (ICE.org 2009)

ATM differs from more common data link technologies like Ethernet in several ways. For example, ATM utilizes no routing. Hardware devices known as ATM switches establish point-to-point connections between endpoints and data flows directly from source to destination. Additionally, instead of using variable-length packets as Ethernet does, ATM utilizes fixed-sized cells. ATM cells are 53 bytes in length that includes 48 bytes of data and five (5) bytes of header information. The performance of ATM is often expressed in the form of OC (Optical Carrier) levels, written as "OC-xxx." Performance levels as high as 10 Gbps (OC-192) are technically feasible with ATM. More common performance levels for ATM are 155 Mbps (OC-3) and 622 Mbps (OC-12).

ATM technology is designed to improve utilization and quality of service (QoS) on high-traffic networks. Without routing and with fixed-size cells, networks can much more easily manage bandwidth under ATM than under Ethernet, for example. (Mitchell, 1999)

**ATM Standards**: The following are some of the basic ATM standards documents available from the International Telecommunications Union (ITU).

* ITU-T I.361 - Defines the ATM Layer functions.
* ITU-T I.363 - Defines the ATM Adaptation Layer protocols.
* ITU-T I.610 - Defines the ATM Operation and Maintenance (OAM) functions.

**The ATM Network:** The technology allows both public (i.e., RBOC or carrier) and private (i.e., LAN or LAN-to-internal switch) ATM networks. This capability gives a seamless and transparent (to the user) connection from one end user to another end user, whether in the same building or across two continents.

Three types of interfaces that exist:

1. User-to-Network Interface (UNI)

2. Network-to-Network Interface (NNI)

3. Inter-Carrier Interface (ICI)

The UNI exists between a single end user and a public ATM network, between a single end user and a private ATM switch, or between a private ATM switch and the public ATM network of an RBOC. The NNI exists between switches in a single public ATM network. NNIs may also exist between two private ATM switches. The ICI is located between two public ATM networks (an RBOC and an interexchange carrier). All of these interfaces are very similar. The major differences between these types of interfaces are administrative and signaling related. The only type of signaling exchanged across the UNI is that required to set up a VIRTUAL CHANNEL for the transmission. Communication across the NNI and the ICI will require signaling for virtual-path and virtual-channel establishment together with various exchange mechanisms for the exchange of information such as routing tables, etc.

The network functions as follows: End User 1 in Chicago wishes to transfer a data file to End User 2 in Los Angeles. A virtual channel is created and a virtual path is established from switch to switch within the public ATM network in Chicago (ATM Network 1). The Chicago RBOC, in turn, establishes contact with the public ATM network in Los Angeles (ATM Network 2). ATM Network 2 also establishes a virtual path from switch to switch within the network and with the Private ATM Switch at the destination. The private ATM network completes the virtual path by establishing a virtual channel with End User 2.

At each interface in this network, a unique virtual path identifier (VPI) and virtual channel identifier (VCI) are established for this transmission. These identifiers are of local significance ONLY: the identifier is significant only for a specific switch and the two nodes adjacent to it in the virtual path. Each node within the virtual path (including both the end users and the switches) maintain a pool of inactive identifiers to be used as needed.

End User 2 encapsulates the file in 53-byte cells, each with its unique VPI/VCI "destination address" in the header. These cells are streamed and sent across the UNI to the ATM network switch. This switch reads the ATM header, consults the routing table created during the virtual path setup, changes the VPI/VCI as necessary, and sends each cell in the stream out of the appropriate port and across the NNI to the next switch in the virtual path.

The last switch within the virtual path for ATM Network 1 repeats this process and sends the cell out through the ICI to ATM Network 2.

ATM Network 2 continues the process in a similar manner until the cell is carried through the UNI to the Private ATM Switch which, in turn, sends the cell to End User 2. End User 2 then reconstructs the file from the sequential cells, stripping the 5-byte header from each cell.

End User 1 or End User 2 terminates the call, i.e., "hangs up," and the virtual path is dismantled. The VCI and VPI values are returned to the pool of available values for each switch.

Notice that only the End Users at either end of the transmission deal with the 48-byte information load within the cell. At each stage of the transmission, the switch is only concerned with accepting the cell from one port, changing the VPI/VCI according to its tables, and routing the cell out the appropriate switch port. (Techfest.com, 1998)

**ATM Devices**: An ATM network is made up of an ATM switch and ATM endpoints. 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 (or end system) contains an ATM network interface adapter. Examples of ATM endpoints are workstations, routers, digital service units (DSUs), LAN switches, and video coder-decoders (CODECs). (Cisco Systems, Inc. 1999)

ATM has proven very successful in the WAN scenario and numerous telecommunication providers have implemented ATM in their wide-area network cores. Many ADSL implementations also use ATM. However, ATM has failed to gain wide use as a LAN technology, and its complexity has held back its full deployment as the single integrating network technology in the way that its inventors originally intended. Since there will always be both brand-new and obsolescent link-layer technologies, particularly in the LAN area, not all of them will fit neatly into the synchronous optical networking model for which ATM was designed. Therefore, a protocol is needed to provide a unifying layer over both ATM and non-ATM link layers, as ATM itself cannot fill that role. IP already does that; therefore, there is often no point in implementing ATM at the network layer. In addition, the need for cells to reduce jitter has declined as transport speeds increased (see below), and improvements in Voice over IP (VoIP) have made the integration of speech and data possible at the IP layer, again removing the incentive for ubiquitous deployment of ATM. Most Telcos now plan to integrate their voice network activities into their IP networks, rather than their IP networks into the voice infrastructure. MPLS, a generic Layer 2 packet-switching protocol, adopted many technically sound ideas from ATM. ATM remains widely deployed, and is used as a multiplexing service in DSL networks, where its compromises fit DSL's low-data-rate needs well. In turn, DSL networks support IP (and IP services such as VoIP) via PPP over ATM and Ethernet over ATM (RFC 2684).

ATM will remain deployed for some time in higher-speed interconnects where carriers have already committed themselves to existing ATM deployments; ATM is used here as a way of unifying PDH/SDH traffic and packet-switched traffic under a single infrastructure. However, ATM is increasingly challenged by speed and traffic shaping requirements of converged networks. In particular, the complexity of SAR imposes a performance bottleneck, as the fastest SARs known run at 10 Gbit/s and have limited traffic shaping capabilities. Currently it seems likely that gigabit Ethernet implementations (10Gbit-Ethernet, Metro Ethernet) will replace ATM as a technology of choice in new WAN implementations’. (Stevenson, 1993)

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