ATM (Asynchronous Transfer Mode)

ATM is an acronym for Asynchronous Transfer Mode. It's a high-speed networking standard designed to support voice, video and data communications, and to improve utilization and quality of service (QoS) on high-traffic networks.

ATM is normally utilized by internet service providers on their private long-distance networks. ATM operates at the data link layer (Layer 2 in the OSI model) over either fiber or twisted-pair cable.

How ATM Networks Work

ATM differs from more common data link technologies like Ethernet in several ways.

For one, ATM uses zero routing.

Instead of using software, dedicated 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 like Ethernet and Internet Protocol does, ATM utilizes fixed-sized cells to encode data. These ATM cells are 53 bytes in length that include 48 bytes of data and five bytes of header information.

Each cell is processed at their own time. When one is finished, the procedure then calls for the next cell to process. This is why it's called **asynchronous**; none of them go off at the same time relative to the other cells.

The connection can be preconfigured by the service provider to make a dedicated/permanent circuit or be switched/set up on demand and then terminated at the end of its use.

Four data bit rates are usually available for ATM services:

1. **Available Bit Rate**
2. **Constant Bit Rate**
3. **Unspecified Bit Rate**
4. **Variable Bit Rate (VBR)**.

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. However, more common for ATM are 155 Mbps (OC-3) and 622 Mbps (OC-12).

Without routing and with fixed-size cells, networks can much more easily manage bandwidth under ATM than other technologies like Ethernet. The high cost of ATM relative to Ethernet is one factor that has limited its adoption to the backbone and other high-performance, specialized networks.

Wireless ATM

A wireless network with an ATM core is called a mobile ATM or wireless ATM. This type of ATM network was designed to offer high-speed mobile communications.

Similar to other wireless technologies, the ATM cells are broadcasted from a base station and transmitted to mobile terminals where an ATM switch performs the mobility functions.

VoATM

Another data protocol that sends voice, video and data packets through the ATM network is called **Voice over Asynchronous Transfer Mode (VoATM**). It's similar to VoIP but doesn't use the IP protocol and is more expensive to implement.

This type of voice traffic is encapsulated in AAL1/AAL2 ATM packets.

Asynchronous transfer mode (ATM) is one of many network transmission protocols included in Windows Server 2003. The most commonly used transmission protocol included in Windows Server 20003 is TCP/IP, which is a connectionless protocol.

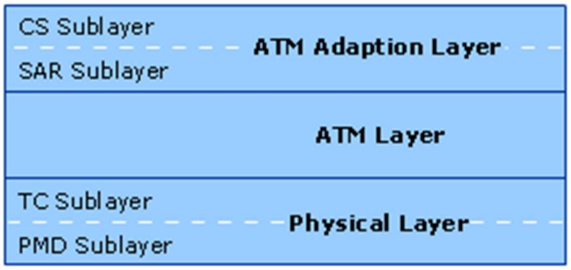
As such, TCP/IP cannot offer some of the advantages that a connection-oriented, virtual circuit, packet-switching technology, such as ATM, can. Unlike most connectionless networking protocols, ATM is a deterministic networking system — it provides predictable, guaranteed quality of service.

The ideal environment in which to use ATM is one that combines computer, voice, and video networking into a single network, and the combination of existing networks into a single infrastructure.

ATM Architecture

ATM is a combination of hardware and software that can provide either an end-to-end network or form a high-speed backbone. The structure of ATM and its software components comprise the ATM architecture, as the following illustration shows. The primary layers of ATM are the physical layer, the ATM layer, and the ATM Adaptation layer.

ATM Architectural Diagram



Each layer and sub-layer is described briefly in the following table, “ATM Layers.”
ATM Layers

Layer	Function
ATM Adaptation	The ATM Adaptation layer facilitates the use of packets larger than a cell. Packets are segmented by the ATM interface, transmitted individually, and then reassembled on the receiving end. The ATM Adaptation Layer includes the Segmentation and Reassembly and Convergence sub-layers.
ATM	The ATM layer regulates cells and cell transport and establishes and releases Virtual Circuits. The ATM layer has no sub-layers
Physical	The Physical layer represents the physical medium and regulates Physical layer functions such as voltages and bit timing. The Physical layer consists of the Transmission Convergence and the Physical Medium Dependent sub-layers

Physical Layer

The physical layer provides for the transmission and reception of ATM cells across a physical medium between two ATM devices. This can be a transmission between an ATM endpoint and an ATM switch, or it can be between two ATM switches. The physical layer is subdivided into a Physical Medium Dependent sub-layer and Transmission Convergence sub-layer.

PMD Sub-layer
The Physical Medium Dependent (PMD) sub-layer is responsible for the transmission and reception of individual bits on a physical medium. These responsibilities encompass bit timing, signal encoding, interacting with the physical medium, and the cable or wire itself.

ATM does not rely on any specific bit rate, encoding scheme or medium and various specifications for ATM exist for coaxial cable, shielded and unshielded twisted pair wire, and optical fiber at speeds ranging from 64 kilobits per second to 9.6 gigabits per second.

In addition, the ATM physical medium can extend up to 60 kilometers or more by using single-mode fiber and long-reach lasers. Thus it can readily support wide-range connectivity, including a private metropolitan area network. The independence of ATM from a particular set of hardware constraints has allowed it to be implemented over radio and satellite links.

Transmission Convergence Sub-layer

The Transmission Convergence (TC) sub-layer functions as a converter between the bit stream of ATM cells and the PMD sub-layer. When transmitting, the TC sub-layer maps ATM cells onto the format of the PDM sub-layer, such as the DS-3 interface or Synchronous Optical Network (SONET) frames.

Because a continuous stream of bytes is required, unused portions of the ATM cell stream are filled by idle cells. These idle cells are identified in the ATM header and are silently discarded by the receiver. They are never passed to the ATM layer for processing.

The TC sub-layer also generates and verifies the Header Error Control (HEC) field for each cell. On the transmitting side, it calculates the HEC and places it in the header. On the receiving side, the TC sub-layer checks the HEC for verification.

If a single bit error can be corrected, the bit is corrected, and the results are passed to the ATM layer. If the error cannot be corrected (as in the case of a multibit error) the cell is silently discarded.

Finally, the TC sub-layer describes the ATM cells, marking where ATM cells begin and where they end.

The boundaries of the ATM cells can be determined from the PMD layer formatting or from the incoming byte stream using the HEC field. The PMD performs the HEC validation per byte on the preceding 4 bytes.

If it finds a match, the next ATM cell boundary is 48 bytes away (corresponding to the ATM payload). The PMD performs this verification several times to ensure that the cell boundaries have been determined correctly.

ATM Layer

The ATM layer provides cell multiplexing, de-multiplexing, and VPI/VCI routing functions. The ATM layer also supervises the cell flow to ensure that all connections remain within their negotiated cell throughput limits.

If connections operate outside their negotiated parameters, the ATM layer can take corrective action so the misbehaving connections do not affect connections that are obeying their negotiated connection contract. The ATM layer also maintains the cell sequence from any source.

The ATM layer multiplexes and de-multiplexes and routes ATM cells, and ensures their sequence from end to end. However, if a cell is dropped by a switch due to congestion or corruption, it is not the responsibility of the ATM layer to correct the dropped cell by means of retransmission or to notify other layers of the dropped cell.

ATM Layer Multiplexing and De-multiplexing

ATM layer multiplexing blends all the different input types so that the connection parameters of each input are preserved. This process is known as traffic shaping.
ATM layer de-multiplexing takes each cell from the ATM cell stream and, based on the VPI/VCI, either routes it (for an ATM switch) or passes the cell to the ATM Adaptation Layer (AAL) process that corresponds to the cell (for an ATM endpoint).

ATM Adaptation Layer

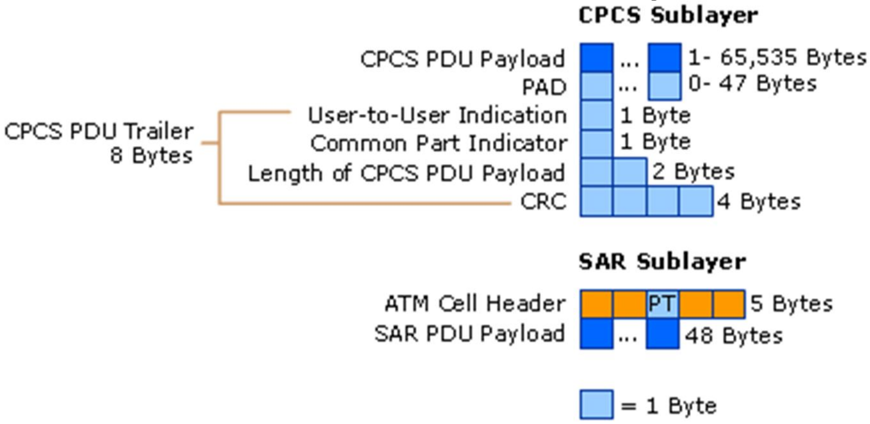
The ATM Adaptation Layer (AAL) creates and receives 48-byte payloads through the lower layers of ATM on behalf of different types of applications. Although there are five different types of AALs, each providing a distinct class of service, Windows Server 2003 supports only AAL5. ATM Adaptation is necessary to link the cell-based technology at the ATM Layer to the bit-stream technology of digital devices (such as telephones and video cameras) and the packet-stream technology of modern data networks (such as frame relay, X.25 or LAN protocols such as TCP/IP or Ethernet).

AAL5

AAL5 provides a way for non-isochronous (time-dependent), variable bit rate, connectionless applications to send and receive data. AAL5 was developed as a way to provide a more efficient transfer of network traffic than AAL3/4. AAL5 merely adds a trailer to the payload to indicate size and provide error detection. AAL5 is the preferred AAL when sending connection-oriented or connectionless LAN protocol traffic over an ATM network. Windows Server 2003 supports AAL5.
AAL5 provides a straightforward framing at the Common Part Convergence Sub-layer (CPCS) that behaves more like LAN technologies, such as Ethernet. The following figure, “Breakdown of an AAL5 Cell Header and Payload,” shows a detailed breakdown

of an AAL5 Cell Header and Payload, followed by a detailed description of each of the components.

Breakdown of an AAL5 Cell Header and Payload



With AAL5, there is no longer a dual encapsulation. The service class frames cells at the CPCS, but not at the Segmentation and Reassembly sub-layer to minimize overhead. It also uses a bit in the Payload Type (PT) field of the ATM header rather than a separate SAR framing.

AAL5 is the AAL of choice when sending connection-oriented (X.25 or Frame Relay) or connectionless (IP or IPX) LAN protocol traffic over an ATM network.

AAL5 CPCS Sub-layer

The preceding figure, “Breakdown of an AAL5 Cell Header and Payload,” shows the framing that occurs at the AAL5 CPCS sub-layer. (Note that only a trailer is added.).

CPCS PDU Payload

The block of data that an application sends. The size can vary from 1 byte to 65,535 bytes. The packet assembler/disassembler (PAD) consists of padding bytes of variable length (0-47 bytes), which create a whole number of cells by making the CPCS PDU payload length a multiple of 48 bytes.

User-to-User Indication

Transfers information between AAL users.

Common Part Indicator

Currently used only for alignment processes so that the AAL5 trailer falls on a 64-bit boundary.

Length of CPCS PDU Payload Field

Indicates the length of the CPCS PDU payload in bytes. The length does not include the PAD.

Cyclic Redundancy Check (CRC)

A 32-bit portion of the trailer that performs error checking on the bits in the CPCS PDU. The AAL5 CRC uses the same CRC-32 algorithm used in 802.*x*-based networks such as Ethernet and Token Ring.

AAL5 SAR sub-layer

Byte-by-byte, the preceding figure, “Breakdown of an AAL5 Cell Header and Payload,” shows the framing that occurs at the AAL5 SAR sub-layer. There is no SAR header or trailer added. On the transmitting side, the AAL5 SAR sub-layer merely segments the

CPCS PDU into 48-byte units and passes them to the ATM layer for the final ATM header.
On the receiving side, the sub-layer reassembles a series of 48-byte units and passes the result to the CPCS. The AAL5 SAR uses the third bit in the PT field to indicate when the last 48-byte unit in a CPCS PDU is being sent. When the ATM cell is received with the third bit of the PT field set, the ATM layer indicates this fact to the AAL; the AAL then begins a CRC and length-checking analysis of the full CPCS PDU.

ATM Components

To support native Asynchronous Transfer Mode (ATM), NDIS has been updated with native ATM commands. Because many applications do not yet use native ATM services, LANE support was added for LAN applications, such as Ethernet. Similarly, Microsoft has added IP over ATM support, thereby eliminating the additional header cost of LAN packets. Microsoft also added Winsock 2.0 native ATM to support the many applications that use Windows Sockets (Winsock).
Furthermore, circuit connectivity has been added to the Telephony Application Programming Interface TAPI (connection management protocol) to provide complete ATM support.