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High-speed networking – ATM: a communication

Lalit Kumar Poddar☼, Tushar Arora, Inderjeet Singh, Tarun Kumar

Department of Computer Science, Dronacharya College of Engineering, Farukh Nagar, Gurgaon, Haryana

Correspondence: Department of Computer Science, Dronacharya College of Engineering, Farukh Nagar, Gurgaon, Haryana; Mail: lalit.dar4@gmail.com

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1. INTRODUCTION

ATM is a high-speed networking standard designed to support both voice and data communications. ATM is normally utilized by Internet service providers on their private long-distance networks. It operates at the data link layer (Layer 2 in the OSI model) over either fiber or twisted-pair cable. 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. The high cost of ATM relative to Ethernet is one factor that has limited its adoption to backbone and other high-performance, specialized networks (www.compnetworking.about.com/).

2. ATM SPECIFICATIONS

2.1 Standards

ATM is based on the efforts of the ITU-T Broadband Integrated Services Digital Network (BISDN) standard. It was originally conceived as a high-speed transfer technology for voice, video, and data over public networks. ATM is a cell-switching and multiplexing technology that combines the benefits of circuit switching (guaranteed capacity and constant transmission delay) with those of packet switching (flexibility and efficiency for intermittent traffic). It provides scalable bandwidth from a few megabits per second (Mbps) to many gigabits per second (Gbps). Because of its asynchronous nature, ATM is more efficient than synchronous technologies, such as *time division* Multiplexing (ATM by Treball).

2.2. ATM Cell Basic Format

ATM transfers information in fixed-size units called *cell*s. Each cell is made up of 53 bytes. The first 5 bytes contain the header information, and the remaining 48 contain the "payload" (it means the user's information).

Advantages of cells:

- switches and interfaces are easiest to implement
- host hardware data units are typically fixed size (e.g. pages)

Disadvantages of cells:

- what is the optimal cell payload size? (ATM by Treball)

2.3. ATM Cell-Header Format

An ATM cell header can be one of two formats: *UNI* or the *NN*I. The UNI header is used for communication between ATM endpoints and ATM switches in private ATM networks. The NNI header is used for communication between ATM switches. Unlike the UNI, the NNI header does not include the Generic Flow Control (GFC) field. Additionally, the NNI header has a Virtual Path Identifier (VPI) field that occupies the first 12 bits. (ATM by Treball)

2.4. ATM Cell-Header Fields

The following fields are used in ATM:

• *Generic Flow Control (GFC)*—Provides local functions, such as identifying multiple stations that share a single ATM interface. This field is typically not used and is set to its default value.

• *Virtual Path Identifier (VPI*)—In conjunction with the VCI, identifies the next destination of a cell as it passes through a series of ATM switches on the way to its destination.

• *Virtual Channel Identifier (VCI*)—In conjunction with the VPI, identifies the next destination of a cell as it passes through a series of ATM switches on the way to its destination.

• *Payload Type (PT*)—Indicates in the first bit whether the cell contains user data or control data. If the cell contains user data, the second bit indicates congestion, and the third bit indicates whether the cell is the last in a series of cells that represent a single AAL5 frame.

• *Congestion Loss Priority (CLP*)—Indicates whether the cell should be discarded if it encounters extreme congestion as it moves through the network. If the CLP bit equals 1, the cell should be discarded in preference to cells with the CLP bit equal to zero.

• *Header Error Control (HEC*)—Calculates checksum only on the header itself. (ATM by Treball)

2.5. ATM Reference Model

ATM functionality corresponds to the physical layer and part of the data link layer of the OSI reference model. The ATM reference model is composed of the following planes:

• *Control*—This plane is responsible for generating and managing signaling requests.

• *User*— This plane is responsible for managing the transfer of data.

• *Managemen*t— This plane is formed by two components:

— Layer management manages layer-specific functions, such as the detection of failures and protocol problems.

— Plane management manages and coordinates functions related to the complete system.

The ATM reference model is composed of the following ATM layers:

The ATM Physical Layer

The ATM physical layer has four functions: bits are converted into cells, the transmission and receipt of bits on the physical medium are controlled, ATM cell boundaries are tracked, and cells are packaged into the appropriate types of frames for the physical medium.

The ATM physical layer is divided into two parts:

- **The *physical medium-dependent (PMD)* sub layer :** It synchronizes transmission and reception by sending and receiving a continuous flow of bits and it specifies the physical media for the physical medium used, including connector types and cable.
- **The *transmission-convergence (TC)* sub layer :** it has four functions: Cell delineation, header error-control (HEC) sequence generation and verification, cell-rate decoupling, and transmission-frame adaptation. (ATM by Treball)

2.6. The ATM Adaption Layer

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The ATM Adaption Layer, (AAL), makes the ATM layer services more adaptable to specific services. The specific services may include user services, control services and management services. The AAL is the layer above the ATM layer and it is responsible for converting the information from the higher layers into 48 byte lengths so that the ATM layer can add the 5 byte header to make the 53 byte cell. The two main functions of this AAL are to provide functions needed to support applications and to break up information into units that will fit into cells. The AAL layer is thus divided into two sub layers: the convergence sub layer (CS) and segmentation and reassembly sub layer (SAR). The convergence sub layer provides the functions needed to support specific applications, such as handling the cell delay variation and keeping a track of the clock. Each application accesses the AAL at a service access point (SAP), which is the address of the application. The SAR sub layer packs the information from the CS into cells and unpacks the information at the destination. The SAR maps SAR headers plus CS information into 48 byte cells. The AAL accommodates all services and in particular adapts both packet switched and circuit switched services. The CCITT service classification is based upon the timing relation, bit rate, and connection mode.

2.7. ATM and Multicasting

ATM requires some form of multicast capability. AAL5 (which is the most common AAL for data) currently does not support interleaving packets, so it does not support multicasting. If a leaf node transmitted a packet onto an AAL5 connection, the packet can get intermixed with other packets and be improperly reassembled. Three methods have been proposed for solving this problem: VP multicasting, multicast server, and overlaid point-to-multipoint connection. Under the first solution, a multipoint -to-multipoint VP links all nodes in the multicast group, and each node is given a unique VCI value within the VP. Interleaved packets therefore can be identified by the unique VCI value of the source. A multicast server is another potential solution to the problem of multicasting over an ATM network. All nodes wanting to transmit onto a multicast group set up a point -to-point connection with an external device known as a multicast server. The multicast server, in turn, is connected to all nodes wanting to receive the multicast packets through a point -to multipoint connection. The multicast server receives packets across the point -to-point connections and then retransmits them across the point -to-multipoint connection—but only after ensuring that the packets are serialized (that is, one packet is fully transmitted prior to the next being sent). In this way, cell interleaving is not allowed. (ATM by Treball)

3. ADVANTAGES OF ATM NETWORKING

- Supports delay close to that of dedicated services
- Supports the broadest range of burstiness, delay tolerance and loss performance through the implementation of multiple QoS classes
- Provides the capability to support both connection-oriented and connectionless traffic using AALs
- Able to use all common physical transmission paths like SONET.
- Cable can be twisted-pair, coaxial or fiber-optic(http://homepages.uel.ac.uk/)

5. DISADVANTAGES OF ATM NETWORKING

- Flexible to efficiency's expense, at present, for any one application it is usually possible to find a more optimized technology
- Cost, although it will decrease with time
- New customer premises hardware and software are required
- Competition from other technologies -100 Mbps FDDI, 100 Mbps Ethernet and fast Ethernet
- Presently the applications that can benefit from ATM such as multimedia are rare
- The wait, with all the promise of ATM's capabilities many details are still in the standards process (http://homepages.uel.ac.uk/)