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A Review on Asynchronous Transfer Mode Networks

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Abstract: For many applications, audio is now conveyed digitally. Video applications are following fast, particularly for videoon-demand. These digital streams require constant-rate digital channels between the source and destination, but a great number of all networks being planned today are based on the packet switched Asynchronous Transfer Mode (ATM) technology. This paper serves as an introduction to ATM, with emphasis on its ability to carry fixed rate channels, and describes the approach of the Cambridge Digital Interactive Television Trial, where Video and Audio on demand are transported to the Home over ATM.

Index terms*: ANSI - American National Standards Institute , ATM - Asynchronous Transfer Mode ,* ***ITU*** *- Intensive Therapy Unit ,* ***SDH*** *- Synchronous Digital Hierarchy ,* ***ISO*** *-International Organization for Standardization ,* ***OSI*** *- Open Systems Interconnection ,* ***B-ISDN*** *-* ***broadband*** *counterpart to Integrated Services Digital Network ,****UNI*** *- User-network interface,* ***NNI –*** *Network-network interface,* ***AAL*** *– ATM Adaptation layer*

I. INTRODUCTION

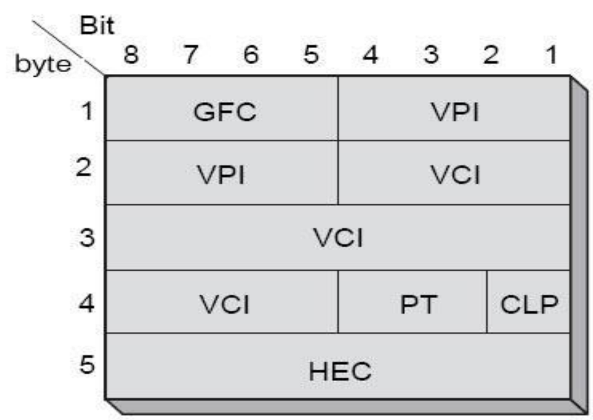
Asynchronous Transfer Mode (**ATM**) is, according to the ATM Forum, "a telecommunications concept defined by ANSI and ITU standards for carriage of a complete range of user traffic, including voice, data, and video signals" ATM was developed to meet the needs of the Broadband Integrated Services Digital Network, as defined in the late 1980s and designed to unify telecommunication and computer networks. It was designed for a network that must handle both traditional high-throughput data traffic (e.g. file transfers), and real time, low-latency content such as voice and video. The reference model for ATM approximately maps to the three lowest layers of the ISO-OSI reference model: network layer, data link layer, and physical layer. ATM is a core protocol used over the SDH backboneof the public switched telephone network (PSTN) andIntegrated Services Digital Network (ISDN), but its use is declining in favour of all IP.ATM provides functionality that is similar to both circuit switching and packet switching networks: ATM uses asynchronous time-division multiplexing, and encodes data into small, fixed-sized packets (ISO-OSI frames) called ***cells.***

II.HISTORY OF ATM

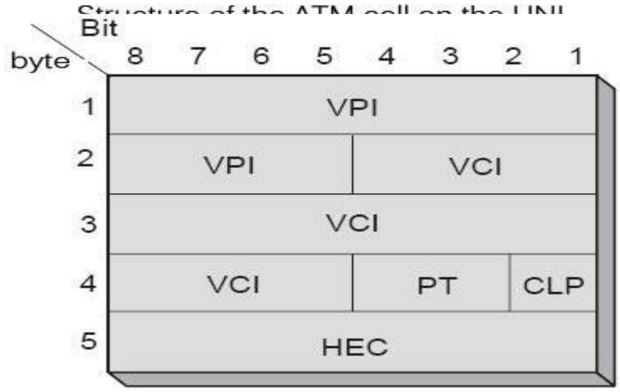
1980: Narrowband ISDN adopted.
Early 80's: Research on Fast Packets.
Mid 80's: B-ISDN Study Group formed.
1986 ATM approach chosen for B-ISDN.
June 1989: 48+5 chosen (64+5vs 32+4).
October 1991: ATM Forum founded.
July 1992: UNIVERSITY V2 released by ATM Forum.
1993: UNIVERSITY V3.
1994: B-ICI V1.

III. STRUCTURE OF AN ATM CELL

An ATM cell consists of a 5-byte header and a 48-byte payload. The payload size of 48 bytes was chosen as described above.ATM defines two different cell formats: UNI (User-Network Interface) and NNI (Network-Network Interface). Most ATM links use UNI cell format.



Structure of the ATM cell on the UNI



Structure of the ATM cell of the NNI

GFC = Generic Flow Control (4 bits) (default: 4-zero bits)
VPI = Virtual path identifier (8 bits UNI, or 12 bits NNI)
VCI = Virtual channel identifier (16 bits
PT = Payload Type (3 bits)
PT bit 3 (ms bit): Network management cell. If 0, user data cell and the following apply:
PT bit 2: Explicit forward congestion indication (EFCI); 1 = Network congestion experienced
PT bit 1 (ls bit): ATM user-to-user (AAU) bit. Used by AAL5 to indicate packet boundaries.
CLP = Cell Loss Priority (1-bit)
HEC = Header error control (8-bit CRC, polynomial = $X^8 + X^2 + X + 1$)

ATM uses the PT field to designate various special kinds of cells for operations, administration and management (OAM) purposes, and to delineate packet boundaries in some ATM adaptation layers (AAL). If the most significant bit of the PT field is 0, this is a user data cell, and the other two bits are used to indicate network congestion and as a general purpose header bit available for ATM adaptation layers. If the ms bit of the PT bit is 1, this is a management cell, and the other two bits indicate the type.

IV. CELLS IN PRACTICE

ATM supports different types of services via AALs. Standardized AALs include AAL1, AAL2, and AAL5, and the rarely used AAL3 and AAL4. AAL1 is used for constant bit rate (CBR) services and circuit emulation. Synchronization is also maintained at AAL1. AAL2 through AAL4 are used for variable bit rate (VBR) services, and AAL5 for data. Which AAL is in use for a given cell is not encoded in the cell. A 1500 byte (12000-bit) full-size

Ethernet frame takes only 1.2μs to transmit on a 10 G bit/s network, reducing the need for small cells to reduce jitter due to contention. Some consider that this makes a case for replacing ATM with Ethernet in the network backbone. Additionally, the hardware for implementing the service adaptation for IP packets is expensive at very high speeds.

At these lower speeds, ATM provides a useful ability to carry multiple logical circuits on a single physical or virtual medium, although other techniques exist, such as Multi-link PPP and Ethernet VLANs, which are optional in VDSL implementations.

V. WHY VIRTUAL CIRCUITS ?

ATM operates as a channel-based transport layer, using virtual circuits (VCs). This is encompassed in the concept of the Virtual Paths (VP) and Virtual Channels. Every ATM cell has an 8- or 12-bit **Virtual Path Identifier** (VPI) and 16-bit **Virtual Channel Identifier** (VCI) pair defined in its header. The VCI, together with the VPI is used to identify the next destination of a cell as it passes through a series of ATM switches on its way to its destination. The length of the VPI varies according to whether the cell is sent on the user-network interface (on the edge of the network), or if it is sent on the network-network interface (inside the network).

VI. USING CELLS AND VIRTUAL CIRCUITS FOR TRAFFIC ENGINEERING

Another key ATM concept involves the traffic contract. When an ATM circuit is set up each switch on the circuit is informed of the traffic class of the connection.

ATM traffic contracts form part of the mechanism by which "quality of service" is ensured. There are four basic types (and several variants) which each have a 4 *1* layer 2 – datagrams set of parameters describing the connection.

1. CBR - Constant bit rate: a Peak Cell Rate (PCR) is specified, which is constant.
2. VBR - Variable bit rate: an average or Sustainable Cell Rate (SCR) is specified, which can peak at a certain level, a PCR, for a maximum interval before being problematic.
3. ABR - Available bit rate: a minimum guaranteed rate is specified.
4. UBR - Unspecified bit rate: traffic is allocated to all remaining transmission capacity.

VBR has real-time and non-real-time variants, and serves for “bursty” traffic. Non-real-time is sometimes abbreviated to vbr-nrt. Most traffic classes also introduce the concept of Cell Delay Variation Tolerance (CDVT), which defines the “clumping” of cells in time.

VII. DEPLOYMENT

ATM became popular with telephone companies and many computer makers in the 1990s. However, even by the end of the decade, the better price/performance of Internet Protocol-based products was competing with ATM technology for integrating real-time and bursty network traffic. Companies such as FORE Systems focused on ATM products, while other large vendors suchas Cisco Systems provided ATM as an option. After the burst of the dot-com bubble, some still predicted that “ATM is going to dominate”. However, in 2005 theATM Forum, which had been the trade organization promotingthe technology, merged with groups promotingother technologies, and eventually became the BroadbandForum.

VII. WIRELESS ATM OR MOBILE ATM

Wireless ATM, or Mobile ATM, consists of an ATM core network with a wireless access network. ATM cells are transmitted from base stations to mobile terminals. Mobility functions are performed at an ATM switch in the core network, known as “crossover switch”, which is similar to the MSC (mobile switching center) of GSM Networks. The advantage of Wireless ATM is its high bandwidth and high speed handoffs done at Layer.

In the early 1990s, Bell Labs and NEC Research Labs worked actively in this field. Andy Hopper from Cambridge University Computer Laboratory also worked in this area. There was a Wireless ATM Forum formed to standardize the technology behind Wireless ATM Networks. The forum was supported by several telecommunication companies, including NEC, Fujitsu, AT&T, etc. Mobile ATM aimed to provide high speed multimedia communications technology, capable of delivering broadband mobile communications beyond that of GSM and WLANs.

IX. BENEFITS OF ATM

- It is very High-speed communication compared with others.
- It is basically a connection-oriented service network which is similar to our traditional telephony.
- Hardware-based switching.

- A single, universal, interoperable network transport.
- ATM is only a single network connection that can reliably mix voice, video, and data.
- Flexible and efficient allocation of network bandwidth.

CONCLUSION

ATM was developed to provide a data network for any type of application, regardless of its bandwidth requirements. Due to its complexity, and the advances made in competing technologies, it has not lived up to the original expectations of its creators, and has not gained possible that gigabit Ethernet will supplant ATM as the technology of choice in new WAN implementations.

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