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ATM Networks

Principles and Use

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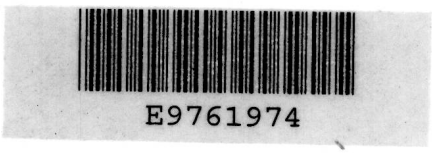

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ATM Networks

Preface

The modern telecommunications world is a complicated place, overloaded with jargon and bewilderingly full of different technical options and opportunities. Many experts are only experts of small domains and within limited geographies. For newcomers it is often difficult to gain a grasp on the basic principles and even harder to unravel the mysterious technical paradoxes and the apparent contradictions of many modern technologies.

My greatest hope in writing this book is that you, the reader, will find help and insight amongst its pages. I wish for no greater commendation than your thoughts that you find the subject of ATM presented here in an accessible and readable form. I hope also that the comprehensive glossary will remain with you, as your wayfinder through all that jargon!

Martin P. Clark
Frankfurt, Germany
20 December 1995

Acknowledgements

No book on Asynchronous Transfer Mode (ATM) could fail to recognize the invaluable contribution to this technology and to world standardization as a whole made by the International Telecommunications Union and the ATM Forum, and you will find references to their work throughout the text. Particular copyright extracts are labelled accordingly, but the full texts may be obtained (as relevant) from ITU Sales and Marketing Service, Place des Nations, CH-1211 Geneva 20, Switzerland or from ATM Forum, 2570 West El Camino Real, Suite 304, Mountain View, California CA 94040, USA. Alternatively, they may be contacted over Internet respectively at sales@itu.ch and info@atmforum.com.

Contents

1

Introduction to ATM

ATM, or Asynchronous Transfer Mode, is the most modern of telecommunications switching techniques, and is at the core of the future Broadband Integrated Services Digital Network (B-ISDN). In this chapter we introduce them both.

1.1 What are ATM and B-ISDN?

What does ATM stand for? It stands for *Asynchronous Transfer Mode.* And what is it? It is the most modern of telecommunications switching techniques, a highly efficient switching technique which is able to switch connections for a wide range of different information types at a wide range of different bitrates (capacities). It is not a switching technique limited to telephone switching or to data networking, but rather a technique which allows a network to be used simultaneously for the transfer of different signal types (e.g. telephone, data, video, etc.). It is an *integrated* switching technique. It is *the* integrated switching technique which will form the basis of the *Broadband Integrated Services Digital Network (B-ISDN).*

So what is the B-ISDN? The B-ISDN is the most modern type of telecommunications network – one offering simultaneous switching of different information types, for the carriage of *multimedia* applications. But not just that. The B-ISDN is the most intelligent of *intelligent networks (INs).* It has built into it powerful network control systems, capable of supporting sophisticated network services and network management operations. Thus, for example, connections could be set up not only according to the dialled number, but also by evaluating the identity of the caller, his creditworthiness, the time of day and the current network loading. For some types of connections, the call charges may be accrued to the called party (*freephone* or *800* service), or charged at premium rate according to the content value of the

information (e.g. videofilm or database information) received by the caller. In short, B-ISDN is the network for everything!

What then, is the difference between ATM and B-ISDN? The terms may often appear to be used synonymously, and correctly so, for ATM is a subset of B-ISDN. ATM is the *switching* technique at the heart of B-ISDN. B-ISDN is not only ATM, but a complete network and management control architecture. Thus when speaking about the switching capabilities of B-ISDN, one can speak interchangeably about B-ISDN or ATM switching capabilities.

In this book the prime focus is on ATM, but we also discuss in depth the various design aspects and technical standards concerning B-ISDN. The two are simply inseparable. The focus is on the principles of the technologies, on the features of their network architecture, on their strengths and on their limitations.

ATM and B-ISDN are technologies – the internal 'innards' of the most modern of telecommunications networks. They are not, in themselves, telecommunications *services* which an end-user may recognize, but rather the means for carrying the various users' information. And in the same way that today you would probably buy a *Pentium* or *Power-PC* based personal computer because of a layman's understanding of the value of greater processing speed, so you would be well advised to base your new telecommunications network around ATM, because of 'greater efficiency and flexibility'. Nonetheless, a more informed appreciation of the full scope of the new possibilities will help to allow you make the best of ATM. This appreciation requires a greater technical understanding. The aim of this book is to explain this technology – to try to make it understandable and accessible.

1.2 The Services Offered by a B-ISDN

The standards classify the services offered by B-ISDN networks into two categories – *interactive services* and *distribution services*. As Figure 1.1 shows, these categories are then further subdivided into five further service types.

Interactive services are normally based on communications between just two parties. There are three subtypes:

1. An example of a *conversational service* is a telephone conversation or a point-to-point data connection, where the two end-points of the communication are in 'real-time' connected with one another and thus 'converse'.

2. A *message service* is a telecommunications service similar to the postal service. A message is submitted to the network (like a letter is posted).

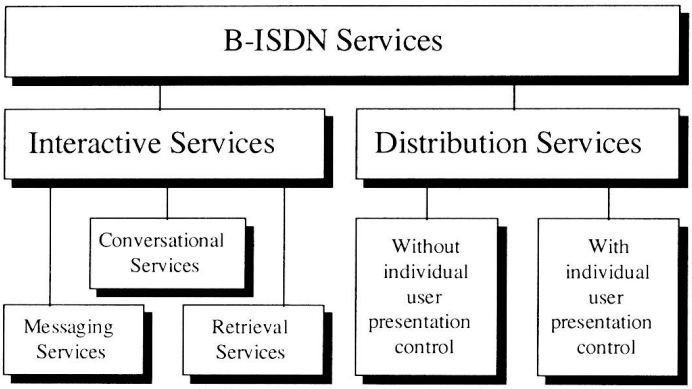


Figure 1.1 The service types offered by B-ISDN

Sometime later, the message is delivered to the given address. The recipient may read the message and reply with a *message* if he wishes, but the sender at this time is no longer connected. Message services are usually not *guaranteed.* The network is not able to check whether the recipient address is valid, and may return no confirmation to the sender of receipt. Thus 'no reply' may result either because the intended recipient never got the message or because the recipient chose not to respond.

3. A *retrieval service* is where a network caller accesses a central server, database or storage archive, requesting the delivery of certain specified information. The caller might receive data about holiday bargains (akin to *videotext services – Prestel, Minitel, Datex-J*, etc.), new video clips, etc.

Distribution services are services in which the information from a single source is distributed to many recipients at the same time. Distribution services are subdivided into those with or without individual *user presentation control.* An example of a distribution service without individual *user presentation control* is the broadcasting of national television. All the recipients receive the same signal at the same time. An example of a distribution service with individual user presentation control is *video-on-demand.* Here only those users who wish to pay and receive a given film do so.

There is intense effort in many branches of telecommunications development and research leading to many exciting potential applications of the various types to run over B-ISDN networks (Table 1.1)

Table 1.1 Potential applications of the various B-ISDN service categories

Category	Service type	Potential applications
Interactive Services	Conversational services	Voice telephony
	Messaging services	Internet Electronic Mail
	Retrieval services	On-Line Database service
Distribution Services	Without user control	Broadcast TV
	With user control	Pay-on-view TV or Video-on-demand

1.3 What Does *Asynchronous Transfer Mode* Mean?

The terminology *transfer mode* indicates that ATM is a telecommunications transport technique – a method by which information may be transferred (switched and transported) from one side of a network to the other. The term *asynchronous* distinguishes the technique from *synchronous* and *plesiochronous* transfer techniques.

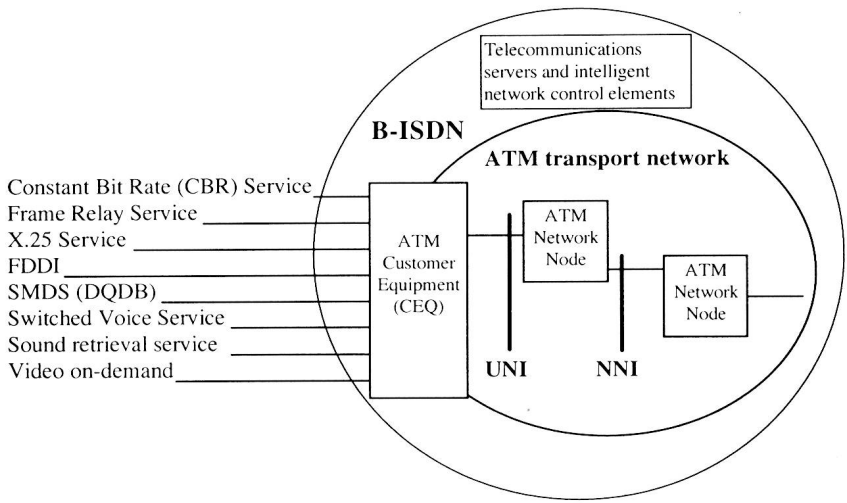
Synchronous transfer mode (STM) is the method used in high speed transmission systems (such as *synchronous digital hierarchy, SDH*, or *synchronous optical network, SONET* – see Appendix 1). In a *synchronous* transfer technique, the line capacity (bitrate) is structured in a strictly regular, and repeating pattern. Thus a 155 Mbit/s SDH line transmission system, for example, is actually composed of a *frame* of 2430 bytes (correctly 2430 *octets*), repeated 8000 times per second. There are no gaps between the frames, so the same part of the frame can be expected in the same place every 125 microseconds – the system is *synchronous*. In a *plesiochronous* system, the system does not run quite synchronously, but pretends that it does. In order to circumvent the inevitable errors which occur because the system is not quite synchronous, some of the capacity is purposely wasted in order that there is slack in the system, and the end-user does not suffer the ill-effects.

In the *asynchronous transfer mode*, frames (or correctly *cells*) of information are only sent when necessary. Thus, for example, cells are only sent across the network to represent the alphabetic characters which I am typing and only when I type something. In between, nothing is sent. By comparison, synchronous transfer mode would convey frames all the time – empty ones at times.

The *asynchronous transfer mode (ATM)* is thus potentially the more efficient of the telecommunications transport techniques. We discuss the reasons further in chapter 2.

1.4 What Types of Connections Does an ATM Network or B-ISDN Support?

So what types of connection does an ATM network support? The answer, as we have seen, is all types. In Figure 1.2, we illustrate as a brief summary the main types of connections and services which ATM networks will offer. We also present some of the main interfaces of ATM (the *UNI* and the *NNI*). Lastly, the diagram shows how ATM relates to B-ISDN.



Term	Meaning
CBR	Constant Bit Rate (a point-to-point connection across an ATM network providing service similar to a *private wire* or *leaseline*)
DQDB	Dual Queue Dual Bus (The technology behind SMDS)
FDDI	Fibre Distributed Data Interface (a campus technology for interconnecting LAN routers)
NNI	Network–Node Interface (an ATM network interface)
SMDS	Switched Multimegabit Data Service (an existing broadband network type)
UNI	User–Network Interface (an ATM network interface)

Figure 1.2 ATM and B-ISDN: the connection types available

1.5 When Should I Consider Using ATM?

Before embarking today on any major new telecommunications network investments or on the development of any major new computer software applications (particularly *broadband* or *multimedia* applications), one should consider including ATM switching elements in the network architecture or ATM network interfaces in the software APIs (application programming interfaces). Why? Because ATM is likely to become *the* universal telecommunications transport technique. It will, however, take a few years yet for ATM to establish itself fully as *the* information highway, during which time the best informed corporations and network operators can steal a march on their competitors. This will require having an understanding of the technical capabilities of ATM, having faith in its potential and determining to make it happen. The remainder of this book is dedicated to helping along the way!

2

The Concept of ATM

As a foundation for understanding the reasons why ATM has developed, and as a basis for our later comparisons of the strengths of ATM compared with other telecommunications transport technologies, this chapter presents the basic technical principles and terminology, explaining what marks out ATM from its predecessors. In particular, we discuss the principles of statistical multiplexing and the specifics of cell switching.

2.1 A Flexible Transmission Medium

ATM is a telecommunications transmission technique. It is one of the most modern transmission techniques. It is designed to be the most flexible and efficient. An ATM-equipped transmission line or telecommunications network is able to support:

- usage by multiple users simultaneously, each with
- different telecommunication needs (e.g. telephone, data transmission, LAN interconnection, videotransmission, etc.) and with
- each application running at different transmission speeds (i.e. with differing bandwidth needs).

But these capabilities are also offered by predecessor technologies, so why pay the premium for an ATM network, you might ask? What distinguishes ATM from its predecessors is that it performs these functions more efficiently. In particular, ATM is capable of an instant-by-instant adjustment in the allocation of the available network capacity between the various users competing for its use. Rather than allocating fixed capacity between the two