Narrowband ATM Network

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Abstract

This paper presents Narrowband Asynchronous Transfer Mode (Narrowband ATM or NATM) Network and its differences from ATM specified by ITU. The technical characters, provided services and its applications are also introduced.

1. Introduction

Information superhighway is now the focus of intense interest on a worldwide scale. BISDN and ATM are frequently appearing in daily newspapers and many kinds of magazines. International Telecommunication Union (ITU) is working diligently on the BISDN standards. The ATM Forum has grown from about six primary members in 1991 to a membership of about 300 companies.(1)

BISDN promises to deal with any kind of information, such as voice, data, text, image and video, in a integrated manner. To fulfill this task, a new transfer mode of communication network named as Asynchronous Transfer Mode (ATM) is introduced. ITU has suggested that ATM is the transfer mode of only solution for BISDN(2).

BISDN provides every user with a bi-directional channel of 155.520Mbps or 622.08 Mbps. ¡The transmission rate between ATM switching nodes is higher than several hundred Mbps. So the cost for building a ATM network is much higher than that a company or a factory likes to bear.

Fig.1 shows the WAN connectivity requirements. This Figure came from StrataCom Company in 1994. It shows that the majority of requirements in these years are less than 2 Mbps. So the ATM trade-off is needed today, even in next several years.

2.Narrowband ATM network

Now we can divide the ATM networks into two kinds, broadband ATM networks and Narrowband ATM (NATM) networks.

The first character of narrowband ATM network is its low transmission rate. We usually call the ATM network with transmission rate less than 10 Mbps a narrowband ATM network. Narrowband ATM network usually uses 2 Mbps(or less) transmission line to connect switching nodes. An ATM network with transmission rate 34Mbps or higher is called Broadband ATM network, which is the same as BISDN.

The second character of NATM network is its less demand on transmission quality. As we know, BISDN is based on optical fiber transmission. The optical fiber transmission has its two distinguished characters. One is extreme high transmission rate, higher to many Gbps. The other is extreme low transmission error rate, less than 10^{-8}. But narrowband ATM network

usually use leased channels or wireless transmission line. The transmission error rate for these channels usually is about 10^{-4} or 10^{-5}, sometimes higher to 10^{-3}.

Due to the low transmission rate, the cell transfer delay in narrowband ATM network will be increased especially when low speech coding rate is adopted. As the transmission error rate is increased, the cell loss rate and cell misinsertion rate are also increased rapidly, this will greatly decrease the network performance.

So there are two key techniques in narrow band ATM network. One is how to enhance the error control ability of narrowband ATM cell, the other is how to control the cell transfer delay. To realize this two purposes a different ATM protocol is needed. We can not adopt the ATM protocol suggested by ITU without any changes.

3. The Cell Design

Narrowband ATM network usually use different cell design. The cell has shorter length in bytes and more bites used for Head Error Control (HEC).

Fig.2 is the cell format suggested by ITU. The cell head has 5 bytes, 1 byte is used for HEC, that means that head: HEC=5:1.Here HEC can correct 1 bit error in cell head and detect 1 bit error at the same time.

Fig.3 is the cell format used in IPX (3), which is a narrowband ATM switch designed by StrataCom company in U.S.A. The cell head has 3 bytes, 1byte is used for HEC, that means that head: HEC=3:1. The cost for HEC in IPX is increased, compared with ITU ATM cell. Here HEC can correct 2 bit errors.

Fig.4 is the cell format used in a wireless ATM network (4). The cell head has 4 bytes, 2bytes are used for HEC, that means head:HEC=1:1. The cost for HEC is higher than that in IPX. Here HEC can correct 3 bit errors and detect 4 bit error at the same time.

The transmission error happened within cell head will cause cell loss or cell misinsertion. Here we define that

cell error = cell loss + cell misinsertion

We can calculate the Cell Error Rate (CER). Tab.1 gives the calculation results. CER(n) is the Cell Error Rate caused by transmission. In tab.1 the Cell Error Rates for 3 kinds of cell format are calculated under 4 BER conditions. From tab.1 we see that narrowband ATM networks still have good performance under the condition of BER 10^{-4}~10^{-5}. For cell format (3) the CER is quite low even when BER equals 10^{-3}. But for standard ATM the network performance is quite unsatisfactory when BER is 10^{-4}.

Narrowband ATM network usually adopt short cell. For example, StrataCom use 24 bytes as its cell length in NATM switch IPX. Short cell suffers less transfer delay. It is especially suitable to voice service, because voice has most strict limit on transfer delay.

4. The User Service

Although the transmission rate in narrowband ATM network is limited to not exceed 2 or 8 Mbps, but quite a lot of communication services can be provided.

The first one is voice service. Speech Coding Technology has made great progress these years. Tab.2 presents main speech coding methods (5). VSELP is used in north America for cellular communication. Although its coding rate is only 8 kbps, but its voice quality is quite high (MOS=3.7). This is the best choice of speech coding for narrowband ATM network, which then can have much more capacity for voice communication.

The second one is data service. Data rate in narrowband ATM network can be from 0 to more than 1 Mbps when 2Mbps is used for transmission, or more than 5Mbps when 8Mbps is used for transmission. Also, data services of connection-oriented, nonconnection and

available bit rate can all be provided in narrowband ATM network.

The third one is video phone. In NISDN video phone uses one B channel for video and the other B channel for voice. In narrowband ATM network video phone service can select different bit rates, such as 128kbps or 64kbps.

The forth one is video conference service. You can have different choices of video bit rate, such as 768kbps, 384kbps, 256kbps or 128kbps.

Multimedia data base access service is also a important service supplied by narrowband ATM network. Other services such as Fax, telex and image transfer are easy tasks, for they are all narrow band services.

Video services with MPEG-1(1.5Mbps) and MPEG-2(4~6Mbps) can be occasionally offered in narrowband ATM network. It is not common service.

5.The Application

Narrowband ATM network is not like BISDN, which can provide broadband services to customers, and it is not like NISDN, which can only provides very narrowband services with bit rate less than 128kbps. Maybe we can use "Wide band Service" to describe the services provided by narrowband ATM network. "Wide band service network" is the solution for today.

Narrowband ATM network can be used in a company, a factory or a school as its private communication network with Wideband Integrated service. Narrowband ATM network can not meet the demand for entertainment, but is good enough for business purpose. Besides the common services from telephone and fax to video conference, narrowband ATM network can also provide remote supervision for enterprises, provide finger-print check-up for the bank, and provide remote education for the schools.

Narrowband ATM network is a good solution to the interconnection among Local Area Networks. Today in many cases E1 is a suitable transfer rate from capacity point or from cost point.

StrataCom has set up 3000 IPX system in more than 300 companies throughout the world, providing voice service of ITU ADPCM, fax service, data service from 1200bps to 1.344Mbps, frame relay service with interface of 56kbps-2.048Mbps and narrowband ATM service of T1/E1.

6.conclusion

This paper introduces a narrowband ATM network. It is wideband ISDN located between BISDN and NISDN. Maybe it is the right solution for today's ISDN.

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VPI		
VPI	VCI	
VCI		
VCI	PT	CLP
HEC		

Fig.2 Cell Format (1)

VCI		
VCI	PT	CLP
HEC		

Fig.3 Cell Format(2)

VCI		
VCI	PT	CLP
HEC		
HEC		

Fig.4 Cell Format(3)

	10^{-3}	10^{-4}	10^{-5}	10^{-8}
CF (1)	$7.60516*10^{-4}$	$7.78027*10^{-5}$	$7.79802*10^{-8}$	$7.78266*10^{-13}$
CF (2)	$1.99238*10^{-6}$	$2.02081*10^{-9}$	$2.02371*10^{-12}$	-
CF (3)	$3.51635*10^{-8}$	$3.58760*10^{-12}$	$3.596*10^{-16}$	-

Tab.1 CER comparison

Coding name	rate(kbps)	MOS	complexity
PCM(G.711)	64	4.3	1
ADPCM(G.721)	32	4.1	10
CVSD	32	3.8	0.1
CVSD	16	3.0	0.1
LD-CELP	16	4.0	10
RPE-LTP	13	3.54	10
VSELP	8	3.7	10
CELP	4.8	3.0	50-100
LPC-10	2.4	2.5	10

Tab.2 Speech Coding

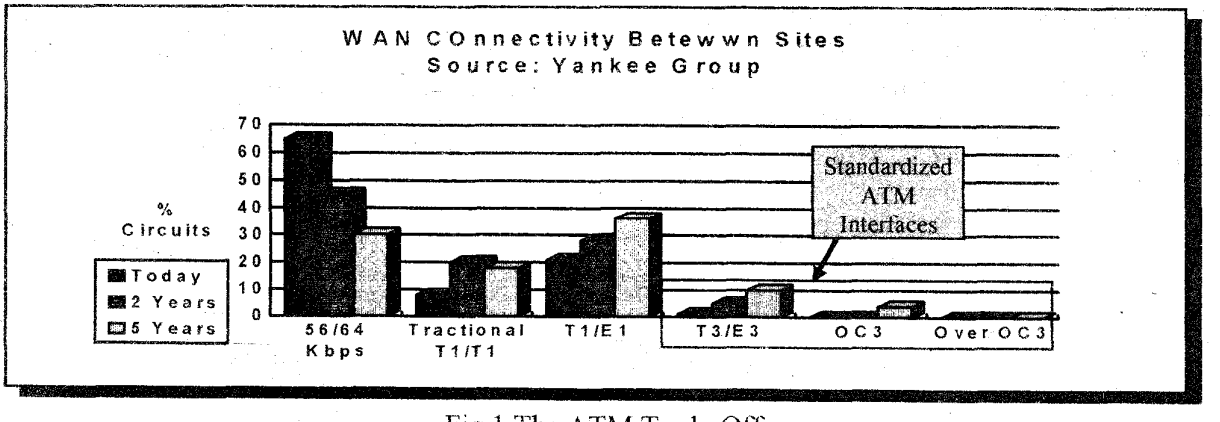

Fig.1 The ATM Trade-Off