Chapter 5
Popular technologies

Chapter summary

A network has a physical shape (topology – *see Chapter 3*) and an implementation, a set of protocols and hardware (technology). Over the years a number of technologies have been established but, like most industries, the market has largely settled for just a few. This chapter doesn't seek to cover all the technologies but only those worthy of note:

- **Ethernet** – without doubt the most popular LAN technology in the world. Hugely dominant and likely to stay that way.
- **Token Ring** – a worthy alternative to early Ethernet, which is still around, although it is becoming less popular.
- **FDDI** – up until early 2004, FDDI was still the standard for backbone cabling. Since 2004, Gigabit Ethernet has taken over.
- **ATM** – this is important as it harmonises the telephone network with computer networking, providing the highest speed transfer of external data to the organisation. It has also been implemented inside organisations as a LAN backbone.

Learning outcomes

After studying this chapter you should aim to test your achievement of the following outcomes. You should be able to:

Outcome 1: Ethernet networks

Understand the development, variants, method of access, typical uses and hardware components of Ethernet networks. Question 1 at the end of this chapter will test your ability to do this.

Outcome 2: Token Ring networks

Understand the development, variants, method of access, typical uses and hardware components of Token Ring networks. Question 2 at the end of this chapter will test your ability to do this.

Outcome 3: FDDI networks

Understand the operation, typical uses and hardware components of fibre distributed data interface (FDDI) networks. Question 3 at the end of this chapter will test your ability to do this.

Outcome 4: ATM Networks

Understand the operation, typical uses and hardware components of asynchronous transmission mode (ATM) networks. Question 4 at the end of this chapter will test your ability to do this.

How will you be assessed on this?

The technologies covered in this chapter represent the range of technologies in use today. The assessment of your studies is almost guaranteed to include them. Commonly, assessments are in the form of a design (in an assignment) and, as part of a TCT, questions regarding their particular features. You are often asked to describe the method of access of either Ethernet of Token Ring, or to discuss Ethernet and its variants.

Section 1: Ethernet networks (IEEE 802.3)

Ethernet (IEEE 802.3) networks are the most popular networks in the world, and the technology is continuing to develop in response to various organisations' needs. It is widely implemented everywhere and looks like being the LAN of choice for some considerable period of time. As such, it is the network that is given the greatest treatment in this chapter.

Method of access

Initially Ethernet was a bus network (*see Chapter 3*), and its method of access is known as Carrier Sense Multiple Access with Collision Detection (CSMA/CD). The assembled data is broadcast (like a TV programme but occupying the whole frequency) over the media. The steps involved in a transmission can be summarised as follows:

- Listen to network.
- If it is clear, begin transmission of the frame.
- Continue to listen to the network.
- If a collision is heard (two frames colliding with one another), send out a jamming signal.
- If the jamming signal is heard, stop transmitting and wait for a random time period before retrying.

Figure 5.1 shows two Ethernet stations (A and C) that wish to transmit at the same time. Both are listening to the network: there is no transmission and so both begin to transmit. The frames eventually collide and both are lost, requiring retransmission. The time taken from transmission to collision to the end of the random time period is, therefore, wasted time.

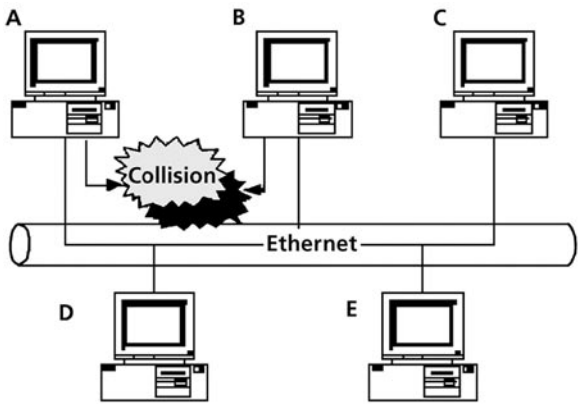

Figure 5.1: An Ethernet collision

The problem with traditional Ethernet (10Base2 and 10Base5) is that, the more frames that are transmitted, the higher is the probability of a collision. And the greater the number of collisions, the more frames that require retransmission. Whilst all this is going on, very little data is getting through, and the users experience severe delays. This tends to happen when the data presented to the network exceeds 7 Mbps. Traditional Ethernet is therefore useful in situations of moderate load and particularly useful for short, bursty traffic loads.

TIPS & ADVICE

'Load' can be affected by the number of computers and the amount of data they transmit.

KEY CONCEPT

It is very important to understand the way the medium is shared, indeed, this is absolutely fundamental when moving on to discuss other networks and other variants of Ethernet. An easy way to remember this is to draw an analogy. Suppose that an army commander needs to get a message through enemy territory during a battle. He writes a note and gives this to the first dispatcher. Both listen and, if all is calm, the dispatcher goes out. Once he's gone the commander listens again. If a shot is heard, the commander knows the message didn't get through and so sends out another dispatcher. The more intense the battle, the more chance there is of a 'collision'. And the more collisions, the longer it takes to get the message through.

Ethernet frame formats

Whatever the variant of Ethernet, they all use the same frame format. As discussed in Chapter 3, data needs to be broken into packets to be sent across the network. Packets are the units used by the Internet protocol (IP) structure (*see Chapter 11*). A particular technology uses a specific frame type. Ethernet frame type is shown in *Figure 5.2*. Being a CSMA/CD method of access, Ethernet requires a minimum frame size in order that errors can be detected properly. If the data to be sent makes the frame smaller than that minimum size, it needs to be 'padded out' (frame contents are discussed in more detail in Chapter 3).

8	6	6	2	0–1500	(46–0)	4
Preamble	Destination address	Source address	Length	Data	Padding	CRC

Figure 5.2: Ethernet frame structure

Ethernet variants

Ethernet is constantly being developed. Early Ethernet utilised a bus or tree topology, whereas later versions used a star topology. The naming convention (shown in *Figure 5.3*) has been adopted for Ethernet.

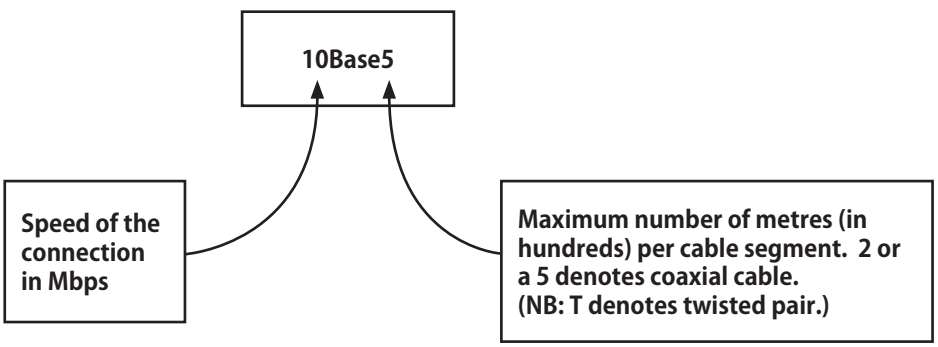

Figure 5.3: Ethernet naming convention

Table 5.1 summarises the variants.

Name	Cable type	Max. dist. /segment (m)	Max. speed (Mbps)	Topology	Max. nodes per segment	Max. segments per LAN
10Base5	10 mm coaxial	500	10	bus/tree	100	5
10Base2	5 mm coaxial	185	10	bus/tree	30	5
10BaseT	twisted pair	100	10	star	2	n/a
100BaseT	twisted pair	100	100	star	2	n/a
1000BaseT (gigabit Ethernet)	twisted pair	100	1000	star	2	n/a
10GE	fibre	up to 40 km on single mode fiber	10,000	star	2	n/a

Table 5.1: Ethernet variants

TIPS & ADVICE

Ethernet is the world's most popular networking technology and, as such, its importance can hardly be overlooked either in an exam or in the real world.

10Base5

This was the original Ethernet development. It is easily distinguished by the thick 10 mm coaxial cable on which it is based, and it operates on the bus/tree topology. Because of the great coverage length achieved for each segment of this cable, after initially being the standard it came to be used as the backbone connecting LANs formed with 10Base2 cabling. Cabling 10Base5 was difficult because of the thickness and rigidity of the cable used. Attaching a computer to this cable required the use of a specialist device, called a **tap** (*see Figure 5.4*). *Figure 5.5* shows how a tap is installed. Other than this, only one networking card per computer (with either in-built transceivers or external transceivers) and terminators were required. 10Base5 was expensive because of the costs associated with the cables and taps. However, current prices are not available as this variant of Ethernet is no longer used.

Figure 5.4: Combined 10Base5 Ethernet tap and transceiver (courtesy of Blackbox Networks)

The advantage of 10Base5 was the long length of cable run, which allowed the network to be extended to cover large buildings.

The disadvantages were the difficulties in laying the cable (due to its rigidity) and the costs of the cable, taps and transceivers.

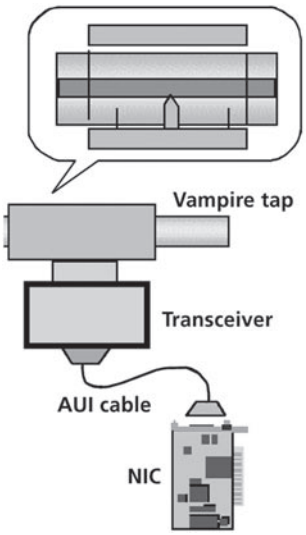

Figure 5.5: Installation of a tap
(courtesy of Surasak Sanguanpong, Kasetsart University, Thailand)

10Base2

This was a very popular variant of Ethernet, mainly due to its very low installation and hardware costs (hence it was also known as 'Cheapernet'). 10Base2 is based on 5 mm coaxial cable (very similar to TV aerial cable) and, in the main British naval connectors (*see Figure 5.6*). Its price made it popular for use in classrooms and for small networking applications (e.g. lawyers' offices, estate agents, small companies and in the home). Adding machines to the network was also easy – all that was required was to disconnect the cable at the required point (when the network wasn't in use) and to connect the new computer. Providing certain standards were observed, the computer would operate. All that was needed to construct a two-station 10Base2 network were two 10Base2 Ethernet cards (NICs) (approximately £10 at the end-of-life price in early 2003), a piece of cable (around £5 at the end-of-life price in 2003) and two terminating resistors (50p at end-of life-price in 2003) (*Figure 5.6* also shows these components). By 2005, UTP Ethernet had taken over and 10Base2 products were extremely difficult to locate.

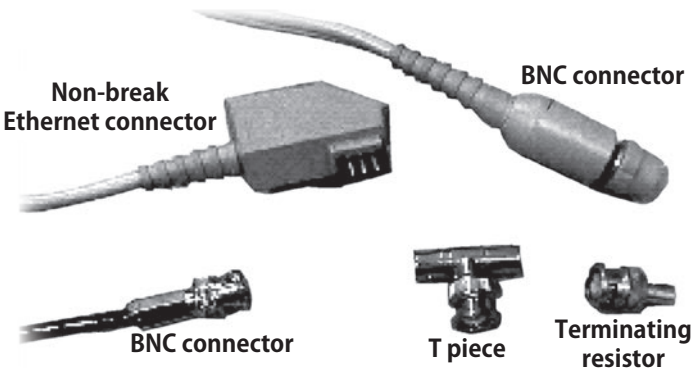

Figure 5.6: Typical 10Base5 connectors

The typical advantages of 10Base2 were:

- its low cost;
- ease of setup;
- the minimum kit requirements;
- the single cabling, which minimises disruption to the installation.

The typical disadvantages were:

- its poor performance for busy networks (e.g. college multimedia lab);
- cable breaks affect all computers (although connectors were later invented to minimise this).

KEY CONCEPT

10Base2 and 10Base5 are both based on differing versions of coaxial cable and represent the 'older' type of Ethernet. Most new installations use twisted pair cabling, as detailed below.

10BaseT

Whilst 10Base2 probably ensured the success of Ethernet as a technology, compared to its competitors it still suffered from cable break problems. Also, in the mid-1990s many organisations were looking to structure their communications and cabling, and Token Ring (its main competitor) was better suited to this. Hence 10BaseT Ethernet was developed.

10BaseT Ethernet is based upon a star technology with a device called a **hub** (*see Figure 5.7*) at the centre. 10BaseT uses RJ-45 connectors and twisted pair cabling (*see Figure 5.8*). This makes the system resilient to cable breaks and also makes it suitable for structured cabling. Thus the management and maintenance of the cabling are somewhat easier than in the past. The method of access is, however, no different. Inside the hub all the ports are connected together just as in a bus topology and so collisions occur and capacity is lost. The network therefore still works as though it were a bus topology.

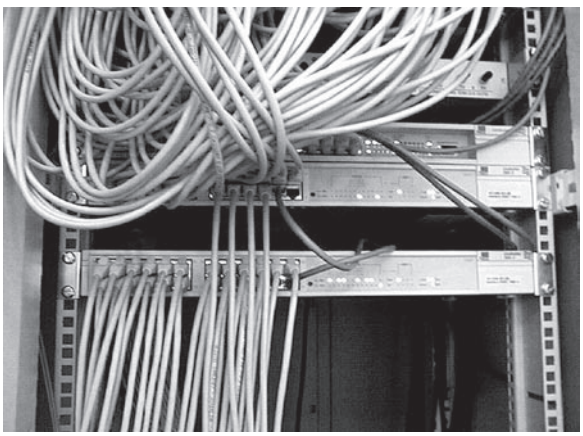

Figure 5.7: 10BaseT hub

10BaseT is now a largely dead technology with the price of 100BaseT equipment having fallen so much as to be comparable to 10BaseT.