FIBRE CHANNEL (FC) - 0

FC-0: cables, plugs and signal encoding

FC-0 defines the physical transmission medium (cable, plug) and specifies which physical signals are used to transmit the bits ‘0’ and ‘1’. In contrast to the SCSI bus, in which each bit has its own data line plus additional control lines, Fibre Channel transmits the bits sequentially via a single line. In general, buses come up against the problem that the signals have a different transit time on the different data lines (skew), which means that the clock rate can only be increased to a limited degree in buses. The different signal

transit times can be visualised as the hand rail in an escalator that runs faster or slower than the escalator stairs themselves.

Fibre Channel therefore transmits the bits serially. This means that, in contrast to the parallel bus, a high transfer rate is possible even over long distances. The high transfer rate of serial transmission more than compensates for the parallel lines of a bus. The transmission rate of actual components increases every few years. Table 3.2 depicts the market entry and the roadmap for new higher transfer rates as of 2009. Fibre Channel components are distinguished as Base2 components and Base10 components. Base2 components have to maintain backward compatibility of at least two previous Base2 generations. For instance 8GFC components must be interoperable with 4GFC and 2GFC

components. Base10 components have to maintain backward compatibility of at least one Base10 generation, in which case, as an exception for 100GFC no backward compatibility is expected.

Table 4.2 Fibre Channel components are distinguished in Base2 components (upper table) and Base10 components (lower table). The table shows the roadmap as of 2009.

Product Naming	MByte/s (per direction)	T11 Spec Completed	Market Availability
1GFC	100	1996	1997
2GFC	200	2000	2001
4GFC	400	2003	2005
8GFC	800	2006	2008
16GFC	1,600	2009	2011
32GFC	3,200	2012	Market demand
64GFC	6,400	2016	Market demand
128GFC	12,800	2020	Market demand
Product Naming	MByte/s (per direction)	T11 Spec Completed	Market Availability
10GFC	1,200	2003	2004
20GFC	2,400	2008	2008
40GFC	4,800	2009	2011
80GFC	9,600	future	Market demand
100GFC	12,000	future	Market demand
160GFC	19,200	future	Market demand

When considering the transfer rate it should be noted that in the fabric and point-to-point topologies the transfer is bi-directional and full duplex, which means that, for instance for 2GFC components the transfer rate of 200 MByte/s is available in each direction. The Fibre Channel standard demands that a single bit error may occur at most once in every 1012 transmitted bits. On average, this means that for a 100 Mbit/s connection under full load a bit error may occur only every 16.6 minutes. The error recognition and handling mechanisms of the higher protocol layers are optimised for the maintenance of this error rate. Therefore, when installing a Fibre Channel network it is recommended that the cable is properly laid so that the bit error rate of 10−12 is, where possible, also achieved for connections from end device to end device, i.e. including all components connected in between such as repeaters and switches.

Different cable and plug types are defined (Figure 3.10). Fiber-optic cables are more expensive than copper cables. They do, however, have some advantages:

• Greater distances possible than with copper cable;

• Insensitivity to electromagnetic interference;

• No electromagnetic radiation;

• No electrical connection between the devices;

• No danger of ‘cross-talking’;

• Greater transmission rates possible than with copper cable

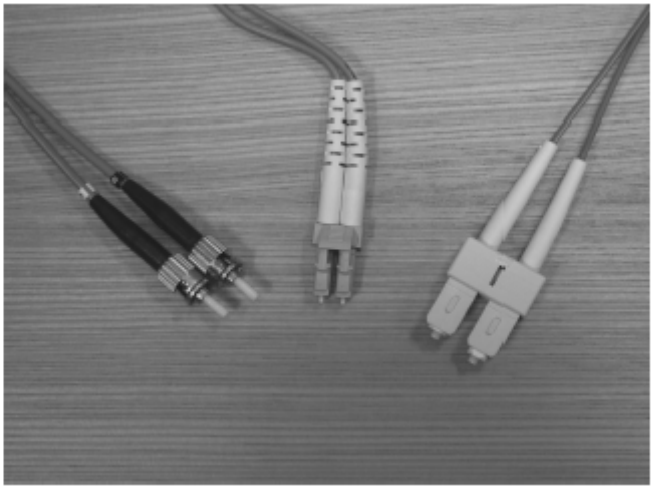

Figure 4.10 Three different plug types for fiber-optic cable.

Cables for long distances are more expensive than those for short distances. The definition of various cables makes it possible to choose the most economical technology for each distance to be bridged.

Typically the Fibre Channel standard specifies for a given medium a minimum distance which must be supported. It is assumed that when respective components enter the market, the state of technology can ensure the error rate for the specified minimum distance. Over the time, further technical improvements and the proper laying of cable enable even larger distances to be bridged in actual installations.

The reduction in the supported distances could present a problem when the equipment of an existing Fibre Channel SAN is upgraded from one generation to the next generation components. Due to technical limitations next generation components typically support for the same medium shorter distances than current generation components. This is especially an issue for longer instances when cables are installed between two collocated data centers which are several 100 meters apart.