HIGH SPEED ETHERNET CABLING

There is a variety of types of cables available for making Ethernet connections at speeds of 1Gigabit per second and above. Trade-offs are cost versus practical maximum cable length.

1-Gigabit Connections

The most commonly used cable for 1Gbps Ethernet is the Category 5 (Cat5) cable with an RJ45 connector on either end. This cable can handle connections of up to about 100 M in length.

For longer connections an optical fiber cable can be used.

Transceivers
Optical fiber connections are constructed with a combination of a transceiver (sometimes called a GBIC – for **G**iga**B**it **I**nterface **C**onverter). The transceiver accepts digital signals from the Ethernet device (switch or adapter card) and converts them to optical signals for transmission over the fiber. Although a number of different form factors for this GBIC have been defined by standards bodies, the most common is the SFP (**S**mall **F**orm Factor **P**luggable Transceiver). The term GBIC initially was used for a specific form factor, but with the widespread adoption of the smaller SFP standard form factor, the term GBIC has fallen into the vernacular as a general term for an optical transceiver. (Some people even call the SFP a "mini-GBIC", but that designation does not come from any standards body.)

Fiber Cables
Fiber cables consist of the cable itself … and connectors. There are multiple choices for cable type and for connector type. The difference in cable choices come from the distance limitations encountered with the various types of optical transmission. Two different commonly available types are of interest in the Ethernet world with the first being, by far, the dominant one:

> Short Range: SX – for connections of up to 550 M in length
> Long Range: LX – for connections of up to 10,000 M (10 KM) in length.

As one would expect, the longer the cable, the more expensive it is. A couple of parameters are factors in this – the quality of the fiber itself and the method of encoding on the light waves. Short range cable almost always uses a type of transmission called "multi-mode" and the transmission wavelength (remember, that's the inverse of frequency in things like light waves) is 850 nanometers. Long range cable uses "single mode" transmission at a wavelength of 1310 nanometers. [There are a few other possibilities for range, mode, and wavelength, but these two predominate.]

The final consideration on the cable is the connector type. The main differences among types of connectors are dimensions and methods of mechanical coupling. Generally, organizations will standardize on one kind of connector, depending on what equipment they commonly use.

Multimode fibers and single-mode fibers require different connectors. SC and LC connectors are by far the most common types of connectors on the market. The fun part is figuring out what is the real origin of the abbreviation for each:

LC: **L**ucent **C**onnector, or **L**ittle **C**onnector, or **L**ocal **C**onnector

SC : **S**ubscriber **C**onnector or **S**quare **C**onnector or **S**tandard **C**onnector

For Ethernet cabling, SC is by far the dominant connector type.
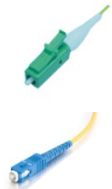
Copper Cables

For 1-Gigabit Ethernet cabling, the standards body determined (eventually) that the traditional Ethernet cable using RJ45 connectors could be used for the new (at the time) higher speed connection if a cable with somewhat better cross-talk characteristics was used. That cable is called "Category 5 unshielded twisted pair" and is generally called Cat5-UTP.

An "enhanced" version of the Category 5 specification was introduced several years ago. It is called Cat5e. Most Ethernet cabling today is this type and the name is often shortened to just Cat5. For lower speed (10 or 100 Mbps) connections only two of the four pairs in Cat5 cable are used – for 1Gbps Ethernet, all four pairs are used. Cables of up to 100 M in length can be used.

10-Gigabit Connections

For 10-Gigabit Ethernet cabling the fiber options are very similar. The transceivers are somewhat different, as is some nomenclature. New possibilities have evolved for copper connections.

Transceivers

Standards bodies initially offered several options for the 10-Gigabit transceiver. The one that ultimately evolved as most popular in commercial data center usage was the XFP transceiver.

XFP stands for **10**–Gigabit **F**orm Factor **P**luggable. In recent years an extension of the SFP transceiver was standardized for use with 10 Gigabit Ethernet and named SFP+. SFP+ has the same mechanical characteristics as the the SFP transceiver – it just is capable of supporting the higher speed (some, but not all, SFP+ transceivers can actually operate at either 1Gbps or 10Gbps). The advantage of SFP+ was, first of all, that it was smaller than the XFP form factor allowing for much more dense packaging

of ports on (primarily) switches. A second advantage was that a new type of very-short-distance copper cable was developed which uses the same mechanical form factor as the optical transceiver and is capable of carrying 10Gbps Ethernet data. This cable type, called "direct attach" copper cable works in the range of up to about 12-15M which is often more than enough for interconnecting systems in racks in data centers. With the advent of this dual-purpose capability, SFP+ has really caught on and has now become the predominant 10G Ethernet connector type.

Fiber cables

10-Gigabit Ethernet fiber connections use the same optical fiber types as 1-Gigabit Ethernet. The range is less due to the higher speed and the names are similar:

> **S**hort **R**ange: **SR** -for connections of up to 300 M in length
> **L**ong **R**ange: **LR** – for connections of up to 2,000 M (2 KM) in length.

A new option is also available, though rather rarely used:

> **E**xtended **R**ange: **ER** – for connections of up to 10,000 M (10 KM) in length.

Connector types are again the same – LC and SC, with SC still predominant. Note that these cables can be connected to either XFP or SFP+ transceivers. The connector type itself defines the mechanical specifications of the fiber-to-transceiver interface. Thus one could have an XFP transceiver on one end of a 10G Ethernet fiber cable and an SFP+ transceiver on the other end. As long as the cable type (SR or LR) and connector type (SC or LC) match there is no problem.
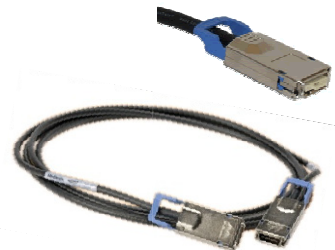
Copper Cables
10GBASE-T
For 10-Gigabit Ethernet cabling, the standards body determined that even the enhanced Cat5e UTP traditional Ethernet cable would not be able to carry the signal reliably for any significant distance. So a new specification – still using RJ45 connectors – was introduced and is commonly referred to by its standards name 10GBASE-T. This calls for a 4-wire twisted pair cable with even more stringent limitations on cross-talk. It is called Cat 6a. 10GBASE-T cables of up to 100 M are supported.

CX4
CX4 is a cable type generally associated with an alternative networking technology called InfiniBand. CX4 cable can also be used in 10Gigabit Ethernet connections. It uses a coaxial copper cable and can support cable lengths of up to 15 M.

SFP+

As discussed above, one of the advantages of the SFP+ connector type was that a new type of very-short-distance copper cable was developed which uses the same mechanical form factor as the optical transceiver and is capable of carrying 10Gbps Ethernet data. This cable type, called "direct attach" copper cable works in the range of up to about 12-15M which is often more than enough for interconnecting systems in racks in data centers. With the advent of this dual-purpose capability, SFP+ has really caught on and has now become the predominant 10G Ethernet connector type.