TELE 3118 Lab 1: Ethernet Cabling [5 points]
Weeks 2-3, Session 1, 2011

Prelab preparation

- Read through the web page http://www.littlewhitedog.com/content-8.html

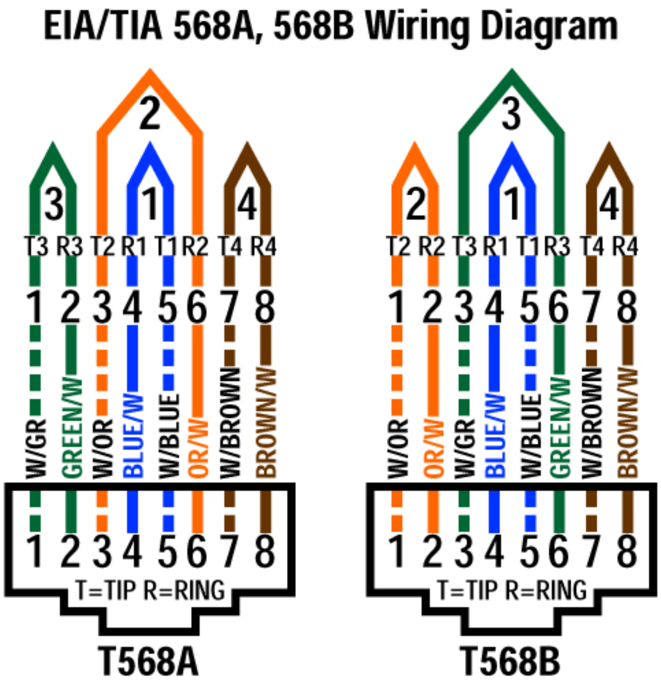
Since this lab involves physical wiring and cutting, it is critical that you perform this lab in a safe manner. In particular, it is important that you place all wire, insulation and cabling offcuts in the rubbish bins provided, and do not permit them to get near or on electrical devices such as computers. The marking criteria include marks for being able to work in a safe and clean manner.

Cables

Twisted pair wires are invariably made of copper, and typically consist of a single **solid** wire, although sometimes they consist of multiple thin wires **stranded** together. We'll focus on solid wires, whose thickness is described in terms of the American Wire Gauge (**AWG**) and typical network cables use AWG 24 wires, each covered by plastic insulation.

There are different **categories** of cables, defined by the Electrical/Telecommunications Industry Association (EIA/TIA) standard 568: *Commercial Building Telecommunications Cabling Standard*. The categories differ according to parameters such as the frequency of the twisting, with higher categories being more tightly twisted (e.g. "cat 3" has a typical twist length of 7.5 to 10 cm, whereas "cat 5" has a typical twist length of 0.6 to 0.85 cm). Higher twisting frequencies provide better immunity from crosstalk, but require more wire and so are more expensive. Current network cabling typically uses cat 3 to cat 6 wire.

Sets of twisted pairs may be wrapped together in a plastic jacket (typically blue, but other colours are possible, as used in this lab, e.g. beige and yellow). Inside the jacket, there may also be a solid (plastic) core and a thread. Network cables typically include 4 sets of twisted pairs, each colour coded.



[Source of figure unknown]

The T568A configuration is used at both ends of a straight-through cable, and for one end of a cross-over cable, where the other end has the T568B configuration.

Connectors

Network cables are terminated by **plugs** that are designed to be inserted into **jacks** on networking equipment.

Plugs are generally clear (e.g. to help view the colour-coded wires and so visually determine the wiring arrangement) and include a clip which secures them in the jack (press down to release). Since the clip points away from the end of the cable on which the plug is mounted, they tend to catch on things when cables are pulled, so it is often easiest to mount plugs *after* pulling cables.

Plugs may be covered by plastic **caps** that bridge the area between the cable and plug, and so protect the plug. Caps are difficult to slide, and (obviously?) should be slid onto a cable with the correct orientation before a plug is affixed.

Registered Jacks (RJ) were standardised by the American Telephone and Telegraph Company (AT&T) (see US patent 3,860,316), and the different types provide different numbers of connectors for cables with varying numbers of twisted pairs. e.g. RJ-11 (typically used with phones) supports two pairs, and RJ-45 (typically used for networking) supports four pairs. The jacks are designed to be compatible with a range of plugs, e.g. a RJ-11 phone plug can be inserted in a RJ-45 jack, which often causes more trouble than benefit.

Wiring cables to connectors

The most common types of cable used with Ethernet are "straight-through" and (less common) cross-over cables. **Straight-through cables** are physically the simplest, with wires going (as the name suggests) straight through from a terminal on one plug to the corresponding terminal on the other plug. **Crossover cables** make the best conceptual match with jacks: transmitter at one end connects to receiver at other end, when ends have same configuration (jack wiring). Cross-over cables are typically used when connected devices are equivalent, e.g. between two routers inside a network, or to directly connect two computers. Straight-through cables are typically used between devices that might be differentiated as "terminal" or "network" devices. The prototypical example is between a computer (terminal) and local switch/router (network device). A more delicate example might be between an access router (to which computers connect) and a backbone router (in the core of the network), in which case the access router *may* distinguish one port as being an "uplink" and expect a straight-through cable to provide the uplink to the backbone router. Sometimes ports are described (using Ethernet terminology) as being "Medium Dependent Interface (Crossover)" (MDI (MDIX)), where a straight-through cable would be used when one end is MDI and the other MDIX, and cross-over cable used otherwise.
Some interfaces are dynamically configured by a simple protocol implemented in the electronics of the line drivers. Such configuration can control which wires are used for which communication roles (as per HP's Auto MDIX technology) and whether any wires are used to carry power (as per the IEEE 802.3af power over Ethernet standard).

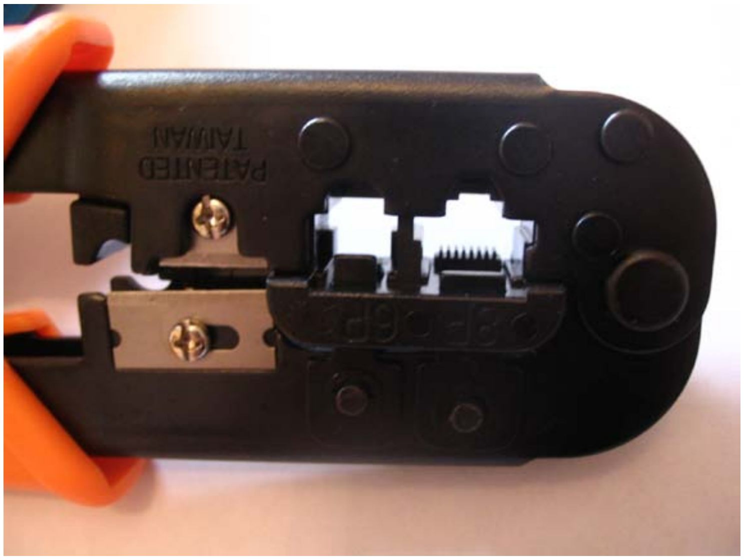
Tools

This lab will involve using wire cutters, a cable testing tool, and a cable crimper.

The **crimper**[1] pushes connectors of the plug into conductors of cable; may also close the plug to provide a physical bond to the cable (for strength). The photo below shows a close-up of the functional end of the tool. From left-to-right, there are:

- a circular hole for holding cable above wide blade (for stipping cable)
- two blades that can be used in tandem to strip insulation off wires (not needed for this lab)
- holders for 6-pin (left) and 8-pin (right) plugs, where the plug is inserted from the side showing, with the clip upwards, and pins positioned above the teeth that will crimp them to the cable when the tool is closed.

[1] From "crimp": to "compress into small folds or ridges"



Instructions

Each student should obtain from the lab demonstrator a 1m length of cable, two plugs. Through the lab demonstrators, students can also exchange their student card for tools, such as the crimper, wire cutter, and cable test tool. All tools must be returned in working condition to the lab demonstrators by the end of the lab.

To connect a plug to the cable:

1. **Strip the jacket off** about 4cm from the end of the cable, using the longer blade which overhangs a circular recess, which holds the cable.

   The crimper instructions say "turn crimper counter clockwise and cable clockwise" – to ensure motion against blade is towards cutting edge, and not orthogonal blunt edge

2. **Straighten the wires**, e.g. by gripping and pulling s.t. fingers slide along wire while applying pressure.

   Hold the cable where it is cut s.t. wires don't get untwisted inside the cable

3. **Order the wires**

4. **Cut the wires** s.t. about 12mm (designed as ½ inch) of wire extends beyond the cable sheath. Be sure to make the cut orthogonal to the cable s.t. all wires are of the same length, and so will equally reach the pins of the plug.

   There is no need to strip insulation off wire, since the crimping will penetrate insulation around individual wires

5. **Push the wires into the plug.** Since wires can get reordered when they are inserted, at this stage it is worth visually re-checking the order of the wires, as seen through the transparent plug.

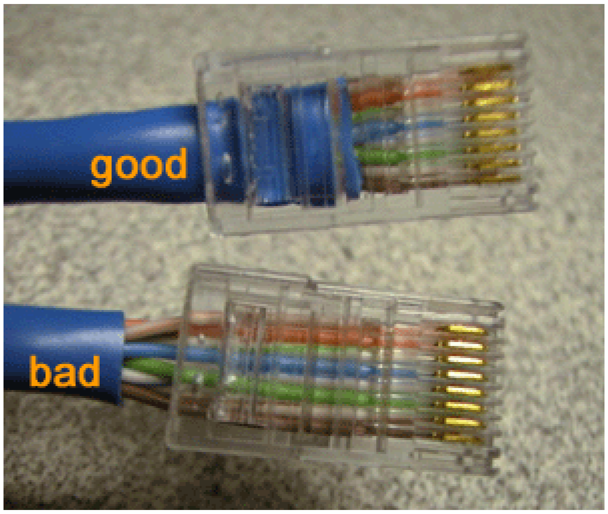
6. **Crimp** the plug and cable together.

Note that once the plug has been crimped, it cannot be reused. If you need replacement plugs, then kindly ask your lab demonstrator.

First, make a cross-over cable. Test that it works using a cable testing tool. Show the lab demonstrator that it works.

Then, cut off the crossed-over end, and turn this into a straight-through cable. Again, test and show it to the lab demonstrator.

If your cables do not work, then determine why they do not work, show this to the lab demonstrator, and ask for replacement cable/plug(s).



Marking guide

40% Build a properly functioning cross-over cable.
40% Build a properly functioning straight-through cable.
20% Demonstrate ability to maintain a clean and safe workplace.

You are required to bring the working straight-through and cross-over cables that you produce as part of this lab for the next lab in week 2.