AT&T

AT&T Cabling Systems

www.att.com/cabling

Upgrading LAN Cabling Systems

Issues to be considered before making decisions

Replacing LAN cabling systems in any organization is a complex (and often expensive) operation which requires serious considerations of all issues involved before any decision can be made.
This decision becomes more complicated when no information is available on the existing cabling system, but if it is several years old, it is most probably made with Category 6 components (if not lower), it is unshielded, the cables are PVC jacketed and they are not classified for reaction to fire.

A common misconception claims that most CAT 5e and CAT 6 unshielded cabling systems "work properly".
In reality, many of these old and outdated systems do not deliver the bit-rate they should have, they overheat under PoE currents and they cannot support new protocols aimed for these categories (such as 2.5GBASE-T and 5GBASE-T) due to excessive alien crosstalk (AXT).

In the last decade, since Category 6A was introduced, the LAN cabling technology was substantially upgraded, adding important transmission requirements, enabling faster protocols, upgrading the field testers and improving the safety level.
Ignoring these updates and staying with an outdated LAN infrastructure may prove to be a very short-sighted decision.

This paper highlights some of the critical issues that must be understood and considered when selecting a new cabling system.

1. Selecting the cabling category:

The lowest category that should be evaluated is Category 6A.
The option of using Category 8 cables in Category 6A links and channels is valid and discussed in another AT&T Cabling paper (available in the Resources section).
Selecting CAT 6 cabling for new installation is waste of money as the installation costs, which are the major factor, are identical for all categories.
Category 6A cabling supports 10GBASE-T, which is the fastest copper protocol available for 100m channels and which will be enough for most users for many years to come.

2. Selecting the horizontal Cable:

The horizontal cable has always been the most critical channel component (and the most difficult to replace) but the latest developments in PoE have made it even more important.
The recommended CAT6A cable construction is PiMF: Pair in metal foil.
This cable construction should be used whether the cabling system is shielded or unshielded.
In LAN cables the efficiency of the shield depends mainly on the DC resistance (*) to the ground:
In S/FTP cables the overall copper braid grounds the currents created by EMI noise in the aluminum foils. The DC resistance of the braid can be reduced as needed by using more wires thus reaching the desired level of shield efficiency, which should be specified and tested (Test methods: Transfer impedance, Zt and coupling attenuation, CA). These values cannot be tested in the field hence the Zt and CA values must be specified, tested and verified by the cable vendor.
In U/FTP and F/FTP cables a single copper drain wire serves as the path to the ground hence the shield efficiency becomes substantially lower.
In U/MTP cables there is no ground at all so the shield efficiency is zero or in other words the cabling is unshielded.
(*) The term DC resistance is used for simplicity although the ground path impedance (Zg) is the actual parameter at HF transmissions. The values are not the same but lower DCR creates lower Zg.

Properly shielded and balanced cabling systems have better EMC (Electro Magnetic Compatibility) so they are recommended for noisy environments or where the data should be highly protected (such as industrial sites, military applications, banks, hospitals etc.) but in many office applications unshielded systems will operate properly.
Notes:
- The cabling standards require that shielded systems shall be grounded on both sides in order to minimize standing waves, but in many cases the outlet side is actually floating.
In cases where there is a significant potential difference (>1v) between the two ends the ground loops created may cause more damage to the transmission quality than the effect of single-end ground.
- Single-end grounds and floating shields may cause standing waves due to the full signal reflection from the non-terminated line but when the cable pairs are highly balanced the effect is negligible.
- Pair balance is the single most important parameter of any LAN cable. Highly balanced pairs ensure minimum disruption from external noise and minimum radiation of signal out and they provide much better transmission properties. In F/UTP cables the pair balance may be compromised by varying distance between each wire and the shield while in high-quality PiMF cables the individual foil maintains the shape of the transmission line in perfect condition during production, packaging and installation of the cable, ensuring a very high and stable balance.
- The amount of metal in the cable affects the heat dissipation and the ability of the cable to support higher PoE currents. In addition, the conductor AWG and the bundle size must be taken into consideration. 23AWG is sufficient for most offices but 22AWG is a valid option when S/FTP cables are selected. Additional information is available upon request.

The advantages of the PiMF construction are detailed in another document in the Resources section, but here are the main points:
All pairs twisted in long lay lengths:
Easier to untwist – shortening termination time
Lower DC resistance per cable length => better PoE support
Lower delay skew (5~8 nS/100m)
Each pair wrapped with a metal foil:
Better heat dissipation => better PoE support
Extremely high NEXT loss and FEXT loss
High tolerance to cable abuse during installation
Foamed insulation:
Lower dielectric constant => Higher velocity of propagation (Vp)
Lower dielectric losses => lower attenuation

3. Safety considerations:
After many years of using PVC jacketed cables there is a gradual shift towards halogen-free (LS0H) cabling.
This trend started in Europe (where LS0H cables are used almost exclusively) but now becomes a de-facto standard in many other countries.
These cables are available in two major flame test options:
IEC 60332-1 for single cables and IEC 60332-3 for cable bundles installed in vertical shafts.
Installing IEC 60332-1 cables in large bundles in vertical shafts may cause a building to become a fire-trap.
The EU CPR (which has been mandatory in the EU since 1 July 2017) should be also considered seriously in regions outside the EU for the sake of building and personnel safety.
Detailed information on these issues is available upon request.

4. Final testing
Field testers launched recently (namely Fluke DSX-5000) enable testing TCL (HF transmission balance) and DC resistance unbalance in installed links and channels together with all the other transmission properties.
TCL is a critical parameter which until now could not be tested in the field, making it essentially unknown. This lead many cable suppliers to ignore this test also at the cable component tests and as a result there

may be many unbalanced channels out there.
CAT 5e and CAT 6 unbalanced channels may support 100BASE-T but when upgrading to 1GBASE-T the excessive unbalance may cause the auto-negotiating NICs to default back to 100BASE-T.

The same situation applies to the DC resistance unbalance (DCRU), but this parameter will affect both the transmission properties and the PoE support.
It is important to note that the currently ratified cabling standards do not include a mandatory requirement to test TCL and DCRU in the field so the default Autotest settings in all field testers does not include these parameters. (These requirements will be added to both ISO/IEC 11801 and TIA-568-2-D).
In Fluke DSX-5000 the extended links and channel tests (including TCL and DCRU) are indicated as "+ALL". It is essential to select these optional limits when testing CAT6A channels.
It is also important to know that presently the ISO/IEC 11801 limits for TCL are only specified up to 250MHz (for all classes), so any unbalance detected above 250MHz in Class EA links and channels (CAT6A, specified up to 500MHz) will be reported as PASS. This means that CAT6A links and channels must be tested only according to TIA-568 CAT6A+ALL limits.
More details are available upon request.

Summary:

- Old and outdated cabling systems of unknown quality and category better be replaced when moving to a new location. Failing to do so may be a constant source of user frustration.
- Newly installed cabling should be Category 6A as this category supports all present protocols designed for 100m channels and provide real 10Gbps data rate.
- The horizontal cable should be PiMF (Pair in Metal Foil), providing many benefits at the same installation costs.
- The cabling better be shielded (especially when severe EMI are expected) and if it is, the Zt and the CA levels must be selected accordingly, clearly indicated in the cable specs, tested and verified.
  If unshielded cabling is selected the horizontal cables should be CAT6A, 23AWG, U/MTP (PiMF design without a drain wire).
- Cable should by halogen-free and should comply with the flame test relevant to the installation method. Cables installed outside the EU better be classified according to the EU CPR even if it is not mandatory yet. This will make it easier to define the safety level of the building and the cables will not have to be replaced when the CPR will be adopted outside the EU.
- Final testing should include TCL and DCRU and should be done according to TIA-568 limits as this will ensure smooth performance and better PoE support and detect any malfunction cabling.

Last updated: 30 August 2017