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Cabling for Wi-Fi

Over the last decade or more, proponents of Wi-Fi networking have promised the end of copper-based networks. While Wi-Fi is hugely popular and growing rapidly, copper networks still keep growing, although more slowly. Part of the reason is that, as a colleague once told me, “there is a lot of wire in wireless”. Let’s explore what kind of wire you’ll need to support the latest in wireless.

New Standards for Faster Wi-Fi

The most advanced Wi-Fi systems widely deployed today are based on the IEEE 802.11ac standard. The standard was published in 2013, but it’s actually not as old as that implies. Within the standard are two implementations, Wave 1, with maximum theoretical data rates of up to 1.3 Gbps, and Wave 2, which can reach 6.9 Gbps. Wave 2 devices started shipping in 2016. Some vendors are already offering 802.11ax devices which can hit speeds of 11 Gbps.

In the real world, contention, interference, and distance limitations will limit these technologies to throughput of something like 50% of their theoretical maximums. Even so, these technologies can easily exceed 1 Gbps – as long as the wire connected to the access point can support it.

So, if one gig won’t cut it, the obvious choice for wired support for these high performance Wi-Fi access points would be ten gig, which means for copper, 10GBASE-T. That will keep your Wi-Fi system humming for another decade or maybe more. 10GBASE-T requires Category 6A to operate (or Category 6 if the run is limited to 30 meters). And that’s a problem in existing facilities, because the majority of the installed cabling out there is Category 5e and 6. Upgrading an existing cabling plant to 6A compliance is a costly and time-consuming effort.

Old Cables Get New Tricks

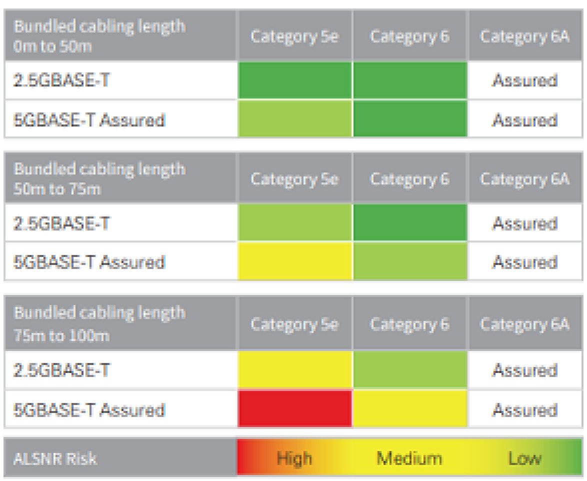
A group of more than forty-five networking and cabling companies came together to found the NBASE-T Alliance and address this problem. The result, the IEEE 802.3bz standard, was adopted in late 2016 and allows for operation of 2.5 and 5 Gbps networks over Category 6 and 5e cabling (with some limitations). This allows customers to upgrade their networks to multi-gigabit rates without replacing their cabling infrastructure. This demonstrates the benefits of planning ahead by installing and certifying category cabling, so that your installation is ready for capabilities that aren’t even thought of when the cabling plant is built.

Two communications technologies are defined by 802.3bz: 2.5GBASE-T and 5GBASE-T. The former can support all Wave 1 802.11ac implementations, as well as some Wave 2, while the latter can support Wave2 and even the still-to-be approved 802.11ax. The NBASE-T implementations are designed to coexist with current BASE standards, using the same physical interface and supporting autonegotiation. That means a user can deploy an NBASE-T switch to support NBASE-T devices, but it will also work with existing 1000BASE-T devices. This sort of incremental deployment reduces costs and disruptions. An extensive list of products that support NBASE-T can be found at https://www.nbaset.org/technology/nbaset-products/, with more coming every day.

The Fine Print

Now, let's get to the limitations noted above. While the clever designers of NBASE-T were able to design it to work on most Cat 5e and Cat 6 cables, there are some cases where the physical limitations of the cabling present a physics problem they could not solve (at least at a reasonable price point). The problem is related to what's known as "Alien Crosstalk" – signals that travel from one four-pair cable to an adjacent four-pair cable. The problem manifests itself when a pair of cables are close together for a long distance, providing more opportunity for the traveling signals to interfere with one another. This can be a problem even when installed cabling has been certified, because most cabling is not tested for Alien Crosstalk, due to the extra cost and effort involved. Since it's rarely a problem in 1000BASE-T, no one really cared until now.

NBASE-T includes a strategy for dealing with cable performance issues. If the cable is having trouble handling, say, 5 Gbps, the devices at each end will just "downshift" to 2.5 Gbps. That will likely solve the problem, but perhaps not in the way you want. So how do you ensure your cable will support the highest speeds?



Bundled cabling length 0m to 50m	Category 5e	Category 6	Category 6A
2.5GBASE-T			Assured
5GBASE-T Assured			Assured

Bundled cabling length 50m to 75m	Category 5e	Category 6	Category 6A
2.5GBASE-T			Assured
5GBASE-T Assured			Assured

Bundled cabling length 75m to 100m	Category 5e	Category 6	Category 6A
2.5GBASE-T			Assured
5GBASE-T Assured			Assured
ALSNR Risk	High	Medium	Low

As noted above, the more distance over which cables are kept near one another, the more that Alien Crosstalk will become an issue. Cables wrapped in large, tight, neat looking bundles are where you'll find this problem. To that end, the NBASE-T alliance has created the chart at right. It shows that there is very little risk of problems when using Category 6 cabling, although problems may occur in 5GBASE-T if Cat 6 cables are bundled together for more than 75 meters. For Category 5e installations, bundles over 50 meters may cause problems, and those over 75 m are at high risk of failure to support 5GBASE-T. There are three ways this risk can be minimized:

- Physically separate the equipment (patch) cords. Crosstalk problems are greatest where the transmit signals are strongest and the receive signals are weakest – at the equipment cords.
- Unbundle the horizontal cabling. Spreading it out in cable trays is the best approach – even if it's not as pretty.
- Move the NBASE-T connections to non-adjacent patch panel positions.

You can also consult with a cabling professional, who can test your cables for Alien Crosstalk. Since only the cables running NBASE-T need to be checked, the extra few minutes of testing won't add up to much. You can read more about this topic at https://www.nbaset.org/library/white-paper-2/

Powering Your Access Points

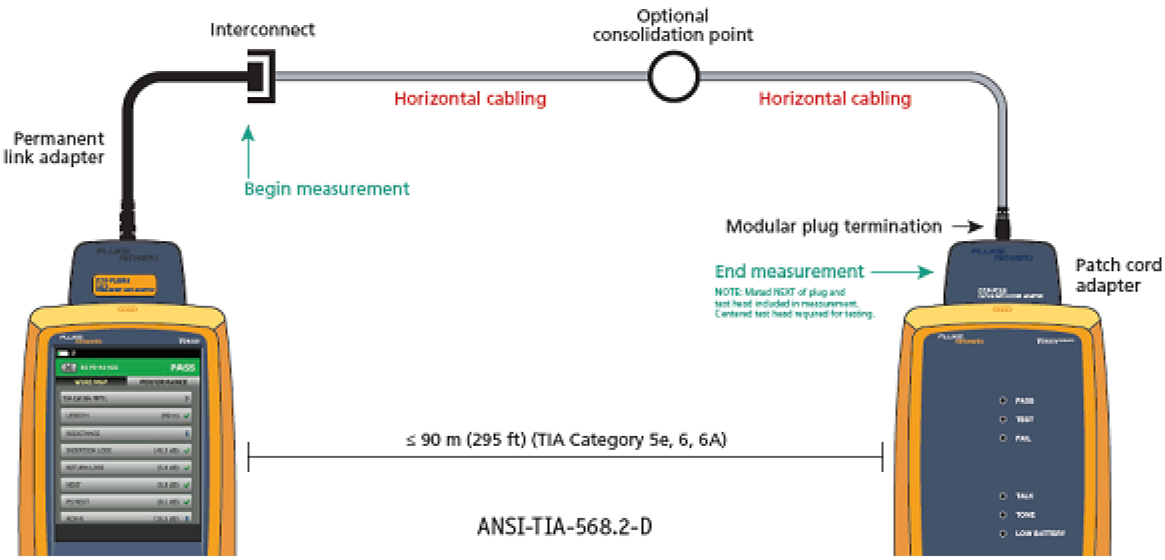
Power over Ethernet, based on IEEE standards 802.3 af, at, and soon-to-be published bt, combines power and data communications into the same four-pair cable. Most wireless access points for commercial installations are powered using PoE, eliminating the need to install an AC outlet and mount a separate power supply. The only thing installers need to watch for when it comes to power levels is to make sure that the power sourcing equipment (in most cases, the switch) is compatible with the access point and can supply adequate power. There are many different versions of PoE, some of which comply with these standards and some which don't. And the different standards offer different levels of maximum power for access points: 13 W for 802.3af, 25.5 W for 802.3at and 71W for 802.3bt. The good news is that most AP's don't need a lot of power, so most will work with low power sources.

A more subtle problem relates to the cabling. Supplying power over category cabling requires that the resistance of the cabling be low – too much resistance and the power will dissipate before it gets to the access point. The resistance also needs to be balanced both between pairs and within a pair – if it's too far out of balance, the power will saturate the receiver's transformers and interfere with data transmissions. This last problem is especially serious when you are running high speed networks such as NBASE-T.

The good news is that category cable is designed and tested to meet strict resistance requirements, so it's not likely to be a source of problems. However, faulty installation techniques may add resistance to the link. And field testing standards, such as TIA-1152-A, don't require resistance measurements for certification. To protect against these problems, it's recommended that field testing include these optional measurements.

Simplifying the Connection

Now that we're rid of the pesky power supply, let's see about streamlining the installation even more. A traditional wall plate and patch cord isn't really necessary in the case of an access point. Unlike an office PC, it won't be moving on a regular basis, so the wall plate and patch cord are unnecessary costs and labor.



BICSI and the TIA recognized this issue and defined the Modular Plug Terminated Link (MPTL) which starts in a patch panel and ends with a field terminated "RJ-45" plug, which can plug directly into the access point, eliminating the patch panel and equipment cord. A variety of manufacturers have released field terminated modular plugs to support this standard. If you're familiar with installing RJ-45 patch cord style plugs, you'll be happy to hear that these new designs are much easier to work with.

The new ANSI-TIA-568.2-D standard includes a definition for testing this link, and tester manufacturers are providing support for it. One thing to be aware of is that fact that, unlike a typical channel measurement, the MPTL includes the performance of that field-installed modular plug, which means that tester will need an optional adapter (typically one designed for patch cords) for testing that part of the link. The good news is that the cost of that adapter is probably less than what you'll save on a single MPTL installation.