IP TELEPHONY
A REVOLUTION FOR STRUCTURED CABLING SYSTEMS

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INTRODUCTION

In today's networking and cabling industry, the buzzword is *IP telephony*. Many see it as a major evolutionary step in telecommunications.

This technology uses the Internet Protocol (IP) to transport voice signals over a data network. Instead of using the conventional analog voice signal (sine wave signal), human speech is converted into a digital signal (1s and 0s) just like the data packets that travel through the data network.

Evolutionary? Yes. But IP telephony is more revolutionary than evolutionary because it merges two very different yet critical worlds:

a) Voice telephony (highly cost sensitive; needs rock-solid reliability); and
b) Data networks (accept occasional failures; subject to rapid change; need a lot of bandwidth).

A solution that merges these two worlds must simultaneously offer reliability, cost effectiveness, a high data rate and the ability to evolve — quickly. That’s quite a challenge for IP telephony solution providers. They must develop and market a solution that takes into account these seemingly incompatible needs.

The pros and cons of IP telephony versus “classic” telephony have been debated in many papers and will not be rehashed here. We want to focus on the impact IP telephony will have on the design and deployment of LAN structured cabling.

IP TELEPHONY ARCHITECTURE

IP telephony devices

Once the choice to use IP telephony is made, one must choose the interface between the voice packet and the user. Two options are available for the job:

a) An IP phone, which looks like a phone, but is more like a PC; or
b) A PC with IP telephony software and microphone/speaker or USB handset, a.k.a. a “soft phone.”

All the major IP telephony companies market IP phones. With list prices ranging from US$300 to more than US$1000 they are substantially more expensive than regular phone sets. However, the advanced models allow access to more advanced services, including Web surfing and Internet banking. They can also be used as “port extensions” to connect a computer directly to the phone.

If IP phones make the data world look like a voice world, the “soft phone” (a PC with IP telephony software) plunges the user into the data world, with voice communication done directly through the computer. Since most of today’s computers have integrated speakers and microphones, the only significant incremental cost is the license for the IP telephony software. It is also possible to purchase an IP telephone set that looks like a standard phone set, but links directly to the computer’s USB port.

IP telephony architecture

Now that we have described the devices (IP phones and soft phones) humans use to interface with IP networks, let’s look at the three choices of architecture:

a) Separate lines: one for the IP phone, one for the PC;
b) Dual port IP phone (single line): the input port connects the IP phone to the IP network, the output port connects the computer to the IP phone;
c) Soft phone (single line): installed software uses the multimedia capabilities of the PC's sound card and microphone/headset.

Figure 1: IP telephony infrastructure
**IMPACT ON STRUCTURED CABLELING TOPOLOGY**

**Separate lines for IP phone and PC**
This architecture option represents the classic approach. It allows the two devices to be linked to two different switch ports, an option that has major advantages:

- Troubleshooting is easier since the two devices are physically independent;
- Quality of service can be improved by assigning prioritization by switch port;
- Capability is optimized because each device independently negotiates its required data rate with the network; and
- Remote powering of the IP phone can be assigned by using a powered IP switch or midspan power unit.

**One line for everything**
Deciding to install a dual port IP phone or soft phone, using a “one-line-for-everything” option, may at first seem attractive since either requires just one data cable per workstation. The one-line-for-everything advantage has been used as a marketing element by some of IP telephony vendors to boost implementation of dual port IP phones. The argument is that one can offset the higher incremental equipment cost with the reduced cabling cost of a single line.

However attractive the one-line-for-everything option sounds at first, one should carefully plan the structured cabling topology: a single cable carrying all information reduces flexibility and redundancy. Any problem and/or the need for additional services (e.g., broadband video or 1000BASE-T applications) will require pulling new cables, which means disrupting services and additional costs.

**Recommended cabling topology**
As per cabling standard ANSI/TIA/EIA-568-B.1 (May 2001), each workstation requires two horizontal cables, one with a minimum of Category 3 or higher (Category 5e recommended) for traditional voice applications and one with a minimum performance of Category 5e for data applications.

Since IP telephony is now being added to the data network, both horizontal cables at the workstation should be considered as cables to support data applications. Thus, a minimum of Category 5e performance is required to support both the data line and the IP telephony line.

However, as of June 2002 a new cabling system standard has entered the cabling world under the ANSI/TIA/EIA-568-B.2-1 standard: Transmission Performance Specifications for 4-pair 100-Ohm Category 6 Cabling. This cabling system offers greater performance and higher bandwidth than category 5e. For example, Category 6 offers 200 MHz, versus just 100 MHz for Category 5e — twice the available bandwidth!

One of the most important advantages of a Category 6 cabling system is the improved signal-to-noise ratio (SNR): ideally, at the receiver end, one expects the signal to be stronger than the noise so the digital signal (all the 1s and 0s) can be detected. Using today’s levels of bandwidth, Category 6 cabling has a much better SNR — about 16 times better that Category 5e — which will become increasingly important as new applications come online. Another benefit for today’s applications is that Category 6 has been shown to provide higher data throughput (fewer bit errors) than Category 5e for applications such as Ethernet 100 Mb/s and 1000 Mb/s.

When it comes to cabling design, considering future technologies is mandatory. It is expected that Category 6 will soon supercede Category 5e due to the introduction of new technologies and the ever-increasing need for bandwidth.
**POWER OVER UTP — INFLUENCE ON CABLE DESIGN**

A critical need for any phone system is the ability to function at any time, especially during a power outage. In traditional phone systems, uninterrupted power is provided to the phone set by either the central office or the PBX system. This architecture — used with low power consumption devices (less than 10 watts per phone set) connected to a centralized power source (a UPS) — allows traditional phone systems to remain operational during power outages.

The introduction of IP telephony greatly changed the parameters of the sensitive power supply equation. Power hungry devices, such as switches and IP phone sets that require uninterrupted power, are now widely dispersed. Switches located in telecommunications rooms are easily linked to UPS systems; supplying power to IP phone sets is a much more challenging task.

IEEE has mandated group 802.3af (Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI)) to define the power sources to be used with Ethernet standard based products. This standard allows data terminal equipment, such an IP phones, to draw power from the same generic cabling as that used for data transmission.

Adding DC power to the data signal is a very convenient and efficient way to use one medium (the structured cabling system) to fulfill two needs (power and data). Integrating these needs on the same cabling system will most likely lead to more stringent requirements for the performance of the structured cabling network. Defining these requirements is a critical objective of the IEEE 802.3af group.

Power source equipment (PSE) may deliver power over the two unused pairs in 10BASE-T or 100BASE-TX (pair 4-5 and pair 7-8). Alternatively, the standard allows for delivering power over the signal pairs (pair 1-2 and pair 3-6) directly through switch ports. Whichever option is used, the PSE will deliver power only over the same pairs as those used for detection. The maximum PSE power output level is 15.4 watts at 44 to 56 volts.

Three practical power options are available:

1) VoIP (Voice over IP) switches with integrated power supplies: Installed in the telecommunications room, these switches can be used to provide power to IP phones via the cabling system.

2) Midspan units: These devices are installed between the active switch and the patch panels to add a DC signal to the data signal, allowing the existing network to power-up the IP phones. The advantage of midspan units is that they offer power to IP phone units using legacy switches.

3) Standalone power sources, consisting of a simple power source plugged into a regular electrical outlet: This is the least expensive option; however, in the case of power outage the IP phone will not be functional.
CONCLUSION

IP telephony’s impact on the ways we design and implement our structured cabling systems will be substantial, and it will come quickly. The following changes should be expected:

1) **The consolidation of voice and data cabling needs.** Today, TIA recommends two horizontal cabling drops per work area location: the first for voice applications (Category 3 required; Category 5e recommended), the second for data applications (Category 5e or higher required). The introduction of IP telephony requires that both horizontal cables at the workstation be considered as cables to support data applications. Thus, a Category 5e performance requirement is the minimum expectation for both cabling drops. Category 6 cable is recommended for improved performance and future readiness.

2) **Signal to noise ratio, i.e., the need for improvement.** Since the majority of today’s networks are Category 5e or lower, IP telephony manufacturers have designed solutions that can run on Category 5e cabling. However, once the convergence of voice, data and video is complete, the need for much-improved SNR and greater bandwidth will justify Category 6 structured cabling systems.

3) **The need for power over UTP.** Today’s phones are fully functional during power outages, but emergency power units are not available for most of the data network equipment. Once the two applications are running on the same network, powering some — if not all — active network equipment will be required. Therefore, IP telephony–ready structured cabling systems will need a plan to power active devices during a power outage. Power over UTP will be a critical technology used to achieve this goal.

4) **The mission-critical data network.** The last major effect the introduction of IP telephony will have on the data network will be to make it mission critical. Therefore, its performance must be carefully controlled. Structured cabling systems that guarantee system performance will become ever more important to end-users.

IP telephony is an emerging technology; its needs are rapidly evolving before us. Today’s structured cabling must take into account both present and future needs if it is to become an asset, not a limitation, to the deployment of IP telephony.
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