TrueNet®

Unshielded Twisted Pair (UTP)

Today's Technology for Tomorrow's Network

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Introduction

Network infrastructure has seen remarkable changes in the past 20 years. Major application transformations and massive upticks in bandwidth requirements have been met head-on with the need for smaller, less restrictive and higher performing cables. The fibre revolution has found its niche, but desktop applications and many data centre needs have continued down the copper path. While much has changed, the early and resilient adoption of UTP cabling has been an industry mainstay, and the reasons for such are as sensible as they are compelling.

In the 1980's and early 1990's, coax and shielded cabling solutions, such as ThickNet, ThinNet and IBM type 1, were very good cables for transmitting data within Local Area Networks (LANs). However, with the advent and explosion of computer networking technologies, more and more cables began to occupy spaces "behind the scenes". Telecommunications closets were expanded to allow for connectivity between networking devices, servers and workstation terminals, while data rates were on the order of 1 to 16Mbps and ran on proprietary cabling solutions. Several protocols existed for these emerging networks, such as Token Ring, ISDN and ATM and there were a number of limiting factors, leading to the standardization and proliferation of UTP cabling.

Why UTP?

Space, time and cost constraints led to the development of a more cost effective medium for transmitting data in UTP cables. By eliminating the need for shielded solutions the end user now needed less space for installation, as well as reducing the cost of material and time of installation. Grounding issues were also mitigated. Most importantly, UTP solutions are used as a baseline interoperability media for the most prevalent protocols.

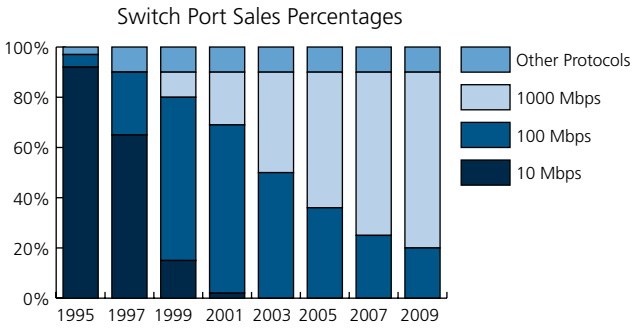
To understand the evolution of UTP, we must first understand the different Categories and the protocols they support.

In most cases a cabling solution is developed to support a faster transmission protocol. Today's fastest protocol over UTP cable is 10GBase-T (10,000Base-T) transmission. This is supported by Cat 6 for a limited distance of 37 to 55 meters, and by Augmented Cat 6 to 100 meters.

UTP and the End of the Protocol War

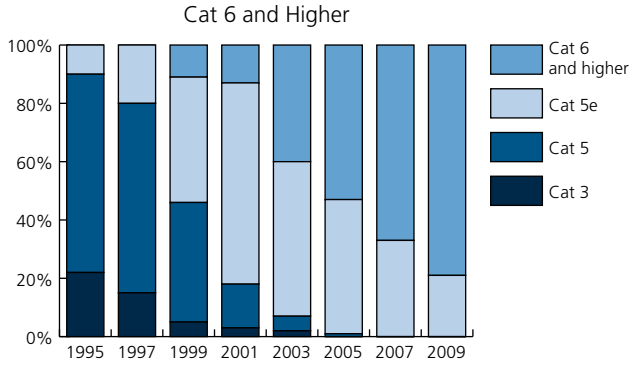
To better understand why UTP cable has evolved from Cat 1 to Augmented Cat 6, we must first understand the primary driver (i.e., data rate progression). In the early '90s a war was raging as to which protocol would become the industry standard for LAN applications. ATM, Token Ring and Ethernet were all in contention. By the mid '90s Ethernet was the clear winner. It provided a highly accessible technology with an outstanding cost basis that ultimately provided the Quality of Service (QoS) needed at the right price. In addition, the progression to 100Mbps transport assured that data rates would be sufficient to support the needed bandwidth for existing and up-and-coming applications.

The following chart provides a good example of the progression of Ethernet as the default standard for today's LAN applications. As evidenced from the chart 10Mbps was the largest market share holder in 1995. By 1999, 100Mbps led the market as the protocol of choice. At this time 1000Mbps had almost gained as much market share as 10Mbps protocol. 2003 saw the



demand for 10Mbps completely dissipate. Today, the market is split between 100Mbps and 1000Mbps, with 100Mbps quickly on the decline.

Note: The "Other Protocols" in the first chart consist of 10 percent of the market consistently over the last six years. These protocols are legacy systems, such as Token Ring and ATM, and/or security systems.



The second chart above shows how historically the cabling Category installed has always led well before the speed of the protocol supported is used. For example, in 1995 the primary UTP cabling being installed was Cat 5, which could support 100Mbps, but the switch ports sold that same year were primarily 10Mbps. In 1999 the primary switch port speed sold was 100Mbps, but the primary cabling solutions, Cat 5e and Cat 6, supported 1000Mbps.

UTP Cable Categories by Protocol Supported to a Minimum 100M Length

Category	POTS	ISDN	Token Ring 4Mbps	10BaseT	Token Ring 16Mbps	100BaseT4	100BaseTX	ATM 155	ATM 622	1000BaseT	10GBaseT
1	X	X									
2	X	X	X								
3	X	X	X	X	X*	X					
4	X	X	X	X	X	X					
5	X	X	X	X	X	X	X	X			
5e	X	X	X	X	X	X	X	X	X	X	
6	X	X	X	X	X	X	X	X	X	X	
6A	X	X	X	X	X	X	X	X	X	X	X

*Active "powered" equipment only.

What this marketing data indicates is that the cabling installed always leads the primary data rate. This was the case until recently. Today our fastest data rate has exceeded 1000Mbps and is now 10 Gb/s over UTP. Most cable installed today is only capable of supporting 1000Mbps. Customers will want a cabling solution that will support the next generation leap in data transmission, 10Gbps especially those next generation data centres looking to future-proof their networks.

Why Do I Need Cat 6?

Originally Cat 6 was developed to support a more cost effective way of running 1000Mbps, by using two pairs within the cable instead of all four. This is the same way we currently run 100BaseTX and the reason that 100BaseT4 never caught on. This would cut the cost of transceivers within the active hardware. At the time a leader in the telecommunications industry was developing the hardware/protocol in question and needed a cable that would extend the frequency bandwidth used from the current 1-100MHz out to 250MHz. This allowed for higher bandwidth potential.

At the same time the development of four pair transceivers using PAM5 encoding supported 1000BaseT over Cat 5e cables. These transceivers weren't as costly as initially expected. Today we see workstation PCs shipped with 10/100/1000BaseT NIC's integrated directly on motherboards. Switch prices have come down substantially and copper is the cheapest way to run Gig within the LAN and data centre.

1000BaseT transmission was being embraced as the latest, greatest protocol technology. Both Cat 5e and Cat 6 cables were being sold to support it. That's right, Cat 5e and Cat 6 both support up to 1000BaseT (Gigabit) Ethernet transmission protocol.

An argument has been made for installing Cat 6 over 5e. Cat 6 does give a much better signal to noise ratio than 5e, at all frequencies. This allows for anomalies within the active hardware that might otherwise cause a greater number of errors on a lesser performing 5e cabling system. Cat 6 does support broadband video applications to a greater extent and provides limited support for 10GBASE-T to a distance of 37 to 55 meters. Finally, the TIA 942 standard references Cat 6 as the minimum standard for data centres.

What is the Next Leap?

First we must understand who drives the need for a better cable? The active hardware manufacturers (IEEE) are key to understanding where the cable needed to go. The TIA must then respond by supporting the IEEE with a cabling standard.

Each leap in Ethernet has meant a tenfold increase in data transmission throughput, i.e. 10 – 100 – 1000Mbps. It quickly became evident, through interaction with the active hardware manufacturers, that Cat 5e and Cat 6 was not able to support the needed electrical requirements for 100 meters. It's electrical characteristics could not support the next wave of transmission.

The IEEE802.3an Task Force was created to investigate ways of running the new transmission speeds for 10GBase-T over 100 meters. The IEEE802.3an standard was created and has since been ratified to support 10GBase-T over twisted pair cabling.

What Cable will Support the Future?

For years, cable designers focused on the pair-to-pair relationship within the cable as paramount to producing a good cable. However, as power increases, the noise generated begins to have an impact on the neighboring cables. Alien Crosstalk is this actual noise heard on a pair within a cable, generated by another cable directly adjacent to it. Naturally, this concerns active equipment vendors who are concerned that random events or events that are unpredictable will negatively impact network performance. While the noise between pairs within a cable can be predicted and eliminated within the active hardware, unpredictable Alien Crosstalk cannot.

This raised the bar yet again, but this time for a reason! The actives now need a better cable to proceed. Limits have been established and testing commenced to understand what is needed from the UTP realm to achieve the goal of 10Gig transmission over a 100m.

Through innovative thinking, ADC was first to achieve the necessary performance to support 10Gig all the way out to 100m, with a new Augmented Cat 6 solution. The results for the new cabling innovation were presented at the November 2003 meeting of the IEEE P802.3 10GBASE-T working group. Several key active hardware manufacturershave also confirmed the findings. Alien Crosstalk performance can now be achieved, as well as the needed insertion loss levels, for transmission over the full-length requirement.

What Does this Mean to the Industry?

UTP cable and connectivity can achieve the needed electrical parameters, and active hardware manufacturers have developed their components. Copper will once again support both LANs and data centres to the next level of transmission performance and match the current highest speed offered by Fibre, in 10Gig. As a result, LANs and data centres can be upgraded today for the protocol of tomorrow, all at a better price and in a well recognized and standard footprint. Augmented Cat 6 will be the primary medium for transporting 10GBase-T.

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