The latest technology of twisted pair cables engineering essay

Engineering

Abstract

In this paper, a study of twisted pair cables been developed to describe the introduction of twisted pair cables, the principle of operation, chaactertistic and the latest technology of twisted pair cables

1. Introduction

There are 2 basic transmitting media. They are bounded (guided) and unbounded (unguided) transmitting media. The bounded transmitting media means that the signal is contained within a conductor or simply ‘’inside the cable". Unbounded transmitting media means that the signal travels outside the bounds of any media like in air or vacuum. Some examples of the bounded (guided) media include twisted cable, coaxial cable and fiber optic cable. Example of unbounded (unguided) media includes Bluetooth, WI-Fi (802. 11g) and satellite transmission. Twisted cable consists of pairs of copper wire that are used to transmit electronic signal. Most common example of twisted pair wiring is telephone cable. Twisted pair is good because it is inexpensive but it has limitations. It is limited but distance and data it can transmit. However, the fact that the wires are twisted around each other is significant because this tend to cause external interference to act on one of the wires on a pair on such a way to cancel the inference on the other wire. This is because the wires twisted around each other occupy almost exactly the same space and the current travels in the 2 wires in opposite directions. Twisted pair cabling is perhaps one of the oldest types of cable ever invented. Alexander Graham Bell patented twisted pair cabling along with his first telephone circuit on October 21, 1879. The interference

canceling aspects of twisted pair cabling is generally adequate. That is whyUnshielded Twisted Pair (UTP) cabling is the most common. Sometimes, however, electromagnetic interference (EMI) can be so pervasive in certain environments, that an additional level of shielding is required. This is why Shielded Twisted Pair (STP) cabling is used as an alternative. STP cabling comes in two flavors. Foiled Twisted Pair (FTP) adds a single mylar/foil shield over the entire cable body. FTP. PNGCapture. PNGstp. PNGThis protects mainly against EMI. Extremely sensitive installations often use Screened Shielded Twisted Pair (S/STP) cabling. This includes the mylar/foil shield in addition to separate shields over each individual pair. This provides added protection against cross-talk. This type of cable is extremely bulky and hard to terminate, so its use is somewhat limitedThey are different levels of twisted pair cable. They range from level 1 which is lowest grade and acceptable only use with telephones. The highest quality grade support high speed LAN.[1]i

2. Principle of operation

Twisted pair cabling is sometimes referred to as a differential system. With the differentialsystem each signal is transmitted on two lines at the same time. On one, the signal is transmitted as a POSITIVE (+) signal, on the other as a NEGATIVE(-) signal. At the receiving end of the cable the receiver device gets two signals. Both of them however, have been changed by the EMI noise that penetrated the cable. The changes came in the form of unwanted voltage added to the wanted signal. At this point it is important to note that the unwanted voltage got added to both lines at the same time and by the same amount because the cable is uniformly twisted. The essence of the

differential system is that the receiver is designed to take the difference between the two signals on the two lines. In doing that, the noise part of the signal, equal on both lines, gets eliminated, and what remains is clear signal. This same concept helps prevent the signal of one line from interfering with the signal on an adjacent line. This adjacent interference is known as crosstalkblok diagram. PNGTo simplify the principle of the operation, signal transmission in a twisted pair cable is based on balance condition. In balanced transmission the both conductors of the signal circuit are at the same electrical position related to environment – usually to the earth potential. Theoretically balanced transmission represents conditions, where no electromagnetic interferences exist. This means that the signal transmitted on a channel or link is not subject to any interference and does not cause any interference to its environment. On the contrary, in unbalanced transmission the conductors are in different electrical positions related to the earth potential and the system is subject to interferences. In balanced conditions the following are in force: no inter. PNGi) The voltages of the two conductors have the same absolute values, but opposite polarities. Therefore the electric fields caused by the conductors cancel each otherii) The currents flowing on the two conductors have the same absolute values, but opposite directions. Therefore the magnetic fields caused by the conductors cancel each other . balance. PNGiii)Interference voltages from the environment do not affect the transmission, because the voltage between the conductors of the pair remains unchanged due to balancemagnetic flow. PNGiv)When magnetic field flows through the loop

made by the pair, the currents induced by the magnetic field cancel each other due to the pair twist

If also the equipment connected to the balanced channel are balanced (symmetrical), the whole system is free of interferences. Perfect balance of channels and links as well as of equipment, however, cannot be achieved. The unbalance of channels and links is caused by the unbalance of cables, connecting hardware and terminations.

Characteristics of twisted paired cable

Twisted-pair cable is a type of cabling that is used for telephone communications and most modern Ethernet networks. A pair of wires forms a circuit that can transmit data. The pairs are twisted to provide protection against crosstalk, the noise generated by adjacent pairs. When electrical current flows through a wire, it creates a small, circular magnetic field around the wire. When two wires in an electrical circuit are placed close together, their magnetic fields are the exact opposite of each other. Thus, the two magnetic fields cancel each other out. They also cancel out any outside magnetic fields. Twisting the wires can enhance this cancellation effect. Using cancellation together with twisting the wires, cable designers can effectively provide self-shielding for wire pairs within the network media. Two basic types of twisted-pair cable exist: unshielded twisted pair (UTP) and shielded twisted pair (STP). The following sections discuss UTP and STP cable in more detail.

Unshielded Twisted Paired Cable (UTP)

The Unshielded Twisted-Pair or UTP is the most common twisted-pair cable used in communications. Cables that consist of pairs of unshielded wire twisted together. It is the most common kind of copper telephone wiring. It has four pairs of colour-coded twisted-pair cables that are covered with a plastic outer jacket. Furthermore, UTP cable is a medium that is composed of pairs of wires. UTP cable is used in a variety of networks. Each of the eight individual copper wires in UTP cable is covered by an insulating material. In addition, the wires in each pair are twisted around each other. UTP cable relies solely on the cancellation effect produced by the twisted wire pairs to limit signal degradation caused by electromagnetic interference (EMI) and radio frequency interference (RFI). To further reduce crosstalk between the pairs in UTP cable, the number of twists in the wire pairs varies. UTP cable must follow precise specifications governing how many twists or braids are permitted per meter (3. 28 feet) of cable. The Electronic Industries Association (EIA) has developed five standards or categories for UTP : Category -1This category is used for voice transmission and it is basically used in telephone systems. It is efficient only for low speed data transmissionCategory – 2This category is used for voice transmission, but it is equally preferred for data transmission of upto 4 mbps. Category – 3This category is used for data transmission because it provides high bandwidth to achieve high data transfer rates. It is standard cable for most telephone systems. Category – 4Provides much higher data transfer rate of 16 mbps. Category – 5Provides a maximum data transfer rate of 100 mbps. For unshielded twisted pair generally RJ45 connectors are used. The following

summarizes the features of UTP cable: Average cost per node—Least expensiveMedia and connector size—SmallMaximum cable length—100 m (short)http://fcit. usf. edu/network/chap4/pics/rj45. gifRJ-45 connectorhttp://fcit. usf. edu/network/chap4/pics/twisted. gifUnshielded twisted pair

Shield Twisted Paired Cable (STP)

Shielded twisted pair is a special kind of copper telephone wiring used in some business installations. An outer covering or shield is added to the ordinary twisted pair telephone wires; the shield functions as a ground. It is used to eliminate inductive and capacitive coupling. Twisting cancels out inductive coupling, while the shield eliminates capacitive coupling. Most applications for this cable are between equipment, racks and buildings. Shielding adds usually some attenuation to the cable (compared to unshielded), but usually not because in the case of balanced transmission, the complementing signals will effectively cancel out any shield currents, so shield current losses are negligible. Shielded twisted-pair (STP) cable combines the techniques of shielding, cancellation, and wire twisting. Each pair of wires is wrapped in a metallic foil. The four pairs of wires then are wrapped in an overall metallic braid or foil, usually 150-ohm cable. As specified for use in Ethernet network installations, STP reduces electrical noise both within the cable (pair-to-pair coupling, or crosstalk) and from outside the cable (EMI and RFI). STP usually is installed with STP data connector, which is created especially for the STP cable. However, STP cabling also can use the same RJ connectors that UTP uses. Although STP prevents interference better than UTP, it is more expensive and difficult to

install. In addition, the metallic shielding must be grounded at both ends. If it is improperly grounded, the shield acts like an antenna and picks up unwanted signals. Because of its cost and difficulty with termination, STP is rarely used in Ethernet networks. STP is primarily used in Europe. The following summarizes the features of STP cable: Speed and throughput—10 to 100 MbpsAverage cost per node—Moderately expensiveMedia and connector size—Medium to largeMaximum cable length—100 m (short)http://www. hyperline. com/img/sharedimg/cable/cable_c8. jpgShielded twisted pair cable

CASE STUDY

Types of twisted wire

Twisted pair cable consists of a pair of insulated wires twisted together. It is a cable type used in telecommunication for very long time. Cable twisting helps to reduce noise pickup from outside sources and crosstalk on multi-pair cables. The most commonly used form of twisted pair is unshielded twisted pair (UTP). It is just two insulated wires twisted together. Any data communication cables and normal telephone cables are this type. Shielded twisted pair (STP) differs from UTP in that it has a foil jacket that helps prevent crosstalk and noise from outside source. In data communications there is a cable type called FTP (foil shielded pairs) which consists of four twisted pair inside one common shield made of aluminium foil. The most commonly used twisted pair cable impedance is 100 ohms. Typical wire conductor sizes for cables used in telecommunications 26, 24, 22 or 19 AWG. 100 ohms: This impedance is the standardized impedance to be used in the twisted pair wiring used in structured wiring systems standardized EIA/TIA

568 standard. Both unshielded and shielded CAT5 and better cables used on this kind of applications have 100 ohms impedance (usually at +-15% or better accuracy). Nowadays the most common LAN standard, Ethernet, is designed for 100 ohms twisted pair cable. Many telecommunication twisted pair cables have impedance of around 100 ohms, and many modern digital communication systems are matched to this impedance. Nowadays practically all modern in-building twisted pair wiring for telecom applications has 100 ohms impedance. 110 ohms: 110 ohms shielded twisted pair cable is standardized as the cable type to be used for digital AES/EBU sound interface. 120 ohms: 120 ohms shielded cable is generally used for RS485 communications in industrial networking. There are many industrial control and data cables which have impedance of around 120 ohms. Also some telecom cables both shielded and unshielded have impedance of 120 ohms, and there are digital telecom systems matched to this impedance also (for example some E1 systems). 150 ohms: This was the impedance used in shielded twisted pair wiring IBM cabling system and Token Ring network. There are also many shielded control and data cables that have impedance of around 150 ohms in use nowadays. Some modern microphone cabling (shielded twisted pair) has impedance of around 150 ohms at high frequencies and you can sometimes hear 150 ohms impedance mentioned in analogue audio applications. Usually typical dynamic professional microphones have impedance of 150-200 ohms. 300 ohms: The twin lead wire used in some antenna applications has impedance of 300 ohms. This is a very low loss antenna cable type. 300 ohms is generally not used for anything else than some antenna applications. 600 ohms: 600 ohms is

standardized impedance used in telephone world. The first long telephone air lines (two wires on the poles separated from each other at some distance) used to have impedance of around 600 ohms. In practice the modern telephone cable does not have impedance of 600 ohms, but for historical reasons this impedance is spoken often and many telephone equipment are still matched to this impedance. Besides, shielded twisted pair (STP) cable is used to eliminate inductive and capacitive coupling. Twisting cancels out inductive coupling, while the shield eliminates capacitive coupling.

Structured wiring systems

Campus cabling: Where a site contains more than one building, Campus cable is used to connect and integrate the network within the overall area. EIA/TIA refers to this as Inter-Building Backbone Cable. Backbone Campus Cabling is usually optical fibre based upon 62. 5/125um Multimode fibre or single mode fibre. Campus cabling connects the main wiring closets on different buildings. Riser/Backbone cables: Riser or Backbone has been traditionally installed using screened or unscreened pair cables. 6 x 4 pair or 25 pair cables are available as standard. Those are used for data and telephones. New data applications are increasingly satisfied by Fibre Optic Cables (typically multimode cables). Riser/Backbone cables are run from the house central wiring closet to wiring closets on different building floors. Horizontal cables: Horizontal twisted pair cables provide the communications link between and into specific work areas. The cables are typically wired from wiring closet to the outlet on the working locations. 4 Pair 24 AWG UTP and FTP cables for high speed networks operating at up to 100 Mbps (even faster speeds up to 1Gbit/s is possible with best cables and newest network

techniques). In line with EIA/TIA 568A these cables can be used in lengths of up to 90 metres. 24 AWG is the most commonly used thickness for fixed wiring, but in some cases thicker 23 AWG could be used. Work area cabling: High performance flexible work area/patch cables are used for localised linking from a wall connection to networked equipment. Patch cables are generally available Unscreened or Foil Screened and come in two sizes 0. 14mm (26 AWG) and 0. 22mm(24 AWG). Patch cables: Short patch cables are used to do the interconnection in the wiring closet from the connectors on the telecom patch panel to active equipment. Patch cables are also used in datacom/telecom racks to interconnect different communication equipment. Patch cables are generally available Unscreened or Foil Screened and come in two sizes 0. 14mm (26 AWG) and 0. 22mm (24 AWG).

Benefits of structured UTP cabling

Unshielded Twisted-Pair (UTP) Structured Premise Cabling permits many communication protocols to reside in the same wire bundle. Examples include voice, data, and CCTV video and control. UTP system is Color-coded cablingA good UTP system gives better interference rejection than coaxUTP is physically smaller than coax and many other cable typesUTP is less expensive than dedicated coax or fibreUTP is extremely easy to terminateUTP is a very easy media to install and reconfigure

Categories of twisted pair cabling systems

Cabling systems are categorized in terms of the data rates that they can sustain effectively. The specifications describe the cable material as well as the types of connectors and junction blocks to be used in order to conform to

a category. For ISO/IEC standards, the category refers to the cable and class refers to the connector. ISO are international standards and can be followed anywhere in the world. A standard is different than a code in that standards are voluntary and provide a guideline so that all manufacturers have a minimum set of parameters to work with. A code, on the other hand, is law and is enforced through an AHJ (Authority having Jurisdiction). While longer connections for Gigabit Ethernet use optical fibre, the goal is to leverage the CAT 5 and CAT 5E twisted-pair wiring most organizations already have in place for connections out to the desktop. (Four pairs of twisted pair are used.) In old split pair configurations, PoE MidSpan cannot be used. PoE is supported on 5E or better; however the higher performing cable provides better heat performance with shielded systems better than UTP. The two most widely-installed categories are CAT 3 (voice) and CAT 5E, traditionally, however with new installations, category 5E for voice and one high speed to support 10GBASE-T for long term usage are the most common. According to a BSRIA study, 78% of all new installations are shielded. While the two cables may look identical, CAT 3 is tested to a lower set of specifications and can cause transmission errors if pushed to faster speeds. CAT 3 cabling is near-end crosstalk-certified for only a 16 MHz signal, while CAT 5 cable must pass a 100 MHz test. CAT 5E replaced CAT 5 in both standards groups. The CAT 6 specification improves on CAT 5E in terms of near-end crosstalk, balance, and bandwidth. According to IEEE, 70% of new installs in 2004 were CAT 6. Category 7/Class F (ISO/IEC), published in 2002, is a fully shielded system. The shielding provides superior noise immunity and performance. Until February 2008, it was the only published standard to support 10GBASE-T to a

full 100m. CAT 7A/Class FA and Category 6A/Class EA specifications were published in February 2008. The table of CAT[ii]classes can be referred in appendix.

Installing Cable - Some Guidelines

When running cable, it is best to follow a few simple rules: Always use more cable than you need. Leave plenty of slack. Test every part of a network as you install it. Even if it is brand new, it may have problems that will be difficult to isolate later. Stay at least 3 feet away from fluorescent light boxes and other sources of electrical interference. If it is necessary to run cable across the floor, cover the cable with cable protectors. Label both ends of each cable. Use cable ties (not tape) to keep cables in the same location together.

Applications:

Category 1: Cabling that meets the minimum requirements for analogue voice or Plain Old Telephone Service (POTS). Category 2: Used for voice and data, up to 4Mbps. Also known with name Grade 2Category 3: Used for data, up to 10 MbpsRequired to have at least 3 twists per footStandard cable for most telephone systemsAlso used in 10-Mbps Ethernet (10Base-T Ethernet)Category 4: Used for data, up to 16 MbpsMust also have at least 3 twists per foot as well as other featuresUsed in Token RingCategory 5: Used for data, up to 100 MbpsMust have 3 twists per inchCategory 5e: Used in Gigabit EthernetRated frequency is 100 MHzCategory 6: Used in Gigabit Ethernet and future technologies. Rated frequency is 200 MHz with some requirements specified for 250 MHz. Telephone network: Twisted-pair cables

are used in telephones lines to provide voice anddata channels. Within buildings: To private branch exchange (PBX)The DSL lines that are used by the telephone companies to provide high data rate connections also use the high-bandwidth capability of unshielded twisted-pair cables. For local area networks (LAN): 10Mbps or 100MbpsLocal area networks, such as 10Base-T and 100Base-T, also used UTP cables.