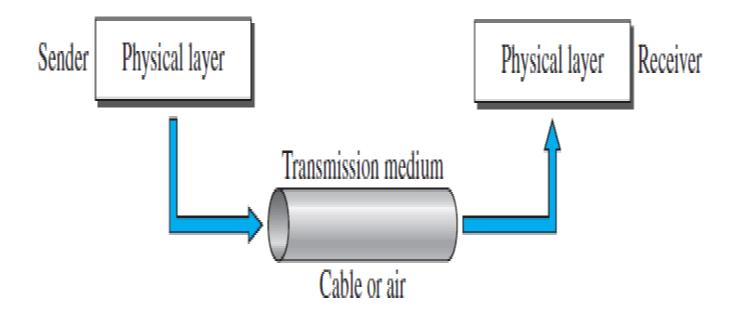
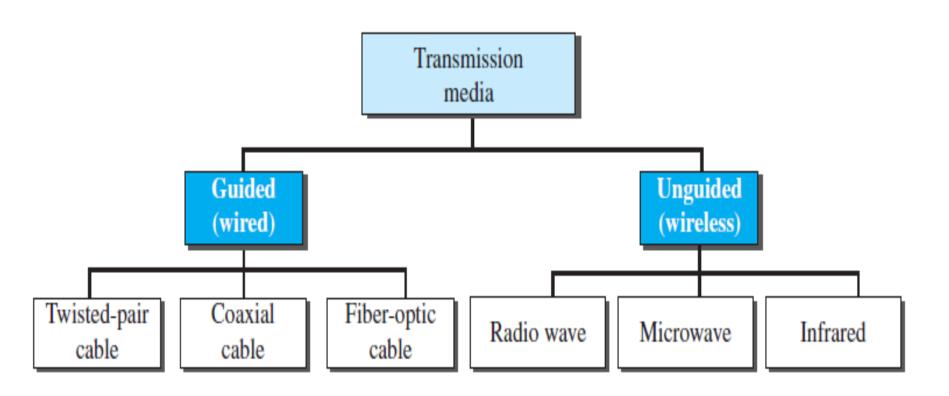
Transmission Media

• A transmission **medium** can be broadly defined as anything that can carry information from a source to a destination.

• For example, the transmission medium for two people having a dinner conversation is the air.



Classes of transmission media

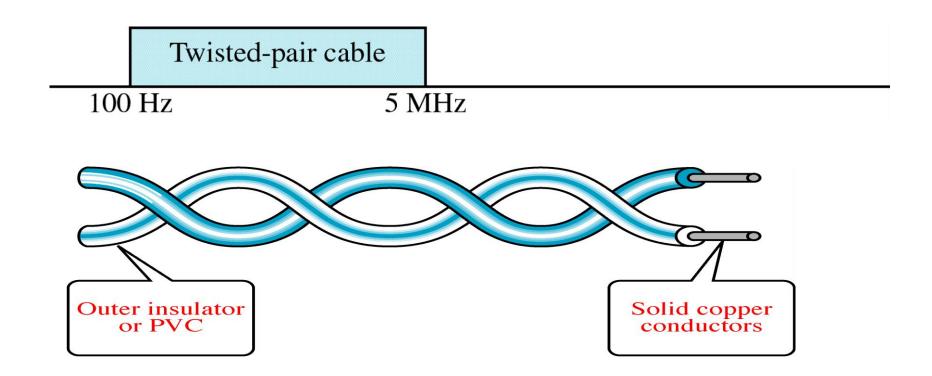


Guided media, which are those that provide a conduit from one device to another.

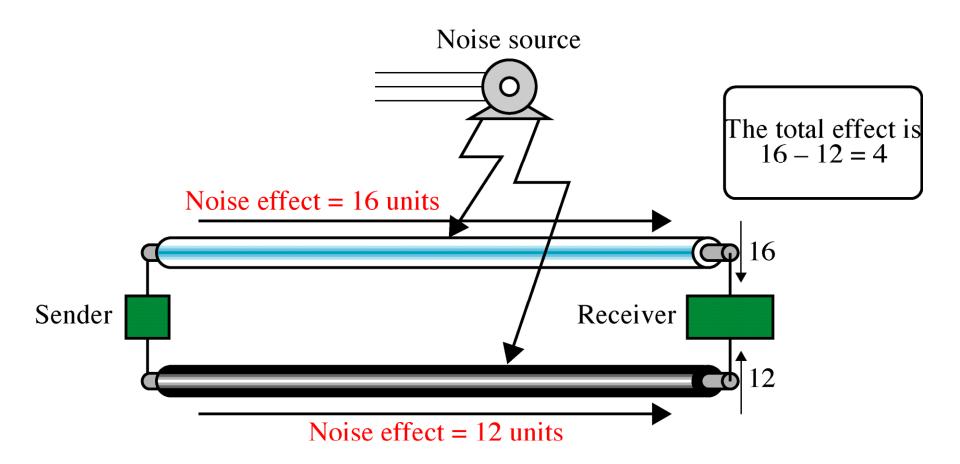
Unguided media transport electromagnetic waves without using a physical conductor.

Twisted-Pair Cable

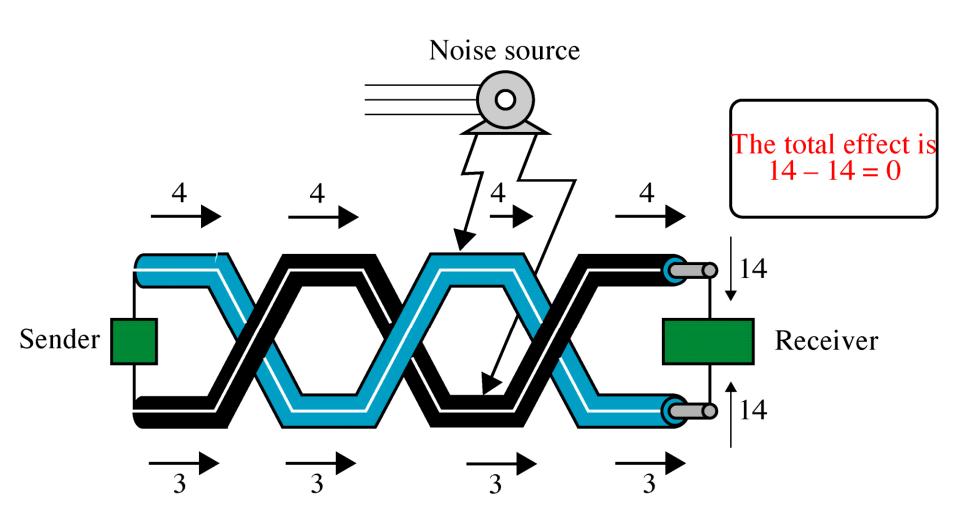
Twisted Pair and Coax use metallic(Copper) conductors that accept and transport the signals in the form of Electrical Current.



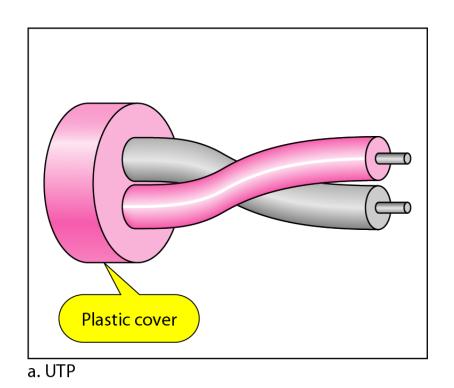
Effect of Noise on Parallel Lines

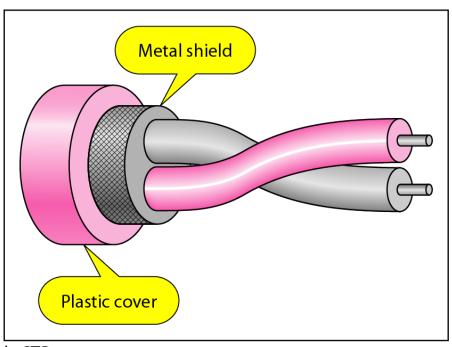


Noise on Twisted-Pair Lines



UTP and STP cables

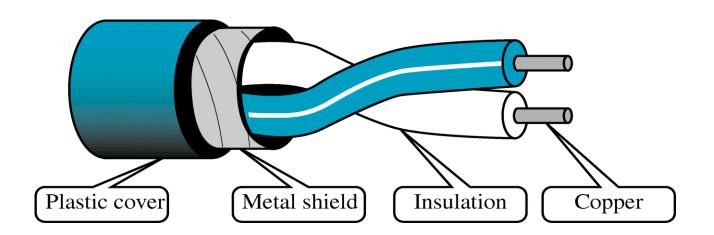




b. STP

Shielded Twisted-Pair Cable

- Metal casing prevents the penetration of electromagnetic noise.
- Eliminate the phenomenon, called CROSSTALK



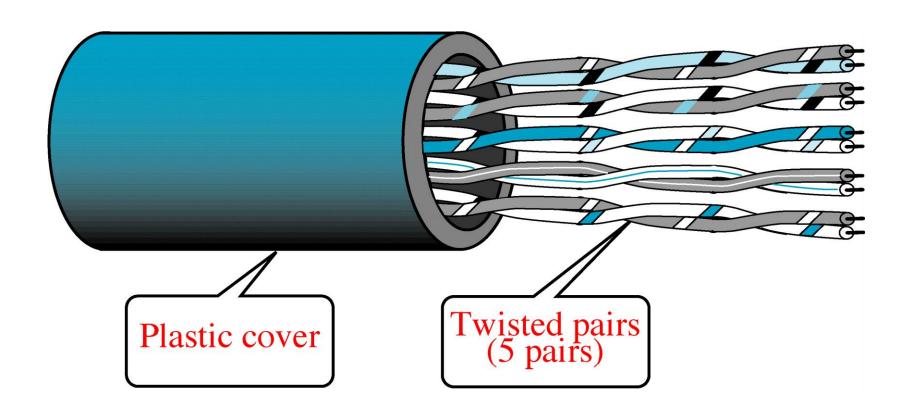
Advantages:

- 1. Cheaper
- 2. Less susceptible to electrical interference caused by nearby equipment or wires.
- 3. In turn are less likely to cause interference themselves.
- 4. Because it is electrically "cleaner", STP wire can carry data at a faster speed.

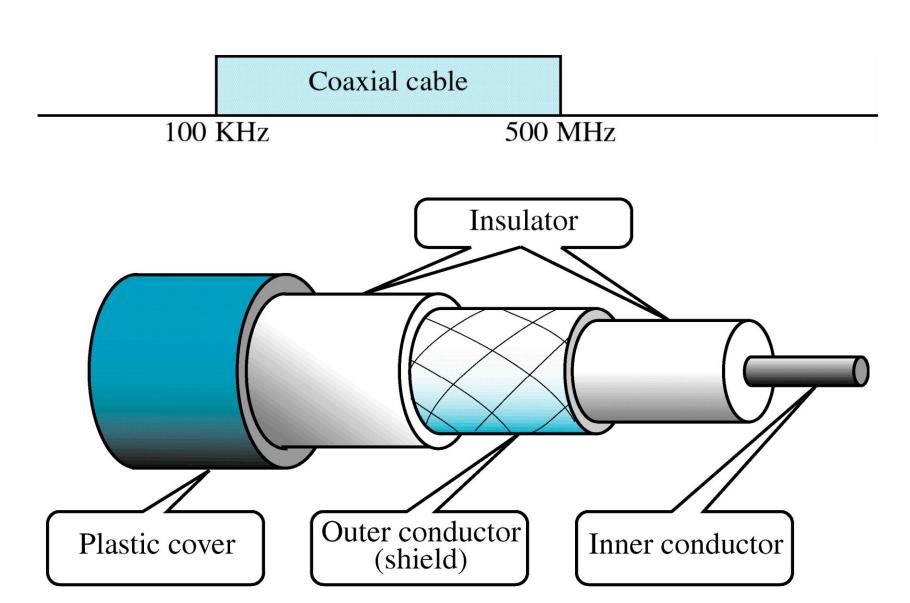
Disadvantages:

1. STP wire is that it is physically larger and more expensive than twisted pair wire.

Unshielded Twisted-Pair Cable



Coaxial Cable



Two kinds of coaxial cable

- ✓ One kind, 50-ohm cable, is commonly used when it is intended for digital transmission from the start.
- ✓ The other kind, 75-ohm cable, is commonly used for analog transmission and cable television.
 - ✓ Cable TV operators began to provide Internet access over cable, which has made 75-ohm cable more important for data communication.

- ➤ High bandwidth
- > Excellent noise immunity.
- The bandwidth possible depends on the cable quality and length.
- > Used within the telephone system, cable television and MAN
- ➤ For long-distance lines, but have now replaced by fiber optics on long distance routes.

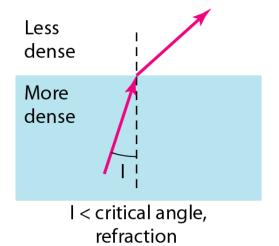
Categories of coaxial cables

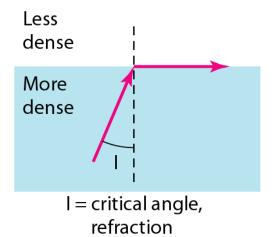
Category	Impedance	Use
RG-59	75 Ω	Cable TV
RG-58	50 Ω	Thin Ethernet
RG-11	50 Ω	Thick Ethernet

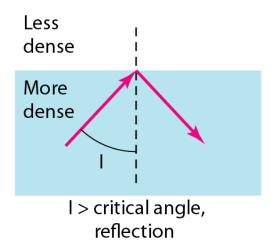
Optical Fiber Cable

Optical Fiber is a glass or plastic cable that accept and transport the signals in the form of Light.

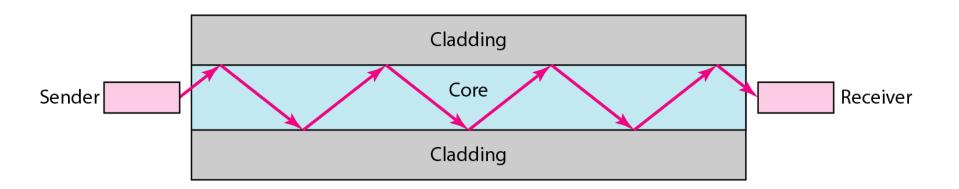
Advantages:				
	Noise Resistance			
	Less Signal Attenuation			
	Higher BW			
Disadvantages:				
	Cost			
	Installation/Maintenance			
	Fragility(Broken Wire)			







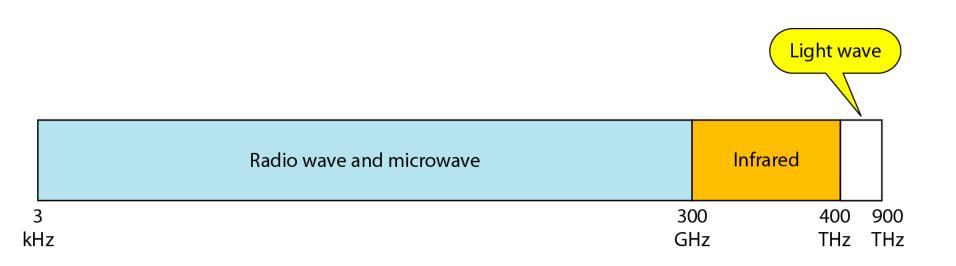
Optical fiber



UNGUIDED MEDIA: WIRELESS

Unguided media transport electromagnetic waves without using a physical conductor. This type of communication is often referred to as wireless communication.

Electromagnetic spectrum for wireless communication



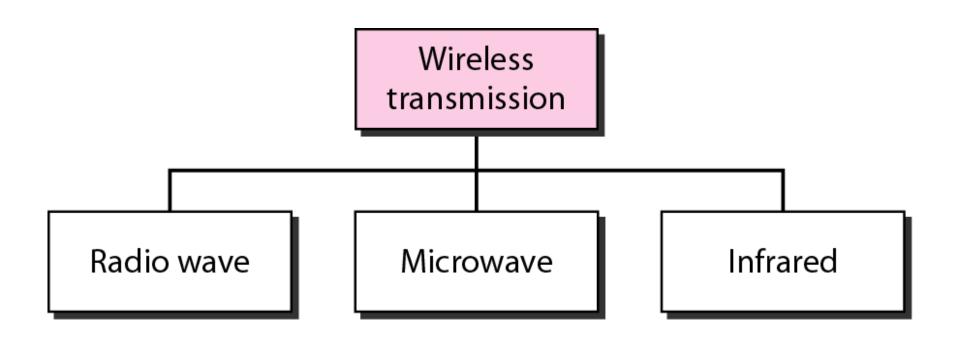
Propagation Methods

- Ground Propagation
- Sky Propagation
- Line-of-Sight Propagation

Bands

Band	Range	Propagation	Application
VLF (very low frequency)	3–30 kHz	Ground	Long-range radio navigation
LF (low frequency)	30–300 kHz	Ground	Radio beacons and navigational locators
MF (middle frequency)	300 kHz–3 MHz	Sky	AM radio
HF (high frequency)	3–30 MHz	Sky	Citizens band (CB), ship/aircraft communication
VHF (very high frequency)	30–300 MHz	Sky and line-of-sight	VHF TV, FM radio
UHF (ultrahigh frequency)	300 MHz–3 GHz	Line-of-sight	UHFTV, cellular phones, paging, satellite
SHF (superhigh frequency)	3–30 GHz	Line-of-sight	Satellite communication
EHF (extremely high frequency)	30–300 GHz	Line-of-sight	Radar, satellite

Wireless transmission waves



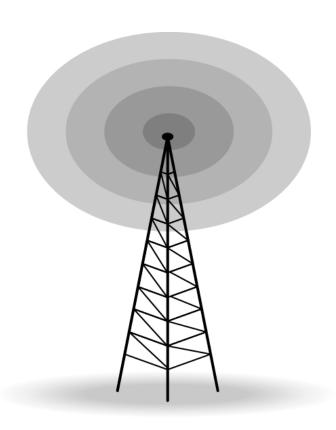


Note

Radio waves are used for multicast communications, such as radio and television.

They can penetrate through walls. Use Omni directional antennas

Omnidirectional antenna



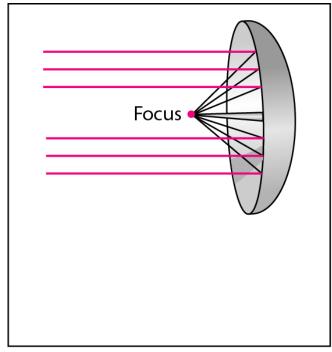


Note

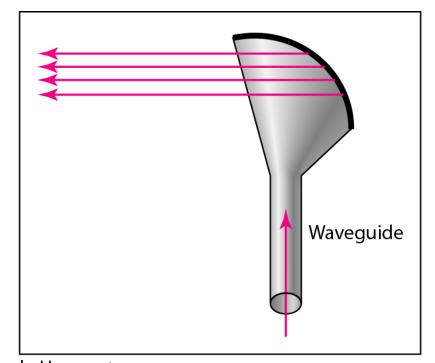
Microwaves are used for unicast communication such as cellular telephones and wireless LANs. Higher frequency ranges cannot penetrate walls.

Use directional antennas - point to point line of sight communications.

Unidirectional antennas



a. Dish antenna



b. Horn antenna



Note

Infrared signals can be used for shortrange communication in a closed area using line-of-sight propagation.

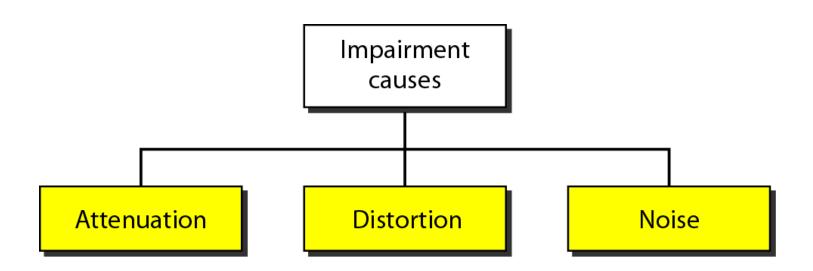
Transmission Impairment

• Signal transmit through medium that are not perfect.

• This imperfection cause signal impairment.

What is sent is not received.

Causes of impairment



Attenuation

- Means loss of energy -> weaker signal
- When a signal travels through a medium it loses energy overcoming the resistance of the medium
- Amplifiers are used to compensate for this loss of energy by amplifying the signal.

Measurement of Attenuation

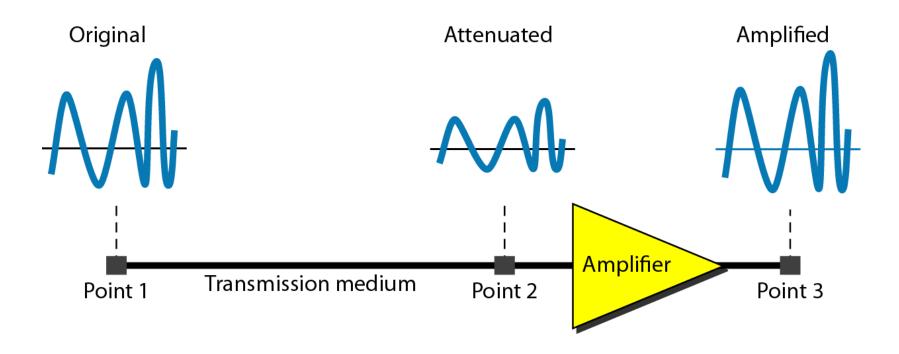
• To show the loss or gain of energy the unit "decibel" is used.

 $dB = 10\log_{10}P_2/P_1$

P₁ - input signal

P₂ - output signal

Attenuation



• Suppose a signal travels through a transmission medium and its power is reduced to one-half. This means that P_2 is $(1/2)P_1$. In this case, the attenuation (loss of power) can be calculated as

Example 3.26

$$10 \log_{10} \frac{P_2}{P_1} = 10 \log_{10} \frac{0.5P_1}{P_1} = 10 \log_{10} 0.5 = 10(-0.3) = -3 \text{ dB}$$

A loss of 3 dB (-3 dB) is equivalent to losing one-half the power.

A signal travels through an amplifier, and its power is increased 10 times. This means that $P_2 = 10P_1$. In this case, the amplification (gain of power) can be calculated as

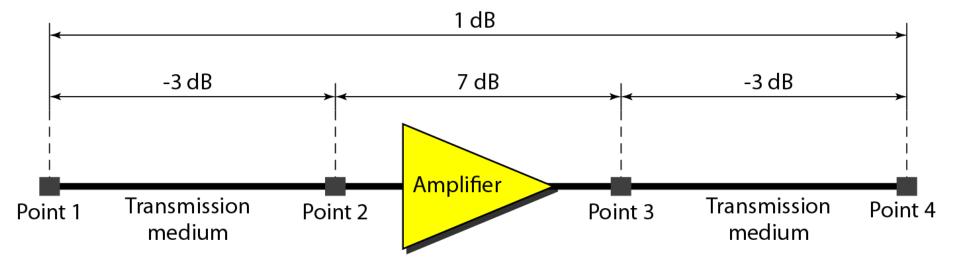
$$10 \log_{10} \frac{P_2}{P_1} = 10 \log_{10} \frac{10P_1}{P_1}$$

$$= 10 \log_{10} 10 = 10(1) = 10 \text{ dB}$$

One reason that engineers use the decibel to measure the changes in the strength of a signal is that decibel numbers can be added (or subtracted) when we are measuring several points (cascading) instead of just two. In Figure 3.27 a signal travels from point 1 to point 4. In this case, the decibel value can be calculated as

$$dB = -3 + 7 - 3 = +1$$

Decibels for Example 3.28



Sometimes the decibel is used to measure signal power in milliwatts. In this case, it is referred to as dB_m and is calculated as $dB_m = 10 \log 10 P_m$, where P_m is the power in milliwatts. Calculate the power of a signal with $dB_m = -30$.

Solution

We can calculate the power in the signal as

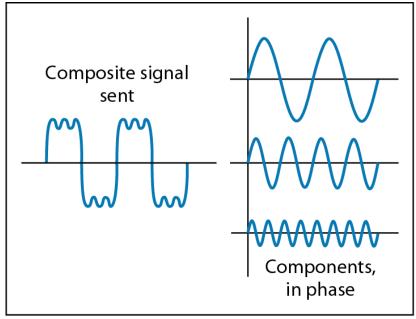
$$dB_{m} = 10 \log_{10} P_{m} = -30$$

$$\log_{10} P_{m} = -3 \qquad P_{m} = 10^{-3} \text{ mW}$$

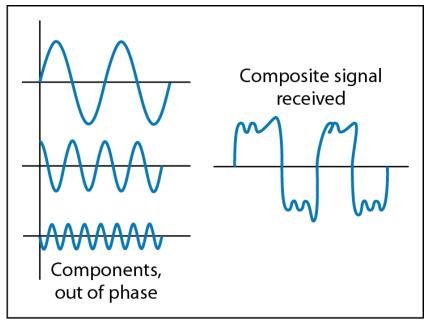
Distortion

- Means that the signal changes its form or shape
- Distortion occurs in composite signals
- Each frequency component has its own propagation speed traveling through a medium.
- The different components therefore arrive with different delays at the receiver.
- That means that the signals have different phases at the receiver than they did at the source.

Distortion



At the sender

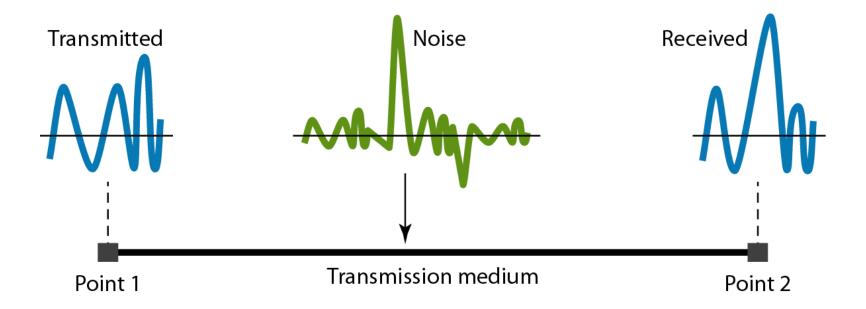


At the receiver

Noise

- There are different types of noise
 - Thermal random noise of electrons in the wire creates an extra signal
 - Crosstalk same as above but between two wires.
 - Impulse Spikes that result from power lines, lightening, etc.
 - Induced

Noise



Signal to Noise Ratio (SNR)

- To measure the quality of a system the SNR is often used. It indicates the strength of the signal wrt the noise power in the system.
- It is the ratio between two powers.
- It is usually given in dB and referred to as SNR_{dB}

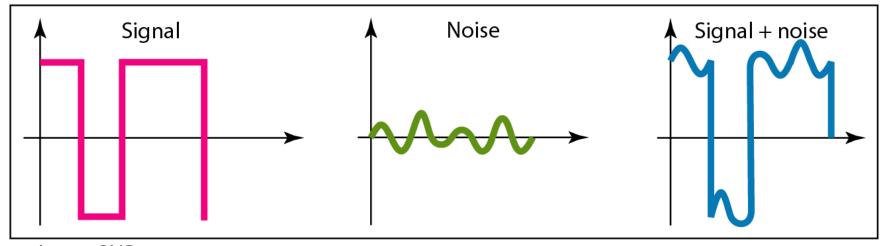
The power of a signal is 10 mW and the power of the noise is 1 μ W; what are the values of SNR and SNR_{dB}?

The values of SNR and SNR_{dB} for a noiseless channel are

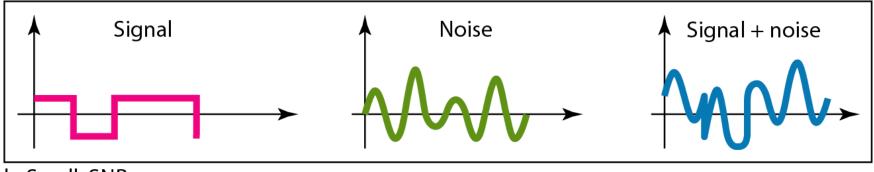
$$SNR = \frac{\text{signal power}}{0} = \infty$$
$$SNR_{dB} = 10 \log_{10} \infty = \infty$$

We can never achieve this ratio in real life; it is an ideal.

Figure 3.30 Two cases of SNR: a high SNR and a low SNR



a. Large SNR

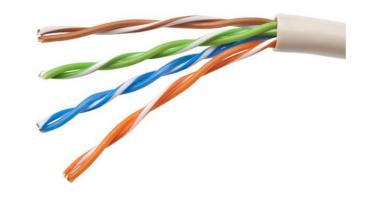


b. Small SNR

Properties of UTP Cabling

UTP has four pairs of color-coded copper wires twisted together and encased in a flexible plastic sheath. No shielding is used. UTP relies on the following properties to limit crosstalk:

- Cancellation Each wire in a pair of wires uses opposite polarity. One wire is negative, the other wire is positive. They are twisted together and the magnetic fields effectively cancel each other and outside EMI/RFI.
- Variation in twists per foot in each wire Each wire is twisted a different amount, which helps prevent crosstalk amongst the wires in the cable.



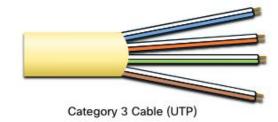
UTP Cabling UTP Cabling Standards and Connectors

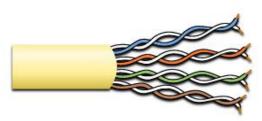
Standards for UTP are established by the TIA/EIA. TIA/EIA-568 standardizes elements like:

- Cable Types
- Cable Lengths
- Connectors
- Cable Termination
- Testing Methods

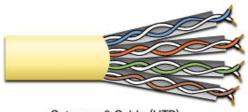
Electrical standards for copper cabling are established by the IEEE, which rates cable according to its performance. Examples include:

- Category 3
- Category 5 and 5e
- Category 6





Category 5 and 5e Cable (UTP)



Category 6 Cable (UTP)

UTP Cabling UTP Cabling Standards and Connectors (Cont.)





RJ-45 Connector

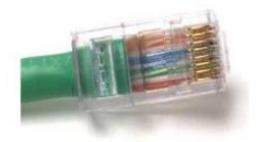




RJ-45 Socket

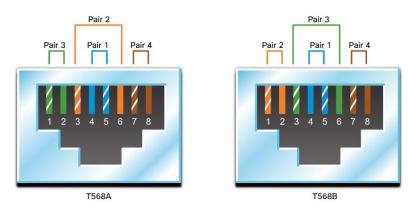


Poorly terminated UTP cable



Properly terminated UTP cable

UTP Cabling Straight-through and Crossover UTP Cables



Cable Type	Standard	Application
Ethernet Straight-through	Both ends T568A or T568B	Host to Network Device
Ethernet Crossover *	One end T568A, other end T568B	Host-to-Host, Switch-to-Switch, Router-to-Router
* Considered Legacy due to most NICs using Auto-MDIX to sense cable type and complete connection		
Rollover	Cisco Proprietary	Host serial port to Router or Switch Console Port, using an adapter

