4712099 – Quiz 2 – Attempt 1

Q1. For a bundle of wires that follow the same paths, you noticed **a high number of bit errors**, which you conjecture are **the result of cross-talk and introduced interference**. Describe **strategies to improve and avoid the generation of interference.**

Strategies to improve and avoid the generation of interference:

1. **Twisted pairs:** The cables are often close as well as far side of the interference source and with equal amounts of energy induced in both leads the influence effectively cancels itself out. When the pairs of parallel wire are twisted with each other, they no longer are tuned to other conductors there by *reducing* the "**cross-talk**" (Wiring two conductors as twisted pairs lets external influences partially cancel each other out).
2. **S/FTP cable with external braid and individually shielded twisted pairs:** When the shielded cable in vicinity of changing electromagnetic interference, a voltage is induced into the outer shield. The resulting current flow in-turn emits an electromagnetic field that according to Lens's law is oriented to flow in the opposite direction. This shield acts as a *Faraday's Cage* thereby effectively eliminating the external influence.
3. A simple method based on an induction coil which allows the interception of signals at lower frequencies (example: voice band of telephone line).

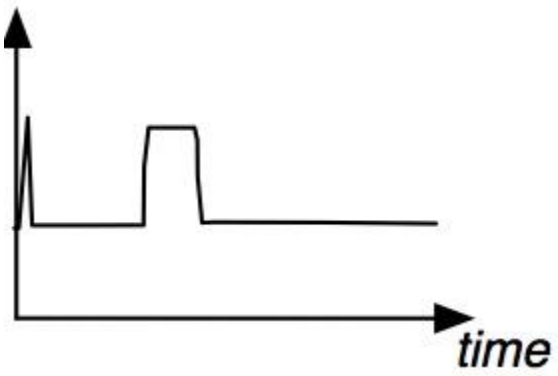
Question 2 (10 points)

Explain what happens to **light inside an optical fiber in a macro bend**.

To maintain functionality, fiber optic cables specify the minimum radius they may be curved around. If the cables installed are having a too tight angle, this will lead to the emergence of **macro bend**. If the minimum bending radius is undercut within the fiber – total internal reflection is achieved only if the incident angle of the beam is larger than the critical angle defined by the refractive indices of core and cladding.

The light inside an optical fiber in a macro bend: Within the area of bend the normal is no longer parallel to the normal of the last reflection, which means that the ray is approaching the core-cladding boundary at a different angle than before. The angle between the normal in the bend and some of the previously reflected rays will now be smaller than the critical angle, and these beams will be ejected from the core into the cladding where they are dissipated as heat: *the fibers experiencing a bending loss* (Macro bending number is a value determined by the physical properties of the fiber).

Question 3 (10 points)



You are the network administrator of a company. You receive repeated reports about an **unreliable network** connection, which seems to periodically stop working. As a diagnosis, **you connect a time domain reflectometer and obtain the trace shown on the right.**
How **many impairments are on the line,** what do you do next?

Number of impairments: Depends on the injected pulse length.

At the time of injected pulse (the sharp peak) and at the time of the injected pulse reaching impu rity (longer pulse), the TDR (Time Domain Reflectometer) will be blind. Hence any secondary impairments during these times will be merged with the reflection of the first impairment which creates a subsequent dead-zone and additional impairments cannot be found. This is because the longer the pulse length, the longer the TDR will be blind for impairments.

Solution I will take/do: Instead of long and high energy pulse, I will begin the TDR measurements at the lowest meaningful pulse length to avoid misreading due to over powered amplifiers or miss detection of impairments due to blind spots and then gradually increase pulse width to detect further issues or those events creating only a minor reflection.

4. Compare and contrast the **security** of **guided vs. unguided communication** media with respect to an **attacker's ability to eavesdrop** and **resistance to interference**.

With respect to attacker's ability to eavesdrop and resistance to interference.

Security of guided communication:

1.For Copper cables: Physical access prevention, Shielding, Testing of Lines, Physical Layer Encryption, Shielding in many forms of Faraday cages.

2.For Optic Fibers: Clip-on couplers, Test access point, Optical time Domain reflectometers, Armoring, Deployment in trenches, implementing resilient redundant and self-healing network topologies.

Security of unguided communication:

1. *For Wi-fi and Bluetooth :* Frequency hopping Spread spectrum (adversaries may intercept only a small fraction if they do not know the exact hopping sequence used by the sender), Chirps (continuously move the transmission frequency), Direct-Sequence Spread Spectrum (difficult for the adversary to decode the signal unless the corresponding code with which it is transmitted is known), Faraday cages (wrapping shielding around an enclosure)

2. *For Satellite:* Coverage Planning, LPI for interference mitigation and interception protection, Electromagnetic Shielding, Integration of higher layer controls, Redundancy and resilience planning, Link jamming resistance, Control system protection, Redundancy and recovery planning, Physical asset and infrastructure protection.

3. *For Microwaves:* Path diversity (routing data stream via different paths), Link Encryption, Reconnaissance detection/avoidance.