**Part 2: Data Communication and Error rates**

Wireless technologies have become an intrinsic part of society today. Many people regularly engage in wireless communications without even knowing what is going on. Between 3G, 4G LTE, and 5G LTE Advanced, wireless communications technologies have enabled the average user to achieve much more than simple voice calls with their cell phone. To start, 3G (standing for 3rd Generation) implemented a feature that instead of using simple analogue and digital technologies like previous generations, it would instead utilize signals that extend from a user’s cell phone to a radio tower (Gwaltney, 2018). This had a number of advantages over its predecessors ranging from audio reliability to overall increased data speeds and bandwidth. 4G LTE further improved portable communications from there. Specifically, 4G networks utilize the LTE communications standard to bolster connection speeds further than was capable with 3G technologies (Gwaltney, 2018). It is noted that the performance boost from incorporating LTE into the 4G pipeline may range up to ten times the performance of equivalent 3G speeds while 5G trends up to 100 times faster than 4G. LTE, however, is an interesting technology method to consider. Standing for Long Term Evolution, LTE is more of a promise than it is an actual software or hardware. Essentially, true 4G and 5G capabilities require such immense infrastructure that many cellular companies are not equipped to handle the bandwidth required to reach it. Instead, the moniker LTE exists to denote the user getting an improved experience as time develops while more and more radio towers and infrastructures are developed to accommodate the full force of 4G and 5G technologies. This is where the moniker LTE Advanced, or LTE-A comes to fruition. To denote that the user will receive the full bandwidth of 4G or onward, the LTE Advanced moniker is applied. Where applicable, 4G LTE Advanced offers the full range of 4G functionality (Andrei, 2010).

All this wireless technology still has a major issue to contend with, however; noise. Three common types of noise in network communications would be Thermal noise, Intermodulation noise, and crosstalk (Tutsmaster.org, 2019). Thermal noise details the interference generated while electrons pas through a resistor on a circuit board while above absolute zero. This noise is present throughout all electrical equipment. Intermodulation noise details signals of different frequencies. Should two different frequencies interact through a nonlinear device, they will produce Intermodulation noise artifacts as a byproduct of the two signals’ harmonics. Crosstalk is a bit less complicated. Simply put, if two wires are close enough together, electrical current passing through either one or both may cause interference in the other and produce unwanted signals or noise as a result. One proposed solution for crosstalk specifically would be something widely used today. Crosstalk happens primarily while a wire is running parallel with another, and thus electrical fields interact with neighboring wires and cause noise. Mitigation efforts towards this effect include the introduction of twisted pairs (Sreerama, 2014). Twitting the wires around each other will alter the electrical field of these wires in a way that mitigates crosstalk noise with the higher frequency in twists acting as a better mitigation effect. This solution is rather effective as the engineer can directly modulate how much mitigation they need in their current systems, as they could simply adjust the twist of the wires to further enhance the effect. This solution, however, is not a complete removal of this noise.

Data correction is a vital discipline to consider when dealing with noise in digital and analogue systems. Although many different types of error correction exist in many different contexts, Forward Error Correction is a popular method. Forward Error Correction deals with sending duplicate signals to a device to allow for a decoder to run through the delivery, and correct for known errors (Brown III, n.d.). This type of error resolution is particularly valuable as it will allow a system to run much more effectively without the need to stop and restart processes. Although error correction in general may fail for a number of reasons, there are a few in which is guaranteed. For example, error correction is unattainable should the transmission be thoroughly mangled as, for any digital signal, error correction can only remain viable if there is a baseline to work from and a suitable method of reconstruction to work through.

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