Assignment1

Mobile Computing
Sujeet Patil | A028

1. What are the main problems of signal propagation? Why do radio waves not always follow a straight line? Why is a reflection both useful and harmful?

   In wireless communication networks the signal propagation takes place by senders to receivers. The range of the signals depends on the power provided which leads to formation of transmission range, Detection range, Interference range.
   the problems of signal propagation are:
   - attenuation: Path loss by presence of matter in the atmosphere eg:air, rain, snow, fog, dust particles, smog etc.
   - scattering: Incoming signal is scattered into several weaker outgoing signals.
   - diffraction: Waves will be deflected at an edge and propa- gate in different directions.
   - reflection: Signals get reflected by the large objects.
   - refraction: the signals bent towards the medium as they travel through the atmosphere.

   As the radio signal always follows a straight line as light does but because of the presence of various structures it affects the path and can divert the waves from a straight line. Only in vacuum and without gravitational effects radio waves follow a straight line, Except for attenuation, all other types of problems in signal propagation affect the path of signal. Without the possibility of reflection radio reception in towns would be almost impossible. A line-of-sight almost never exists. However, reflection is the main reason for multipath propagation causing ISI.
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2. What are the means to mitigate narrowband interference? What is the complexity of the different solutions?

   narrowband interference is characterized by relatively high interference power levels concentrated at specific frequencies, which usually originate from other mobile networks or from non-cellular sources.
   To mitigate narrowband interference (which might be caused by other senders, too) following methods can be used:
   - Dynamic Frequency Selection: Senders can sense the medium for interference and choose a frequency range with lower/no interference. Network operators can also use this scheme to dynamically assign frequencies to cells in mobile phone systems. DFS has a relatively low complexity as the selected frequencies do not change between two successive assignments and during a call.

   - Frequency hopping: Slow frequency hopping (several symbols per frequency) may avoid frequencies with interference most of the time with a certain probability. wireless systems can use this principle for multiplexing as it is done in Bluetooth systems (still slow hopping as Bluetooth sends many symbols, indeed a whole packet, on the same frequency). Fast hopping schemes transmit a symbol over several frequencies, thus creating a spread spectrum. FHSS has medium complexity as time synchronization of devices is necessary.

- Direct sequence spread spectrum: Data is XORed with a chipping sequence resulting in a spread signal. This is done in all CDMA systems, but also in WLANs using, e.g., Barker sequences for spreading (e.g., 802.11b). The signal is spread over a large spectrum and, thus, narrowband interference only destroys a small fraction of the signal. This scheme is very powerful but requires more powerful receivers to extract the original signal from the mixture of spread signals.
  DSSS has high complexity as it requires more powerful receivers to extract the original signal from the mixture of spread signals.

3. Name several methods for ISI mitigation. How does ISI depend on the carrier frequency, symbol rate, and movement of sender/receiver? What are the influences of ISI on TDM schemes?

   ISI arises when the delay is caused by the extended path length of the reflected signal. If the delay is a significant proportion of a symbol, then the receiver may receive the direct signal which indicates one part of the symbol or one state, and another signal which indicates another logical state. If this occurs, then the data can be corrupted.
   for ISI mitigation large enough guard spaces between symbols/low symbol rate, channel estimation/calculate the n strongest paths, and adapt the receiver accordingly. Using higher frequencies reduces the effects of multipath propagation and thus ISI (waves more and more behave like light). The higher the symbol rate the stronger the ISI. If senders and/or receivers move fast the chances for ISI are higher because the location of obstacles changes, hence the number, magnitude, and timing of the secondary pulses – it is difficult to follow the signals and adjust the delays for recombination. ISI lowers the bandwidth of a TDM scheme as the guard spaces require some time.

4. What are the main benefits of a spread spectrum system? How can spreading be achieved?

   spread spectrum techniques involve spreading the band-width needed to transmit data.
   Main benefits of a spread spectrum system is that they are very robust against interference, inherent security (if the spreading code is unknown it is very difficult to tap the transmission), and can be used in the “background” of existing systems if the signal level is low enough.
   Spreading can be achieved by XORing a bit with a chipping sequence or frequency hopping. Guard spaces are now the orthogonality of the chipping sequences or hopping patterns. The higher the orthogonality (well, that is not very mathematical, but intuitive), the lower the correlation of spread signals or the lower the collision probability of frequency hopping systems. DSSS systems typically use rake receivers that recombine signals travelling along different paths. Recombination results in a stronger signal compared to the strongest signal only.

5. What are the main reasons for using cellular systems? How is SDM typically realized and combined with FDM?

   The main reason for using cellular systems is the support of more users as no such place would exist with zero coverage.these Cellular systems reuse spectrum according to certain patterns. Each cell can support a maximum number of users, and thus results in a higher

number of users in the transmission range. Smaller cells also allow for less transmission power (thus less radiation!), longer runtime for mobile systems, and less delay between sender and receiver. The downside of the system is the tremendous amount of money needed to set-up an infrastructure with many cells.
Typically, each cell holds a certain number of frequency bands. Neighbouring cells are not allowed to use the same frequencies. According to certain patterns cellular systems reuse frequencies. If the system dynamically allocates frequencies depending on the current load, it can react upon sudden increase in traffic by borrowing capacity from other cells. However, the "borrowed" frequency must then be blocked in neighbouring cells.

Open Ended Problem (Based on FHSS)

1. The school has a novel dress protocol. Each standard student can use a colored dress on different days, but it should still be identifiable. How can the protocol follow a hopping sequence for using the colors for the dress code: blue (B), Green (G), yellow (y), and orange (O).

In order to differentiate each class with given colors a each class needs to be assigned a color for each day

Class	Day wise color sequence M T W T F S
class1	B B B B B B
class2	G G G G G G
class3	B G B G B G
class4	Y B G O Y G

As each class has a different sequence w.r.t. weekdays thus these classes can be different