

WIRELESS MEDIUM ACCESS CONTROL AND CDMA, 3G AND 4G COMMUNICATION

Lesson 05

Introduction to CDMA

CDMA (CODE DIVISION MULTIPLE ACCESS) BASED SYSTEM

- When wireless stations (WSs) use the same space (sector in a cell), same time-slot, and same frequency f_c , then an alternative is CDMA for accessing the medium
- Each WS uses a distinct code $C_0 \dots C_{p-1}$ when accessing the medium
- p bit code, $C_0 \dots C_{p-1}$

CDMA STANDARD

- GSM standards regulate all aspects of the GSM network infrastructure
- CDMA-based standards only govern the radio interface
- IS-95 (interim standard-95) first CDMA used by Qualcomm, USA

CDMA SYSTEMS

- CDMA more robust for multi-path delays and provides higher immunity towards frequency selective fading
- Each mobile station's or base transceiver's signals are coded with two or three codes

CDMA SYSTEMS

- Signals of higher voice and data quality and small bit-error rates
- Soft handover
- Soft handover means that an MS at the boundary of two adjacent cells does not have to drop calls due to signal break during handover at the boundary region
- CDMA systems provide seamless connectivity to the MS

CDMA SYSTEMS

- CDMA systems perform power control generally by open loop method to solve the problem of drowning of signals from far mobile terminals by those from the near terminals
- CDMA systems employ spread spectrum techniques (DSSS and FHSS) for medium access control thus problems in narrow band transmission not present

NARROW BAND TRANSMISSION IN FSK

- A frequency band equal to f_m for transmission of 1s and 0s (assuming that higher harmonics are filtered)

MAJOR DISADVANTAGES OF NARROW BAND TRANSMISSION

- Frequency selective fading— May be along a path between the MS and BTS
- Co-channel interference— The signals close in frequency to f_{c0} may also be exposed to interference from mobile stations operating at the same frequency in a nearby cell

SOLUTION TO FREQUENCY SELECTIVE FADING AND CO-CHANNEL INTERFERENCE

- Data-frame channel frequency, assigned to each wireless (or mobile) station by the BTS, can be changed (hop) at select frequencies at a certain rate according to a predetermined sequence
- The GSM hopping rate is 207.4 hops/s
- Use of hopping is optional for a GSM system

SPREAD SPECTRUM

- A transmission technique that provides a novel solution to the interference problem
- Direct sequence spread spectrum (DSSS)
- Frequency hopping spread spectrum (FHSS)
- CDMA systems use DS spread spectrum
- Signals at frequencies f_{c0} , $f_{c0} + f_s$, $f_{c0} + 2f_s$, ..., $f_{c0} + (n-2)f_s$, $f_{c0} + (n-1)f_s$

SPREAD SPECTRUM

- Spectrum widens by a factor of n
- Spread between f_{c0} and $f_{c0} + (n-1)f_s$, where n is the number of chipping frequencies used and f_s is symbol frequency (symbol/s, number of symbols chipped/s)
- The spread = $n \times f_s$

EQUALLY SPACED FREQUENCIES

- A set of n equally spaced frequencies, called chipping or hopping frequencies used for transmission
- Either in direct sequence or there is frequency hopping among n frequencies

CDMA SYSTEMS

- An n -symbol code assigned for each mobile or base transceiver wireless-station (WS) and each channel of that user
- Another m -symbol code can also be assigned to each user channel, for example, synchronization, paging, traffic, and pilot channels
- Another k -symbol code can also be assigned for each carrier of the user

CDMA SYSTEM CODES

- Use a good set of codes
- Orthogonal codes
- Codes which results in autocorrelation at the receiver

REDUCTION IN CO-CHANNEL INTERFERENCE IN SPREAD SPECTRUM

- Each chipping or hopping frequency can be transmitted at much less power as compared to the case of narrow band transmission
- This reduces the co-channel interference of signals from neighbouring WSSs which are also transmitting at the same frequencies

REDUCTION IN NARROW BAND INTERFERENCE IN SPREAD SPECTRUM

- Spread spectrum method reduces greatly the narrow band interference

NUMBER OF CHANNELS IN SPREAD SPECTRUM

- Multiple access by greater number of channels
- The chipping or hopping frequencies coded distinctly for different wireless stations (WSs)
- Greater number of channels can access the medium simultaneously

NUMBER OF CHANNELS IN SPREAD SPECTRUM

- Assume that p WSs are coded in p ways out of 2^n possible ways of coding when using n chipping frequencies in the spread spectrum
- Number of codes can be considered good (which provide orthogonal and autocorrelation) for transmission and reception

SPREAD SPECTRUM

- Receiver using complex computational processing with the help of the digital signal processors (DSPs)
- Use of a large frequency band

SPREAD SPECTRUM

- Frequencies of the band can interfere with other station and transceiver signals in the wireless medium and therefore an appropriate power control strategy is thus required to control the near and far terminal effects

SPREAD SPECTRUM

- All the codes formed by combination of bits are not usable and therefore selection of an appropriate set of codes code is important

SUMMARY

- Code division multiple access
- Each mobile station's or base transceiver's signals coded with two or three codes
- DSSS using equally spaced chipping frequencies
- FHSS Co-channel interference and frequency selective fading problems non existent

End of Lesson 05
Introduction to CDMA