COLLEGE OF ENGINEERING & TECHNOLOGY

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Course Title : Telecommunication Systems Engineering
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Sheet (5)

Orthogonal Frequency Division Multiplexing (OFDM)

1. How does OFDM work? Please briefly describe. What are the key advantages of OFDM over single carrier systems?

2. We need to design a system with user data rate of 1Mbps. typical outdoor channels show RMS delay spread σ of 10μs. Determine whether ISI will occur in a single carrier system? If yes, propose a multicarrier system that would avoid ISI. Please note that channel coherence bandwidth is defined as, $Bc = 1/5\sigma$ and frequency selectivity occurs when $\sigma <$ symbol duration/10.

3. A list of parameters of a Wireless LAN air-interface (IEEE 802.11a) using OFDM is given below:

   - 64 subcarriers, 48 for data, 4 for pilots and 12 null subcarriers.
   - Symbol duration 4μs
   - 0.8μs for CP
   - BPSK, QPSK, 16-QAM, 64-QAM
   - Convolutional coding with rate ½, 2/3 ; 3/4
   - System bandwidth 20MHz
   - Bit rates of 6, 12, 18, 24, 36, 48 & 54Mbps

Calculate the following parameters:

1. FFT time-period.
2. Subcarrier frequency spacing.
3. For different data rates, different coding scheme and different combination of modulation scheme, calculate:
   a. Coded bits per subcarriers.
   b. Coded bits per OFDM symbol.
   c. Data bits per OFDM symbol.

4. We want to design an OFDM WiMAX system for a 60GHz channel with a max RMS delay spread of approximately 25ns (max delay spread around 200ns). The target bit rate is 80Mbps using rate 1/2 coding and QPSK modulation.

   Suggest the following parameters:

   a. Guard interval and FFT period.
   b. Number of FFT points (should be a power of 2).
   c. Number of subcarriers used for data.
   d. Sampling frequency.