Exp. 2: Delay and Doppler Spread - Answer Book

- **Name:** **Lab Date:**
- **Student No.:** **Day of the week:** **Time:**

3. Experiment

3.1 Delay Spread

3.1.1 Impulse In a Channel

- *Explain Delay Spread in words and draw a simple block diagram. Assume for now that transmitter and receiver are stationary. The channel will introduce reflections but it does not change over time.*

- *When you look at the results from the impulse response model (see the lab outline), you notice that the reflected versions of your transmitted signal decay (or fade) over time. Do you expect the received signal (whatever this signal is) always to be smaller in magnitude than the transmitted signal? Can you tell from the impulse response? Explain your answer and give examples.*

- *Run the impulse response model. Change the delay values found inside the channel block and present below a channel with a larger delay spread. Indicate the delay values (in "number of samples") for each of the received components. Draw if necessary.*

3.2 Tones Through a Channel

3.2.1 One Tone

- *From the time domain plot (either the one you have on the screen or the one presented above), what is happening to the received signal? What is the point of looking at the frequency domain plot for a received signal?*

- *Change the frequency of the sinusoidal signal until you see a significant change on the received signal (different than the one you first got). The channel remains unchanged. Plot the picture below and explain what happened. What if the propagation delays of the channel paths had also changed?*

3.2.2 Bandlimited Signals

- *By looking at the frequency domain plot only, what would indicate a large delay spread?*

- *Why would these effects be undesired anyway? (think of coherence)*

- *If you had any control over the amount of delay introduced by the channel (as you do in this simulation), what would you do to the delay spread in order to avoid the undesired effects observed in the frequency domain?*

- *Compare the frequency domain plots of the large delay spread and the small delay spread. Explain what you see in term of "rate of variation of frequency response".*

- *Intuitively, why would you desire to have a large coherence bandwidth?*

- *If you had to carry a conversation with someone 5 metres away from you, would you prefer to do it a) in a very reflexive, empty room; b) in a room full of drapes and carpets, or c) in an open field? Why?*

3.3 Doppler Spread

3.3.1 Doppler On a Single Tone

Run the model as described in the outline and observe the scopes. Answer the questions below

- *From visual inspection, what is the bandwidth utilized to transmit the "moving" tone? Since users move "at random" relative to the receiver, could you predict how the bandwidth would vary?*

- *The picture you see on the scopes for this particular case* **resembles** *a modulation scheme studied in ECE316 (it even sounds like it if you play it through a loudspeaker). Which one is it? Be careful not to confuse the subjects. Why are they not the same?*

3.3.2 Two Tones Moving In Different Directions

Run teh model as described and answer the questions below.

- *What is the most obvious problem with the results seen? (Look at the frequency domain)*

- *Think of each user as a source of a bandlimited signal, and suggest three ways to avoid teh problem above for the given spectrum. Note that "tell them to move slower or stop" is not an option.*

3.3.3 Bandlimited Signals On The Move

- *Based on the model you have just run, draw below the plot you see and explain who are the transmitted signals, who are the received signals and what are the observed features in the received signals. Explain why these features are there. You will need this plot for the next section.*

3.3.4 Two Moving Users and Multiple Signal Paths

- *What is different from the previous frequency domain plot? (i.e., the plot you obtained* **without** *the multiple paths)*

- *If you kept the delays small for each of the paths and each of the users, and had the users (transmitters) moving very slowly relative to the receiver, what would the plot look like?*