CS536: Data Communication and Computer Networks

Lab1 Answers

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1 Problem 3

I've tried to find the special character at the end of the output from each legacy apps, but failed. The following is what I did to look for it. I used the command `od -x` output the hex code for a file. Let's first take a look at what will happen for `ls` app.

```
escher01 88 $ ls -a | od -x
0000000 0a2e 2e2e 660a 6669 636f 696c 762d 2e32
0000020 0a63 6966 6f66 6573 2d72 3276 632e 000a
0000037
```

At the end of `ls -a` command, we see `000a` at the end of the output. It means that the last character is a **ASCII NULL** following a newline character. However, if we input another similar command, things would change.

```
escher01 102 $ ls -l | od -x
0000000 6f74 6174 206c 0a38 722d 2d77 2d72 2d2d
0000020 2d2d 3120 7720 6e61 3467 3131 2033 6177
...
0000200 2e32 0a63
0000204
```

The end of this output is not a **ASCII NULL** character any more. Instead, it only has a newline character. It is obvious that we cannot have the newline character as the end of transmission. Hence, I could not find any special character indicating the end of transmission.

However, there might be another way used to indicate the reading has ended. if no process has the FIFO open for writing, `read()` will return 0 to indicate end of file. Therefore, the program may be able to keep reading until `nread` (the return value of `read()`) is 0, which means it encounters the end of file. In this setting, the server creates a child process and opens the client's FIFO with write only permission. Then, it uses `dup2` to redirect its stdout to this FIFO. After the child

process terminates, the client would receive end of file and the return value of `read()` is 0. It will stop reading and print the response.

2 Bonus Problem

1. **Explain the meaning of bandwidth used in networking: bps, bandwidth of signal, bandwidth of communication medium.**

   (a) bps. Bandwidth in bps is used to measure the maximum amount of bits of data that can be transferred from one side to another with in one second. It refers to the real transmission capacity of a connection and typically determines the speed of a network or the Internet connection.

   (b) bandwidth of signal. The bandwidth of a signal is defined as the difference between the upper and the lower frequencies of the signal generated. It is typically measured in hertz. Sometimes, cutoff bandwidth also represents the difference between the highest and lowest cutoff frequencies of a signal spectrum.

   (c) bandwidth of communication medium. A signal needs to be transmitted from one side to other side by either a physical wired or air. The medium defines a range of bandwidth. Only the signals whose frequencies in the range of bandwidth can be successfully transmitted. The range of bandwidth varies from medium to medium.

2. **Why are cutoff bandwidths that are too small or too large detrimental to the audio quality decoded from the electromagnetic waves used to carry analog data?**

   If the cutoff bandwidths are too small, the remaining frequencies in the range of bandwidths are not enough to correctly decode the analog data in the time domain, because we drop too many frequencies that may have much contribution to the original signal.

   If the cutoff bandwidths are too large, the inter-channel interference might happen. The spectra of several signals may overlap, so it is difficult to decode each signal correctly. For example, we have two signals whose main frequency are 100 MHz and 101 MHz respectively. If the cutoff bandwidth is 2 Hz, their spectra will overlap and can hardly be used to decode.

3. **See if you can do the same for aviation frequencies in the AM modulated aviation band (about 122 MHz to 136 MHz).**

   Personally I believe if the cutoff bandwidth is too small or too large, it is still detrimental to the audio quality. If it is too small, some frequencies are missing so it's hard to reconstruct the original waves. If it is too large, it might overlap with other signals.

4. **How can SDR software such as CubicSDR using FFT spectrum output (in our case graphical waterfall) help determine a good cutoff bandwidth?**

   SDR software will transform the signals as spectrum using FFT. In the spectrum graph, there will be several waterfalls. One waterfall might represent a meaningful sound. We first select the middle of the waterfall as the center of the cutoff bandwidth, and then adjust the width of bandwidth to make the decoded audio quality better. When reaching a proper cutoff bandwidth, we are able to listen to the meaningful radio instead of noise.