Computer Networks Laboratory

Assignment 4

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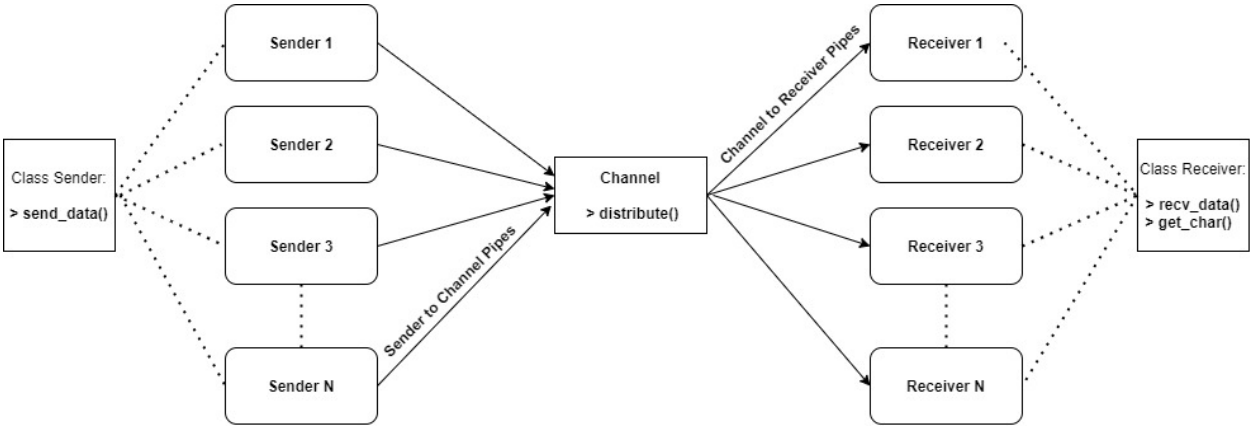
Problem Statement:

Implement CDMA with Walsh code

In this assignment you have to implement CDMA for multiple access of a common channel by n stations. Each sender uses a unique code word, given by the Walsh set, to encode its data, send it across the channel, and then perfectly reconstruct the data at n stations.

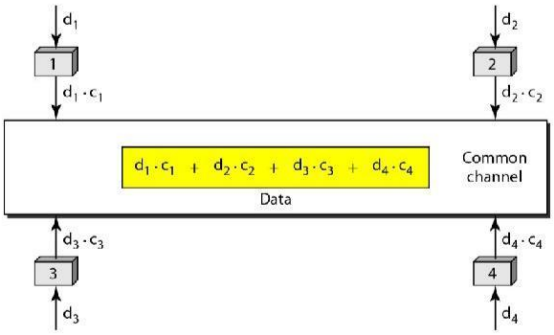
Design:

CDMA has been implemented in this assignment. In the main.py file, walsh table is built for encoding data. Pipes have been created for transfer between sender and channel and receiver. Data is transferred from senders to channel using one pipe. For transfer from channel to receiver, a pipe has been created for each receiver. In main, user has to give input of the number of bytes that have to be transferred from sender to receiver. In each sender, those many characters have been randomly generated and sent to the channel. The channel adds data received from each sender and then sends the same data to all receivers. The receiver receives the data from the channel and extracts data sent to it from the corresponding sender. When it has received the full byte it writes the byte to the corresponding output file. After the senders have completed sending all the bytes, the bytes sent, delay and throughput are written to a file. The operations occurring like sending data, receiving data are written to a file continuously. Below is a diagram showing the design.



CDMA Design Implementation

CDMA stands for Code Division Multiple Access. It is basically a channel access method and is also an example of multiple access. There are multiple users which are provided or assigned variant CDMA codes and thus the users can access the entire band of frequencies or the whole bandwidth. This method does not limit the frequency range of the user. Hence, with the help of CDMA, multiple users can share a band of frequencies without any kind of undue interference between them. A full spectrum is used by all the channels in CDMA. There is no particular limit to the number of users in a CDMA system but with increase in the number of users the performance degrades.



Sharing Channel in CSMA

Code Snippets:

```
def sendData(self):
    startTime = time.time()
    bytec=0
    totalBitSent = 0
    bytec=self.c
    while self.c>0:
        byte=chr(64+random.randint(1,26))
        #print(byte)
        data = '{0:08b}'.format(ord(byte))
        for i in range(len(data)):
            dataToSend = []
            dataBit = int(data[i])
            if dataBit == 0: dataBit = -1

            for j in self.walshCode:
                dataToSend.append(j * dataBit)
            self.senderToChannel.send(dataToSend)
            with open('lg.txt', 'a+', encoding='utf-8') as rep_file:
                rep_file.write(str("Sender{} || Data bit send {}\n".format(self.name+1, dataBit)))
            time.sleep(0.1)
        self.c-=1
    with open('lg.txt', 'a+', encoding='utf-8') as rep_file:
            rep_file.write(str("Sender{} || DONE SENDING\n".format(self.name + 1)))
    print("Sender{} || DONE SENDING".format(self.name + 1))
    with open('Res/res'+str(self.name)+'.txt', 'w', encoding='utf-8') as rep_file:
        rep_file.write("\tBytes sent : {}".format(bytec)+"\n"+\
            "\tTotal Delay: {} secs".format(round(time.time() - startTime, 2)) + '\n' + \
                    "\tThroughput : {}".format(const.totalSenderNumber*bytec/round(time.time() - startTime, 2)) +  '\n')
```

The sending of data takes place in sender.py using the following sendData function

```
def channeldata(self):
    while True:
        for i in range(const.totalSenderNumber):
            self.syncValue += 1
            data = []
            data = self.senderToChannel.recv()
            with open('lg.txt', 'a+', encoding='utf-8') as rep_file:
                rep_file.write("Channel || " + str(data)+"\n")
            for i in range(len(data)):
                self.channelData[i] += data[i]
            if self.syncValue == const.totalSenderNumber:
                for receiver in range(const.totalReceiverNumber):
                    self.channelToReceiver[receiver].send(self.channelData)
                # Resetting channelData for next bit transfer
                self.syncValue = 0
                self.channelData = [0 for i in range(len(data))]
```

The channeldata function in channel.py adds data from all senders and sends to receivers

```python
def receiveData(self):
    with open('lg.txt', 'a+', encoding='utf-8') as rep_file:
        rep_file.write(str(" Receiver{} will receive data from Sender{}\n".format(self.name+1,self.name+1,self.sender+1)))
    totalData = []
    while True:
        channelData = self.channelToReceiver.recv()
        # extract data
        summation = 0
        for i in range(len(channelData)):
            summation += channelData[i] * self.walshTable[self.sender][i]

        # extract data bit
        summation /= self.codeLength
        if summation == 1:
            bit = 1
        elif summation == -1:
            bit = 0
        else: bit = -1

        with open('lg.txt', 'a+', encoding='utf-8') as rep_file:
            rep_file.write(str("Receiver{} || Bit received: {}\n".format(self.name+1, bit)))

        if len(totalData) < 8 and bit != -1:
            totalData.append(bit)

        if(len(totalData) == 8):
            character = self.getCharacter(totalData)
            outFile = self.openFile(self.sender)
            outFile.write(character)
            outFile.close()
            totalData = []
```

The receiveData function in receiver.py accepts data from channel and extracts data bit and when it has receiver full byte it gets the character that was sent to it by sender and writes it to corresponding output file.

```python
def buildWalshTable(length, i1,i2, j1,j2, isComplement):
    if length == 2:
        if not isComplement:
            wTable[i1][j1] = 1
            wTable[i1][j2] = 1
            wTable[i2][j1] = 1
            wTable[i2][j2] = -1
        else:
            wTable[i1][j1] = -1
            wTable[i1][j2] = -1
            wTable[i2][j1] = -1
            wTable[i2][j2] = 1
        return
    midi = (i1+i2)//2
    midj = (j1+j2)//2

    buildWalshTable(length/2, i1, midi, j1, midj, isComplement)
    buildWalshTable(length/2, i1, midi, midj+1, j2, isComplement)
    buildWalshTable(length/2, midi+1, i2, j1, midj, isComplement)
    buildWalshTable(length/2, midi+1, i2, midj+1, j2, not isComplement)

    return
```

Function to build Walsh table in main.py

Results:

An observation table for throughputs of various “input size” and different “total senders” in the system.

TABLE 1

No. Of Senders	**String Size** (in bytes)	**Delay** (in s)	**Throughput** (in bytes/s)
2	5	5.030	1.992
	10	10.310	1.932
	20	20.535	1.957
	30	30.955	1.938
	50	51.715	1.934
4	5	4.960	4.032
	10	10.285	3.890
	20	20.372	3.927
	30	30.782	4.092
	50	50.045	4.027
8	5	4.765	8.394
	10	9.625	8.311
	20	19.201	8.339
	30	29.797	8.054
	50	47.843	8.536
16	5	4.514	16.778
	10	9.545	16.763
	20	18.786	17.035
	30	27.910	17.198
	50	46.592	17.171

32	5	4.855	32.961
	10	9.599	33.339
	20	31.308	20.443
	30	54.552	17.599
	50	110.285	14.508
64	5	5.659	56.786
	10	34.639	18.478
	20	90.964	14.072
	30	130.447	14.719
	50	236.521	13.53

TABLE 2

NO. OF SENDERS	AVERAGE THROUGHPUT
2	1.950
4	3.993
8	8.327
16	16.988
32	**23.770**
64	**23.517**

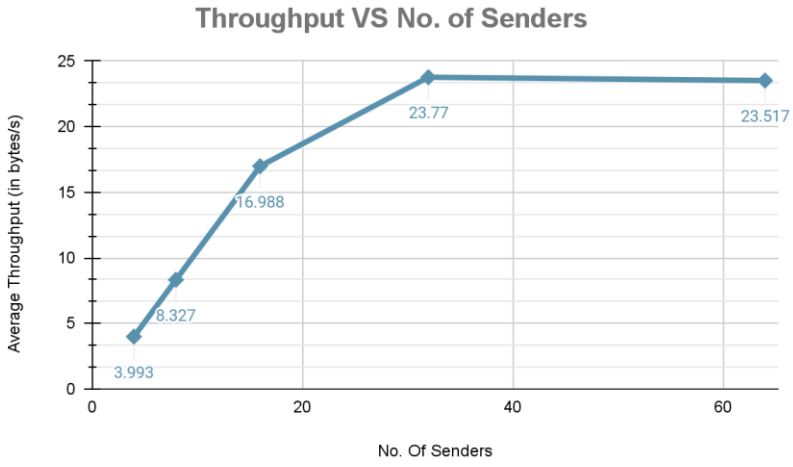
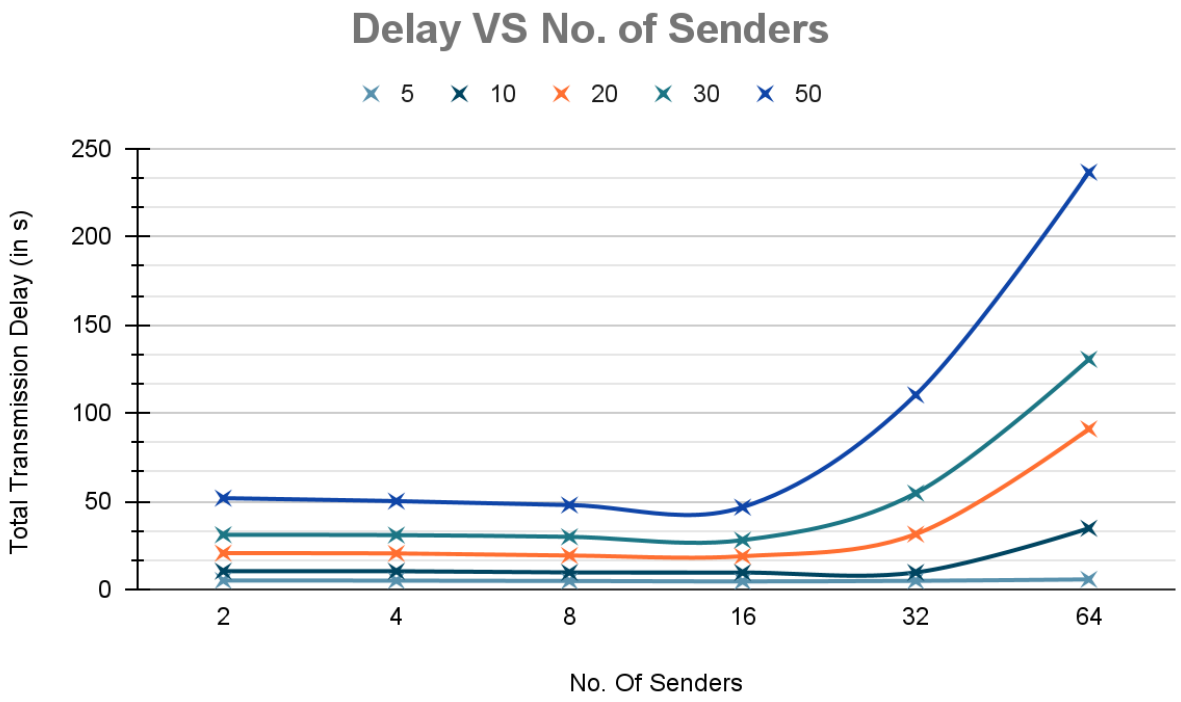


TABLE 3

NO. OF SENDERS	RANGE (MAX-MIN) OF THROUGHPUT
2	0.06
4	0.20
8	0.48
16	0.44
32	**18.331**
64	**43.256**

The unusual increase in the range value for 32 & 64 senders shows the delay produced while operating with walsh table of larger size.



This chart depicts the delay in transmission for different data-packet size and number of senders.

Analysis:

The throughput increases as we increase the number of senders as depicted in TABLE 2 and CHART 1. However, this linear increase is evident only for a fixed amount of senders, 16 in this case, after which there is a slight increase for 32 senders and a decrease for 64 senders.

The same phenomenon is observed for Total Delay VS Senders graph. The Delay is constant for all number of packets till 16 senders, after which there is a steep rise in the graph showing a huge time consumption for large number of senders (32 & 64).

This is mainly caused due to the increased size of Walsh Table for 32 and 64 senders. As a result it takes more time to traverse the entire table and operate on the data to obtain the throughput.

We have also compared the Range of Throughput values for different senders with varying input size. The increased range for 32 & 64 senders proves the above statement.

Improvements:

As I have not considered any flow control protocol, no errors have been injected in the data. Absence of errors in all packets deviates from practical scenarios.