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Advancement in ARPANET

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ABSTRACT

Here we propose a scheme to increase the throughput of ARPANET to nearly 100 Mbps. We look into the possibility of using CMOS circuits to implement the idea and the option of Q-dot device is also kept. We increase the capacity by using double codes and 4 levels PAM modulation for CDMA transmission.

1.0 INTRODUCTION

Wireless communication is evolving according to advancement in wireless technology. Recent demand in research is for high speed data transmission nearing 1Gb/s rate in the wireless indoor and outdoor local area networks [1][2]. Designing very high speed wireless links that offers good quality of services in absence of line of sight communication offers a significant research and engineering challenge. 1Gb/s transmission means the bandwidth (measured in Hz) and spectral efficiency (measured in bits/sec/Hz) product reaches a billion. In this article we find Wideband Code Division Multiple Access (WCDMA) as a solution to the problem along with a PAM modulation scheme for 100Mbps. This could be increased further if we can implement communication for in-phase and quadrature-phase and further if we modulate Hx and Hy. In absence or in presence of fading this is sufficient to meet the goal of near 100M bits/second, though the A/D design in baseband is alleviated which is prime point of discussion here.

The organization of this article is as follows. The Section I introduces the subject. The Section II describes how and why we should use pseudorandom codes to increase the capacity, while using optimum receiver. The next section deals with the noise increase in the receiver and overall decrease in performance due to increase in capacity. The Section IV introduces the concept of analog adders without using OP-Amp and their optimization. The Section V talks about magnetic resonance antenna which performs as filter with gain. The next Section describes the schematic of the receiver. We conclude the paper in the following Section.

2.0 CODE

In the reference [3] we describe QAM modulation for transmission through cable. But cable cannot transmit over long distance due to its low pass characteristic and high decible rejection in filter of unwanted signal. We use magnetic resonance antenna which has a bandpass characteristics of LC resonator. Here we try to use QAM CDMA, but with only in-phase component. This is used because quadrature phase can get extra delay in wireless transmission and destroy the in-phase component. Thus we look for multiple pseudo random codes which are like 1001011 and 1001110 for length 7. We increase the number of codes to 14 by rotating each PRN sequence. This is very good except the cross correlation between two different PRN codes are high as given by -1, 3 and -5. Moreover we need large number of adders which is not welcome. Hence we look into other possibility of truncated PRN codes of length 5. The codes for that are 10010 and 10011. We also find that for length of 3, we can have five codes [010 , 100 , 001, 111]]. The last code we get by delay the codes by 3/4of Tc using delay locked loop (DLL).

Now we can find the throughput of the internet: the bandwidth considered is 30 MHz, only in-phase components. Hence we get 30Mbps and it is multiplied by 5/3 of increased number of user. Lastly we increase the throughput by 2 using PAM modulation which has 4 levels. This gives a total of 100 Mbps over many channels with magnetic resonance antennas.

3.0 CROSS-CORRELATION

We have to understand that the increase in number of users comes with a higher noise variance. So we calculate the correlation matrix and its corresponding inverse matrix for decorrelating detector[4]. We first choose 14 users with length 7 and calculate the increase in noise. It is synchronous CDMA and hence it is quite simple.

$$R = \begin{bmatrix} 7 & -1 & \dots & -1 & 5 & -1 & -1 & \dots & -1 \\ -1 & 7 & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & 7 & -1 & \dots & \dots & \dots & \dots & \dots \\ -1 & -1 & \dots & 7 & \dots & \dots & \dots & \dots & \dots \\ 5 & \dots & \dots & \dots & 7 & -1 & -1 & \dots & -1 \\ -1 & \dots & \dots & \dots & -1 & 7 & -1 & \dots & -1 \\ -1 & \dots & \dots & \dots & -1 & -1 & 7 & \dots & -1 \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & 7 & -1 \\ -1 & \dots & \dots & \dots & -1 & -1 & -1 & \dots & 7 \end{bmatrix}$$

Next we consider 10 users of length 5. The codes are 10100 and 10001. This has a attenuation of signal strength 5/7. Its correlation matrix is given below.

$$R = \begin{bmatrix} 5 & -3 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & -3 \\ -3 & 5 & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ 1 & \dots & 5 & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ 1 & \dots & \dots & 5 & \dots & \dots & \dots & \dots & \dots & \dots \\ 1 & \dots & \dots & \dots & 5 & \dots & \dots & \dots & \dots & \dots \\ 1 & \dots & \dots & \dots & \dots & 5 & 1 & -3 & -3 & 1 \\ 1 & \dots & \dots & \dots & \dots & \dots & 5 & \dots & \cdots & \ddots \\ 1 & \dots & \dots & \vdots & \vdots & \vdots & \dots & 5 & \dots & \dots \\ 1 & \dots & \dots & \dots & \dots & \dots & \dots & \dots & 5 & \dots \\ -3 & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & 5 \end{bmatrix}$$

Lastly, we consider a length of 3 which has signal strength reduction to 3/7. Its correlation matrix is given below with the inverse of the matrix.

$$R = \begin{bmatrix} 3 & 0 & -1 & 0 & -1 \\ 0 & 3 & 0 & -1 & -1 \\ -1 & 0 & 3 & 0 & -1 \\ 0 & -1 & 0 & 3 & -1 \\ -1 & -1 & -1 & -1 & 3 \end{bmatrix}$$

$$\mathrm{inv}(R) = \begin{bmatrix} .625 & .25 & .325 & .25 & .5 \\ .25 & .625 & .25 & .325 & .5 \\ .325 & .25 & .625 & .25 & .5 \\ .25 & .325 & .25 & .625 & .5 \\ .5 & .5 & .5 & .5 & 1 \end{bmatrix}$$

We compare the attenuation of signal and increase in noise variance (twice for chip length 3) for the three cases mentioned above. Also we look into the implementation of adders in feed forward or in feedback network in analogue domain which replaces the matrix inversion. We use a receiver which is given in reference [4] which is again explained here. The mathematically the receiver is a double integration process. In bode plot we can draw the -20dB per decade curve from frequency 1 Hz and the other curve is of a high pass RC network centered at 1000 Hz of 10dB/decade. We expect the signal to be at higher than 5 KHz. Hence it will result into a curve with -30dB at 1Hz and -60dB at 1000 Hz in power. This is shown in Figure 1.

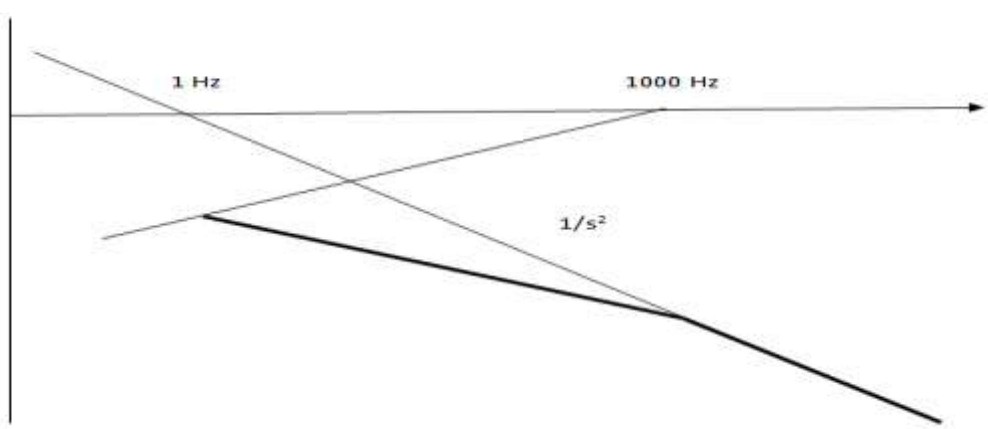

Figure 1. Noise reduction in optimum CDMA receiver-bode plot.

Hence, the overall noise increase will be a curve -24 dB down and the signal power will be 3dB less than usual due to integration. This is better for longer chip sequence with higher complexity in adder. Here 0 dB is the noise floor if we do not use capacitive receiver for bpsk. Thus we get a gain from transmitter and a gain from antenna. The last gain is from capacitive receiver, thus we can find the noise floor which is mainly the contribution from mixer.

4.0 ADDERS

The adder in analog domain is normally implemented by OP-Amp. But it will be quite big to justify its use here and also their frequency response is not sufficient. To reduce the burden further we choose the feedback circuits [4] in the receiver which has least number of adders. Hence our choice of length of chip sequence is 3, just because it requires 2 adders for 4 users (noise variance is twice) and 4 adders for the fifth user(noise variance is thrice).

In this section we propose an adder by connecting two inverters output to a single resistor. It is shown in Figure 2.

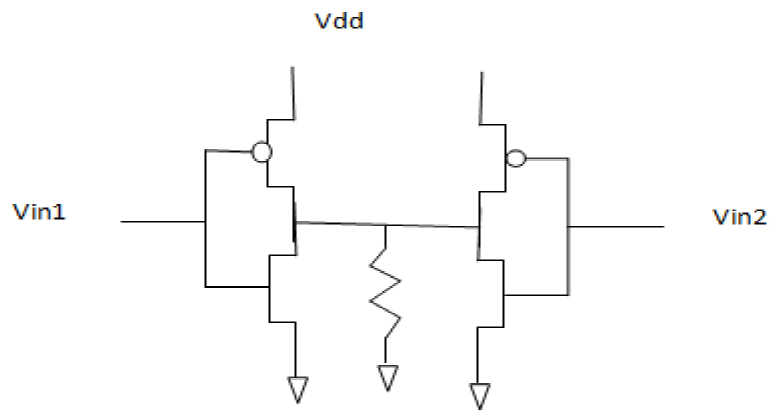

Figure 2. Adder with inverted output.

The resistor is helpful in damping the feedback circuit. It is quite simple to get the small signal analysis.

5.0 MAGNETIC RESONANCE ANTENNA

Here the resonating circuit and the filling material are different. Both together make it an antenna which has band pass filter characteristics (for resonating current). It is a parallel plates of capacitor filled with paramagnetic material. There is a inductor circuit around the capacitor all giving the magnetic field in the same direction perpendicular to the electric field between the capacitor plates. The induced magnetic field due to changing electric field is circular perpendicular to the Electric field between the plates of capacitor. The resonating electric field(E) and magnetic field (B) (in L and C) will be magnified due to the magnetic resonance which produces the magnetization vector M. The resonating frequency can be found out by equating the electric energy and magnetic energy that should be equal to the magnetic resonance frequency.

The equations are as followed from Feynmann's Lectures on Physics[5]. The figure 3 explains the circuit and the inductor circuit.

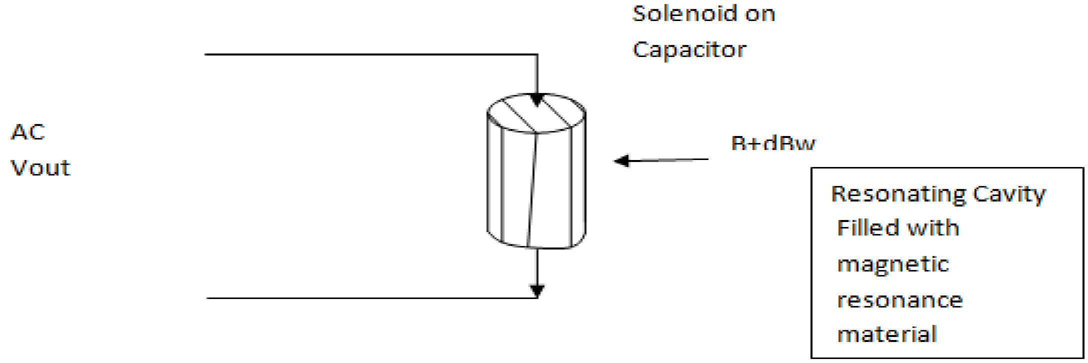

Figure 3. To add resonance in multiplicative way.

The magnetization vector M is calculated

$$M = Ng^2 \frac{j(j+1)}{3kT} \mu_B^2 B$$

Where $B=B_{solenoid}$+dBw and dbw is the signal at the resonating frequency.

$B_{solenoid} = \mu ni$, where n is the number of turn and i is the current. We can calculate the emf generated across the solenoid. We also can calculate the E for B including M. The circuit resonate at frequency w_p. For that $B=2m_p w_p/gq_e$ where the equation is as explained by Feynman.

We expect a higher Q for this resonance than Prof Richtmyre found for Dielectric Resonance. We hope we can demodulate PAM-CDMA as given in the next Section..

6.0 SCHEMATIC DIAGRAM

We know that the receiver has a structure as stated in reference [4]. The difference is that we like to double the number of users by using PAM signaling whether it is possible demodulate. We understand that the receiver is a decorrelating detector. Hence it is possible. We use 3 comparators with -2, 0, 2 as Vref of the comparator assuming the signal constellation is -3, -1, 1, 3. In reality the values are found by finding the MAX and MIN. The middle Vref is average of these two term. The other ones are MAX*2/3 (change) and MIN*2/3. The outputs are 111, 011, 001, 000. To convert them to 11, 10, 01 and 00, we minimize the function using Karnaugh Map. The minimized function is B(1)=XY and B(0)= Y.(X xnor Z).

Thus, for 100KHz bandwidth in antenna, we can transmit five 200/3 Kbps signals. The diagram is shown in Figure 4.

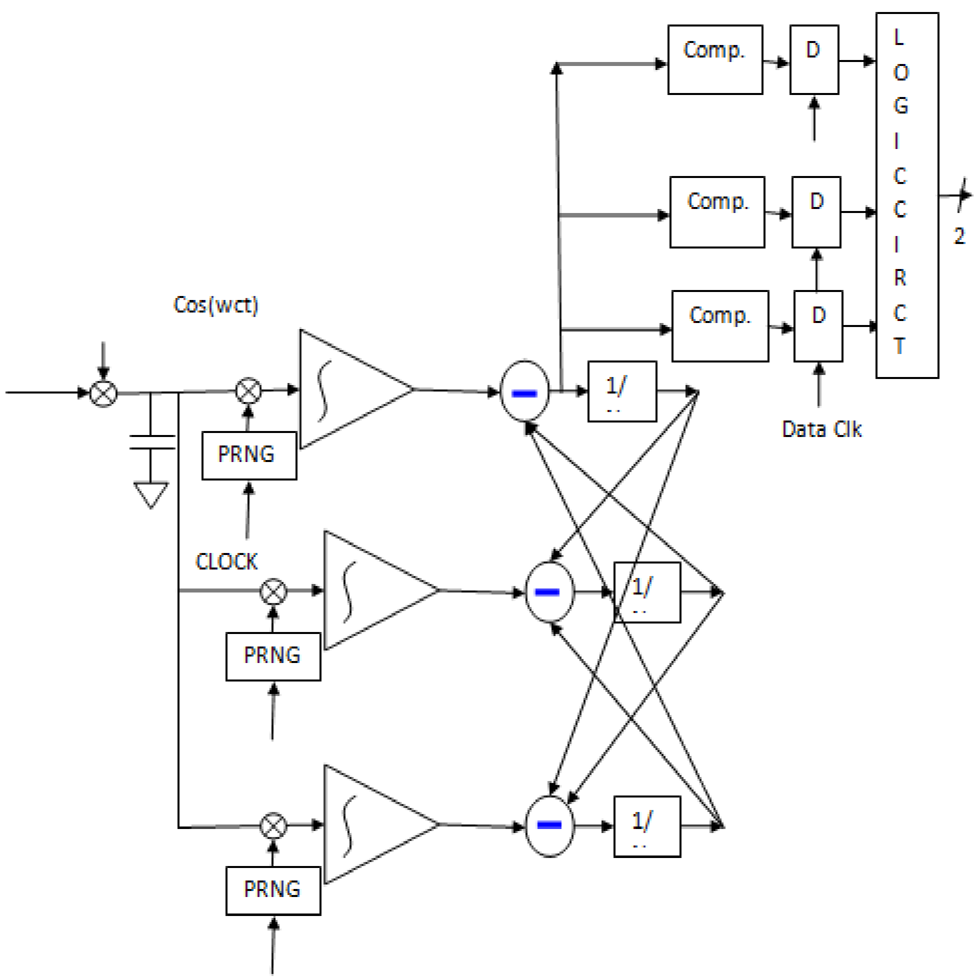

Figure 4. Receiver. It has extra blocks like clock recovery PLL and DLL.

CONCLUSION

Here we achieve a theoretical prediction of increase in capacity of internet (ARPANET) to 100 Mbps. We have given the necessary innovation in hardwire to get that performance. If we use Q-dot device for the receiver it will need less power.

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