Enhancing Quality of Service using OFDM Technique for Next Generation Network

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ABSTRACT
The migration to 4G networks will bring a new level of expectation to wireless communications. As after digital wireless revolution made mobile phones available for everyone, the higher speeds and packet delivery of 4G networks will make high quality multimedia available everywhere. The key to achieving this higher level of service delivery is a new air interface, OFDM, which is in turn enabled by the high level of performance. OFDM provides a robust signal that requires relatively little power yet uses bandwidth very efficiently. Carriers will benefit from greater flexibility by using OFDM, since in the same spectrum they will be able to offer more channels, including higher-bandwidth channels, with more types of services. Currently these systems are still being defined and prototyped. Achieving higher data rates requires OFDM systems to make more efficient use of the bandwidth than CDMA systems. One method of achieving this higher efficiency is through the use of higher order modulation. In this paper we have compared two digital modulation techniques QPSK and DQPSK used for digital transmission of data. Our main objective to develop this configuration is to compare the performance of each modulation techniques. Comparison is done by Bit Error Rate analysis of both modulation techniques. We have developed existing configurations and improved them with high quality senders and receivers using MATLAB technology. In this paper we have also considered how OFDM can improve the real time video streaming over the wireless network. We have considered the problem of multiuser video streaming over OFDM. OFDM is a multi carrier modulation. The growing interest in Multi-Carrier Transmission by researchers and product developers motivated us to propose this topic for a special issue of Wireless Video transmission and Communications.

General Terms

Performance, Design, Verification.

Keywords
QPSK- Quadrature Phase Shift Keying, DQPSK- Differential Quadrature Phase Shift Keying, OFDM-Orthogonal Frequency Division Multiplexing. QoS-Quality of service

1. INTRODUCTION
In OFDM, usable bandwidth is divided into a large number of smaller bandwidths that are mathematically orthogonal using fast Fourier transforms (FFTs). Reconstruction of the band is performed by the inverse fast Fourier transform (IFFT). One beneficial feature of this technique is the ease of adaptation to different bandwidths. The smaller bandwidth unit can remain fixed, even as the total bandwidth utilization is changed. For example, a 10-MHz bandwidth allocation may be divided into 1,024 smaller bands, whereas a 5-MHz allocation would be divided into 512 smaller bands. These smaller bands are referred to as subcarriers and are typically on the order of 10 kHz. One challenge in today's wireless systems is an effect called 'multipath.' Multipath results from reflections between a transmitter and receiver whereby the reflections arrive at the receiver at different times. The time span separating the reflection is referred to as delay spread. This type of interference tends to be problematic when the delay spread is on the order of the transmitted symbol time. Typical delay spreads are microseconds in length, which are close to CDMA symbol times. OFDMA symbol times tend to be on the order of 100 microseconds, making multipath less of a problem. In order to mitigate the effect of multipath, a guard band of about 10 microseconds, called the cyclic prefix, is inserted after each symbol. Achieving higher data rates requires OFDM systems to make more efficient use of the bandwidth than CDMA systems. The number of bits per unit hertz is referred to as the spectral efficiency. One method of achieving this higher efficiency is through the use of higher order modulation. Modulation refers to the number of bits that each subcarrier transmits. The design consideration of OFDM scheme has been discussed in past [1].

2. RELATED WORK
In the PSK digital modulation techniques, the Phase is the main parameter on which work is carried out. In our configuration we have taken AWGN channel (Gaussian Channel) where white Gaussian noise is added to the signal and that noisy signal is sent towards the receiver that is recovered with appropriate demodulator and decoders. The Wireless LAN standard, IEEE 802.11b, uses a variety of different PSKs depending on the data-rate required. At the basic-rate of 1Mbit/s, it uses DBPSK (differential BPSK). To provide the extended-rate of 2 Mbit/s, DQPSK is used. In reaching 5.5 Mbit/s and the full-rate of 11 Mbit/s, QPSK is employed, but has to be coupled with complementary code keying. The higher-speed wireless LAN standard, IEEE 802.11g has eight data rates: 6, 9, 12, 18, 24, 36, 48 and 54 Mbit/s. The 6 and 9 Mbit/s modes use OFDM modulation where each sub-carrier is BPSK modulated. Many parameters for managing basic QoS for next generation network have been discussed in past [8] [10].

Multi-Carrier Modulation (MCM) is the principle of transmitting data by dividing the stream into several parallel bit streams, each of which has a much lower bit rate, and by using these sub streams to modulate several carriers. OFDM abandoned the use of steep band pass filters that completely separated the spectrum of individual subcarriers, as it was common practice in older Frequency Division Multiplex (FDMA) systems. OFDM time-domain waveforms are chosen such that mutual orthogonality is ensured even though subcarrier spectra may overlap. It appeared that such waveforms can be generated using a Fast Fourier Transform at the transmitter and receiver.

3. ORTHOGONAL FREQUENCY DIVESION MULTIPLEXING (OFDM)

OFDM is a combination technique between modulation and multiplexing. Modulation is a mapping of the information on changes in the carrier phase, frequency or amplitude or their combination. Meanwhile, multiplexing is a method of sharing a bandwidth with other independent data channel. In multiplexing, independent signals from different sources are sharing the channel spectrum. In OFDM, multiplexing is applied to independent signals but these independent signals are a sub-set of the one main signal. In OFDM the signal itself is first split into independent channels, modulated by data and then re-multiplexed to create the OFDM carrier.

The multicarrier transmission technique uses the discrete Fourier transform. By using a DFT, the whole bandwidth will be split into N sub channels. As a result, a high data stream will be transformed into N low rate streams, which are transmitted over different sub-channels. OFDM symbols, which contain several modulation symbols, are formed as linear combinations of mutually orthogonal complex exponentials of finite duration [12].

The splitting of high rate data stream into a number of lower rate streams results in the increase of symbol duration. Mean while a lower rate parallel subcarriers reduces the relative amount of dispersion in time caused by multipath delay spread. Therefore OFDM is an advanced modulation technique which is suitable for high-speed data transmission due to its advantages in dealing with the multipath propagation problem and bandwidth efficiency.

Fig: 1 show the spectrum of individual sub channel and the spectrum of the entire OFDM signal respectively. It can be noticed that there is no crosstalk from other channels at the center frequency of each subcarrier. As Fig: 2 shows the parallel transmission of data over multiple simultaneous carriers makes the OFDM system to be more robust against frequency selective fading or narrowband interference; some subcarriers may be degraded.

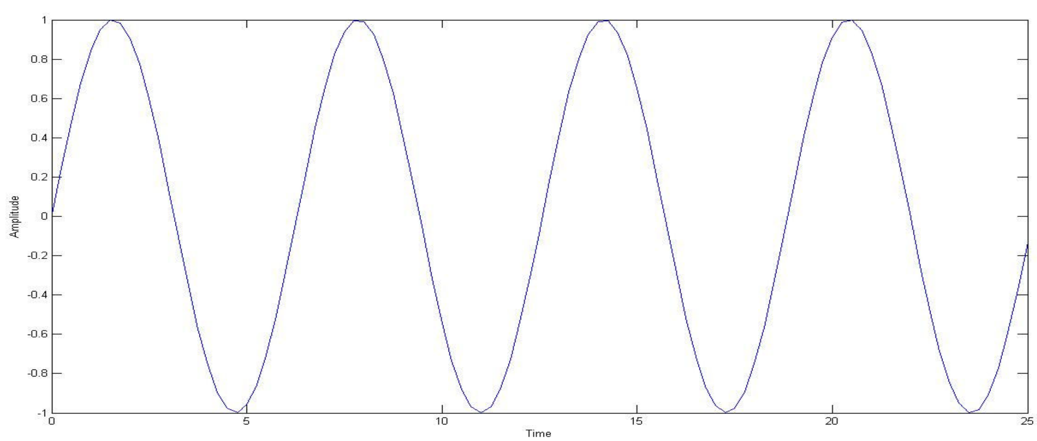

Fig 1 : Frequency Plot for sigle carrier signal

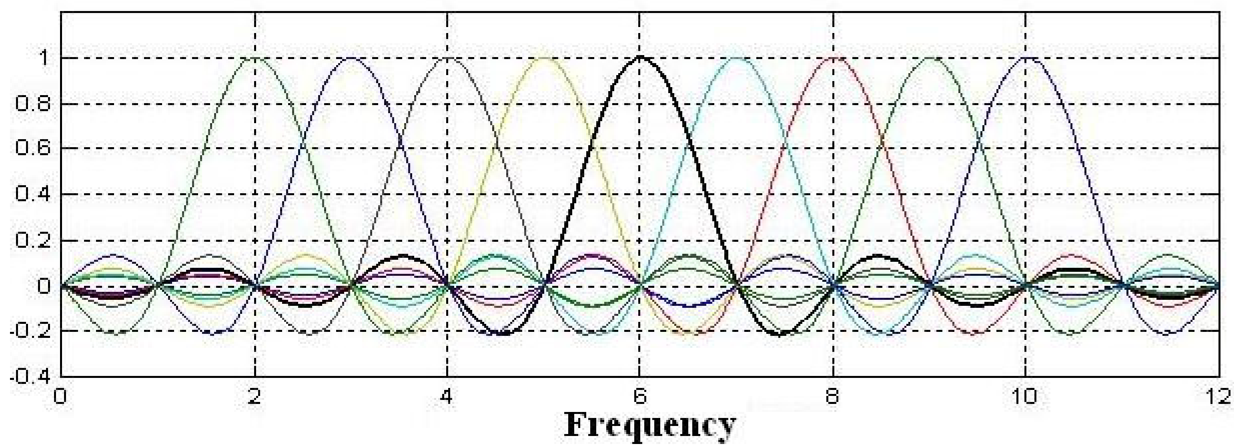

Fig 2 : Frequency Plot for Multi carrier signal

3.1 QPSK MODULATION

Quadrature Phase Shift Keying is also called as 4- PSK where 4 phases are used. In QPSK modulation a cosine carrier is varied in phase while keeping a constant amplitude and frequency. QPSK uses four points on the constellation diagram, equispaced around a circle. With four phases, QPSK can encode two bits per symbol, with Gray coding to minimize the BER — twice the rate of BPSK. Analysis shows that this may be used either to double the data rate compared to a BPSK system while maintaining the bandwidth of the signal or to maintain the data-rate of BPSK but halve the bandwidth needed. The QPSK signal consists of two parts in phase and quadrature phase. In phase gives the real part of the signal and quadrature gives the imaginary part of the signal.

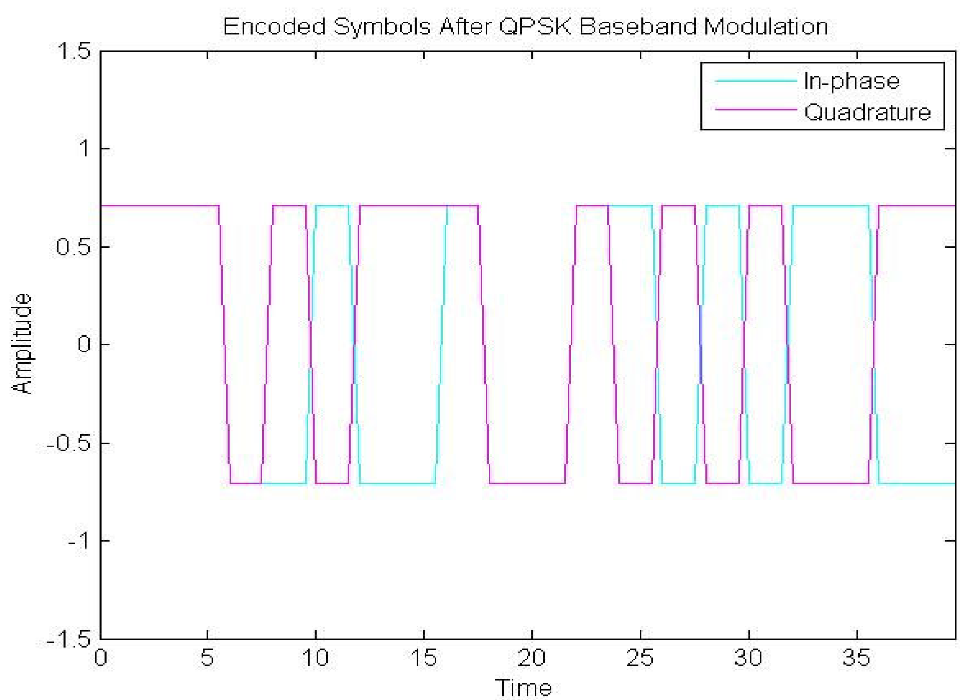

Fig-3Signal waveform after QPSK modulation

3.2 DQPSK MODULATION

Differential Quadrature Phase Shift Keying is also 4- PSK modulation that overcomes the limitation of the earlier QPSK modulation. Here also Phase is the main parameter. This uses change in the bit pattern to define the phase. The Phase is sent to the receiver.

This kind of encoding may be demodulating in the same way as for non-differential PSK but the phase ambiguities can be ignored. From the Fig-4 we can easily analyze that in DQPSK modulation change in the phase is sent. This type of modulation is relatively simple then QPSK modulation. DQPSK modulation is more prone to errors.

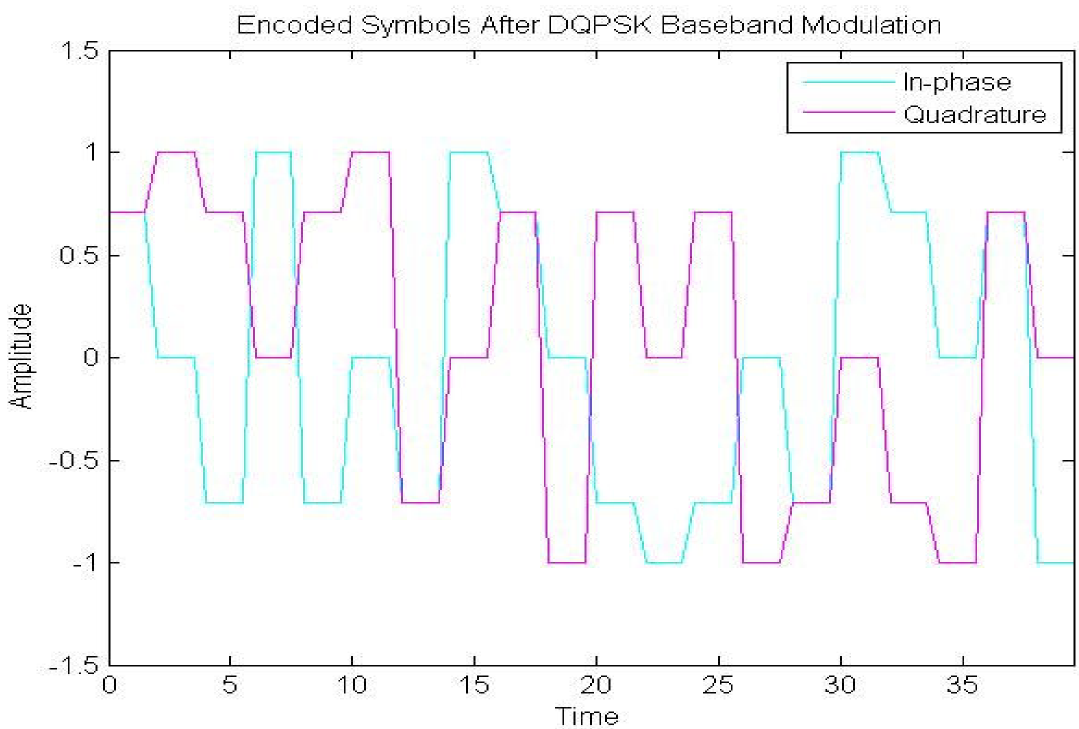

Fig-4 Signal waveform after DQPSK modulation

4. METHODOLOGY AND CHANNEL MODEL CONFIGURATION

As mentioned in the introduction, in this paper we have compared the configuration of QPSK and DQPSK techniques with OFDM technique. Methodology steps of the configuration are as follows:-

1. Data Source
   a. Select the random integer (in the range of 0 to 4).
   b. Select the initial seed point (in the configuration we have taken 3 as seed point)
   c. Select the sample rate (192 samples/ frame in the configuration)
   d. Convert the integer into bits (2bits per integer)
2. Modulation (QPSK/ DQPSK)
   a. Apply the Modulation technique on generated random data source. Output of the modulator baseband is complex type.
   b. Get the real part of the modulated data.
3. Apply OFDM modulation
   a. Divide the carrier into subcarriers (10 sub carriers in the configuration)
   b. Add cyclic redundancy for error detections and correction
   c. Apply IFFT (Inverse Fast Fourier Transform) and take a conjugate symmetry to take real part of the transformed signal.
4. Add Noise to the carriers
   a. Pass the signal over AWGN signal, this can be done by specifying Signal to Noise Ratio (SNR=15 in the configuration)
5. Apply OFDM demodulation
   a. Remove the cyclic redundancy
   b. Apply FFT (Fast Fourier Transform) to the signal
   c. Convert the samples into frame
6. Demodulation (QPSK/DQPSK)
   a. Apply the demodulation technique on the output of OFDM.
   b. Convert the integer into bits

7. Receive the data at the receiver end by converting bits into integer.

By means of an Inverse Fast Fourier Transform (IFFT), the transmitter transforms the frequency domain data samples on several sub-carriers (which are equidistantly distributed in frequency domain) into the time domain, adds a prefix/postfix and transmits the resulting signal over the channel. The receiver cancels the prefix/postfix and uses a Fast Fourier Transform (FFT) to transform the received signal back into the frequency domain. We will dwell on the details of pre-/postfixes in the following section. The number of sub-carriers is usually a power of 2, to allow for efficient implementation of the IFFT/FFT.

One major challenge for the design of an OFDM system is the selection of an appropriate FFT size (number of sub-carriers). In order to avoid OFDM inter-symbol-interference, the length of the guard interval GIT must be larger than the maximum channel impulse response1 However, the guard interval is an additional overhead that should not exceed a certain threshold max η (usually, 25% of the OFDM symbol length). Otherwise, the spectral efficiency would be reduced too much.

OFDM can be seen as either a modulation technique or a multiplexing technique. One of the main reasons to use OFDM is to increase the robustness against frequency selective fading or narrowband interference. The main objective of this paper is to compare OFDM system with QPSK and DQPSK modulation system. For multimedia services high data rate is required. Bit error rate can increased due to interference of multipath and intersymbol during data transmission through wireless channel. Many efforts has been taken in past to design and simulate OFDM techniques on next generation networks [3].

Here we analyze both the techniques with respect to packet loss and bit loss of proposed system and provides best configuration that can be suitable for wireless environments. The Basic architecture of the OFDM techniques is shown as per fig 5.

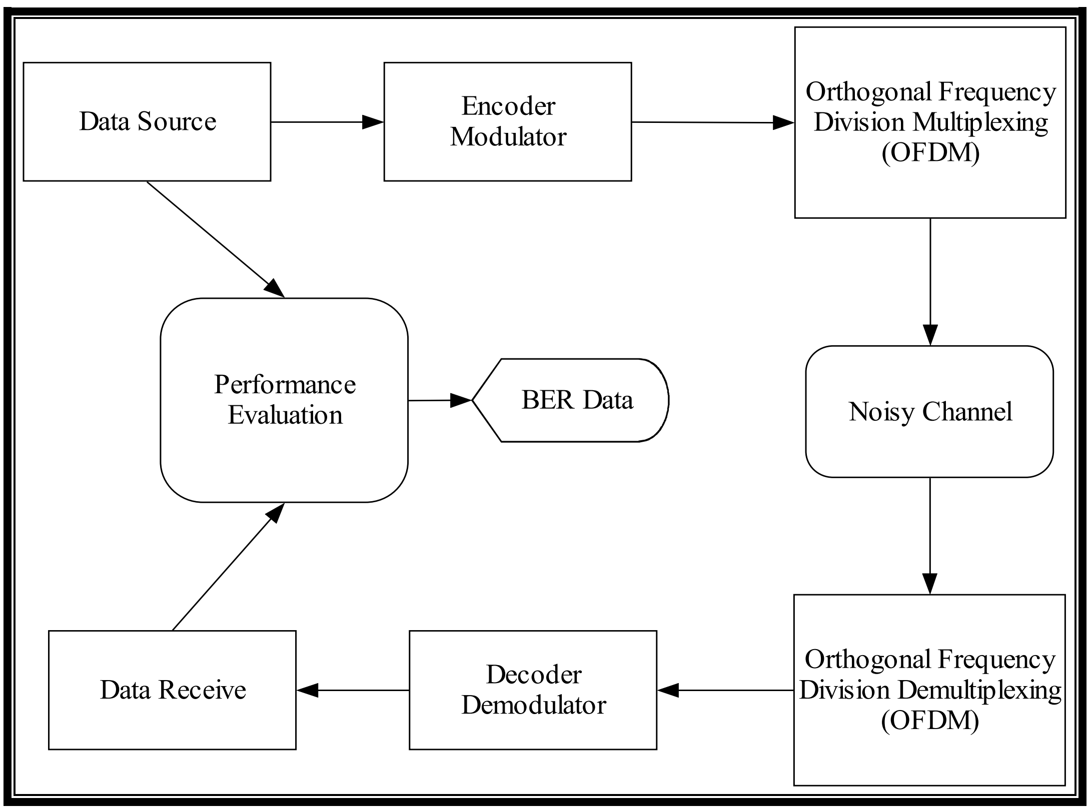

Fig 5: Basic architecture of OFDM technique

4.2 CHANNEL MODEL CONFIGURATION WITH QPSK

The methodology and designed architecture used for QPSK modulation is shown in Fig-6. Input signal can be either analog (real time signal) or digital signal. OFDM techniques using QPSK model was designed using simulink and results were analyzed.

Although QPSK can be viewed as a quaternary modulation, it is easier to see it as two independently modulated quadrature carriers. With this interpretation, the even (or odd) bits are used to modulate the in-phase component of the carrier, while the odd (or even) bits are used to modulate the quadrature-phase component of the carrier.

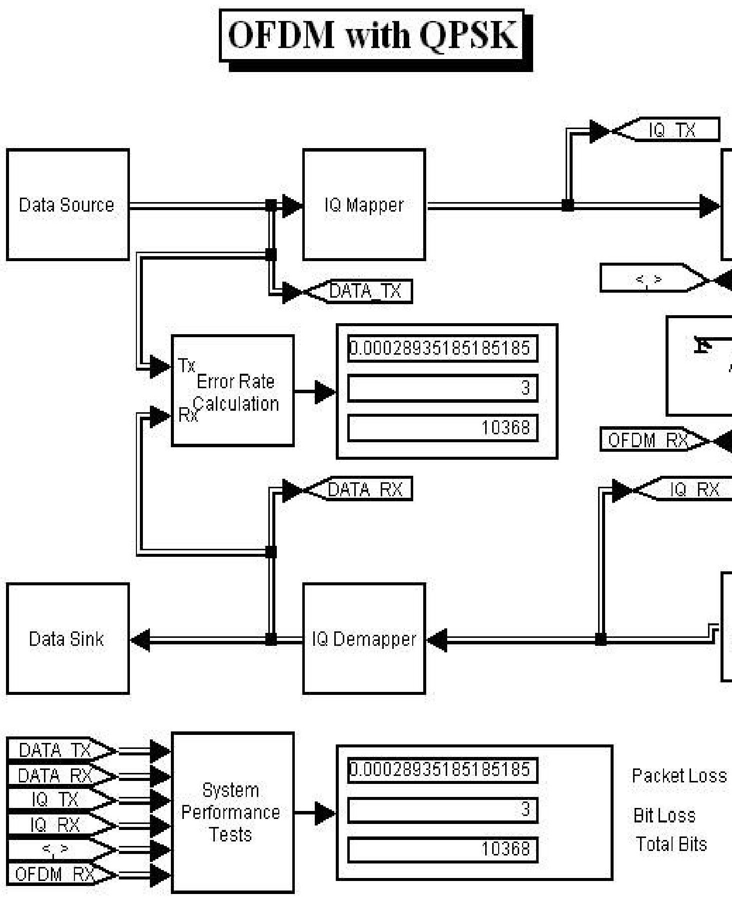

Fig6: Architecture of OFDM with QPSK technique

BPSK is used on both carriers and they can be independently demodulated. Probability of BER in QPSK is given by: -

$$Pb = Q\left(\sqrt{\frac{2Eb}{No}}\right)$$

Probability of Symbol Error Rate (SER) is given by: -

$$Ps = 1 - (1 - Pb)^2$$

$$= 2Q\left(\sqrt{Es/No}\right) - Q^2\left(\sqrt{Es/No}\right)$$

If the Signal to Noise ratio is high then Ps can be normalized as

$$Ps \approx 2Q\left(\sqrt{\frac{Es}{No}}\right)$$

4.3 CHANNEL MODEL CONFIGURATION WITH DQPSK

The methodology and designed architecture used for DQPSK modulation is shown in Fig-6. Input signal can be either analog (real time signal) or digital signal. OFDM techniques using DQPSK model was designed using simulink and results were analyzed.

DQPSK MODULATION AND BER: - The probability of Bit Error Rate is difficult to calculate in DQPSK modulation.

$$P_b = \frac{1}{2} e^{-E_b/N_0}$$

At the higher values of Eb/N0 it gives worse result than QPSK modulation.The methodology and designed architecture used for DQPSK modulation is shown in Fig-6. Many conceptual aspect of QPSK and DQPSK modulation scheme has been discussed in past [7].

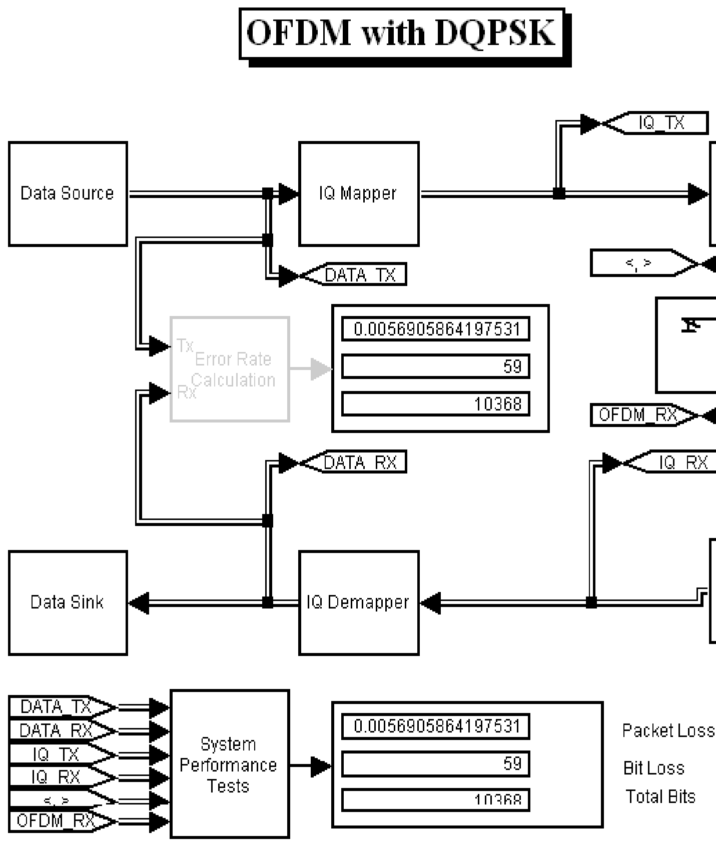

Fig 7: Architecture of OFDM with DQPSK technique

5. PERFORMANCE EVALUATION

In the presented model we have used Bit loss and packet loss evaluating the performance of both the modulation techniques with OFDM. We used MATLAB simulator to implement above model.

Simulation shows that the signal is passed through noisy channel that is AWGN channel after OFDM modulation. Noise immunity can be altered in the signal and BER can be analyzed with different noise immunity. From the simulation results we observed that DQPSK modulation is more prone to errors while transmitting signal through noisy channel than QPSK. Many performance evaluation of OFDM based system has been done earlier [2] [5].

In our configuration 54 frames are transmitted, and each frame contains 192 bits, so total numbers of bits are transmitted as 10368.

Table 1. shows comparative analysis between two modulation scheme using OFDM techniques. Result shows that QPSK scheme having minimum bit loss and packet loss so the QPSK modulation scheme can be efficiently used for 4G networks.

Table1. Comparative Analysis

Modulation	**Total Bits**	**Bit Loss**	**Packet Loss**
DQPSK	10368	59	0.0056905864
QPSK	10368	3	0.0002893518

QPSK SIMULATION RESULT

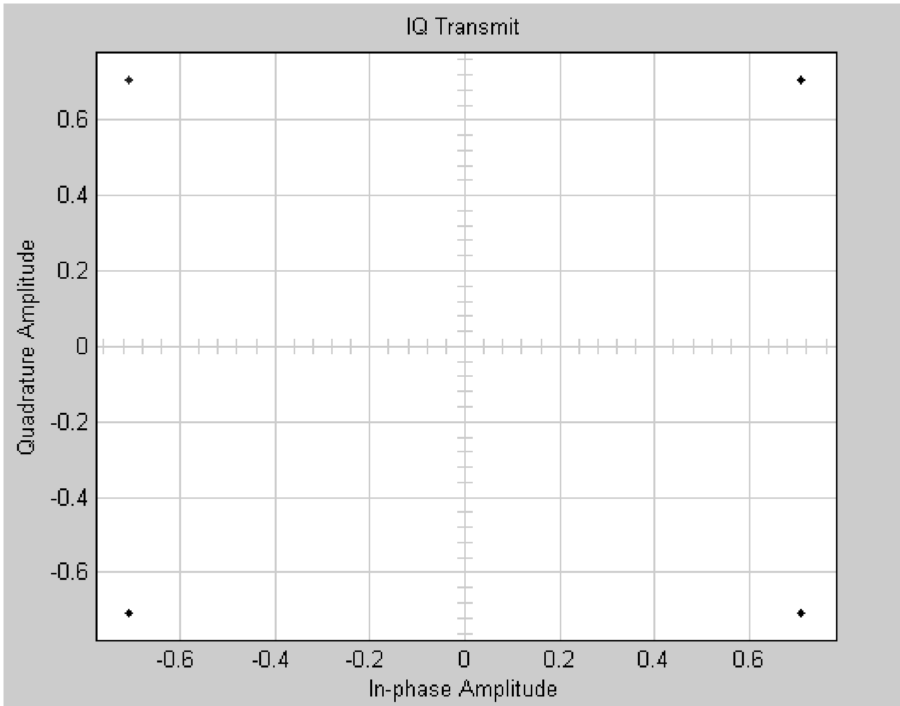

Fig 8: QPSK Transmitter Time Scatter Plot

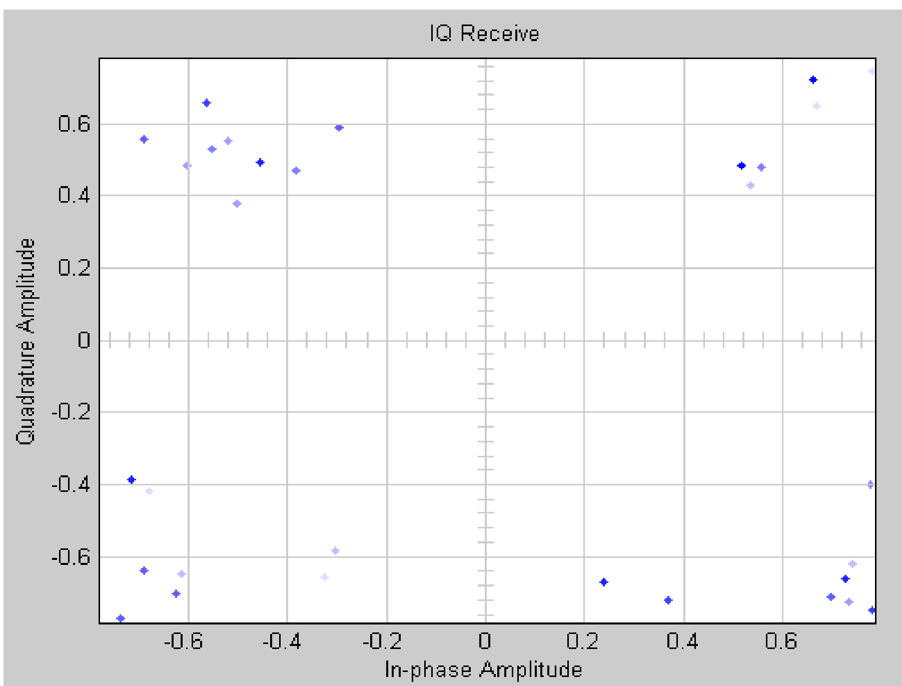

Fig 9: QPSK Receiver Time Scatter Plot

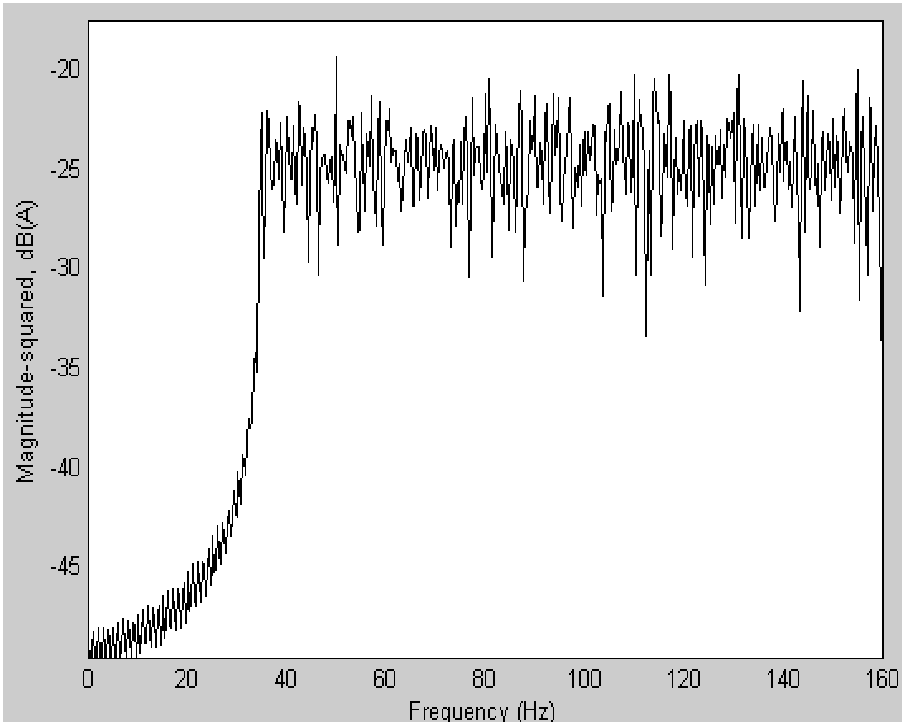

Fig 10: QPSK Transmitter frequency Plot

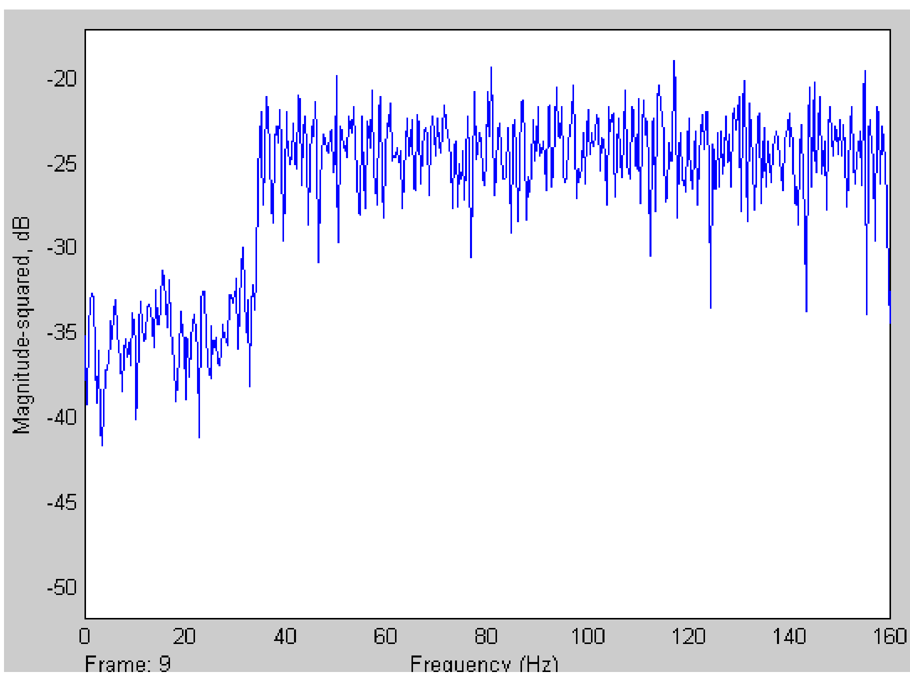

Fig 11: QPSK Receiver frequency Plot

DQPSK SIMULATION RESULT

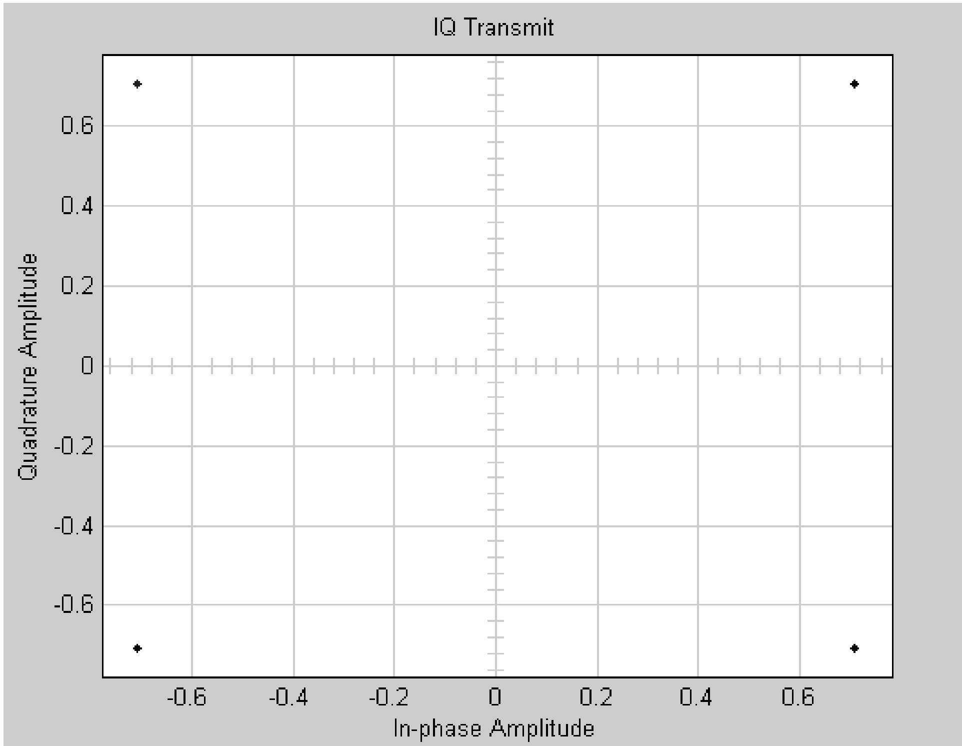

Fig 12: DQPSK Transmitter Time Scatter Plot

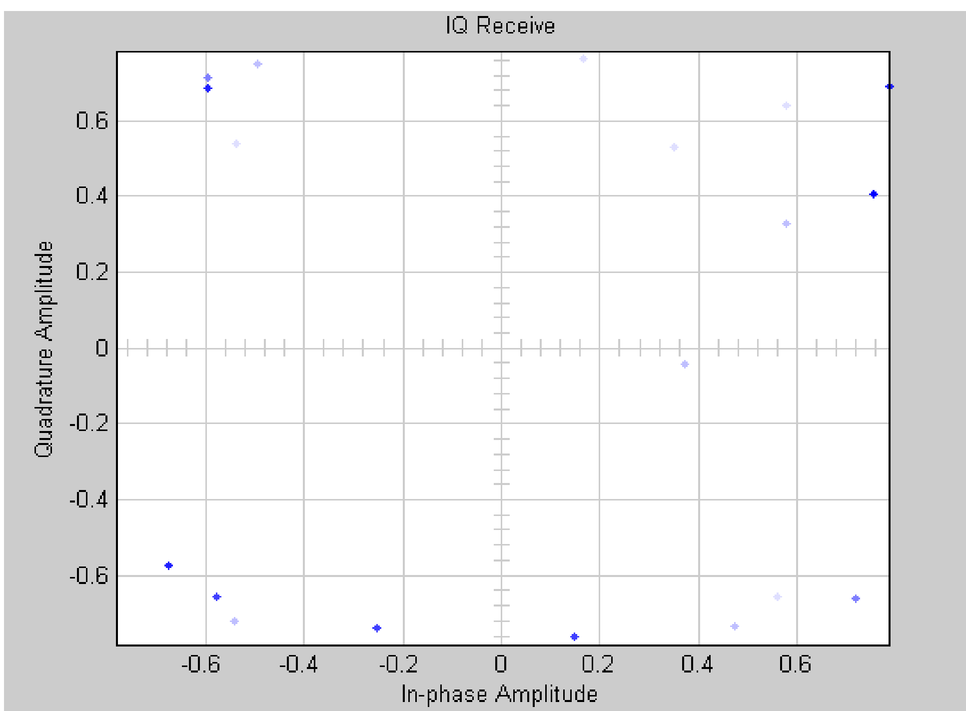

Fig 13: DQPSK Receiver Time Scatter Plot

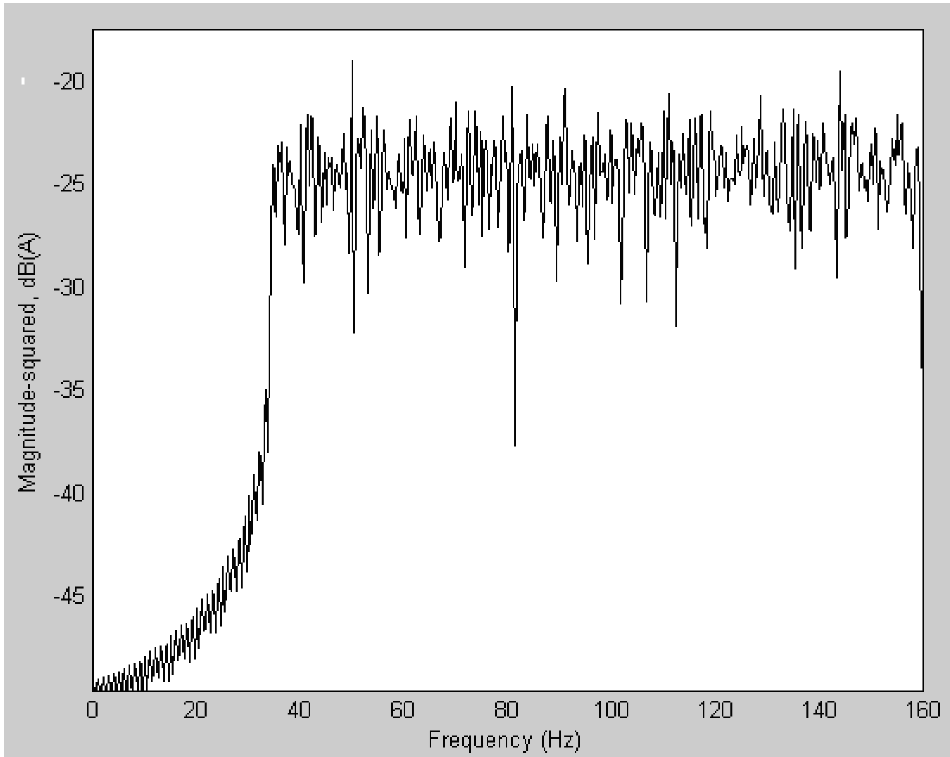

Fig 14: DQPSK Transmitter frequency Plot

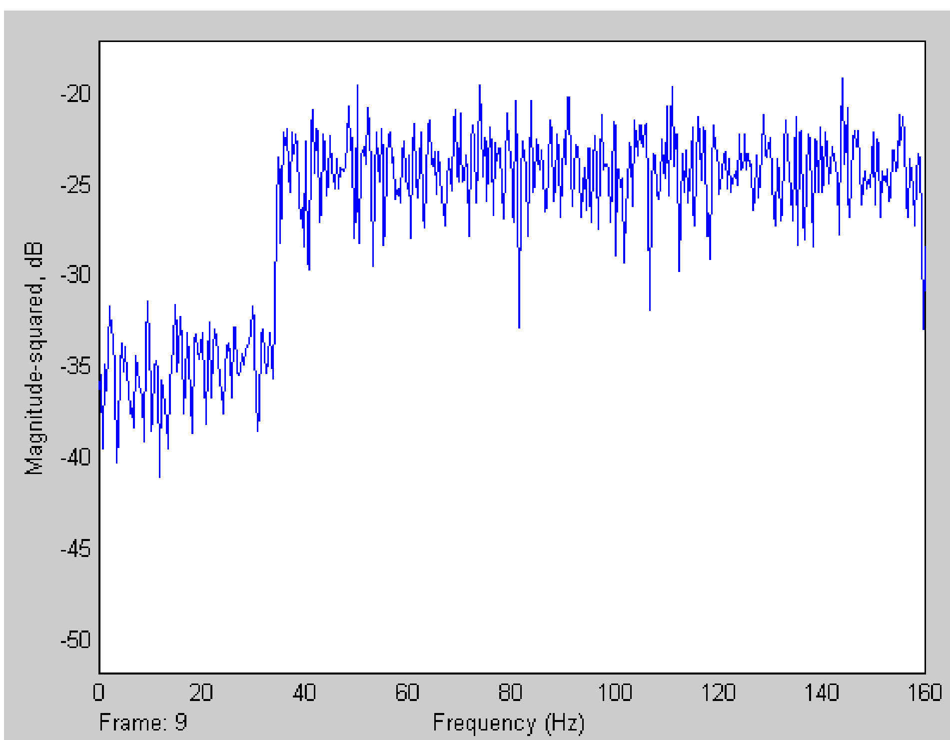

Fig 15: QPSK Receiver frequency Plot

6. REAL TIME VIDEO STREAMING WITH OFDM

Video streaming has become a very popular application in communications as achievable data rates have improved dramatically. When real time video is transferred over the wireless network or real time video is displayed on the cellular phones then there are two issues that must be resolved

6.1 Bandwidth Requirement:

Since the video transfer requires high data rate and high bandwidth Video requires large amount of data storage that is transferred over the network with limited bandwidth. This can be done by compressing the video before transmission.

6.2 Modulation:

Secondly very important issue is modulation of bits that are transferred. Because of the obstacles in the medium of the wireless data transmission the signal level can result in the loss of important information which must be perceived by the receiver.

Streaming video is content sent in compressed form over the Internet and displayed by the viewer in real time. With streaming video or streaming media, a Web user does not have to wait to download a file to play it. Instead, the media is sent in a continuous stream of data and is played as it arrives.

In our paper we have configured Orthogonal Frequency Division Multiplexing using MATLAB and SIMULINK. The main idea behind this is that divide the data to be sent into different blocks and each block is modulated with different sub carrier, and all the sub carries are orthogonal to each other. Results show a considerable amount of improvement in quality of video signals using OFDM techniques.

7. CONCLUSION

The demand for increased channel capacity in wireless and mobile communications has been rapidly increasing worldwide. The driving force behind the need to satisfy this requirement is the explosion in mobile telephone, Internet and multimedia services coupled with a limited radio spectrum. The BER is an important parameter in mobile communication for quality measurement of recovered data. In this paper we have presented a method to evaluate the performance of OFDM system with QPSK and DQPSK. The comparison given in Table 1 and it shows the bit loss and packet loss of each modulation scheme. By comparison, it is observed that QPSK modulation techniques having less packet loss and bit loss than DQPSK technique which enhance quality of experience to the user. Results have been obtained which is useful for channel parameter estimation and can be efficiently used for 4G networks.

8. ACKNOWLEDGEMENT

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