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# Designing Asymmetric Digital Subscriber Line with Discrete Multitone Modulator

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**Abstract:** The objective of Digital Subscriber Line (DSL) is to propagate signal from the transmitter to the receiver over telephone lines. In communication industry Asymmetric Digital Subscriber Line (ADSL) is widely used because it can handle both phone services and internet access services at same time. As the communication industry develops, its main concern is to maximize the user handling capacity of communication systems. For this purpose, ADSL uses Discrete Multitone (DMT) modulator with QAM bank. But as the number of users increases the system complexity and interference also increases. The communication channel is not free from the effects of channel impairments such as noise, interference and fading. These channel impairments caused signal distortion and Signal to Ratio (SNR) degradation. One method that can be implemented to overcome this problem is by introducing channel coding. Channel encoding is applied by adding redundant bits to the transmitted data. The redundant bits increase raw data used in the link and therefore, increase the bandwidth requirement. So, if noise or fading occurred in the channel, some data may still be recovered at the receiver. While at the receiver, channel decoding is used to detect or correct errors that are introduced to the channel.

**Keywords:** DSL, ADSL, DMT, BER

## I. INTRODUCTION OF ADSL

Digital Subscriber Line (DSL) is a family of technologies that are used to transmit digital data over telephone lines. In telecommunications marketing, the term DSL is widely understood to mean Asymmetric Digital Subscriber Line (ADSL), the most commonly installed DSL technology, for Internet access. DSL service can be delivered simultaneously with wired telephone service on the same telephone line since DSL uses higher frequency bands for data. On the customer premises, a DSL filter on each non-DSL outlet blocks any high-frequency interference to enable simultaneous use of the voice and DSL services[5].

The bit rate of consumer DSL services typically ranges from 256 kbit/s to over 100 Mbit/s in the direction to the customer (downstream), depending on DSL technology, line conditions, and service-level implementation. Bit rates of 1 Gbit/s have been reached. In ADSL, the data throughput in the upstream direction (the direction to the service provider) is lower, hence the designation of asymmetric service. In Symmetric Digital Subscriber Line (SDSL) services, the downstream and upstream data rates are equal. Researchers at Bell Labs have reached speeds over 1 Gbit/s for symmetrical broadband access services using traditional copper telephone lines, though such speeds have not yet been deployed elsewhere[9].

DSL (Digital Subscriber Line) is a modem technology that uses existing telephone lines to transport high-bandwidth data, such as multimedia and video, to service subscribers. DSL provides dedicated, point-to-point, public network access. This DSL connection is typically between a Network Service Provider (NSP) central office and the customer site, or on local loops created either within buildings or campuses. DSL draws significant attention from implementers and service providers [15]. This is because it delivers high-bandwidth data rates to dispersed locations with relatively small changes to the existing telecommunications infrastructure.

DSL is a communications medium used to transfer digital signals over standard telephone lines. Along with cable Internet, DSL is one of the most popular ways ISPs provide broadband Internet access. When user make a telephone call using a landline, the voice signal is transmitted using low frequencies from 0 Hz to 4 kHz. This range, called the "voiceband," only uses a small part of the frequency range supported by copper phone lines. Therefore, DSL makes use of the higher frequencies to transmit digital signals, in the range of 25 kHz to 1.5 MHz. While these frequencies are higher than the highest audible frequency (20 kHz), then can still cause interference during phone conversations. Therefore, DSL filters or splitters are used to make sure the high frequencies do not interfere with phone calls as shown in Figure 1.

Symmetric DSL (SDSL) splits the upstream and downstream frequencies evenly, providing equal speeds for both sending and receiving data. However, since most users download more data than they upload, ISPs typically offer

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Asymmetric DSL (ADSL) service. ADSL provides a wider frequency range for downstream transfers, which offers several times faster downstream speeds. For example, an SDSL connection may provide 2 Mbps upstream and downstream, while an ASDL connection may offer 20 Mbps downstream and 1.5 Mbps upstream.

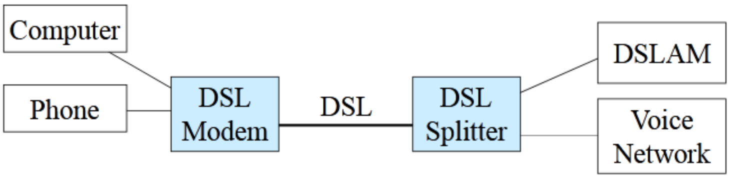


Figure 1. Digital Subscriber Line.

In order to access the Internet using DSL, you must connect to a DSL Internet Service Provider (ISP). The ISP will provide you with a DSL modem, which you can connect to either a router or a computer. Some DSL modems now have built-in wireless routers, which allows you to connect to your DSL modem via Wi-Fi. A DSL kit may also include a splitter and filters that you can connect to landline phones [19].

## II. SYSTEM MODEL OF ADSL WITH DMT

The physical layer of ADSL uses a multicarrier modulation technique known as Discrete Multitone (DMT). A DMT system transmits data on multiple subcarriers in a manner very similar to the orthogonal FDM (OFDM) technique that is used in many wireless applications. A DMT modulator takes in N data symbols in parallel and transmits the symbols on N subcarriers. The data rate on each subcarrier is 1/N the original data rate [8].

Reducing the data rate results in a DMT symbol period that is N times as long as the original symbol period. Increasing the symbol period can make the symbol longer than the time span of the channel. This situation can make it easier to combat the effects of intersymbol interference. The DMT signal is formed by using an Inverse Fast Fourier Trans-form (IFFT) to generate orthogonal subcarriers at the transmitter. The data symbols at the transmitter are treated as being in the frequency domain and act as complex weights for the basis functions (orthogonal sinusoids at different frequencies) of the IFFT. The IFFT then converts the data symbols into a time-domain "sum of sinusoids" signal [9]. The block of IFFT output samples is known as a DMT symbol. This time-domain signal is transmitted across the channel, and an FFT is used at the receiver to bring the signal back into the frequency domain.

A 2N-point IFFT is used to generate the DMT symbol, and the N negative-frequency IFFT bins are the complex conjugate of the N positive-frequency bins. This symmetric spectrum results in a real time-domain signal. The DMT signal is centered at DC with the subcarriers around DC zeroed out (not used) to create a hole in the DMT spectrum in order to make room for the POTS spectrum. DMT is thus a true baseband system. DMT supports inclusion of a cyclic prefix. A cyclic prefix is a block of samples with a length $L_P$, that is a replica of the last $L_P$ samples of the DMT symbol. The prefix is then transmitted first, followed by the 2N samples of the DMT symbol. The length $L_P$ is chosen such that it will be longer than the length of the channel response. The cyclic prefix contains redundant information. However, the DMT receiver exploits the presence of the prefix in order to mitigate the effects of the channel. The use of the cyclic prefix will be described in further detail in the Impairments section [4].

The dynamic bit allocation technique allows DMT to make efficient use of the available channel capacity. This technique enables the system to vary the number of bits per symbol for each subcarrier based on the subcarrier's Signal-to-Noise Ratio (SNR). Subcarriers with a low SNR transmit Binary Phase-Shift Keying (BPSK) or Quadrature PSK (QPSK) because they are robust modulation formats. If the subcarrier's SNR is very low, that subcarrier will not be used to transmit data at all. Subcarriers with a higher SNR transmit higher-order Quadrature Amplitude Modulation (QAM) in order to achieve an increased throughput.

DMT is a multi-carrier process, it divides the frequency band assigned to it into many subchannels. With ADSL there are up to 256 carrier frequencies for data, each with a bandwidth of 4.3125 kHz. The bit information is modulated onto the individual carriers by QAM, such as 4-QAM (QPSK) or 16-QAM. The serial data stream that is to be transmitted is combined into a number of bits at DMT and mapped onto complex sub-symbols that are sent in parallel on these carriers. To do this, they are simultaneously modulated onto the available carriers, whose sum signal is then sent [9].

DMT is based on the same principles as Orthogonal Frequency Division Multiplexing (OFDM). In contrast to OFDM, with DMT the individual carriers can be operated with different spectral efficiency . In other words, with the same symbol rate of all carriers, the number of bits coded per symbol can be changed per carrier. For example, a 16-QAM

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with 4 bits per symbol can be used in channels with a good Signal-To-Noise Ratio (SNR), whereas only a 4-QAM with 2 bits per symbol is used on carrier frequencies with poor SNR.

In extreme cases with very poor SNR, individual carriers can also be completely blocked. It is necessary to negotiate which channels use which bit rate (in this case e.g. 128-QAM) or not, since constellation diagrams are not compatible with lower ones and even if they were, the purpose of error avoidance would not be fulfilled. If it is no longer possible to negotiate (e.g. due to a very bad SNR), the connection is broken and re-established. When connecting, a low bit rate is often used first to avoid errors when establishing the connection [2]. Another advantage of DMT is that the carriers can be set with different levels of transmission power. This makes it possible to compensate for the non-ideal frequency response of concrete telephone lines

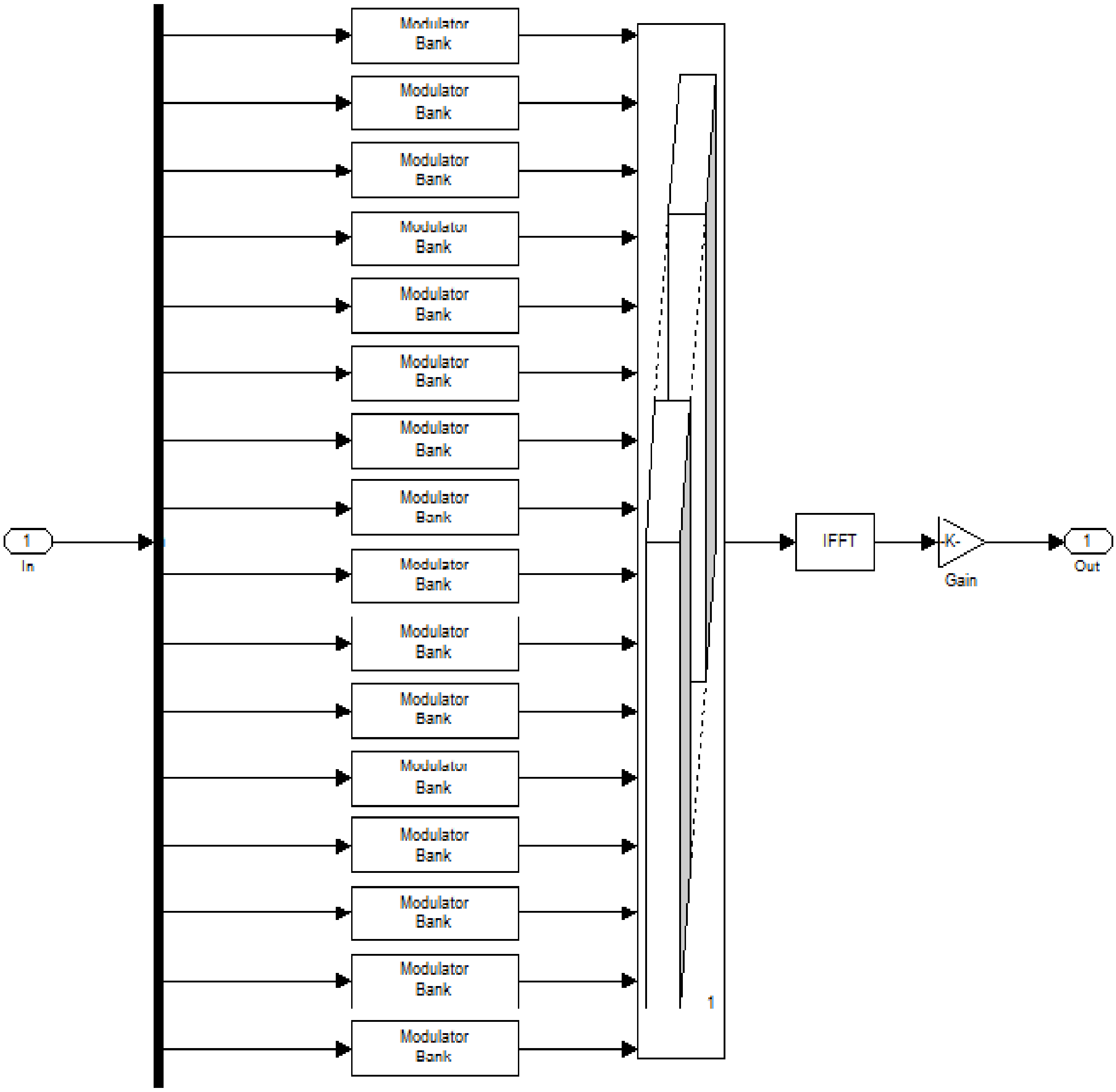


Figure 2. Example of DMT with 256 Channels.

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## III. ADSL PERFORMANCE ANALYSIS

In the performance analysis of ADSL system the transmitted signal, received signal and bit error rate of the systems are analyzed.

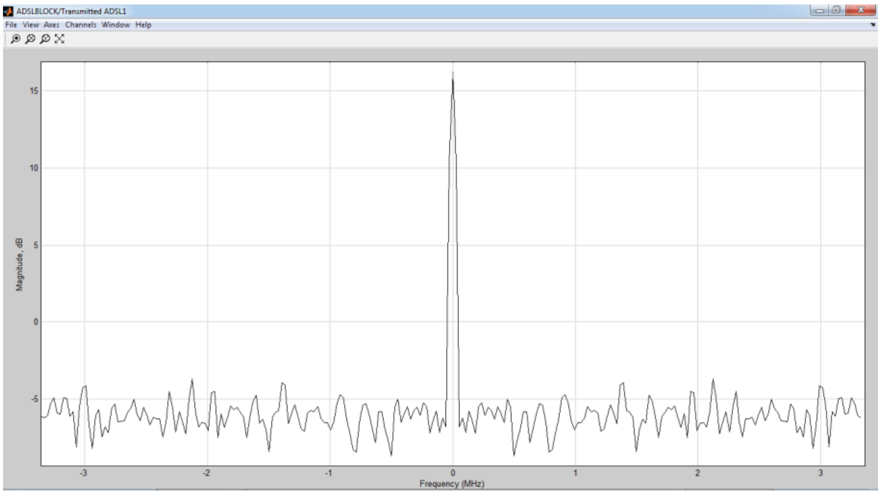


Figure 3. Transmitted Signal of ADSL Before DMT Modulator.

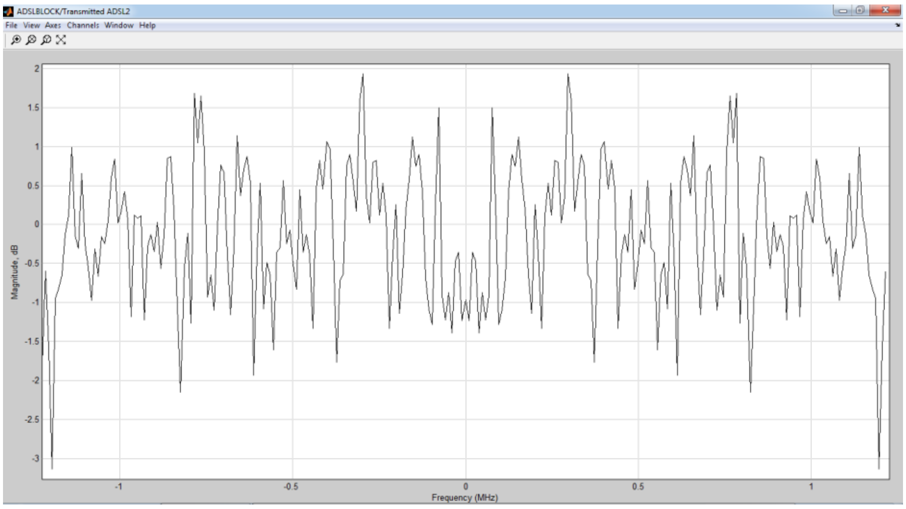


Figure 4. Transmitted Signal of ADSL

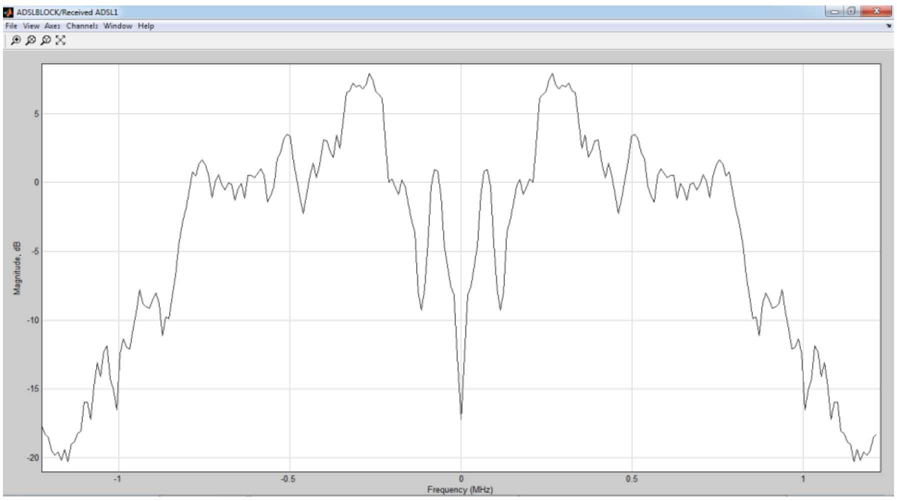


Figure 5. Received Signal of ADSL

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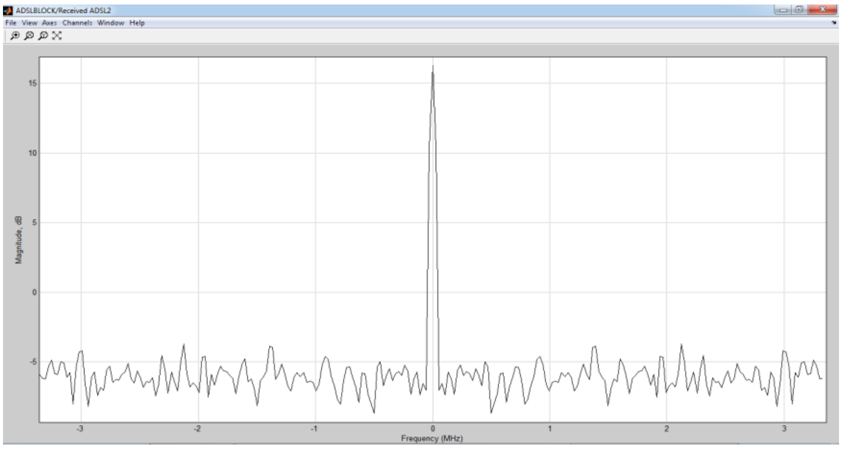

Figure 6. Received Signal of ADSL after DMT Demodulator

The Figure shows the transmitted and received signal of ADSL system. To plot these signals spectrum scope is used. The Spectrum Scope block computes and displays the periodogram of the input. From the plot of transmitted and received signal it is clear that the received signal is so much distorted as comparison to transmitted signal due to channel. The simulation results are plotted in term of the performance of ADSL system that is transmitted, received signal.

## IV. CONCLUSION

An alternative technique based on DMT was introduced. The new model is important to minimize the BER in the standard ADSL. The proposed and standard models are simulated using Matlab software. A gain was obtained from the proposed model relative to the standard model at the AWGN channel. In the presence of impulse noise, the BER for both models was increased but the proposed model has less BER than the standard model in all range of SNR. So the proposed model can be considered as an alternative technique to the standard one.

## REFERENCES

[1]. Qi Wang, Rong Zhang, Lie Liang Yang and Lajos Hanzo, "Non – Orthogonal Multiple Access: A Unified Perspective", IEEE Wireless Communications, pp. 1-7, 2018.
[2]. Anugrah Nair, Gaurav Gupta and Kartik Srinivas, "Review On Multiple Access Techniques Used In Mobile Telecommunication Generations", International Research Journal of Engineering and Technology, Vol. 5, Issue 10, pp. 350-354, 2018.
[3]. Vanitha M U, B N Ravisimha and M.Z. Kurian, " A Survey on PAPR Reduction using Signal Scrambling Techniques", Advances in Computer Science and Information Technology, Vol. 4, Issue 1, pp. 55-56, 2017.
[4]. Monika Kapoor and Dr. Anubhuti khare, " Performance Analysis of Reed Solomon Code & BCH Code for various Modulation Schemes over AWGN Channel", International Journal of Applied Engineering Research, Vol. 12, No. 24, pp. 15801-15813, 2017.
[5]. J.H. Van and L.P. Linde, "Performance Evaluation Of A Gigabit DSL Modem Using Super Orthogonal Complete Complementary Codes Under Practical Crosstalk Conditions", South African Institute Of Electrical Engineers, Vol. 108, pp. 144-149, 2017.
[6]. Aasheesh Shukla and Vinay Kumar Deolia, "Performance Analysis of Chaos Based Interleaver in IDMA System", International Journal on Communication Technology, vol. 7, issue 4, pp. 1397-1401, December 2016.
[7]. Ankita Jhamb, "A Review On Interleave Division Multiple Access In Underwater Communication", International Journal of Engineering Development and Research, Vol. 4, Issue 4, pp. 873-876, 2016.
[8]. Arsla Khan, Sobia Baig and Tabassum Nawaz, " DWMT transceiver equalization using overlap FDE for downlink ADSL", Turkish Journal of Electrical Engineering & Computer Sciences, pp. 681-697, 2015.
[9]. A B N Goolamhossen and T P Fowdur, "Improving ADSL Performance with Selective QAM Mapping and Hybrid ARQ ", ADBU-Journal of Engineering Technology, Vol. 2, pp. 1-7, 2015.
[10]. Shweta Bajpai and D. K. Srivastava, "Performance Analysis of IDMA Schemes using different Coding techniques with receiver diversity using Random Interleaver", International Journal of Science Research Engineering & Technology, vol. 3, issue 6, pp. 1008-1012, September 2014.
[11]. Sweta Singh and Parul Malhan, "A Review Paper on Multiple Access Techniques for Mobile Communication", International Journal For Innovative Research in Technology, Vol. 1, Issue 6, pp, 1244-49, 2014.
[12]. Anshu Aggarwal and Vikas Mittal, " Implementation of Different Interleaving Techniques for Performance Evaluation of CDMA System", International Journal of Application or Innovation in Engineering & Management, Vol. 2, Issue 5, pp. 337-342, 2013.
[13]. Rupesh Singh, "Multiple Access Techniques for 4G Mobile Wireless Network", International Journal of Engineering Research and Development, Vol. 5, Issue 11, pp. 86-94, 2013.
[14]. Salih Mohammed Salih, "BER Reduction for DMT-ADSL Based on DMWT", Cankaya University Journal of Science and Engineering, Vol. 8, No. 2, pp. 237-254, 2011.
[15]. Francesc Rey, Meritxell Lamarca and Gregori Vazquez, "Adaptive Interleaver Based on Rate-Compatible Punctured Convolutional Codes", IEEE transactions on communications, vol. 57, no. 6, pp. 1593-1598, 2009.