ABSTRACT

High-bandwidth services like video-on-demand, internet, digital audio and video broadcast systems are services that are very much in demand today. To provide high bit rates to the customer, many new access technologies are being developed such as Digital Subscriber Line technologies. The attractive feature of these technologies is that they reuse the existing infrastructure such as the twisted copper wire pair, thereby reducing the investment on creating new infrastructure to support these technologies. The challenge before communication engineers is to fully utilize the potential of the billions of kilometres of existing telephone cables by effectively transmitting and delivering vast amounts of information swiftly and accurately over them. The advent of new and complex digital communication techniques and advances in digital signal processing have made high speed transmission on the twisted copper wire lines possible.

Modulation is an integral part of these communication systems and Multicarrier Modulation (MCM) is a practical and viable technology for high speed data transmission over highly dispersive channels such as the telephone wire. Discrete Multitone Transmission (DMT) and Orthogonal Frequency Division Multiplexing (OFDM) are two of the most widely used MCM technologies. Studies have shown that these multicarrier schemes are suitable for many applications thanks to the flexibility brought by processing in multiple streams. In both DMT and OFDM, modulation is done using Inverse Discrete Fourier Transform and demodulation is done using the Discrete Fourier Transform (DFT). However the low level of attenuation (-13dB) causes significant spectral overlap between subchannel filters, in DFT based MCM systems. Filter bank based MCM systems such as filtered multitone, discrete wavelet multitone and cosine modulated filter bank based transmultiplexer systems allow the use of longer length subchannel filters which means that filters can be designed to increase attenuation in the sidebands for better spectral containment. Better separation between subcarriers enhances the flexibility of the scheme for various purposes such as narrowband interference mitigation. The adequacy of this modulation scheme is analyzed in the very high bit rate digital subscriber line (VDSL) environment. VDSL is a standard for the transmission of very high bit rates (up to 50 Mbits/s) over highly dispersive channels.
This work aims to design an oversampled filter bank transmultiplexer based on cosine modulation to exploit the inherent advantages of the filter bank based approach for the implementation of the multicarrier modulation scheme. Oversampling increases computation since there are more samples to deal with than in the critically sampled filter bank. The goal is to obtain an efficient MCM scheme with minimum increase in computational cost. The process involves the design of the prototype filter, where the basic filter is designed using the window method. The coefficients of the filter are to be optimized to satisfy certain criteria. The goal is to choose a method of design that will obtain filters with optimum characteristics at minimum computational cost while bearing in mind that the process of filter design involves nonlinear optimization of the filter coefficients. The next step is to design the filter bank and the filter bank based transmultiplexer. As a criterion for system performance, the inter-symbol-interference ratio (ISI), the inter-channel-interference ratio (ICI) and the signal-to-interference ratio are calculated and compared with existing methods. The computational costs of designing the oversampled cosine modulated filter bank are determined.