# Ultra Wide Band
# Channel For The Next Generation Low Power Communication

San Francisco State University

Paper by

Venkata Satya Vishwanth Naidu Ganti

***Abstract*—In view of today's emerging technologies for low power high frequency communication models, Ultra Wide Band (UWB ) has the ability to function as a reliable system. Till now Bluetooth, zigbee and various versions of 802.11 have been extensively used. Topics related to the power levels, bandwidth ranges and frequency of signaling have been discussed clearly. For better understanding of UWB the areas of implementation and the limitations of each of those have been included in this paper. Since the power consumption of UWB is small, its a challenge to achieve high range compared to the existing high power models. However this is what sets UWB apart from the Bluetooth and WiMax. UWB can be used to for a personal area network (PAN). Ultra wide band was approved by the Federal Communications Commission (FCC) in March 2002 for unlicensed operation in the 3.1 to 10.6 Ghz band.**

## I. INTRODUCTION

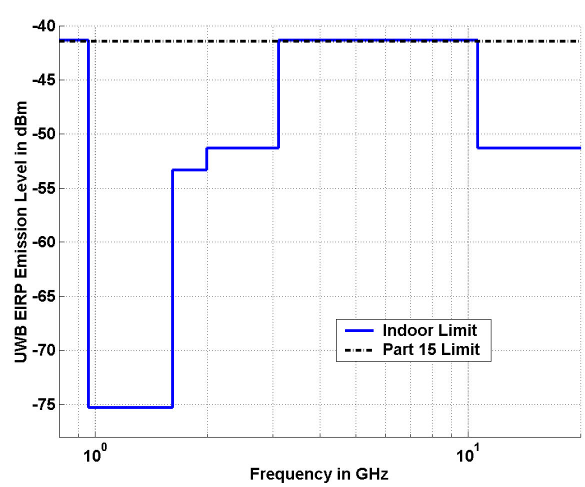
ULIKE the regular microwave RF devices which operate at 2.4 GHz, the UWB has a very large channel width and operates in the frequency range of 3.1 to 10.6 GHz. This enables very low channel interference and there by the noise levels in the signal received by the receiver is relatively low when compared with conventional radio frequency waves. The power requirements for transmission of a UWB signal is very little ( 750 mill watts ) which makes it shorter range signal compared with the latest signaling scheme of 802.11n which can transmit upto a range of 200 meters. UWB is only for few 10's of meters and usually used in replacement of wired connectivity for Universal serial bus or IEEE Firewire connectivity module.

The Radio over fiber technology commonly used in 2nd and 3rd Generation cellular networks, the Radio Frequency signal bandwidth is in the order of 10 MHz and the corresponding average power range is several 100mW. This requires high cost photonic components in the Central transmission station and medium cost components in the Base station. Ultra-wideband radio over fiber is targeting the Personal Area Network (PAN) market which is the mostly simplest wireless home networks that is characterized by very low cost and low power (10's µW) access point. In this scheme of data transmission, an optical fiber is used to carry extremely wide RF signals. Since the usage of optical fibers has been proven to be extremely shielded from external interference, the combination of using optical fibers and ultra wide band makes use of the advantages of both these systems.

The parallel implementation of wireless and optical fibers would benefit in a better way when the network infrastructure is not limited to a smaller area. The ultra wide band base access stations may be wired in the network using optical fibers and access points can function as wireless transceivers providing wireless connectivity to various devices on various channels. This way access point takes full advantage of UWB right from the point of signal origination to the point of signal termination. This becomes a very good platform for the development of a network for High Definition Content transmission.

Another important challenge which UWB puts forward is that of selection of a multipath channels owing to the high frequency and bandwidth. Due to the limitations set for average and peak transmit power, modulation schemes which are power efficient such as binary pulse modulation which is in both amplitude and position are typically used in ultra wide band signaling. An alternative solution for achieving higher data transmission rates is to use M- array orthogonal signaling scheme although it requires higher Signal to noise ratio (SNR) at receiver input terminal.

Figure 1: UWB Spectral Mask Per FCC Part 15 Rules [1]




The network topology in which the UWB devices will be connected determines various characteristics that need to be modified to suit the requirement of the network. Some devices need 802.11 modules for long range network connectivity. In these conditions, the UWB module has to be kept at a little separation to avoid interference between the two modules. The alternative is to use a single UWB module which connects to a access point using the ultra wide band frequency channel. The access point has to be connected to a High speed network such as wireless broadband which reduces the task of having an additional module. However there are several challenges the most significant one being the wide spread availability of a UWB network which is connected to a high speed network such a optical fiber based internet connection. Noise generated on the chip for a ultra wide band circuit is much higher than in the case of narrow band signaling. The solution for this is to run the UWB chip at a different clocking frequency compared to the rest of modules which surround the UWB chip in the whole circuit. This makes the region close to the UWB chip function differently compared to the surrounding area on the whole board.

## II. Areas of Usage

A classic implementation of UWB in Ultra Wideband Radio over Optical Fiber is discussed herein as an example. The main idea is to enhance the extent of coverage with very low noise margin alternatively termed as Reach. Using UWB the signal has to be enhanced by a minimum of 1 to 3 times the actual signal quality relative to microwave radio frequency signaling schemes. There are two ways in which the transmitted signal may occupy the transmission channel. First one is a part of the bandwidth in excess of 20 % of the center frequency and the other option is in excess of 500 MHz of absolute bandwidth to be classified as UWB Signal.

These high speeds will let you do things such as download high-resolution maps to a handheld device and transmit them to your car's GPS or feed a high-definition signal to a wall-mounted HDTV without using video cables. [3] Freescale Semiconductor Inc is working on offering a chipset with 1.6Gbps of bandwidth, which is enough to transmit an uncompressed 720p or 1080i high-definition video signal wirelessly to the TV receiver from a server or a transmission base station. The advantage of using such a system to stream high definition content seamlessly over the wide bandwidth provisioned by UWB along with low interference governed by external noise sources.

## III. Working Principle

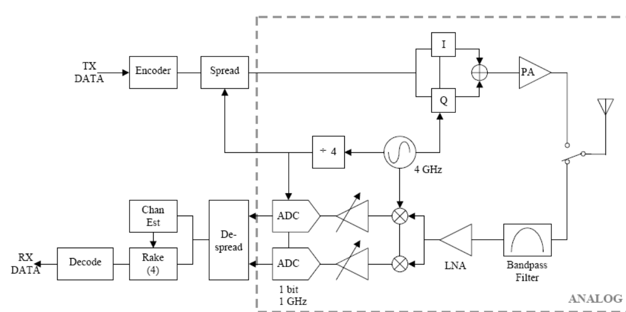
In view of cost and ease of integration with low power circuits, UWB transceivers have to be built into one single chip. Using the suitable nano meter scaling technology to design the CMOS circuits with low parasitic and high gain amplification, overall circuit would host digital circuits and use digital only CMOS process which have very limited support for analog circuit elements such as resistors, capacitors and low noise or high dynamic range amplifiers. If this level of integration is realized it is clear that a single chip CMOS radio is first thing to start working on. [1] Flash ADC architecture is the rule of thumb choice for the sample rates and resolution required for the proposed UWB architectures. These converters use a preamplifier to drive an array of 2n comparators which can quantize the sample with n bits of resolution. Due to the gate capacitance of the comparator array, the preamplifier consumes more power into order to meet the settling time requirements of higher sample rates and input bandwidth.

[2] UWB differs substantially from conventional narrowband radio frequency (RF) and spread spectrum technologies (SS), such as Bluetooth* Technology and 802.11a/b/g. A UWB transmitter works by sending billions of pulses across a very wide spectrum of frequency several GHz in bandwidth. The Corresponding receiver then translates the pulses into data by listening for a familiar pulse sequence sent by the transmitter. UWB's combination of larger spectrum, lower power and pulsed data improves speed and reduces interference with other wireless spectra. In the United States, the Federal Communications Commission (FCC) has mandated that UWB radio transmissions can legally operate in the range from 3.1 GHz up to 10.6 GHz, at a limited transmit power of –41dBm/MHz's and the implication of this is limited interference and dramatic change in short-range channel.

## IV. Multiband Architecture

Various UWB channel architectures have been proposed so far. Since the number of channels in ultra wide band are more and-hopping modulation schemes Individual pulses are transmitted sequentially in time over these sub-bands yielding a band hopping modulation scheme, where the pulse repetition frequency in each sub-band is I/N of a comparable single-band system.

Figure 2: Direct Sequence – UWB System Architecture [2]




The Direct Sequence architecture for ultra wide band is achieved by cascading various stages of ADC and mixers which enforce high gain with low cross channel capacitance and noise margins.

## V. Future Scope

Many original equipment manufacturers are already working on the possibilities of including special communication modules which are either fully functional UWB transceivers or some form of emulators at the [4] physical connectivity layer. This proves a point of the importance UWB is going to make in the future networking equipment. The special focus of most of these companies is in the implementation of Personal Area Networks using networking devices which work in the frequency ranges of 4.5GHz to 7.5GHz which is the mid frequency band of the Ultra wide band. Due to the FCC regulation of free usage of this frequency spectrum, UWB's widespread implementation is relatively easier than a locked frequency range which special designated channels for dedicated purposes. Network solution providers are forging towards upgrading to UWB equipment to be prepared to meet the future requirement and also to over come the challenges faced in the initial stages. The challenge however is to make the UWB device compatible to work with existing RF based personal area networks as the transition to UWB may take in phases. Since the challenge provided by the backward compatibility of UWB with 802.11x is still under research.

## REFERENCES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[5]