DVB Enhancement by using MIMO-OFDM

Name:Mr.Chandane.E.R
Student in Department of Electronics & Telecomm
Sveri's, College of Engineering Pandharpur,
Solapur, India
Email: eliachandane.07@gmail.com

Name: Mrs. M M Pawar
Asst. Prof in Department of Electronics & Telecomm
Sveri's College of Engineering Pandharpur
Solapur, India
E-mail: minakshee2000@gmail.com

Abstract—Multiple-input/multiple-output (MIMO) technology offers tremendous performance gains for wireless LANs (WLANs) at relatively low cost. Any system with multiple inputs into the receiver and multiple outputs to the transmitter is a MIMO system, but implementing such a system involves several distinctly different radio techniques. Some of these techniques are beneficial and fully compatible with today's standard WLAN equipment, while others do not improve performance when used with existing equipment.

Orthogonal frequency division multiplexing (OFDM) is becoming the chosenmodulation technique for wireless communications. OFDM can provide large datarates with sufficient robustness to radio channel impairments. Many research centersin the world have specialized teams working in the optimization of OFDM forcountless applications. The basic processinginvolved in the generation and reception of an OFDM signal in a physicalchannel and to provide a description of each of the steps involved. For this purpose, we use, as an example, one of the proposed OFDM signals of the DigitalVideo Broadcasting (DVB) standard for the European terrestrial digital television(DTV) service.

Keywords— OFDM; DVB;DTV; MIMO

I. INTRODUCTION

There are two types of benefits of using multiple antennas: link budget / spatial diversity improvement and throughput improvement from spatial multiplexing. Both are intrinsic to wireless channels, where rich spatial variations or spatial dimensionality exist [3]. Spatial diversity refers to the fact that the probability of having all antennas at bad locations is significantly lower as the number of antennas increases. Link budget improvement refers to the fact that the signals from the various antennas can be combined to form a signal stronger than any of the individual signals. For receive spatial diversity, signals received on multiple antennas are weighted and combined, e.g. maximal ratio combining (MRC)[3]. There are two types of transmit spatial diversity, open-loop and closed-loop. Open-loop transmit diversity involves transmitting signals from multiple antennas in some deterministic pattern, that does not depend on the channel. Open-loop techniques include cyclic delaydiversity (CDD) and space-time block codes (STBC)[3]. Closedlooptransmit diversity techniques, in contrast, require channel information to guide transmissions. An example is transmit beam forming (TxBF), where proper magnitude and phase weights computed from the channel estimation are re-applied acrossantennas to aim the signal in a given desired direction[3]. MIMO systems with spatial diversity achieve better performance, i.e. longerrange for a given data rate, or higher data rate than SISO systems given same location.

A second way to exploit rich spatial dimensionality is via spatial multiplexing, i.e. transmitting and receiving multiple data streams from multiple antennas at the same time, and in the same frequency spectrum. The latter is possible because the signals received at different antennas are unique combinations of thetransmitted data streams. Advanced digital signal processing algorithms can be used to recover the original data streams [3]. Spatial multiplexing can be implemented in either open-loop or closed-loop. In open-loop spatial multiplexing, different streams are simply transmitted from different antennas. In closed-loop spatial multiplexing, every stream is transmitted from all of the antennas using weights computed from the channel estimation. MIMO systems with spatial multiplexing achieve higher peak data rates and increases spectrum efficiency.

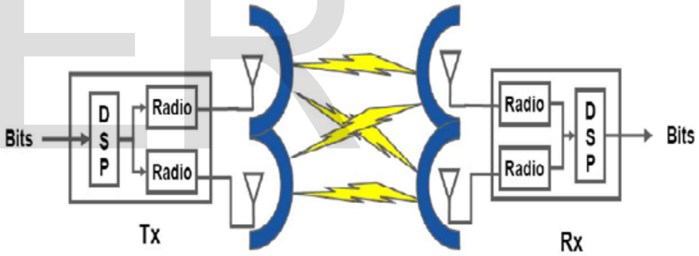


Fig 1.1 MIMO Transmitter & Receiver System

This process is called subcarrier-based maximal receive combining. It significantly improves overall gain, especially in multipath environments. In such environments, signals pass through and reflect from various objects so that different signal characteristics reach the two receiving antenna. Some frequencies tend to be attenuated at one antenna but not the other, as shown by channel measurements in a multipath environment

By combining signals from the antennas at each frequency, maximal receive combining increases signal power. At frequencies where signals have similar strength, the receiver selectively combines their signal strength, thus more than doubling the signal power even when using only two antennas.

This increase has two components: power gain and array gain. The power gain results from multiple transmit antennas delivering more power into the air, thus increasing the total amount of energy by the number of antennas. A two-transmitter MIMO system delivers twice the power. The MIMO transmitter dramatically improves the range over which a receiver can obtain a high-bandwidth signal, so MIMO offers better coverage for large homes or offices. The MIMO transmitter also makes WLAN setup easier because users can pick up a usable signal even at extreme ranges.

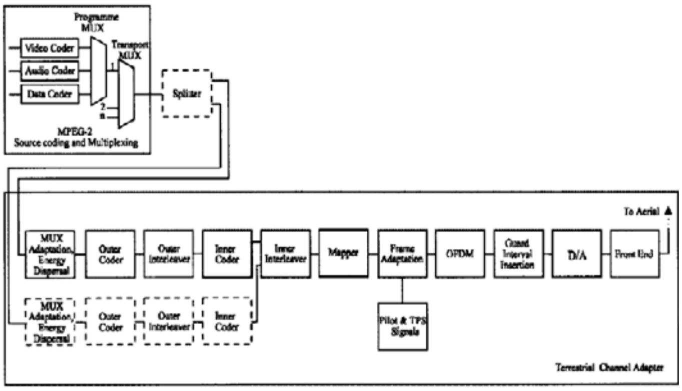


Fig 1.2 DVB-T Transmitters

A. **OFDM Transmitter**

In an OFDM scheme, a large number of orthogonal, overlapping, narrow bandsub-channels or subcarriers, transmitted in parallel, divide the available transmissionbandwidth. The separation of the subcarriers is theoretically minimal such thatthere is a very compact spectral utilization. The attraction of OFDM is mainly due tohow the system handles the multipath interference at the receiver. Multipath generatestwo effects: frequencies selective fading and inter -symbol interference (ISI).The "flatness" perceived by a narrow-band channel overcomes the former, andmodulating at a very low symbol rate, which makes the symbols much longer thanthe channel impulse response, diminishes the latter. Using powerful error correctingcodes together with time and frequency interleaving yields even more robustness
against frequency selective fading and the insertion of an extra guard intervalbetween consecutive OFDM symbols can reduce the effects of ISI even more.Thus, an equalizer in the receiver is not necessary.

2.1 DVB-T Example

OFDM can be explained by first taking the symbol starting at t=ts & given as,

$$s(t)=\mathrm{Re}\left\{\sum_{i=-\frac{N_s}{2}}^{\frac{N_s}{2}-1} d_{i+N_s/2}\exp\left(j2\pi\left(f_c-\frac{i+0.5}{T}\right)(t-t_s)\right)\right\},\ t_s\le t\le t_s+T$$

$$s(t)=0,\ t<t_s \quad\wedge\quad t>t_s+T$$

where *di*are complex modulation symbols, *Ns*is the number of subcarriers, *T* thesymbol duration, and *fc*the carrier frequency.

Some numerical values are also to be considered for 2k mode,

Table 1: Numerical values for the OFDM parameters for the 2k mode

Parameter	2k mode			
Elementary period T	7/64 µs			
Number of carriers K	1,705			
Value of carrier number K_{min}	0			
Value of carrier number K_{max}	1,704			
Duration T_U	224 µs			
Carrier spacing **1/T_U**	4,464 Hz			
Spacing between carriers K_{min} and K_{max}(K-1)/T_U	7.61 MHz			
Allowed guard interval Δ/T_U	1/4	1/8	1/16	1/32
Duration of symbol part T_U	2,048xT 224 µs			
Duration of guard interval Δ	512xT 56 µs	256xT 28 µs	128xT 14 µs	64xT 7 µs
Symbol duration $T_S=\Delta+T_U$	2,560xT 280 µs	2,304xT 252 µs	2,176xT 238 µs	2,112xT 231 µs

$$s(t)=\mathrm{Re}\left\{e^{j2\pi f_c t}\sum_{k=K_{min}}^{K_{max}} c_{0,0,k}\,e^{j2\pi k'(t-\Delta)/T_U}\right\} \qquad (2.1.4)$$

with $k'=k-(K_{max}+K_{min})/2.$

Since various efficient FFT algorithms exist to perform the DFT and its inverse, it isa convenient form of implementation to generate N samples Xn corresponding tothe useful part, T_U long, of each symbol. The guard interval is added by taking copiesof the last NΔ/TU of these samples and appending them in front. A subsequentup-conversion then gives the real signal s(t) centered on the frequency *fc*.

II. FFT IMPLEMENTATION

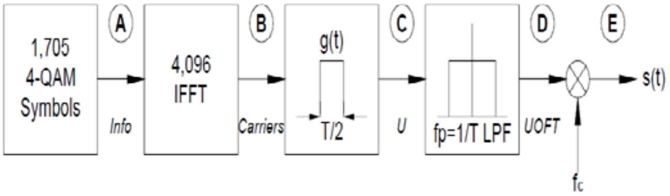


Fig 2.3 OFDM symbol generation system

The OFDM symbol duration, T_U, is specified considering a 2,048-IFFT (N=2,048); therefore, we shall use a 4,096-IFFT.Here 4,096-1,705=2,391 zeros to the signal *info* at(A) to achieve over-sampling, 2X, and to center the spectrum.The result of this operation and that the signal carriersuse T/2 as its time period. We can also notice that a carrier is the discrete timebaseband signal. We use this signal in baseband discrete-time domain simulations,but we must recall that the main

OFDM drawbacks occur in the continuoustimedomain; therefore, we must provide a simulation tool for the latter. The firststep to produce a continuous-time signal is to apply a transmit filter g(t), to the complex signal carriers.Reconstruction is done by D/A filter;it is a Butterworth filter of order 13 and cut-off frequency of approximately 1/T. the filtering performs as expected since we are left with only the baseband spectrum. We recall that subcarriers 853 to 1,705 are located at the right of 0 Hz,and subcarriers 1 to 852 are to the left of 4 *c f* Hz.

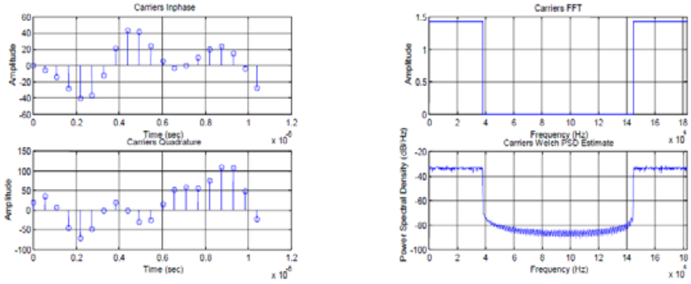


Fig 2.3 Time/Frequency Response at (A)

The filter response of D/A filter is given as,

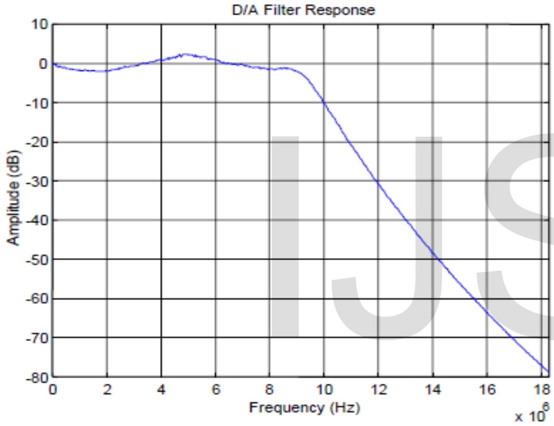


Fig 2.4 Filter Response

Also the time/frequency response of the same filter is given by,

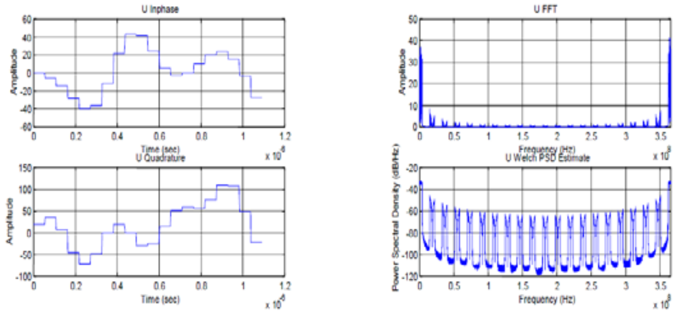


Fig 2.5 Time/Frequency Response at (C)

$$s(t)=m_I(t)\cos(2\pi f_c t)+m_Q(t)\sin(2\pi f_c t)$$

The next step is to perform the quadrature multiplex double-sideband amplitudemodulation of *uoft (t)*.

$$s(t)=\sum_{k=K_{min}}^{K_{max}}\mathrm{Re}\left(c_{0,0,k}\right)\cos\left[2\pi\left(\left(\frac{k-\frac{K_{max}+K_{min}}{2}}{T_U}+f_c\right)t-\frac{\Delta}{T_U}\right)\right]-\sum_{k=K_{min}}^{K_{max}}\mathrm{Im}\left(c_{0,0,k}\right)\sin\left[2\pi\left(\left(\frac{k-\frac{K_{max}+K_{min}}{2}}{T_U}+f_c\right)t-\frac{\Delta}{T_U}\right)\right]$$

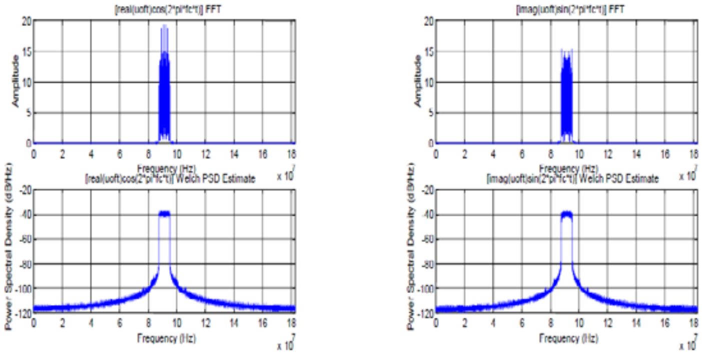


Fig 2.6 Time/Frequency response at (D)

After Implementation of IFFT to the info signal the output is given by the different response as,

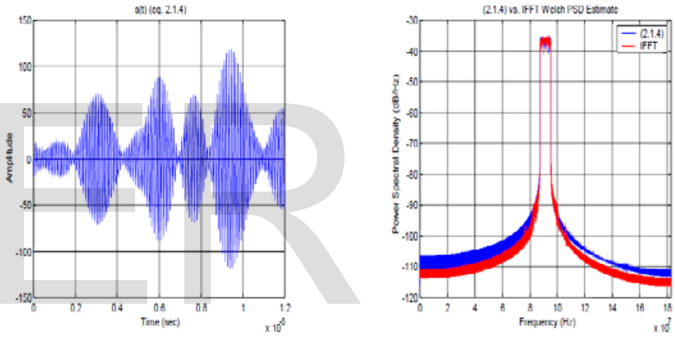
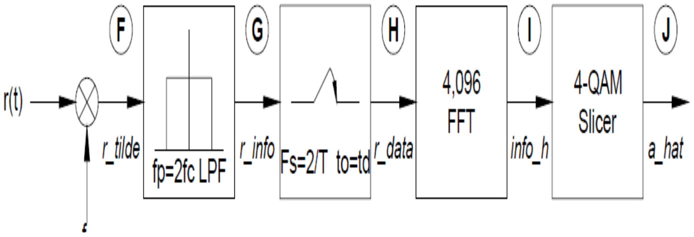


Fig 2.7Time/Frequency Response after applying IFFT.

B. **OFDM Reception**



OFDM is very sensitive to timing and frequency offsets [2]. Even in this idealsimulation environment, we have to consider the delay produced by the filteringoperation. For our simulation, the delay produced by the reconstruction and demodulationfilters is about t_d=64/Rs. This delay is enough to impede the reception,and it is the cause of the slight differences we can see between the transmitted and received signals. With the delay takencare of, the rest of the reception process is straightforward.

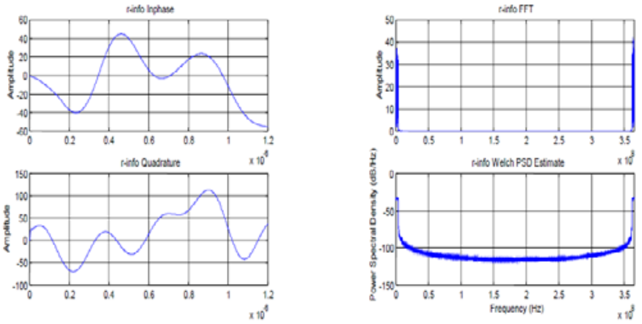


Fig 2.8 Time/Frequency Response at (G)

The de-sampling of the information signal (r_info signal) takes place with the sampling rate of Fs= 2/T, (to=td) which is then passed over to the FFT where the FFT is processed on the received signal & then this gives the required information data,

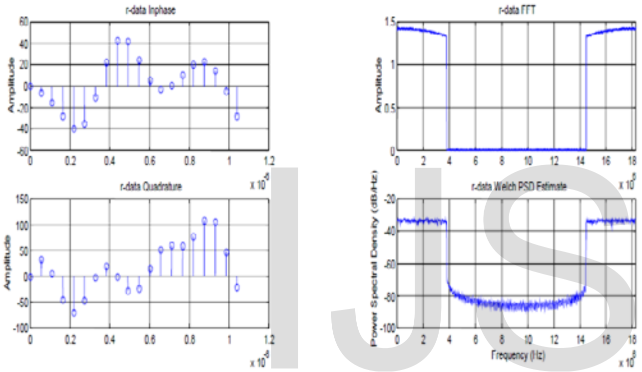


Fig 2.9 Time/Frequency Response at (H)

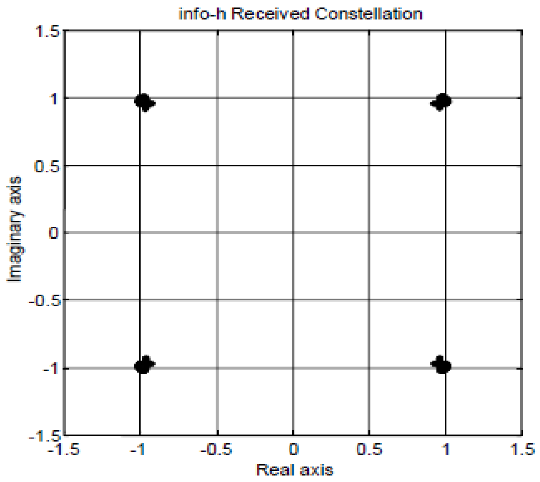


Fig 2.10 info_h constellation

Above fig (2.10) gives the output of the received signal when an FFT is applied to it this generally gives the constellation of the information signal which also gives the real & imaginary part of the of the received signal. Similarly the a_hat constellation for 4- QAM type of signal is given by,

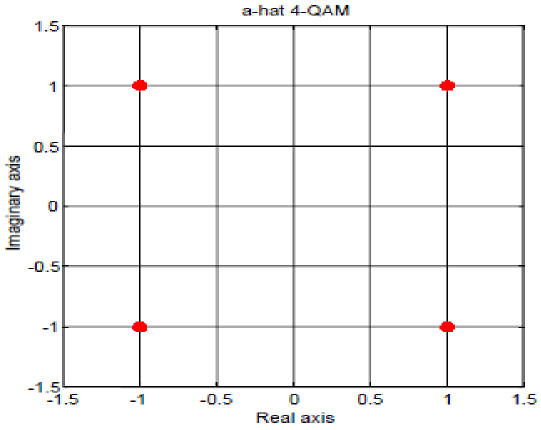


Fig 2.11 a_hat constellation

C. **Conclusions**

MIMO hence is a rising star with OFDM & any type of signal can be used & processed for the maximum throughput, multiple power also for adaptive type of beam forming. More over by using OFDM as tool for showing how the Digital Video Broadcasting can be efficiently carried out by using an system of it & also problems like frequency selective fading & intersymbol interference (ISI) are reduced without using an equalizer.

D. **REFERENCES**

[1] ETS 300 744, "Digital broadcasting systems for television, sound and dataservices; framing structure, channel coding, and modulation for digital terrestrialtelevision,. *European Telecommunication Standard*, Doc. 300 744,1997.

[2] R. V. Nee and R. Prasad, *OFDM Wireless Multimedia Communications*,Norwood, MA: Artech House, 2000.

[3] J. A. C. Bingham, "Multi-carrier modulation for data transmission: An ideawhose time has come", *IEEE Communications Magazine*, vol.28, no. 5, pp.5-14, May 1990.

[4] A. V. Oppenheim and R. W. Schafer, *Discrete-Time Signal Processing*,Englewood Cliffs, NJ: Prentice Hall, 1989.

[5]Boosting Wireless LAN Performance with Full Compatibility “Getting most out of MIMO” Whitepaper by “*ATHEROS Communications*”, 2005.