INTRODUCTION TO RESEARCH WORK

This research work is presented for the topic “Investigations and Numerical Modeling of Efficient Wireless Systems”, to the department of Electronics and Communication, J.J.T. University, Jhunjhunu-Rajasthan.

1.1 Motivation

During the past decades, wireless communication has undergone through the significant developments and it is considered as the key enabling technique of pioneering future consumer products. For the sake of satisfying the requirements of various applications, significant technological achievements are required to ensure that wireless devices have appropriate architectures suitable for supporting a wide range of services including small requirement of bandwidth along with high efficient data rates that are delivered to the users. In the foreseeable future, the large-scale deployment of wireless devices and the requirements of high bandwidth and high data rate applications are expected to lead to tremendous new challenges in terms of the efficient exploitation of the achievable spectral resources and constitute a substantial research challenge in the context of the emerging WLANs and other indoor multimedia networks [1].

In wireless communications, spectrum is a scarce resource and hence imposes a high cost on the high data rate transmission. In this century people wants highly efficient transmission with a very high speed but with a reasonably low cost. At no point of termination, degradation in the quality of service will never be tolerated for modern communication techniques. The view of modern wireless techniques is continuously converging towards the high data rate transmission with sufficiently low bandwidth at very low error rate. Again the most efficient system in virtual case must be coping up with real time data analysis in practical atmosphere that is the prime requisite of current era whether it’s the field of audio or video or image or networking.

Again, due to the physical limits imposed by the mobile radio channel which cause performance degradation and make it very difficult to achieve high bit rates at low error rates over the time dispersive wireless channels. Other detrimental characteristics are co-channel interference (CCI), Doppler effect, intentional jamming in military communications and Inter symbol interference (ISI) induced by multipath fading;
however, there is an irreducible error floor that imposes a limit on the maximum attainable transmission rate.

![Image of wireless communication systems](image.jpg)

**Figure-1.1 Efficient Wireless Communication Systems**

So the above stated limitations of current technologies leads to the development of modern efficient wireless systems such as WiMAX, DVB-S2, DVB-T, etc. which fits as the futuristic system with highest data rates along with best qualities at lowest error rate. Figure-1.1 shows the complete scenario of various such modern wireless communication systems along with their physical and logical interfaces to establish the end to end connection.

### 1.2 Problem Definitions

Wireless communication has suffered from the fading problem ever since its first appearance in 1897, when Guglielmo Marconi transmitted a wireless signal to a ship in
the English Channel. The following century witnessed the remarkable development of wireless communication, especially in the last decade. Consequently, the demand for bandwidth and capacity becomes more and more urgent, and the fading problem has never been so critical.

The capacity of modern wireless communication systems with a single antenna can be very low, due to the multi-path propagations in wireless channels. The multi-path signals add up constructively or destructively at the receiver antenna to give a fluctuating signal, which can vary widely in amplitude and phase. When the amplitude of the signal experiences a low value it is termed fading and the capability of the wireless channel is severely limited.

Research efforts have focused on ways to make more efficient use of this limited capacity and have accomplished remarkable progress. Efficient techniques, such as frequency reuse and OFDM, have been invented to increase the bandwidth efficiency; on the other hand, advances in coding techniques, such as Reed Solomon codes, Convolution codes and low density parity check (LDPC) codes make it possible to almost reach Shannon capacity the theoretical performance limit of the channel. However, the development of the techniques for a single channel has yet to catch up with the increasing demand for the capacity [2].

While transmitting over one ‘bad’ wireless channel cannot meet the requirement, it is intuitive to transmit over several ‘bad’ channels, in order to hedge against the possibility that all the channels are bad simultaneously. The technique of using multiple channels is called diversity. Most generally used diversity techniques include time diversity, frequency diversity and space diversity. Along with the space diversity techniques, still to increase system capacity with very low error rate, various channel coding techniques such as STBC and BLAST structure are making their way out for modern wireless systems [3].

To fit in the scope of current generation demands, the two most promising technologies, which are considered as today’s most interesting inventions, are IEEE 802.16 standard and Digital Video Broadcasting techniques for terrestrial use, for cable TV use and for satellite use. They are treated to be 4th generation wireless communication standards which are bringing lots of innovations in the current existing standards.
In the present scenario, the maximum research work has been carried out traditional transmission and reception architecture of the above stated techniques which can’t prove their up to the mark efficiency as a 4G standard. With real time audio and video signals, the Bit Error Rate and speed of the system are the serious limitations during the real time implementation phase. Moreover up till now the antenna diversity with STBC has remained the main focus for the researcher. Very few results for simulating and modeling the 4G techniques such as IEEE 802.16 and DVB are available with BLAST structure for real time data transmission (such as image, video, speech, etc.) at reasonable error rate with higher system capacity [4].

1.3 Contribution Of This Research Work To The Problem Definitions

In wireless communications, spectrum is a scarce resource and hence imposes a high cost on the high data rate transmission. To develop the modern wireless systems which possess maximum possible data rate with the reasonably low requirement of bandwidth at lowest error rate is the sole objective of this research work.

Initially the research oriented background(s) of modern wireless communication systems such as DVB along with its variants for terrestrial (DVB-T), satellite (DVB-S & S2) and cable (DVB-C) and IEEE 802.16 will be studied thoroughly along with the modeling of the different wireless channel that are suitable for above mentioned techniques so as to overcome the limitations put by the performance of the virtual channel in the real time i.e. multipath fading that describes the small scale fluctuations of the signals between transmitter to receiver [5].

Another aspect of this research work deals with the performance analysis of antenna diversity and its coding schemes i.e. BLAST structure which improves data rate and STBC which improves bit error rate. Their comparative analysis would be done with different wireless channel mechanism as the choice of a suitable wireless channel according to their application domain will result in a highly efficient system.

Combining all these together for IEEE 802.16 and DVB, the complete model will be developed and simulated in MATLAB Simulink environment and their comparative analysis will be performed in terms of system capacity, data rate as well as bit error rate with respect to real time condition of wireless channel. Further the actual utilization of
any wireless communication system can be realized in the real time scenario. So the numerical modeling and critical performance analysis of modern wireless communication systems will be carried out with the transmission of real time data such as image and speech for the observation of BER, channel capacity and data rate.