IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Broadband Wireless Access Systems (2009), this standard specifies the air interface, including the medium access control layer (MAC) and physical layer (PHY), of combined fixed and mobile point-to-multipoint broadband wireless access (BWA) systems providing multiple services. The MAC is structured to support multiple physical layer (PHY) specifications, each suited to a particular operational environment. The standard enables rapid worldwide deployment of innovative, cost effective, and interoperable multivendor broadband wireless access products, facilitates competition in broadband access by providing alternatives to wire line broadband access, encourages consistent worldwide spectrum allocations, and accelerates the commercialization of broadband wireless access systems. The standard is a revision of IEEE Std 802.16-2004, and consolidates material from IEEE Std 802.16eTM-2005, IEEE 802.16-2004/Cor1-2005, IEEE802.16fTM-2005, and IEEE Std 802.16gTM-2007.

The researchers have tried to address the issue of non-ideal channel condition (channel with transmission errors). Sipon Miah et al (2011) have analysed and compared path loss model for COST 231 Hata model, ECC-33 model, SUI model, Ericsson model and COST 231 Walfish-Ikegami model in urban, suburban and rural environments in NLOS condition. In urban area, the SUI model showed the lowest path loss (121 dB in 10 m receiver antenna
height) as compared to other models. In suburban area the SUI model showed quite less path loss (116 dB) when compared to other models. In rural area considering all receiver antenna heights SUI model showed less path loss (148 dB in 3 m and 143 dB in 6 m) whereas COST-Hata showed higher path loss (154 dB in 3m and 144 dB in 6 m).

Recently, a lot of work has been carried out to enhance the performance of 802.16d using FEC. Vinit Grewal and Ajay Sharma (2011) have investigated the performance of WiMax system that can be optimized to a lower BER of $10^{-2}$ at 3dB SNR with the introduction of turbo coding in AWGN channel.

Mohammed Aboud Kadhim and Widad Ismail (2010) have proposed a novel implementation of WIMAX baseband transceiver on multi-core Software-Defined Radio (SDR) platform. The authors’ work presents a new approach to the adaptation of WIMAX technology on the basis of SFF SDR development platform. The proposed WIMAX system was modelled-tested, and its performance was analysed with Stanford University Interim (SUI) Channel Models.

Zahid Hasan and Mohammad Reaz Hossain (2010) studied the different fading communication channel models to verify its effectiveness and also compared adaptive digital modulation techniques (QPSK, 16-QAM and 64-QAM) performance using RS code with1/2 rated convolutional code. BPSK modulation technique is highly effective to combat in the Wimax communication system.

Anamul Islam et al(2010) have analysed the BER performance of the real audio data communication through broadband WiMAX-PHY layer based wireless communication system. Convolutional channel coding (1/2,2/3), different digital modulation schemes under AWGN and frequency-
flat Rayleigh fading channels at 100Hz of Doppler shift are also used for the analysis. In the context of system performance, the authors have concluded that the implementation of BPSK modulation with half (½) rated channel coding technique provides satisfactory result among the digital modulation schemes with limited SNR.

Hari (2000) proposed a six interim channel model for G2 MMDS fixed broadband wireless communication application. The channel model is heavily dependent upon the radio architecture. The path loss model and the multipath fading model are also presented for the proposed channel. Daniel Baum (2001) has proposed the simulation of the SUI models to help in the implementation of these models into a software channel simulator.

Zhang and Soong (2005) have studied and proposed three schemes dealing with the packet on encountering the wireless channel impairment. The closed-form formula for the performance metrics with respect to the mean queue length and the average packet delay are developed. The result shows that the metrics will be greatly underestimated if the wireless channels unreliability is not taken into account.

Salous et al (2011) have analysed the performance for emergency vehicles to indoor from radio channel measurements in the 4.9 GHz band. The results show that the maximum bandwidth used in the standard of 20 MHz can be easily employed for the present scenario of outdoor to indoor propagation. For an error rate of $1 \times 10^{-3}$ modest SNR levels are required with the worst case being 22 dB for 64QAM with ¾ coding for delay profile with a K ratio equal to 0.2. This requirement is relaxed to 17.2 dB for a channel with a K ratio of 5.2.

Hardeep Kaur and Singh (2012) have analysed the BER evaluation of IEEE802.16d in OFDM system. For the poor channels conditions (low
values of Eb/No (db) =2dB), BPSK is the best modulation technique with least BER=0.0085. For good channels conditions (higher values of Eb/No (db) = 10dB), 32-QAM can be applied.

Shiann-Shiun Jeng et al (2011) have presented a novel coverage probability analysis scheme with rayleigh fading for the OFDM system over the SUI channel. The BER is $10^{-4}$ and coverage probability achieves 99%, while the cell radius of the SUI-1 and SUI-6 channels with rayleigh fading decreases by 674 m and 204 m, respectively. It is seen that the cell radius becomes smaller when the SUI channel with rayleigh fading is considered. The transmission ranges of the SUI-1 and SUI-6 channels with rayleigh fading decreases to 16.1 % and 15.4% less than those without rayleigh fading, respectively.

Tal Kaitz (2001) has proposed the investigation of Forward Error Correction (FEC) Scheme for 802.16.3 OFDM PHY. This proposed scheme employs a concatenated Reed- Solomon and a convolutional code, with relatively short blocks. For both AWGN and SUI channels, at a packet error rate of about 1% (for 1000 bytes packets), the performance of the CC alone is better or equal to the performance of the concatenated code using short block codes. At lower packet error rates and for 64QAM modulation, the concatenated schemes may have better performance, increasing the block length of the RS code to the full (255,239) to gain a significant SNR improvement.

Bonghyuk Park et al (2001) have proposed a Viterbi decoding using channel state information and compared several coding rate system by means of the packet error rate. The channel state information was derived from the pilot carriers. The used channel state information is defined as a signal-to-noise ratio, and they used this channel state information in Viterbi decoder to improve the system performance. The simulation results for FEC
in 802.16 OFDM system, the performance of convolutional coding with CSI is improved by 3dB rather than without CSI.

Abhayawardhana et al (2005) have analysed the comprehensive set of propagation measurements taken at 3.5 GHz in Cambridge, UK which is used to validate the applicability of the three models ECC-33, SUI and COST-231 Hata for rural, suburban and urban environments. The result shows that in general, the SUI and the COST-231 Hata model over-predict the path loss in all environments. The ECC-33 models show the best results, especially in urban environments.

Josip Milanovic et al (2007) have presented a comparison of propagation model accuracy under different propagation conditions in a 3.5 GHz frequency band for Fixed WIMAX. Measurements are taken for an installed WiMAX system in Osijek, Croatia. The SUI model gives most accurate results for NLOS. This model adapts different parameters to a specific propagation condition, and its main shortcoming is a lack of distinguishing urban, suburban and rural environments. The error propagation standard deviation for the SUI model for joined NLOS and LOS results is 9.10 dB. The Macro Model and the Model 9999 shows worse performance for NLOS propagation, while the results for LOS propagation condition obtained with this prediction model are better than the results obtained with the SUI and the COST 231 Hata model.

Joseph Wout and Martens Luc (2006) have studied the performance of a typical broadband fixed wireless system based on the IEEE 802.16-2004 operating below 11 GHz specifications. The authors investigated the business applications with outdoor customer premises equipment in the 3.5 GHz frequency band. Different path loss models and terrain types are also considered. Coverage and throughput in a sector are determined.
Hata (1981) has proposed a channel model from Okumura's report. The propagation loss in an urban area is presented in a simple form: $A + B \log_{10} R$, where $A$ and $B$ are frequency and antenna height functions, and $R$ is the distance. The author introduced a new formula which is applicable to system designs for UHF and VHF land mobile radio services, with a small formulation error, under the following conditions: frequency range 100-1500 MHz, distance 1-20 km, base station antenna height 30-200 m, and vehicular antenna height 1-10 m.

Vinko Erceg et al (1999) have presented a statistical path loss model derived from 1.9 GHz experimental data collected across the United States in 95 existing macrocells. The model is for suburban areas, and it distinguishes between different terrain categories. It applies to distances and base antenna heights not well-covered by existing models. The parameters are statistically modelled, with the dependencies on base antenna height and terrain category. The resulting path loss model applies to base antenna heights from 10 to 80 m, base-to-terminal distances from 0.1 to 8 km, and three distinct terrain categories.

Cimini (1985) have presented a paper on the analysis and simulation of a technique for combating the effects of multipath propagation and co-channel interference on a narrow-band digital mobile channel. The system uses the discrete Fourier transform to orthogonally frequency multiplex many narrow subchannels, each signaling at a very low rate, into one high-rate channel with the technique of the author when used with pilot-based correction, the effects of flat Rayleigh fading can be reduced significantly. An improvement in signal-to-interference ratio of 6 dB can be obtained over the bursty Rayleigh channel.

Larry Greenstein (1997) have derived a statistical model for the distribution of RMS delay spread within a cellular environment, including the
effects of base-to-mobile distance, environment type (urban, suburban, rural, and mountainous areas), and the correlation between delay spread and shadow fading. The intuitive arguments that $\tau_{\text{rms}}$ should be lognormal distributed at any given distance $d$; that the median of this distribution should grow as some (weak) power of $d$ and that the variation about the median should be negatively correlated with shadow fading gain. The author then presented the empirical evidence, drawn from a wide array of published reports, which gives strong support to these conjectures. The result is a compact statistical model for the joint distribution of path gain and delay spread. The model lends itself readily to Monte Carlo simulation and is useful for performance studies of cellular systems with bandwidths up to 10 kHz.

Larry Greenstein et al (1999) have proposed a new model for the probability distribution of $K$ as experienced by fixed wireless users because, fading has important implications for the design of both narrow-band and wideband multipoint communication systems that are deployed in such environments which must be well characterized. They find $K$ to be lognormal, with the median being a simple function of season, antenna height, antenna beam width, distance and with a standard deviation of 8 dB.

Greenstein and Vinko Erceg (1999) have presented a statistical model for fixed suburban paths at 1.9 GHz, based on angle-of-arrival measurements in New Jersey. The use of a directional terminal antenna on a wireless link can enhance the received power by as much as the antenna gain. In local scattering, however, the enhancement will be smaller. The results address the influences of antenna height, antenna beam width, distance and season.

Michelson et al (1999) have proposed the five channel parameters for narrowband fixed wireless channels, and they are the average path gains and Ricean K-factors for each branch and the complex envelope correlation
coefficient between the time-varying parts of the two path gains. Propagation measurements collected in typical suburban environments have shown that each of these parameters, or its logarithm, is close to Gaussian. The set may be combining of five-element vector of jointly random Gaussian processes which are completely specified by the means, standard variations, and mutual correlation coefficients of the five parameters.

Chatzigeorgiou et al (2007) have demonstrated the turbo codes and convolutional codes for block fading characteristics of Fixed Wireless Access (FWA) channels. The turbo codes are not necessarily the optimal solution in block fading channels. Convolutional codes are carefully selected so as to present the same decoding complexity as turbo codes, to achieve similar performance when used in systems without antenna diversity. When antenna diversity is exploited, turbo codes outperform convolutional codes only for a large number of antennas.

Hoymann (2005) have analysed the performance evaluation of different scenarios, which results in overall system performance measures. The interaction of fragmentation and padding of OFDM symbols and its effect on the system capacity are also evaluated. A prototypical IEEE 802.16 protocol stack including a sophisticated channel model has been implemented. By means of this stochastic event-driven computer simulator, downlink and uplink delay as well as throughput evaluation are performed.

Salous et al (2008) have demonstrated fixed WIMAX system with 10 MHz bandwidth at 2.5, 3.5 and 5.8 GHz which were performed in a rural/semi-rural environment in the UK. The frequency range of the orthogonal frequency division multiplexing symbol bandwidth that has dropped below a predefined level, termed as average fade bandwidth, and the corresponding level crossing are employed to quantify the severity of frequency selectivity. The channel data were used to estimate the bit error rate
and for the 256 carrier-OFDM IEEE802.16 standard, frequency domain channel simulator is especially designed for this study. The result shows that the performance of quasi-stationary wireless broadband systems depends mainly upon the frequency selectivity and the channel coding rate with 1/2 rate coding giving a superior performance to 3/4 rate coding. Puncturing was found to weaken the capability of forward error correction coding in the presence of series of deep fades in the channel transfer function.

Hong et al (2003) have derived a tapped delay line channel impulse response model of the Single-Input Single-Output (SISO) channel from the measurement performed using 3.5 GHz broadband fixed wireless access channel in a suburban environment by using a sectored base station antenna and a directional subscriber antenna. It is reported that the multipath tap gain also decreases with an increase in the SU antenna height, and the narrowband Ricean K-factor and wideband root mean squared delay spread are observed to correlate strongly with excess path loss.

Hong et al (2003) have presented the results of propagation measurements at 3.5 GHz for a Broadband Fixed Wireless Access (BFWA) system with a directional subscriber antenna and a sectored base station antenna. The influence of SU antenna height on a BWA system is employed by using directional SU antennas and sectored BS antennas at 3.5 GHz. The path loss exponent at a SU antenna height of 10m is close to 4, and between 2.2 and 2.7 for SU antenna heights between 7m and 9m. The wideband characteristics of the BWA channel, as quantified by the RMS delay spread shows that 90% of the channels have a delay spread of less than 100ns. The average RMS delay spread is also observed to decrease with increasing SU antenna height. The maximum RMS delay spread observed in our measurements is less than 270ns.
Gans et al (2002) have presented the results of propagation measurements at 2.485 GHz for fixed wireless loops. Path loss measurements were performed and characterized at 43 subscriber locations around a base station antenna located on top of Crawford Hill in Holmdel, NJ. The authors’ selection of suburban location is characterized by rolling hills, foliage, and terrain blockages. Temporal and horizontal motion path loss fluctuations were found to be uncorrelated, each characterized by a different Ricean distribution. Lower RMS delay spreads were obtained with directive subscriber antennas than with omni-directional antennas. No substantial gain loss (less than 2 dB) of subscribers' directive antennas was observed. The effects of trees, with foliage, surrounding the base station upon the path loss and the ratio of scattered power to specular power are also examined. The distance exponent of path loss versus distance (about 1.5) was observed to be less than free-space. Diffraction loss from hilltop trees, shadowing the base station, is suspected to be the cause. This loss decreases as the remote area moves further away and comes out of the shadow. Scattered power from directions other than line-of-sight was observed to be as high as one half of the specular contribution when tree scattering near the base station was significant.

Willink (2005) have designed a broadband Multiple-Input Multiple-Output (MIMO) OFDM system and evaluated a fixed wireless link between tall buildings in an urban area. Channel measurements for a typical installation location are analysed to determine the relevant spatial, temporal and frequency characteristics. The small number of multipath components leads to a high spatial correlation and limited potential for spatial diversity to provide spectral efficiency gains. However, the slowly-varying characteristics support the use of a closed-loop diversity scheme, such as spatial multiplexing along the eigenmodes of the channel matrix, to maximise the achievable throughput. This scheme was evaluated using the measured channel data, and
it is shown that the self-interference caused by channel estimation errors is the limiting factor on the system performance. Considering the estimation errors and feedback delay, it is demonstrated that a three-fold increase in spectral efficiency relative to a single-element antenna system is achievable using eight-element antennas, even in this highly correlated environment.

Berrou et al (1993) have designed a new class of convolutional codes called turbo-codes. It was built using a parallel concatenation of two recursive systematic convolutional codes, and the associated decoder, using a feedback decoding rule, was implemented as P pipelined identical elementary decoders. The performances in terms of Bit Error Rate (BER) are close to the Shannon limit.

Bolcskei et al (2001) have analysed an overview of fixed broadband wireless access technology. Focusing on the band below 3 GHz, the authors describe BWA service and carrier needs, deployment scenarios, architectural requirements, physical layer, medium access control, and radio link protocol requirements. They characterized fixed BWA channels, outline the major challenges of fixed BWA, and studied requirements for future BWA systems. The result shows that the use of multiple antennas at both ends of a fixed wireless link provides significant leverages.

Rohling et al (1999) have presented the use of OFDM in fixed broadband service because, future multimedia services will require the transmission of very high data rates over broad-band radio channels. In order to provide these services to mobile users, an appropriate transmission technique has to cope with frequency-selective and time-variant radio channels. The computation complexity for an equalizer increases in a frequency-selective radio channel and for high data rate applications the performance was improved by using OFDM.
Jeng et al (2010) have analysed the transmission range and the coverage probability of an IEEE 802.16 system is varied for different wireless scenarios. The IEEE 802.16 system, a promising wireless communication system has a maximum transmission range of 50 km according to the IEEE 802.16 standard. They used Stanford University Interim (SUI) channel model in IEEE 802.16 specifications which is suitable for evaluating the performance of IEEE 802.16 systems. The authors preferred smart antenna system to enhance IEEE 802.16 system performance. In terms of different antenna heights of the Base Transceiver Station and Customer Premises Equipment, the performance evaluation results show that the cell radius with the SAS is at least 30 more than that without the SAS.

Athanasiadou et al (2000) have developed hybrid technique algorithm and site specific urban propagation model suitable for microcellular operational environments. Moreover, except for the position of each image, the exact area for which this image is valid is also calculated and stored in the image map. The employment of accurate “illumination zones” dramatically enhances the performance of the model. In order to evaluate the accuracy of the outdoor model, comparisons of wide-band and narrow-band predictions with measurements were performed for a variety of scenarios.

The power predictions were evaluated for three different transmitter positions in a typical urban environment. The predictions followed the trend of the measurements closely even in deep shadow areas. The mean errors were less than 1.1 dB and the RMS errors did not exceed 3.7 dB. Predictions emulating the measurement process showed that the deviations between are measured and simulated results can exist due to limited averaging of the measurements. The outdoor wide-band analysis revealed that attention must be paid when comparing predicted and measured wide-band results, because
the RMS delay spread for systems with finite bandwidth is a function of the multipath phase and varies significantly at distances separated by fractions of a wavelength. In practice only average is measured and predicted RMS delay spread values can be compared and as a result, limited averaging can produce large RMS errors (results from Park Street). The RMS errors from a second measurement campaign with more averaging (BT Labs) were around 10 ns for LOS and 32 and 40 ns for NLOS scenarios. In all cases, the mean prediction error was less than 10% of the mean measurement in LOS and 24% in NLOS cases.

Jie-Ping Xu and Bo-Ran Guan (2005) have proposed an efficient symbol timing synchronization algorithm for an orthogonal frequency division multiplexing system which is adapted to IEEE 802.16d standard. This efficient algorithm is based on the preamble structure defined in IEEE 802.16d. The preamble’s symmetrical structure is exploited to reduce computational complexity. The useful signal can be distinguished from others according to the receipt of the long preamble, and the beginning of the signals can be found. The results show that the timing will be more accurate at very low signal-to-noise ratios.

Alexei Gorokhov and Jean-Paul Linnartz (2004) have presented a general framework for a controlled removal of Inter Carrier Interference (ICI) and channel acquisition. In orthogonal frequency-division multiplexing, time variations of a multipath channel lead to a loss of orthogonality between the subcarriers, and thereby limit the achievable throughput. The method is to use a finite power series expansion for the time-varying frequency response, along with the known statistical properties of mobile channels. Channel acquisition and ICI removal are accomplished in the frequency domain and is allowed for any desired trade off between the residual ICI level, the required training for channel acquisition and processing complexity. The authors
proposed approach enables a high spectral efficiency (64-QAM) of digital video broadcasting-terrestrial in highly mobile environments.

Sinem Coleri et al (2002) have investigated the channel estimation techniques for OFDM systems based on pilot arrangement. The channel estimation based on comb type pilot arrangement was studied through different algorithms for both estimating channel at pilot frequencies and interpolating the channel. The estimation of channel at pilot frequencies is based on LS and LMS while the channel interpolation is done using linear interpolation, second order interpolation, low-pass interpolation, spline cubic interpolation, and time domain interpolation. Time-domain interpolation was obtained by passing time domain through IDFT (Inverse Discrete Fourier Transform), zero padding and going back to frequency domain through DFT (Discrete Fourier Transform). In addition, the channel estimation based on block type pilot arrangement is performed by sending pilots at every sub-channel and using this estimation for a specific number of following symbols. They have also implemented decision feedback equalizer for all sub-channels followed by periodic block-type pilots. The authors have compared the performances of all schemes by measuring bit error rate with 16QAM, QPSK, DQPSK and BPSK as modulation schemes, and multi-path Rayleigh fading and AR based fading channels as channel models.

Li et al (1998) have investigated robust channel estimation for OFDM systems by using digital modulation techniques. The authors derived a Minimum Mean-Square-Error (MMSE) channel estimator, which makes full use of the time and frequency domain correlations of the frequency response of time-varying dispersive fading channels. Since the channel statistics are usually unknown, they also analyzed the mismatch of the estimator-to-channel statistics and proposed a robust channel estimator that was insensitive to the channel statistics. The robust channel estimator can significantly
improve the performance of OFDM systems in a rapid dispersive fading channel.

Al-Qahtani and Aldhaheri (2009) have studied the performance of an OFDM WiMAX transmission system with Adaptive Modulation and Coding (AMC) over different fading channels they analyzed the Bit Error Rate (BER) and the spectral efficiency versus the ratio of bit energy to noise power spectral density (Eb/No).

Bo Han et al (2007) have proposed a collision-free centralized scheduling algorithm for IEEE 802.16 based Wireless Mesh Networks (WMN) to provide high-quality wireless multimedia services because, in IEEE 802.16 employs TDMA (Time Division Multiple Access) as the access method and the policy for selecting scheduled links in a given time slot will definitely impact the system performance. The authors also designed a relay strategy for the mesh nodes in a transmission tree, taking special considerations on fairness, channel utilization and transmission delay. They evaluated the proposed algorithm with four selection criteria through extensive simulations, and the experimental results are instrumental for improving the performance of IEEE 802.16 based WMNs in terms of link scheduling.

Han and Lee (2005) have proposed new PAPR reduction techniques for multicarrier transmission including amplitude clipping, filtering, coding, partial transmit sequence, selected mapping, interleaving, tone reservation, tone injection, and active constellation extension. High peak-to-average power ratio of the transmit signal is a major drawback of multicarrier transmission such as OFDM.

Lei et al (2004) have proposed an adaptive power distribution algorithm which aims at improving the spectral efficiency in OFDM under the
condition that the target BER should be maintained and the transmit power threshold should not be exceeded. This algorithm is based on the iterative mechanism and every iteration, the power and the corresponding number of bits is loaded to the subcarrier at which there is a modulation mode demanding the minimum average incremental transmit power per incremental bit to guarantee the pre-designated BER performance. The iterative procedure terminates once the transmit power threshold is reached. The results show that the proposed adaptive power distribution algorithm always outperforms the scheme of equal power distribution in a large dynamic range of transmit power threshold. The performance improvement is very large when the transmit power threshold is required to be low.

Drieberg et al (2005) have designed and addressed the problem of designing very low Peak-to-Average Power Ratio (PAPR) preamble for OFDM systems. It makes equalization simple and effective. However, accurate channel estimates are necessary at the receiver for the optimum operation of OFDM systems. Channel estimation usually employs some form of training signal, also known as the preamble, in the front of the packet. It is desirable to have a preamble signal with the lowest PAPR so that the estimation Signal to Noise Ratio (SNR) can be maximized. The initial preamble is designed using Generalized Chirp Like (GCL) sequences. In order to obtain the lowest PAPR, the preamble is optimized using constrained nonlinear optimization technique. The results show that the proposed preamble has a PAPR of just 0.871 dB that translates into a gain of 2.129 dB when compared to the prescribed preamble of IEEE 802.16a standard that has a PAPR of 3 dB.

Wyglinski et al (2005) have proposed a discrete adaptive bit loading algorithms for multicarrier systems with uniform power allocation operating in a frequency selective fading environment. The algorithms try to
maximize the overall throughput of the system while guaranteeing that the mean BER remains below a prescribed threshold. The results of proposed algorithms have approximately the same throughput and mean BER as the optimal allocation while having a significantly lower computational complexity relative to other algorithms.

Lim et al (2005) have proposed the novel OFDM transmission scheme that can effectively overcome Inter Symbol Interference by adjusting Cyclic Prefix length. The combating Inter Symbol Interference caused by multipath delay which is longer than the guard interval, interference canceller or powerful channel coding has been proposed. Such approaches may reduce ISI, but it needs much complex computation or considerably decreases transmission efficiency to completely eliminate Inter Symbol Interference. In authors’ proposed scheme, Cyclic Prefix length can be adaptively controlled by simply adjusting sampling rate. Hence it does neither much increase receiver complexity nor decrease effective data rate, compared to the conventional schemes. The results show that by employing the proposed OFDM transmission scheme, Inter Symbol Interference can be effectively avoided in mobile environment with various multipath delays.

Park and Im (2004) have proposed a new method to eliminate Intersymbol Interference (ISI) and ICI for discrete multitone/orthogonal frequency division multiplexing (DMT/OFDM) systems with insufficient Cyclic Prefix (CP). The proposed structure prevents ICI with a preprocessing method that utilizes redundancy in the frequency domain at the transmitter and removes ISI with a simple cancellation method at the receiver. The results show that the proposed method can reduce computational complexity, while providing the same spectral efficiency as the frequency-domain equalizer, which utilizes redundancy in the frequency domain at the receiver, in the presence of additive white Gaussian noise.
Toeltsch and Molisch (2000) have proposed a technique in computationally efficient OFDM transmission. The ISI due to time dispersion of the channel is combated by ISI cancellation. The authors preferred “Operator Perturbation Technique” (OPT) for ICI cancellation. This technique reduces the error floor to zero for frequency-selective channels.

Cai et al (2003) have proposed a technique based on the autocorrelation function, to estimate the Doppler spread in Rayleigh fading channels for mobile OFDM systems. It is implemented with the cyclic structure of OFDM symbols, and any other additive data and pilots need not to be inserted into the common OFDM symbols. This algorithm can be applied directly to the OFDM system with Transmit Diversity (TD) and to MIMO OFDM systems.

Wang et al (2006) have demonstrated the performance of OFDM signals in mobile radio applications, such as 802.11a and Digital Video Broadcasting (DVB) systems. The time variations of the channel during one OFDM symbol interval destroy the orthogonality of the different subcarriers and generate power leakage among the subcarriers, known as ICI. They considered the evaluation of the error probability of an OFDM system transmitting over channels which is characterized by frequency selectivity and Rayleigh fading. For conventional modulation methods such as Phase-Shift Keying (PSK) and Quadrature-Amplitude Modulation (QAM), the bivariate probability density function of the ICI is shown to be a weighted Gaussian mixture. The large computational complexity involved in using the weighted Gaussian mixture pdf to evaluate the error probability serves as the motivation for developing a two-dimensional Gram-Charlier representation for the bivariate pdf of the ICI. The proposed technique was demonstrated that it is truncated version of order 4 or 6 which provides a very good
approximation in the evaluation of the error probability for PSK and QAM in the presence of ICI.

Speth et al (1999) have presented a paper on the inner OFDM receiver and their functions necessary to demodulate the received signal and to deliver soft information to the outer receiver for decoding. The effects of relevant non ideal transmission conditions are thoroughly analyzed: imperfect channel estimation, symbol frame offset, carrier and sampling clock frequency offset, time-selective fading, and critical analog components. Through an appropriate optimization criterion (signal-to-noise ratio loss), minimum requirements on each receiver synchronization function are systematically derived. An equivalent signal model encompassing the effects of all relevant imperfections is then formulated in a generalized framework.

Das et al (2005) have proposed a novel multi rate OFDM system. It is mainly suited to inter carrier interference limited situations, when a large number of sub carriers are used within the available bandwidth constraint. It alters the uniform performance of the sub carriers in an OFDM system by using different bandwidths for different subcarriers. This is advantageous in the situation where different users and data channels in a wireless network have different data rates and quality of service requirements. Different sub carriers with different performance figures can be mapped to the data channels with matching requirements. This scheme can enhance the conventional OFDM systems to become flexible. It is shown that, using different sub carrier bandwidths can improve the throughput of some sub carriers at the cost of the others. The results show that overall system performance also improves with the proposed scheme even without any optimal mapping of data stream to the sub carriers for slightly higher frequency offsets.
Ahn (2002) have presented a paper on evaluation for the effects of various modulation scheme combinations, target BER, Doppler frequency, and various adaptation intervals as control period on the performance of adaptive OFDM and also proposed a predicted feedback information scheme which increases the adaptation interval using the predicted power estimation in order to reduce the transmission time of feedback information from receiver to transmitter. The simulation results show that the case with BPSK, QPSK and 16QAM modulation combination at target BER $10^{-2}$ achieves 2Mbit/s is improved over other combination cases in high Doppler frequency. On the other hand, at target BER $10^{-3}$, the case with BPSK, QPSK, 8PSK and 16QAM modulation combination achieves 3Mbit/s improvement when compared to the case of target BER $10^{-2}$. It is also shown that the predicted feedback information scheme effectively reduces the transmission time of feedback information from the receiver to transmitter.

Shah et al (2010) have analysed multiple effects of varying length of cyclic prefix for Additive White Gaussian Noise (AWGN) channel and with Rayleigh fading channel. In OFDM, the spectrum of the individual carriers mutually overlaps. Nevertheless, the OFDM carriers exhibit orthogonality on a symbol interval if they are spaced in frequency exactly at the reciprocal of the symbol interval, which can be accomplished by utilizing the Discrete time Fourier Transform (DFT). In the baseband, complex-valued data symbols modulate a large number of tightly grouped carrier waveforms. The transmitted OFDM signal multiplexes several low-rate data streams in which each data stream was associated with a given subcarrier.

The main advantage of this concept in a radio environment was that each of the data streams experiences an almost flat fading channel. In slowly fading channels, the ISI and ICI within an OFDM symbol can be avoided with a small loss of transmission energy using the concept of a cyclic prefix. With
the development of modern signal processing technology, OFDM has become practical to implement and has been proposed as an efficient modulation scheme for applications ranging from modems, digital audio broadcast, to next generation high speed wireless data communications. The high speed wireless LAN standard IEEE 802.11a is based on OFDM. Also OFDM is been used for WIMAX and a candidate for 4G technology. This paper is an attempt to understand multiple effects of varying length of cyclic prefix for Additive White Gaussian Noise (AWGN) channel and with Rayleigh fading channel.

Tomasin et al (2005) have designed a model called receiver scheme that iteratively cancels the ICI. In mobile reception, the reliability of OFDM is limited because of the time-varying nature of the channel. This causes ICI and increases inaccuracies in channel tracking. The design uses to maximize the signal-to-noise and ICI ratio at the detector input. The authors also proposed a new channel estimator, and it achieves reliable mobile reception in practical situations that are relevant to terrestrial Digital Video Broadcasting (DVB-T).

Hou and Chen (2005) have demonstrated an efficient ICI suppression with less noise enhancement for multicarrier equalization and was presented by using a parallel canceling scheme via frequency-domain equalization techniques, with the assumption that the Channel Impulse Response (CIR) varies linearly during a block period. In OFDM systems, time-varying multipath fading leads to the loss of subcarrier orthogonality and the occurrence of ICI. In order to avoid performance deterioration due to unreliable initial estimations in the parallel cancellation scheme, a cost function with proper weighting factor was introduced to improve the performance of the proposed equalizer. The proposed equalizer consists of a set of prefilters and a set of ICI cancellation filters, with two stages to perform
different functions to achieve Minimum Mean Square Error (MMSE) equalization. The prefilters compensate for the multiplicative distortion at the first stage, and the ICI cancellation filters removes the effects of ICI by a parallel cancellation scheme at the second stage. The proposed equalizer indicated improves the performance significantly.

Joe et al (2007) have analyzed a fixed worldwide interoperability for microwave access performance at 5.8 GHz in a sea port environment in the presence of multipath, Doppler shift, and boat's rocking. Multipath and Doppler shift measurements were carried out to understand BER results from a fixed WiMAX equipment. Percentage probability of root-mean-square delay spread from multipath measurement reached 100% within the fixed WiMAX symbol period. Doppler shift was the main factor degrading in fixed WiMAX performance. It was found that this effect can be significantly mitigated by using a directive antenna. Received signal distribution from antenna mounted on a diving boat was compared with that from antenna mounted on shore to understand the effect of boat's rocking to signal reception.

Subha and Bhaskar (2011) have presented the performance of a WiMAX system under various diversity schemes (Selection combining, Maximal ratio combining and Equal gain combining), employing different adaptive transmission policies, such as Optimal power and rate adaptation policy, optimal rate adaptation with constant transmit power policy, and channel inversion with fixed rate policy, subjected to co-channel interference. The WiMAX system incorporates OFDM with BPSK modulation as the transmission scheme and the results of the estimated spectrum efficiency shows that the implementation of Optimal power and rate adaptation policy is highly effective to combat co-channel interference in the WiMAX communication system, under Selection combining.
Rashed et al (2010) have proposed a Radio Network Planning for Fixed WiMax Network for Dhaka City. To develop the plan a cell radius of 400 meter was assumed. For the justification of this assumption the authors performed several numbers of experiments. Two experiments are executed to know the data speed with respect to the distance for both uplink and downlink communication. Another two experiments are executed for both downlink and uplink to know the most preferable WiMax frequency band for Dhaka city. The experiments were done for different types of modulation schemes. From the performance tests it was decided that the designed network will perform pretty well with the cell radius of 400 meter and at the frequency band of 2.5 GHz.

De Bruyne et al (2008) have demonstrated fixed WIMAX network in a suburban environment, which have come out with the results of extensive measurements of the network performance (i.e., throughput, latency, and jitter) of an 802.16 -based system during a field trial, investigating the influence of different base station and WiMAX modem heights. The authors’ also analyzed the correlation of these network performance characteristics with distance and CINR. These models can then be used to estimate throughput, latency, and jitter by means of CINR measurements.

Otung and Enoch (2011) have studied the cell site diversity technique in fixed WiMAX which is carried out using data collected in the United Kingdom through a dense network of rain gauges. They considered both dual- and four-site scenarios and covered radio transmissions at frequencies between 10 and 50 GHz over 5 km terrestrial links. It was found that a simple dual-site configuration that connects a subscriber station to one of two base stations separated in azimuth by 180 provides an effective mitigation against intense rain, by reducing required rain fade margins up to 40.
Pavani Sanghoi and Lavish Kansal (2012) have analysed WiMAX-MIMO systems under different modulations with different CC code rates for different fading channels (Rician and Nakagami channel). Spatial Diversity technique of MIMO system is used for the simulation purpose. SNR vs BER plots are analyzed. MIMO systems are also of major interest in the field of wireless communication as it allows data to be sent and received over different antennas. WiMAX-MIMO systems are mainly developed to increase the performance of simple WiMAX system.

Hafeth Hourani (2004) have proposed different techniques to mitigate the fading problem in wireless channel. Fading problem is a major impairment of the wireless communication channel. The trivial solution for the fading problem would be to add a fading margin at the transmitter. However, this is not an efficient solution at all. One alternate solution is to take advantage of the statistical behavior of the fading channel. Here comes the basic concept of diversity; where two or more inputs at the receiver are used to get uncorrelated signals. Diversity Combining: MRC outperforms the Selection Combining; Equal Gain Combining (EGC) performs very close to the MRC. Unlike the MRC, the estimate of the channel gain is not required in EGC. Among different combining techniques MRC has the best performance and the highest completion rate.

Rohani and Fakhraie (2008) have presented a floating-point model for OFDM part of the IEEE 802.16a standard. This part has been assigned as the mandatory structure for WiMax. Then they present a bit-true model for Viterbi decoder and encoder of it with the constraint of having less than 0.5 dB degradation in the performance of the system while minimizing the hardware cost of it. Since the most sensitive modulation in the standard is 64QAM with the rate 5/6 for convolution coding, it has been used for bit-true modeling. While all of the system blocks are floating-point, it has extracted
the BER of the ideal system under different channel noises with random binary input data and AWGN noise. They have validated this model by comparing its results with those of analytical formulas which are driven for AWGN channel noise. They have developed the bit-true model of the Viterbi block and have tuned the system to satisfy all of the standard requirements and the condition of less than 0.5 dB degradation in the performance at the worst case. This 0.5 dB condition is used in many papers as the implementation marginal value. Finally, the bit-true parameters of this experience can be used for different hardware realization structures (fixed-point or floating-point). Also samples of the input and output data of each block in the bit-true model can be used as a test bench for the same hardware structure. The final Viterbi decoder has been designed with traceback depth equal to 50 and 8 bit soft decision.

Seok-Jun Le et al (2008) have reviewed the requirements for forward error correction (FEC) decoding for next generation wireless modems-mobile Worldwide Interoperability for Microwave Access (WiMAX) and third generation partnership project long term evolution (3GPP LTE). FEC decoder consists of mainly three components: control channel decoder, data channel decoder, and Hybrid Automatic Repeat Query (HARQ) combining. Control channel decoder is constrained by latency budget which impacts buffering as well as power management of modem signal processing chains. For WiMAX, both Viterbi and Turbo decoders are required to receive control channel while for LTE, only Viterbi decoder is required. For data-channel, a high-throughput Turbo decoder is required to support high data rate. HARQ combining is mainly dominated by memory size and bandwidth requirements given the maximum data rate, maximum number of HARQ processes and re-transmission formats. They have analyzed the requirements and discussed possible candidate architectures for three components.
Madhu et al (2012) have proposed algorithm for Forward Error correcting Codes (FEC). This scheme is overhead in many wireless communication systems, even though they have enhanced data rates for the GSM Evolution (EDGE), because, worldwide interoperability for microwave access (WiMAX) and Long Term Evolution (LTE) have adopted Low-Density Parity-Check (LDPC). There are many efficient algorithms for decoding these codes. However, the different decoding approaches for these two families of codes usually lead to different hardware architectures. The belief propagation BP algorithm provides a highly effective general methodology for devising low-complexity iterative decoding algorithms for all convolutional code classes as well as turbo codes. In this paper, they have exploited the parity-check matrix (H) representation of tailbiting convolutional and turbo codes, enabling decoding through a Unified Belief Propagation (UBP) algorithm. This unified propagation and scaling algorithm reduces to a convergent alternative to loopy belief propagation when no constraints are present. While a small performance loss is observed when decoding turbo codes with BP, this is offset by the lower complexity of the BP algorithm and the inherent advantage of a unified decoding architecture.

Carsten Ball et al (2008) have analysed the performance comparison between both upcoming OFDM based mobile technologies for broadband radio access – 3GPP UTRA LTE and IEEE 802.16e. Based on link level simulation results, key performance indicators like physical layer throughput has been evaluated for different channel conditions and different Modulation and Coding Schemes (MCS). Besides SISO, both MIMO 2x2 diversity and MIMO 2x2 spatial multiplexing scenarios has been investigated showing very promising results for the downlink direction. A thorough analysis has been presented highlighting the differences of both competing technologies and their impacts on spectral efficiency and radio performance.
For this, in a first assessment, system parameters have been aligned towards equal peak throughput per MCS to show the technology specific behavior under different SNIR conditions. In a second assessment, full 3GPP and IEEE standard compliant system configurations have been ranked including for example typical layer one overhead. It has been shown that WiMAX as well as LTE proves to be state-of-the art technologies, with excellent performance but with certain advantages and disadvantages on both sides. The overall radio performance, however, is rather equal and thus clear-cut performance statements has to be based on higher layer design and even on the network level.

Hagenauer et al (1996) have proposed iterative decoding of two-dimensional systematic convolutional codes which have been termed as “turbo” (de)coding. Using log-likelihood algebra, they show that any decoder can be used which accepts soft inputs-including a priori values-and delivers soft outputs that can be split into three terms: the soft channel and a priori inputs, and the extrinsic value. The extrinsic value is used as an a priori value for the next iteration. Decoding algorithms in the log-likelihood domain are given not only for convolutional codes but also for any linear binary systematic block code. The iteration is controlled by a stop criterion derived from cross entropy, which results in a minimal number of iterations. Optimal and suboptimal decoders with reduced complexity are presented. Simulation results show that very simple component codes are sufficient, block codes are appropriate for high rates and convolutional codes for lower rates less than 2/3. Any combination of block and convolutional component codes is possible. Several interleaving techniques are described. At a bit error rate (BER) of $10^{-4}$, the performance is slightly above or around the bounds given by the cutoff rate for reasonably simple block/convolutional component codes with interleaver sizes less than 1000 and for three to six iterations.
Scott Seidel et al (1991) have presented typical and Worst-Case Root Mean Square (RMS) delay spreads and excess delay spreads (10 dB) and mean channel path loss at 900 MHz in four European cities using typical cellular and microcellular antenna locations. Several thousand power delay profile measurements were made at six typical cellular and microcellular base station locations in the four cities. The data were obtained at local worst-case time-dispersion locations over hundreds of kilometers of typical operating routes, such as highways, bridges, and city streets, and form the basis for statistical models which can be used to predict the percentage of locations or the percentage of time in which channels will possess particular values of RMS delay spread and excess delay spread. The effect of reference distance on wideband path loss and the propagation path loss laws for cellular and microcellular radio channels are studied. Radar cross sections computed from the data for typical scatterers in cellular and microcellular radio channels are also studied.

Feuerstein (1994) has presented the results of wide-band path loss and the delay spread measurements for five representative microcellular environments in the San Francisco Bay area at 1900 MHz. Measurements were made with a wide-band channel sounder using a 100-ns probing pulse. Base station antenna heights of 3.7 m, 8.5 m, and 13.3 m were tested with a mobile receiver antenna height of 1.7 m to emulate a typical microcellular scenario. The results of his work provide insights into the statistical distributions of measured path loss by showing the validity of a double regression model with a break point at a distance that has first Fresnel zone clearance for line-of-sight topographies. The variation of delay spread as a function of path loss was also investigated, and a simple exponential overbound model was developed. The path loss and delay spread models are then applied to communication system design allowing outage probabilities, based on path loss or delay spread, to be estimated.
Xia et al (1993) have analysed the radio propagation characteristics in the microcellular environments for personal communications services, and a comprehensive measurement program was conducted by Telesis Technologies Laboratory in the San Francisco Bay area using three base station antenna heights of 3.2 m, 8.7 m, and 13.4 m and two frequencies at 900 MHz and 1900 MHz. The authors’ have chosen the urban, suburban, and rural areas in order to study propagation in a variety of environments. This work reports the LOS measurements in different environments, all of which show variations of signal strength with distance that have distinct near and far regions separated by a break point. It was also found that the location of the break point for different frequencies and antenna heights can be calculated based on the first Fresnel zone clearance. The regression analysis reveals a slope that is less than two before the break point, while it is greater than two after the break point. This break distance can be used to define the size of microcell and to design for fast hand-off. Beyond the first Fresnel zone break distance, the base station antenna height gain was observed to approximately follow the square power law of antenna height.

Zhao et al (2001) have modeled a method for efficient ICI cancellation, method termed as ICI self-cancellation scheme. This method works in two very simple steps. At the transmitter side, one data symbol is modulated onto a group of adjacent subcarriers with a group of weighting coefficients. The weighting coefficients are designed so that the ICI caused by the channel frequency errors can be minimized. At the receiver side, by linearly combining the received signals on these subcarriers with proposed coefficients, the residual ICI contained in the received signals can then be further reduced. The Carrier-to-Interference power Ratio (CIR) can be increased by 15 and 30 dB when the group size is two or three, respectively, for a channel with a constant frequency offset. Although the redundant
modulation causes a reduction in bandwidth efficiency, it can be compensated, for example, by using larger signal alphabet sizes.

Tomasin et al (2005) have analyzed mobile reception, and the reliability of OFDM is limited because of the time-varying nature of the channel. This causes ICI and increases inaccuracies in channel tracking. Authors modeled the ICI using derivatives of the channel amplitude. Designed a relatively simple receiver scheme that iteratively cancels the ICI. The design of the canceller aims at maximizing the signal-to-noise-plus-ICI ratio at the detector input. They also propose a new channel estimator, and we show that it achieves reliable mobile reception in practical situations that are relevant to terrestrial Digital Video Broadcasting (DVB-T).

Chen et al (2004) have analyzed Channel variation during an OFDM block, which leads to the loss of orthogonality among subcarriers, resulting in ICI in OFDM systems. Many schemes have been proposed to suppress ICI, but they are computationally complex or at the price of sacrificing bandwidth. In some cases, such as High-Density Television (HDTV) broadcasting and satellite OFDM systems, the very long delay spreads pose the possibility that the channel length exceeds that of the moderate CP, resulting in ISI and ICI. A Time-Domain Equalizer (TEQ) is usually used in the receiver to reduce the duration of the overall response of the transmission system, and therefore minimize the ISI and ICI. However, the optimum design of TEQ turns out to be a difficult task. The ICI’s introduced by insufficient CP and channels variations are different and usually exploit different methods to mitigate them. In this paper, they have provided an ICI and ISI analysis in time-and frequency-domain for OFDM systems with insufficient CP over time-variant channels. Based on this analysis, they proposed an iterative method for joint ICI and ISI cancellation whose complexity is linear in the OFDM symbol length. Theoretical analysis
and simulation results indicate that the proposed method can effectively mitigate ICI and ISI introduced by channel variation and insufficient CP with high bandwidth efficiency.

Das et al (2006) have introduced an algorithm for implementing Variable Guard Interval (VGI) in OFDM based wireless networks. The required guard interval is derived as a function of the root mean square (rms) delay spread of the channel, time duration of discrete Fourier transform used in OFDM and the required Signal to Noise Ratio (SNR). The algorithm has been verified in a highly dynamic channel condition and results show that the algorithm can reduce guard interval significantly and is also found to be robust against time variation of rms delay spread and mean excess delay of the channel.

Wang et al (2006) have analysed the performance of OFDM signals in mobile radio applications, such as 802.11a and Digital Video Broadcasting (DVB) systems, e.g., DVB-CS2. This work considers the evaluation of the error probability of an OFDM system transmitting over channels characterized by frequency selectivity and Rayleigh fading. The time variations of the channel during one OFDM symbol interval destroy the orthogonality of the different subcarriers and generate power leakage among the subcarriers, known as ICI. For conventional modulation methods such as PSK and QAM, the bivariate probability density function (pdf) of the ICI is shown to be a weighted Gaussian mixture. The large computational complexity involved in using the weighted Gaussian mixture pdf to evaluate the error probability serves as the motivation for developing a two-dimensional Gram-Charlier representation for the bivariate pdf of the ICI. They have demonstrated that its truncated version of order 4 or 6 provides a very good approximation in the evaluation of the error probability for PSK and QAM in the presence of ICI. Based on Jakes’ model for the Doppler
effects, and an exponential multipath intensity profile, numerical results for the error probability are illustrated for several mobile speeds.

Wyglinski (2006) have evaluated a cognitive radio transceiver employing both Non-Contiguous Multicarrier Modulation (NC-MCM) and adaptive bit allocation. Although NC-MCM and bit allocation have potential benefits with respect to enabling Dynamic Spectrum Access (DSA) and increasing throughput, they also require the transmission of overhead information between the transmitter and the receiver. To reduce this overhead information, operating parameters can be assigned to a block of subcarriers, at the cost of some throughput. The trade-offs between subcarrier block size and two different bit allocation approaches for several DSA scenarios are assessed. The results show that as percentage of available spectrum decreases, the throughput loss of systems employing larger subcarrier block sizes rapidly increases.

El-Najjar et al (2008) have studied most wireless multi-hop networks, 802.16 mesh suffers from interference that decreases considerably the throughput and spatial reuse of the network. Interference in 802.16 mesh is a result of several phenomena, namely concurrent transmissions in the neighborhood and data collisions (that need to be avoided) at a receiver from transmitting nodes that are outside the range of each other (hidden terminal nodes). Authors have studied the problem of minimizing interference (MI) in 802.16 mesh centralized scheduling networks by appropriately routing end connections and assigning slots to them. The proposed model includes the effect of hidden terminal nodes as well as the interferences coming from neighboring nodes. Results show that power-aware routing and adequate frame size selection yield better network performance, which is a consequence of the improved network spatial reuse.
Joseph Wout et al (2006) have analyzed fixed wireless access systems operating below 11 GHz which have the potential to provide broadband wireless access for non line-of-sight operation. The performance of a typical broadband fixed wireless system based on the IEEE 802.16-2004 specifications is determined. A scenario for business applications with outdoor customer premises equipment is investigated in the 3.5 GHz frequency band. Different path loss models and terrain types are considered. Coverage and throughput in a sector are determined for this business scenario.

Josip Milanovic et al (2007) have analyzed the FWA networks based on WiMAX technology which provide the efficient packet radio interface enabling high data transmission rates. The accurate prediction of path losses is a crucial element in the first step of network planning with the few empirical models suitable for path loss prediction in mobile as well as fixed wireless systems like WiMAX. Experimental measurements of received power for the 3.5 GHz WiMAX system are made in urban and suburban areas of Osijek, Croatia. Measured data are compared with those obtained by four prediction models: SUI model, COST 231 Hata, Macro Model and Model 9999. Analysis is made separately for location with NLOS and LOS propagation conditions. Standard deviation of the prediction error for NLOS condition is the lowest for the SUI model. The Macro Model achieved the lowest error standard deviation for LOS propagation conditions.

Ioannis Chatzigeorgiou et al (2007) have demonstrated that turbo codes substantially outperform other codes, e.g., convolutional codes, both in the non-fading AWGN channel as well as multiple-transmit and multiple-receive antenna fading channels. Moreover, it has also been reported that turbo codes perform very well in fast fading channels, but perform somewhat poorly on slow and block fading channels of which the broadband Fixed Wireless Access (FWA) channel is an example. The authors’ have thoroughly
compared the performance of turbo-coded and convolutional-coded broadband FWA systems both with and without the antenna diversity under the condition of identical complexity for a variety of decoding algorithms. In particular, they derive mathematical expressions to characterize the complexity of turbo decoding based on the state-of-the-art Log-MAP and the Max-Log-MAP algorithms as well as convolutional decoding based on the Viterbi algorithm in terms of the number of equivalent addition operations. Simulation results show that turbo codes do not offer any performance advantage over convolutional codes in FWA systems without antenna diversity or FWA systems with a limited antenna diversity.

Sanzi et al (2003) have investigated two iterative channel estimators for mobile orthogonal-frequency division multiplexing. The first estimator is based on iterative filtering and decoding whereas the second one uses a posteriori probability (APP) algorithm. The first method consists of two cascaded one-dimensional Wiener filters, which interpolate the unknown time-varying two-dimensional frequency response in between the known pilot symbols. The performance can be increased by feeding back the likelihood values at the output of the APP-decoder to iteratively compute an improved estimate of the channel frequency response.

The second method applies two APP estimators, one for the frequency and the other one for the time direction. The two estimators are embedded in an iterative loop similar to the turbo decoding principle. This iterative estimator is superior and its performance is independent of whether the chosen time-frequency pilot grid satisfies the two-dimensional sampling theorem or not. The bit-error rate as a function of the signal-to-noise ratio is used as a performance measure. In addition, the convergence of the iterative decoding loop is studied with the extrinsic information transfer chart.
Vinit Grewal and Ajay Sharma (2012) have studied the performance of IEEE 802.16d/e based PHY layer which is investigated by implementing its two improvements: AMC and MCCDMA in both the fixed and mobile environments. The results of AMC show that the performance of WiMAX system can be optimized to a higher throughput and lower BER based on the channel conditions with lower modulation scheme for the increased range while switching to higher modulation schemes for the range closer to the base station. Further, results for mobile users show that the fading environments, as well as mobile environments severely degrade the performance of the system. The proposed combination of OFDM and CDMA, MC-CDMA, has provided a better BER performance, high bandwidth efficiency and higher throughput in fading environments encountered by mobile users. The BER performance of WiMAX OFDM based PHY layer is hence improved with MCCDMA in PHY layer.

Wasan Saad et al (2012) have studied the mobile WiMAX system which is based on the IEEE 802.16m standard and is used to develop an advanced air interface (AAI) to meet the requirements for IMT-Advanced next generation networks. They are able to provide high speed access and are used to provide a rate of broadband data for low mobility scenarios up to 1 Gbit/sec. This investigates the application of link adaptation techniques (AM and AMC) to the downlink for the IEEE 802.16m-depending on the mobile WiMAX networks to achieve spectral efficiency gain.

Also, by use of link adaptation it is possible to combine the MIMO technique with link adaptation in order to maximize the throughput. The work of authors’ considers six various MCS for link adaptation in order to find the largest throughput improvement. The working thresholds of the SNR for the various combinations of modulation, coding and MIMO will be determined through utilizing the ITU pedestrian channel model. Therefore, through
employing a system level simulation, the performance evaluation results explain that the adaptive modulation and coding system is noticeably superior compared to the systems that utilize Fixed Modulation (FM) or Adaptive Modulation (AM) schemes with regard to the spectral efficiency.

Based on the literatures available, it is clear that the mostly flat terrain with light tree densities (Terrain C) and Hilly terrain with light tree density or flat terrain with moderate to heavy tree density (Terrain B) have required suitable modulation technique with cyclic prefix and proper encoding to transmit the information in the fading channel with minimum degradation.